Appointment

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 12/2/2016 2:19:19 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Orlin, David [Orlin.David@epa.gov]; Silverman, Steven [silverman.steven@epa.gov]; Yoon, Rebecca (NHTSA) [rebecca.yoon@dot.gov]

Subject: Petition for Harmonization & Tier 3 Fuel
Location: Jim's Office and Conference Call

Start: 12/2/2016 8:30:00 PM
End: 12/2/2016 9:30:00 PM
Show Time As: Busy

Recurrence: (none)

Conference call number:
Ph 866-299-3188
Code Conference Line/Code / Ex. 6
The meeting may be less than 1 hour.

Appointment

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 11/23/2016 4:34:22 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Matthew Rudnick [matthew.rudnick@gm.com]; barbara.kiss@gm.com; Barba, Daniel [barba.daniel@epa.gov]; Charmley, William [charmley.william@epa.gov]; Moran, Robin [moran.robin@epa.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Kargul, John [kargul.john@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]; McDonald, Joseph [McDonald.Joseph@epa.gov]
CC: Maurice.Hicks@dot.gov; Warren Bogard [Dan.Bogard@dot.gov]; Thomas.Kang@dot.gov; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]

Subject: Meeting with GM regarding MTE
Location: Meeting will be in C35

Start: 12/1/2016 2:00:00 PM
End: 12/1/2016 4:00:00 PM
Show Time As: Busy

Call-in: 1-866-299-3188

Conference Line/Code / Ex. 6

Appointment

From: Dunham, Sarah [Dunham.Sarah@epa.gov]
Sent: 10/18/2017 3:40:09 PM
To: Dunham, Sarah [Dunham.Sarah@epa.gov]; Lewis, Josh [Lewis.Josh@epa.gov]; Gunasekara, Mandy [Gunasekara.Mandy@epa.gov]; Dominguez, Alexander [dominguez.alexander@epa.gov]; Harlow, David [harlow.david@epa.gov]; Dravis, Samantha [dravis.samantha@epa.gov]; Bolen, Brittany [bolen.brittany@epa.gov]; Baptist, Erik [baptist.erik@epa.gov]; Orlin, David [Orlin.David@epa.gov]; Kataoka, Mark [Kataoka.Mark@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]; Grundler, Christopher [grundler.christopher@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Simon, Karl [Simon.Karl@epa.gov]; Charmley, William [charmley.william@epa.gov]
CC: Nassar, Jimmi (NHTSA) [jimmi.nassar@dot.gov]; Douglas, Dana (NHTSA) [Dana.Douglas@dot.gov]; Jim Tamm [james.tamm@dot.gov]; heidi.king@dot.gov; Schwab, Justin [Schwab.Justin@epa.gov]; Ryan Hagen [ryan.hagen@dot.gov]; timothy.mullins@dot.gov; Steve.Wood@dot.gov; Catanzaro, Michael J. EOP/WHO [EOP Email / Ex. 6]; Szabo, Aaron L. EOP/OMB [EOP Email / Ex. 6]; Cook, Leila [cook.leila@epa.gov]

Subject: NHTSA/EPA Vehicles Discussion
Attachments: Draft v1 - Agenda for October 25 2017 NHTSA-EPA Meeting_1.docx
Location: WJC-N 5415 + Video with AA + [Conference Line/Code / Ex. 6]

Start: 10/25/2017 8:30:00 PM
End: 10/25/2017 10:00:00 PM
Show Time As: Busy

To: Dunham, Sarah; Lewis, Josh; Gunasekara, Mandy; Dominguez, Alex; Harlow, David; Dravis, Samantha; Bolen, Brittany; Baptist, Erik; Orlin, David; Kataoka, Mark; Hengst, Ben; Grundler, Chris; Moran, Robin; Olechiw, Mike; Simon, Karl; Charmley, Bill

Draft v1 - Agenda for October 25 2...

Appointment

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 9/21/2017 8:49:59 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Kargul, John [kargul.john@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Fernandez, Antonio [fernandez.antonio@epa.gov]; Lieske, Christopher [lieske.christopher@epa.gov]; Wysor, Tad [Wysor.Tad@epa.gov]; McDonald, Joseph [mcdonald.joseph@epa.gov]; Bohac, Stani [bohac.stani@epa.gov]; Safoutin, Mike [safoutin.mike@epa.gov]; Erika Nielsen [enielsen@borgwarner.com]; Jim Tamm [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Mikkelsen, Brandon [Mikkelsen.Brandon@epa.gov]
CC: Pak, Gloria@ARB [Gloria.Pak@arb.ca.gov]; Mader, Pippin@ARB [pippin.mader@arb.ca.gov]; Shobna Sahni [ssahni@arb.ca.gov]; Neam, Anthony [Neam.Anthony@epa.gov]; Lee, Soduk [Lee.Soduk@epa.gov]

Subject: Meeting with Borg-Warner re MTE and Off-cycle Program
Attachments: Meeting with Borg-Warner re MTE and Off-cycle Program; BW_'17 Ride n Drive Meeting Invite_9.21.17-V2.pdf
Location: Borg Warner Facility - Auburn Hills, MI

Start: 9/26/2017 6:00:00 PM
End: 9/26/2017 9:00:00 PM
Show Time As: Busy

BorgWarner
3800 Automation Ave.
Auburn Hills, MI 48326

Tel: +1-248-754-0422
Cell: +1 248-877-7346
enielsen@borgwarner.com

Meeting extended 1 hour to allow for facility tour.

BorgWarner Propulsions Systems Stakeholders Meeting and Ride-n-Drive – September 26,2017

Please forward the invite attached as you see fit to various the agency contacts you would like to attend.

Webcast Link
(See link below as some computers could have issues using link from the PDF)

ATTENDEE INFORMATION

PARTICIPANTS WILL USE THIS LINK TO REGISTER AND JOIN THE LIVE EVENT. THIS LINK BECOMES THE ARCHIVE (RECORDING LINK) AFTER THE EVENT.
This link gives participants access to the live and/or archived event.

https://engage.vevent.com/rt/borgwarner~092617

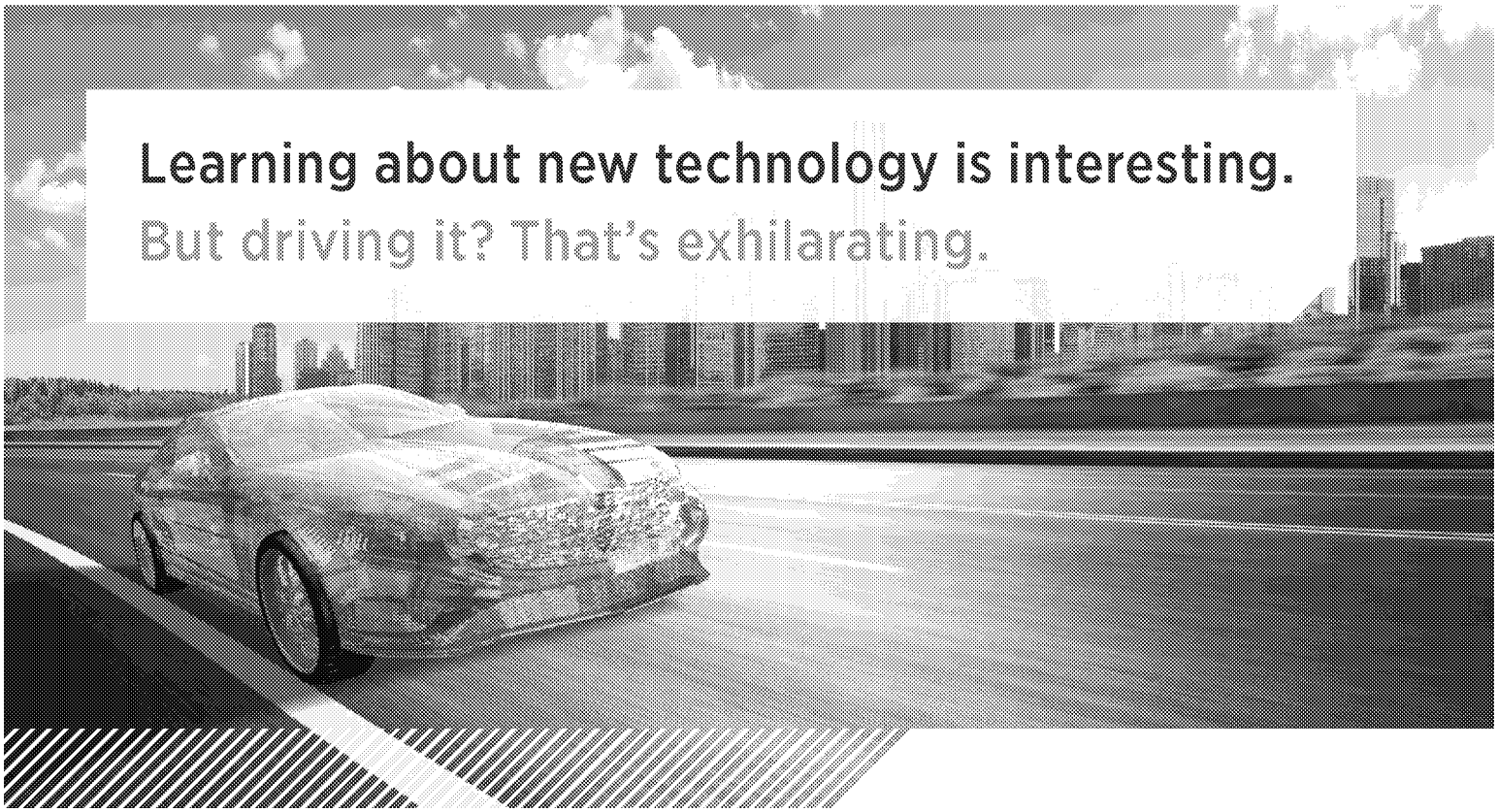
Please note that for optimal viewing, it is best not to use VPN, but instead to connect directly to the Internet.
Please disable your pop-up blockers in order to view the content in its entirety.

This event is being streamed. It is recommended that you listen via your computer speakers. Additional options for audio listening:
Toll-Free Attendee Dial In: 833-812-9297
Conference ID: 86574701

Please test your connection prior to joining to ensure a successful user experience.

Connection Test: Click Here

For system requirements, visit our FAQ



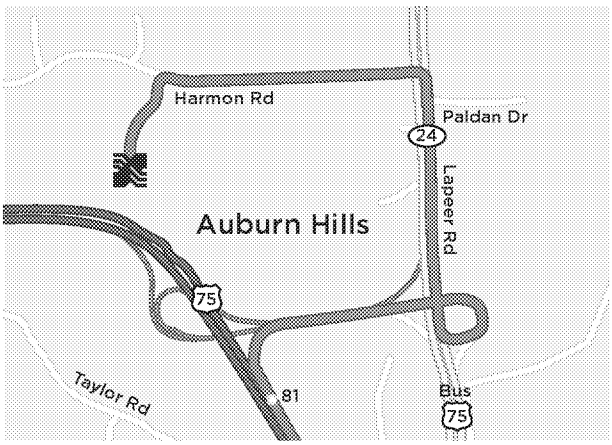
BorgWarner Propulsion System Stakeholders Meeting & Ride-n-Drive – September 26, 2017

BorgWarner invites you to get behind the wheel of the future. Join us and other select invitees from the EPA, DOT, ARB and DOE to learn about—and experience—the innovative propulsion technologies designed to meet the fuel economy/CO_2 and emissions standards of tomorrow. Following a tour of our Auburn Hills Technical Center and a presentation covering the latest propulsion technologies, you'll also have the chance to test drive some of BorgWarner's newest innovations. Unable to join us in person? Take part in the excitement via live webcast. Don't miss this chance to discuss the propulsion systems of Tomorrow!

BorgWarner Auburn Hills Technical Center
3800 Automation Avenue
Auburn Hills, MI 48326
Contact: Erika Nielsen
Director, Global Government Affairs
(248) 877-7346

- Take I-75 to Lapeer
- Go North on Lapeer about ¾ mile to Harmon Road
- Turn left (West) and go approximately ¾ mile
- Turn left onto Automation Avenue
- Building is at the end of street

Please park in the coned off area at the front of our lot



Agenda

1:15 – 2:00	Pre-meeting tour of BW facility
2:00 – 2:15	Introductions and opening remarks (BW and agencies)
2:15 – 2:30	MTE State of Play – EPA FR Notice, NHTSA Scoping Notice (EPA, NHTSA and CARB)
2:30 – 4:00	BorgWarner presentation on propulsion mix needed to meet the 2025 standards
4:00 – 4:15	Wrap-up, next steps
4:15 – 5:00	"Ride-n-Drive"

Webcast Information

Participants will use this link to register and join the live event. This link also becomes the archive (recording link) after the event.

https://engage.vevent.com/rt/borgwarner~092617

Please note that for optimal viewing it is best not to use VPN, but instead to connect directly to the internet. Please disable your pop-up blockers in order to view the content in its entirety.

This event is being streamed. It is recommended that you listen via your computer speakers. Additional options for audio listening:

Toll-Free Attendee Dial In: 833-812-9297
Conference ID: 86574701

Please test your connection prior to joining to ensure a successful user experience.

Connection Test: Click Here

For system requirements, visit our FAQ

Potential demo cars available to see or drive in Auburn Hills:

- **Jaguar F-Pace** – Combustion category – Production – Features BW EGR coolers, turbocharger, timing drives, phasers, transfer case
- **Chevrolet Impala or Malibu** – Combustion category – Production – Features BW stop/start solenoid accumulator system
- **Ford 150** – Hybrid Category P0- Demonstrator - Features BW eBooster® electrically driven compressor and BAS
- **Audi A3 eTron** – Hybrid Category P2– Production- Features BW clutch plates for hybrid module
- **Ford F150** – Hybrid Category P3 - Demonstrator- Features BW P3 electrified transfer case
- **Chevrolet Volt** – Hybrid Category P5 – Production-Features BW Transmission chain and MDA solenoids
- **BW Intern Buggy** – Electric Category-Demonstrator – Features BW electric motor HVH120, power electronics, chain
- **Tesla Model X/BMW i3** - Electric Category-Production- Evaluation vehicle

BorgWarner

Appointment

From: Moran, Robin [moran.robin@epa.gov]
Sent: 9/20/2017 7:30:05 PM
To: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]; Neam, Anthony [Neam.Anthony@epa.gov]; French, Roberts [french.roberts@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Lieske, Christopher [lieske.christopher@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Hula, Aaron [Hula.Aaron@epa.gov]; Barba, Daniel [barba.daniel@epa.gov]; McDonald, Joseph [mcdonald.joseph@epa.gov]; Newman, Kevin [newman.kevin@epa.gov]; Kargul, John [kargul.john@epa.gov]; Mikkelsen, Brandon [Mikkelsen.Brandon@epa.gov]; mike mccarthy [michael.mccarthy@arb.ca.gov]; Mader, Pippin@ARB [pmader@arb.ca.gov]; Jim Tamm [james.tamm@dot.gov]; kevin.green@dot.gov [Kevin.Green@dot.gov]; Julia Rege [jrege@globalautomakers.org]; Chris Nevers [CNevers@autoalliance.org]; Michael Hartrick [MHartrick@autoalliance.org]; Charmley, William [charmley.william@epa.gov]; Caffrey, Cheryl [caffrey.cheryl@epa.gov]; Amandine Muskus (amuskus@globalautomakers.org) [amuskus@globalautomakers.org]; Ellies, Ben [ellies.ben@epa.gov]; AA-Room-Office-C147-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C147-ConfRoom@epa.gov]; AA-Room-Office-C159-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C159-ConfRoom-AA-OTAQ-OFFICE@epa.gov]; AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N125-ConfRoom@epa.gov]; AA-Room-Office-N170-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N170-ConfRoom@epa.gov]; AA-Room-Office-N62-ASDCDConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N62-ASDCDConfRoom@epa.gov]; AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N66-ConfRoom@epa.gov]; AA-Room-Office-N95-ConfRoom-AAOTAQ-Office [AA-Room-Office-N95-ConfRoom-AAOTAQ-Office@epa.gov]; AA-Room-Office-S00-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S00-ConfRoom@epa.gov]; AA-Room-Office-S109-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S109-ConfRoom@epa.gov]; AA-Room-Office-S32-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S32-ConfRoom@epa.gov]
CC: Mader, Pippin@ARB [pippin.mader@arb.ca.gov]

Subject: Alliance/Global Automakers meeting to present Novation Analytics studies
Attachments: 20170921 EPA-Alliance meeting on Novation studies_Final.pptx
Location: Call-in Conference Line/Code / Ex. 6 AA-Room-Office-C126-ConfRoom/AA-OTAQ-OFFICE

Start: 9/21/2017 5:00:00 PM
End: 9/21/2017 7:30:00 PM
Show Time As: Busy

The EPA presentation is attached.

Note that the agenda has changed slightly per the Alliance's request. The Alliance indicated that the Novation briefing will not discuss the "baseline study" during this meeting, and will focus on the ALPHA to LPM step of the modeling process.

Agenda

1. Novation Analytics Briefing
2. Summary Thoughts on MTE Modeling from Trade Associations
3. EPA Presentation: Powertrain efficiency in EPA's technical assessment to-date, and plans for ongoing updates
4. Discussion

Call-in: Conference Line/Code / Ex. 6

WebEx connection : http://epawebconferencing.acms.com/mte-stakeholder/

Meeting with Alliance/Global Automakers

Powertrain efficiency in EPA's technical assessment to-date, and plans for ongoing updates

September 21, 2017
Office of Transportation and Air Quality
National Vehicle and Fuel Emissions Laboratory

High-level Summary of Alliance comments based on Novation Analytics review of 2016 EPA powertrain modeling

Alliance comment 1

LPM does not account for engine operating load over the test cycles, and therefore incorrectly projects technology effectiveness when operating loads differ from the exemplar vehicles'

Alliance comment 2

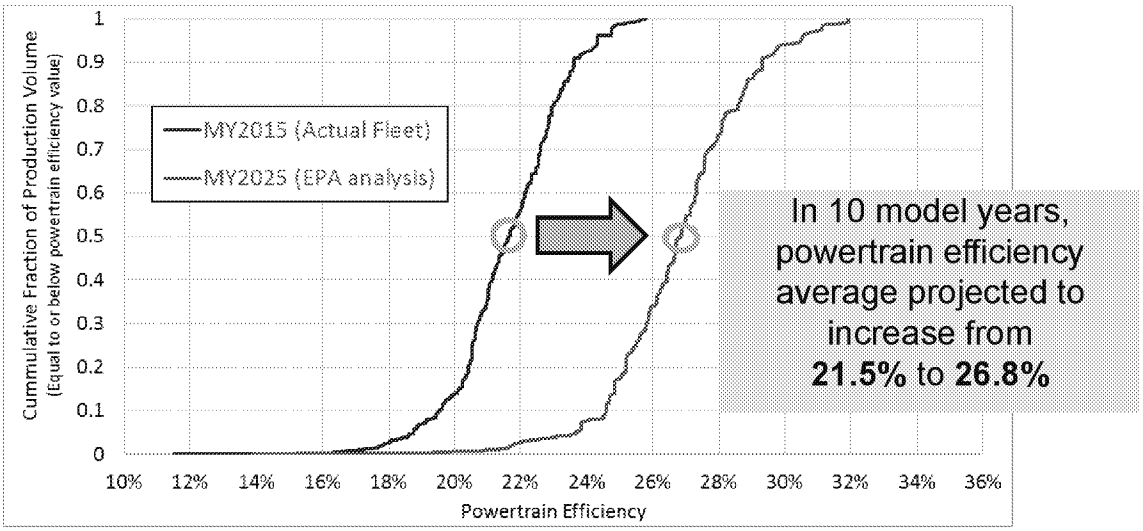
LPM outputs should be screened using energy efficiency metrics

Alliance comment 3

Recent rate of powertrain efficiency improvement is not sufficient to meet MY2025 GHG standards

Review of EPA's 2016 PD Results using Powertrain Efficiency Metrics

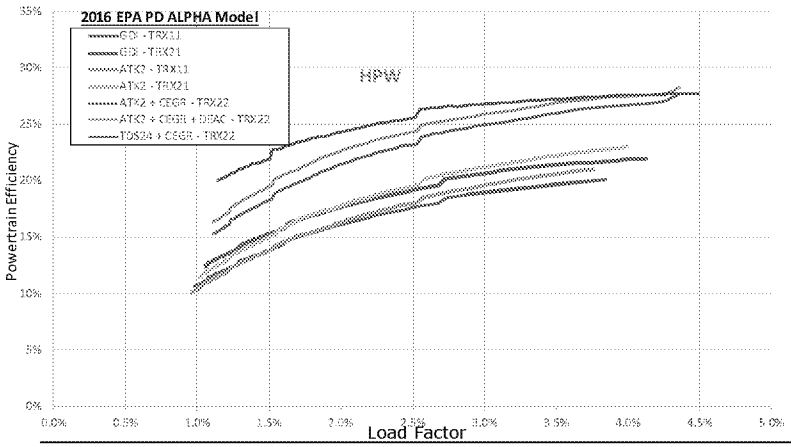
2016 EPA Proposed Determination: Baseline vs. Future Gasoline Powertrain Efficiency



In 10 model years, powertrain efficiency average projected to increase from **21.5%** to **26.8%**

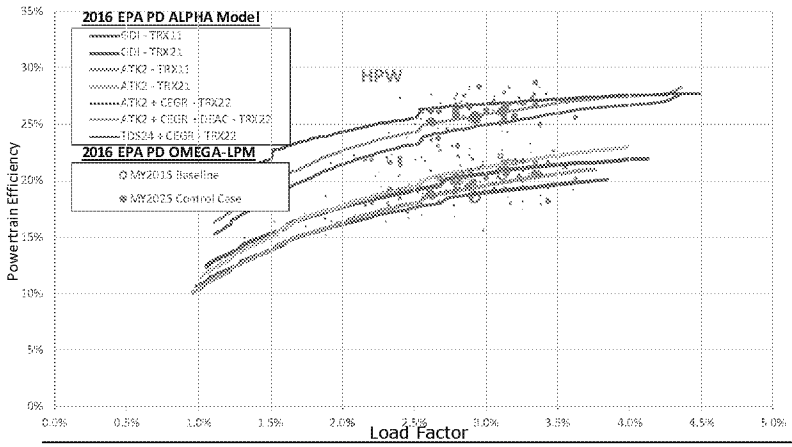
2016 EPA Proposed Determination: Accounting for Operating Load in ALPHA and LPM

- ALPHA model results project lower powertrain efficiencies as the ratio of operating load to engine power decreases



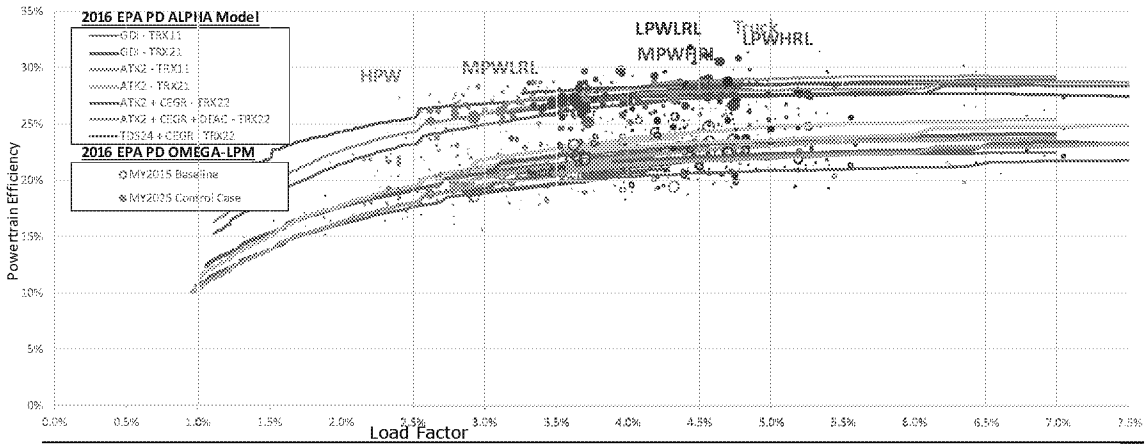
2016 EPA Proposed Determination: Accounting for Operating Load in ALPHA and LPM

- ALPHA model results project lower powertrain efficiencies as the ratio of operating load to engine power decreases
- OMEGA-LPM effectiveness values for MY2025 packages are generally within the bounds of powertrain efficiencies modeled in ALPHA
  - Small proportion of vehicles exceed ALPHA modeled powertrain efficiencies due to baseline technology characterization and road load coefficients and emissions values reported by certification test group.



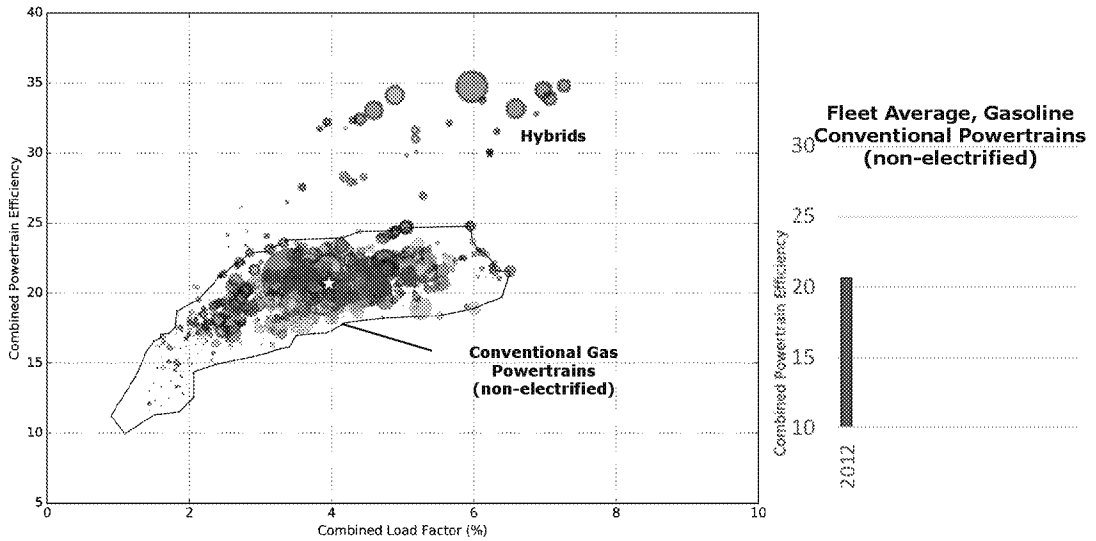
2016 EPA Proposed Determination: Accounting for Operating Load in ALPHA and LPM

- ALPHA model results project lower powertrain efficiencies as the ratio of operating load to engine power decreases
- OMEGA-LPM effectiveness values for MY2025 packages are generally within the bounds of powertrain efficiencies modeled in ALPHA
  - Small proportion of vehicles exceed ALPHA modeled powertrain efficiencies due to baseline technology characterization and road load coefficients and emissions values reported by certification test group.
- The same findings apply across all six ALPHA classes

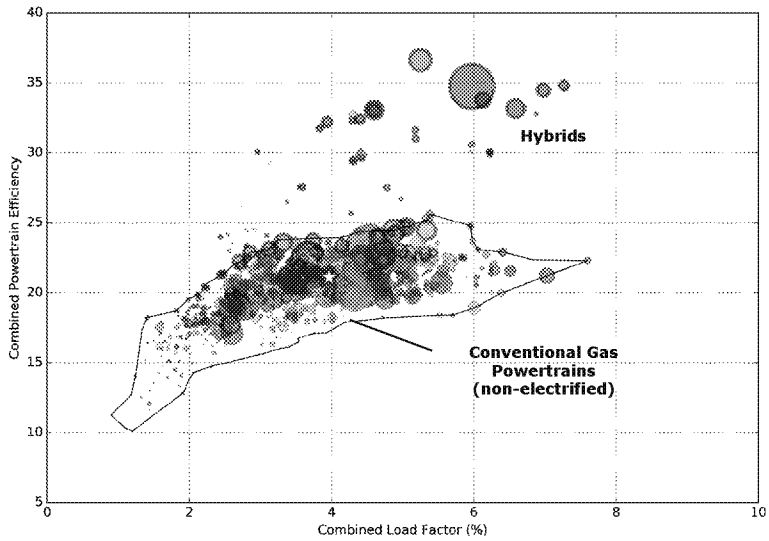


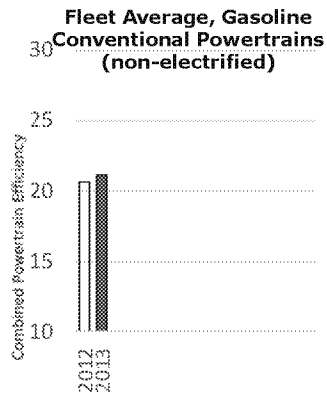
Fleet Powertrain Efficiency 2012-2016

Distribution of Fleet Powertrain Efficiencies MY2012

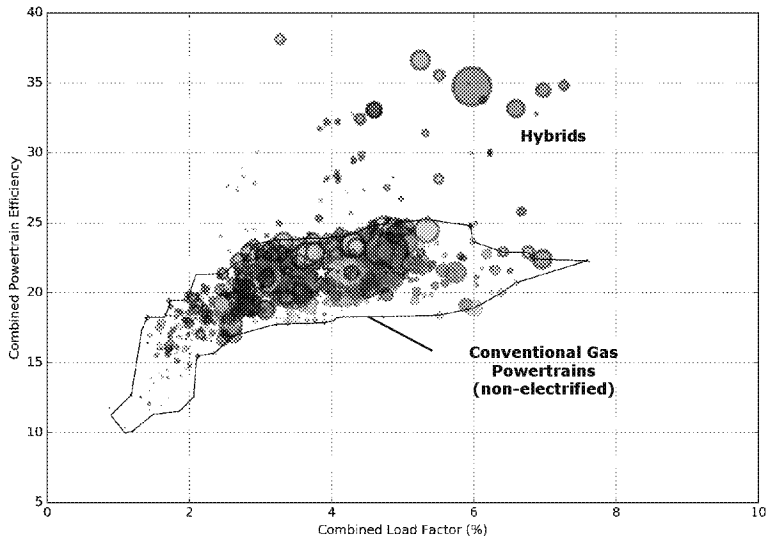


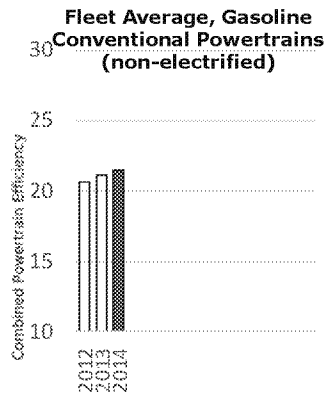
Distribution of Fleet Powertrain Efficiencies MY2013



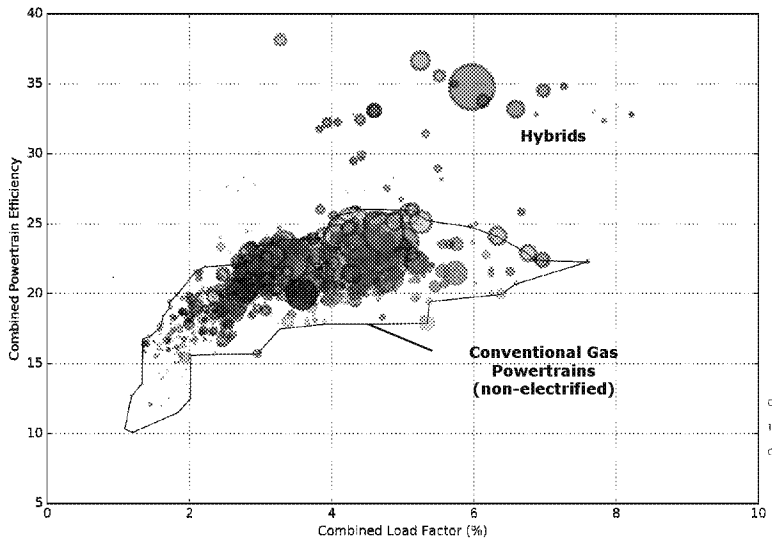


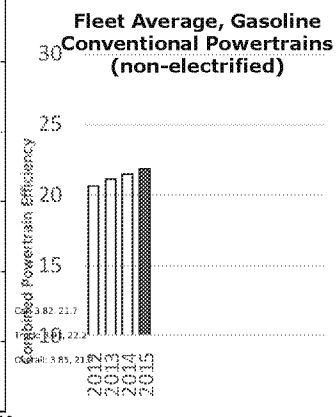
Distribution of Fleet Powertrain Efficiencies MY2014



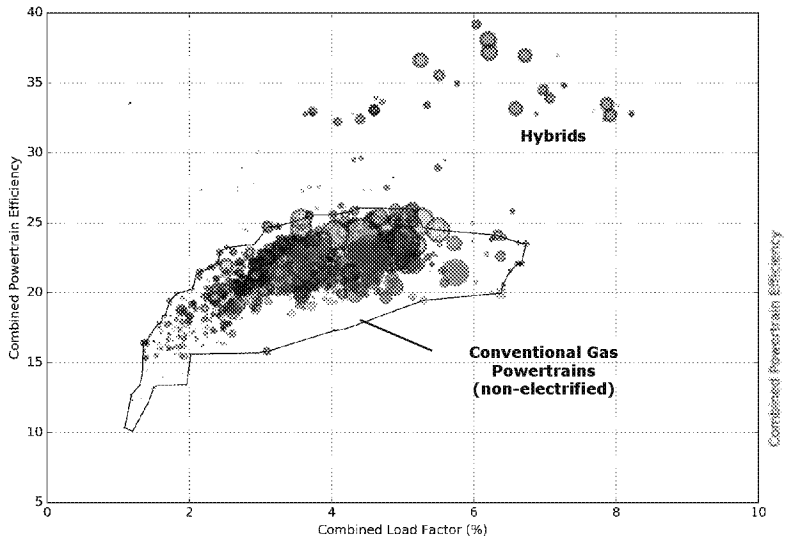


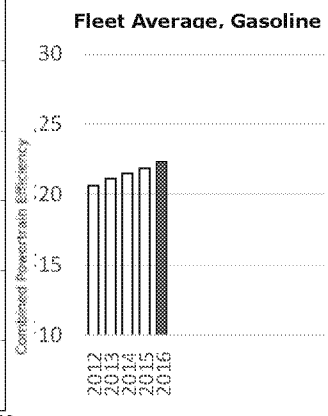
Distribution of Fleet Powertrain Efficiencies MY2015





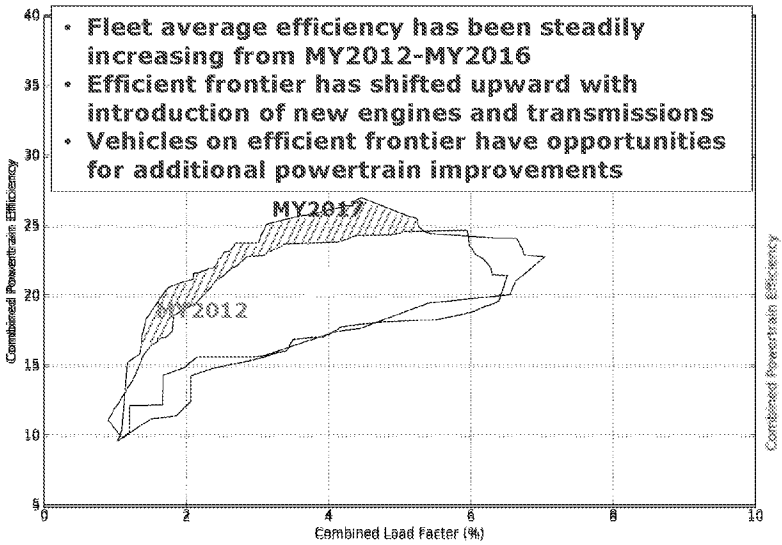
Distribution of Fleet Powertrain Efficiencies MY2016

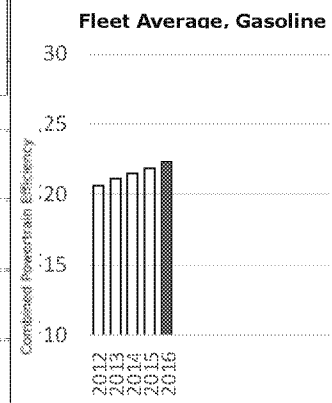




Rate of Improvement in Fleet Powertrain Efficiencies MYs 2012 - 2016

- Fleet average efficiency has been steadily increasing from MY2012-MY2016
- Efficient frontier has shifted upward with introduction of new engines and transmissions
- Vehicles on efficient frontier have opportunities for additional powertrain improvements





Current Work on Incorporating ALPHA results into OMEGA

Ongoing MTE updates to EPA's Modeling Process for Technology Effectiveness

- **Stakeholders submitted comments for the Draft TAR and PD on the Lumped Parameter Model (LPM), including:**
  - Lack of transparency in the calibration of the LPM
  - Recommendation to incorporate ALPHA results more directly into OMEGA
- **EPA has initiated the peer review process of a revised methodology for integrating ALPHA modeling results into the OMEGA fleet compliance model**
  - Ongoing expansion of technology library and computational improvements enable direct ALPHA simulation for each of the ~1300 vehicles in the baseline fleet
  - Computational improvements allow full factorial modeling of future technology combinations
  - Full factorial modeling allows an automatic calibration of response surface equations for multiple future technology combinations, where the underlying data are directly tied to outputs from ALPHA full vehicle modeling.
- **The revised fleet compliance modeling methodology would be substantially similar to the previous methodology, but with a set of auto-calibrated response surface equations taking the place of the LPM.**

Appointment

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 8/21/2017 5:39:08 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; barbara.kiss@gm.com; Matthew Rudnick [matthew.rudnick@gm.com]; Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Kargul, John [kargul.john@epa.gov]; Mikkelsen, Brandon [Mikkelsen.Brandon@epa.gov]; Newman, Kevin [Newman.Kevin@epa.gov]; Jim Tamm [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Caffrey, Cheryl [caffrey.cheryl@epa.gov]
CC: Larry D. Laws [larry.d.laws@gm.com]; Nick Smith [nick.smith@gm.com]; Hebert, Annette@ARB [annette.hebert@arb.ca.gov]; Mader, Pippin@ARB [pippin.mader@arb.ca.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]

Subject: Meeting with GM regarding the MTE
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE

Start: 8/31/2017 5:00:00 PM
End: 8/31/2017 8:00:00 PM
Show Time As: Busy

http://epawebconferencing.acms.com/mte-stakeholder/

Conference Line/Code / Ex. 6

Appointment

From: Moran, Robin [moran.robin@epa.gov]
Sent: 6/6/2017 2:52:51 PM
To: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Kargul, John [kargul.john@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]; james tamm [james.tamm@dot.gov]; Kevin Green [Kevin.Green@dot.gov]; Mader, Pippin@ARB [pmader@arb.ca.gov]; Charmley, William [charmley.william@epa.gov]; Julia Rege [jrege@globalautomakers.org]; Chris Nevers [CNevers@autoalliance.org]; MHartrick@autoalliance.org; McDonald, Joseph [McDonald.Joseph@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Amandine Muskus (amuskus@globalautomakers.org) [amuskus@globalautomakers.org]; Helfand, Gloria [helfand.gloria@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; AA-Room-Office-C126-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C126-ConfRoom@epa.gov]; AA-Room-Office-C147-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C147-ConfRoom@epa.gov]; AA-Room-Office-C159-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C159-ConfRoom-AA-OTAQ-OFFICE@epa.gov]; AA-Room-Office-C34-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-C34-ConfRoom@epa.gov]; AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N125-ConfRoom@epa.gov]; AA-Room-Office-N170-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N170-ConfRoom@epa.gov]; AA-Room-Office-N62-ASDCDConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N62-ASDCDConfRoom@epa.gov]; AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-N66-ConfRoom@epa.gov]; AA-Room-Office-N95-ConfRoom-AAOTAQ-Office [AA-Room-Office-N95-ConfRoom-AAOTAQ-Office@epa.gov]; AA-Room-Office-S00-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S00-ConfRoom@epa.gov]; AA-Room-Office-S109-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S109-ConfRoom@epa.gov]; AA-Room-Office-S32-ConfRoom/AA-OTAQ-OFFICE [AA-Room-Office-S32-ConfRoom@epa.gov]

Subject: Alliance/Global Meeting on MTE issues
Attachments: Meeting with Alliance and Global 6_22_2017_final.pptx
Location: AA-Room-Office-C35-ConfRoom/AA-OTAQ-OFFICE <AA-Room-Office-C35-ConfRoom@epa.gov> Conference Line/Code / Ex. 6
Conference Line/Code / Ex. 6

Start: 6/22/2017 5:00:00 PM
End: 6/22/2017 7:00:00 PM
Show Time As: Busy

*** EPA Presentation Attached**

The Alliance and Global, along with member OEMs, would like to meet to discuss open issues from their past comments on the TAR/Proposed Determination. The associations will send a list of topics and specific questions about a week prior to the meeting.

NHTSA and CARB are invited to participate. Please let me know if there are other staff you'd like added to this invite.

Conference Line/Code / Ex. 6

WebEx connection: http://epawebconferencing.acms.com/mte-stakeholder/

Meeting with the
Alliance of Automobile Manufacturers and Global Automakers

TECHNICAL UPDATE ON THE MIDTERM EVALUATION

June 22, 2017
Office of Transportation and Air Quality
National Vehicle and Fuel Emissions Laboratory

Meeting Request & Agenda

- The Alliance of Automobile Manufacturers and Global Automakers requested a meeting with the purpose of "understanding EPA's ongoing efforts and developments since January."
- The trade associations indicated they would plan to present slides on the topics below, and would like to hear updates from EPA on any ongoing work in these areas
- Suggested Agenda:

GlobalAutomakers AUTO ALLIANCE

Industry and Agencies Meeting
June 22, 2017 1:00pm -3:00pm EST

Draft Agenda

1. Welcome and Introductions / Antitrust & Confidentiality Reminder
2. Discussion Items
   - 2.1 2016 Vehicle Performance
   - 2.2 Technology Assessment
   - 2.3 ALPHA Model Discussion
   - 2.4 LPM Model Discussion
   - 2.5 OMEGA Model Discussion
   - 2.6 Evaluation of Costs
   - 2.7 Consumer Acceptance
   - 2.8 Economic Impacts
3. Close

EPA's Reconsideration of the MTE Final Determination

March 15, 2017 - EPA Administrator Pruitt and DOT Secretary Chao announced a Federal Register Notice stating that EPA will reconsider the Final Determination published in January 2017:

> *" … EPA has concluded that it is appropriate to reconsider its Final Determination in order to allow additional consultation and coordination with NHTSA in support of a national harmonized program."*

> *"In accord with the schedule set forth in EPA's regulations, the EPA intends to make a new Final Determination regarding the appropriateness of the MY 2022-2025 GHG standards no later than April 1, 2018."*

EPA's On-going Work

- In following with the Administrator's decision to reconsider the Final Determination, EPA is continuing to assess the most up-to-date information.
- The technical staff's goal is to provide the Administrator with updated technical information that can be used in the reconsideration of the Final Determination
- Updated technical information is being obtained from multiple sources, including:
  - *Stakeholder outreach*
  - *EPA-sponsored research*
  - *Technical conference participation*
  - *Reviews of the literature and other published reports*
  - *Monitoring current light-duty compliance, technology trends, and market developments*

Technical Conferences from which EPA has Gathered Data/Information (since January 2017)

- Advanced Automotive Battery Conference
- Vienna Motor Symposium
- CAR Powertrain Roundtable
- Great Designs in Steel
- 2017 Low Voltage Vehicle Electrification Summit
- Society of Plastic Engineers AUTO EPCON
- Advanced Thermal Management Systems conference - ITB Group
- Detroit Advisory Panel of the Automotive/Petroleum Industry Forum
- Clemson University Global Tire Conference
- ICCT/Bipartisan Policy Center: International Competitiveness and the Auto Industry: What's the Role of Motor Vehicle Emission Standards?
- CTI Symposium - Transmissions
- Association of Environmental & Resource Economists Summer Conference
- Society for Benefit Cost Analysis
- SAE Hybrid and Electric Vehicle Technologies
- SAE Government/Industry
- SAE World Congress
- SAE High Efficiency IC Engine
- SAE Light-duty Forum
- Automotive World Fuel Economy Detroit (Megatrends)
- Global Automotive Lightweight Materials (GALM)
- University of Wisconsin Engine Research Center Symposium - Impact of Future Regulations on Engine Technology

➢ EPA has collected numerous technical papers/presentations from these conferences which we continue to review for new information

Cost Studies

FEV tear-down cost studies in process:

- Diesel
  - 8 Cylinder Gas to 6 Cylinder Diesel
  - 6 Cylinder Gas to 4 Cylinder Diesel
  - 4 Cylinder Gas to 4 Cylinder Diesel
- Turbo Downsize
  - 8 Cylinder NA to 6 Cylinder Turbo
  - 6 Cylinder NA to 4 Cylinder Turbo
  - 4 Cylinder NA to 4 Cylinder Turbo
- CVT
- High Efficiency Gearbox (HEG)
- Update of databases used to inform previous cost studies
  - e.g., material costs, labor rates, adjust to 2016$, etc.

In-depth Work Underway to Evaluate Advanced Powertrains

Vehicle benchmarking:

- 2016 Chevy Malibu w/1.5 liter GDI-turbo-charged w/6-speed AT
- 2016 Acura ILX w/dual-clutch transmission with torque converter
- 2017 Ford F150 w/10 speed AT

Engine benchmarking:

- 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 w/ CVT
- 2016 Mazda CX-9 2.5 liter GDI-turbo-charged w/ 6-speed AT
- 2018 Toyota Camry with 2.5 liter Toyota New Global Architecture (TNGA) engine

Demonstration and modeling:

- Demonstration of cooled EGR on a modified European Mazda 2.0 liter GDI naturally-aspirated 14:1 CR engine
- GTPower modeling of a 2012 PSA 1.6 liter GDI-turbo-charged engine with cooled EGR and an advanced turbo
- GTPower modeling of a 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR engine
- ALPHA model comparison of several CVTs

ALPHA modeling of all vehicles included in above component and vehicle benchmarking.

Status of Vehicle Benchmarking Work

1. **2016 Chevy Malibu w/1.5 liter GDI-turbo-charged w/ 6-speed AT**
   - Vehicle has been procured, instrumented and testing is complete
2. **2016 Acura ILX w/dual-clutch transmission with torque converter**
   - Vehicle has been procured, instrumented and initial testing is complete
3. **2017 Ford F150 w/10 speed AT**
   - Vehicle has been procured and is being prepped for testing
   - Plan to evaluate transmission shift strategy and efficiency

Status of Engine Benchmarking Work

1. **2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR w/ CVT**
   - Goal of benchmarking: Confirm Honda's publically shared efficiency map and understand the engine's technology and combustion strategy
   - Chassis testing is completed, and engine dyno mapping is nearly complete
   - Data review and engine benchmarking report are underway
   - Initial ALPHA vehicle validation of the Honda Civic is complete
   - Currently investigating various methods to conduct CVT powertrain testing
2. **2016 Mazda CX-9 2.5 liter GDI-turbo-charged w/ 6-speed AT**
   - Goal of benchmarking: Obtain engine efficiency and operational maps
   - Chassis testing completed
   - Engine installed in test cell and initial testing has begun
3. **2018 Toyota Camry with 2.5 liter Toyota New Global Architecture (TNGA) engine**
   - Goal of benchmarking: Confirm Toyota's publically shared efficiency map (for non-HEV applications) and understand the engine's technology and combustion strategy
   - Plan to procure vehicle within the next month

Status of Demonstration and Modeling Work

1. **Demonstration of cooled EGR on a modified European Mazda 2.0 liter GDI naturally-aspirated 14:1 CR engine**
   - Follows up on validation work described in SAE 2017-01-1016 and GT-Power modeling done in SAE 2016-01-0565
   - Currently investigating effects of cooling system improvements and in-cylinder motion
2. **GT-Power modeling of a 2012 PSA 1.6 liter GDI-turbo-charged engine with cooled EGR and an advanced turbo**
   - Benchmarking work completed on base engine with Tier-2 and Tier-3 fuels, and a GT-Power model constructed (Tier-2 fuel only)
   - Cool EGR and VNT turbo modeled in GT-Power
   - Currently drafting benchmarking report and reviewing GT-Power model
3. **GT-Power modeling of a 2016 Honda Civic 1.5 liter GDI-turbo-charged 10.6:1 CR engine**
   - Benchmarking almost complete (see earlier benchmarking slide)
   - GT-Power model created based on benchmarking data
   - Plan to examine the effect of adding cooled EGR, improved cooling, and improved turbos
4. **ALPHA model comparison of several CVTs**
   - Initial ALPHA vehicle validation completed on the Honda Civic equipped with a CVT
   - Benchmarking completed on Nissan Jatco CVT8 and currently drafting report
   - Comparison of available CVT data is underway

Four New EPA SAE Papers Published in 2017

Available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg

ALPHA Related SAE Journal papers:

1. **"Characterizing Factors Influencing SI Engine Transient Fuel Consumption for Vehicle Simulation in ALPHA,"** *SAE Int. J. Engines* 10(2):2017, doi:10.4271/2017-01-0533, Dekraker, P., Stuhldreher, M., Kim, Y. (SwRI).
   - *This paper addresses some of the transient engine operating conditions that must be considered to address shortfalls that can occur when simulating vehicle fuel consumption. It examines fuel adjustments for:*
     - *a) Powertrain Torque Management*
     - *b) Changes in Engine Power*
     - *c) Deceleration Fuel Cutoff (DFCO)*
     - *d) Cylinder Deactivation (CDA) Transition*

2. **"Fleet-Level Modeling of Real World Factors Influencing Greenhouse Gas Emission Simulation in ALPHA,"** *SAE Int. J. Fuels Lubr.* 10(1):2017, doi:10.4271/2017-01-0899, Dekraker, P., Kargul, J., Moskalik, A., Newman, K., Doorlag, M., Barba, D.
   - *The 1st part of the paper reviews the 3 steps EPA used to prepare for fleet modeling (benchmarking, validating ALPHA, and characterizing a core set of future powertrains)*
   - *The 2nd part of the paper shows how the above test data was generalized for use in modeling future fleets. Aspects of this generalization include engine scaling, transmission scaling, roadloads, cost-start adjustment for future vehicles, and performance neutrality.*

Four New EPA SAE Papers Published in 2017 (continued)

Available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/medium-evaluation-light-duty-vehicle-greenhouse-gas-ghg

Component Related:

3. **"Potential Fuel Economy Improvements from the Implementation of cEGR and CDA on an Atkinson Cycle Engine,"** SAE Technical Paper 2017-01-1016, 2017, doi:10.4271/2017-01-1016, Schenk, C., Dekraker, P.
   - *This paper presents testing results from implementation of cEGR and CDA hardware on an Atkinson cycle capable engine*
     - *Open ECU and cEGR hardware was installed on base engine, a production 2.0L SKYACTIV-G engine with 75 degrees of intake cam phase authority and a 14:1 geometric compression ratio, and CO2 reduction effectiveness is evaluated.*
     - *Additionally, two cylinders were deactivated to determine what CO2 benefits could be achieved.*
   - *This test cell validation follows up on benchmarking and GT-Power modeling work described in two 2016 SAE papers (SAE 2016-01-1007 and SAE 2016-01-0565).*

4. **"Modeling and Validation of 12V Lead-acid Battery for Stop-Start Technology,"** SAE Technical Paper 2017-01-1211, 2017, doi:10.4271/2017-01-1211, Lee, S., Cherry, J., Safoutin, M., McDonald, J.
   - *This paper presents the development and validation of the lead-acid battery model.*
   - *Resistances and capacitances were calculated using test data from a Duracell 92Ah lead-acid battery which is aftermarket equipment for the Chevrolet Malibu.*
   - *The lead-acid battery library in the ALPHA model was validated with data obtained from Argonne National Laboratory (ANL) from their chassis dynamometer testing of the 2010 Mazda 3 Hatchback i-Stop and 2010 VW Golf TDI Diesel Bluemotion.*
   - *The simulated battery voltages, currents, and state of charge (SOC) are in excellent agreement with the vehicle test data on a number of drive schedules.*

Consumer/Economic Issues

- Consumer Acceptance
- Affordability
- Willingness to pay for vehicle attributes
- Vehicle sales
- Employment and economy-wide impacts

Consumer Acceptance: How do consumers respond to vehicles subject to the standards?

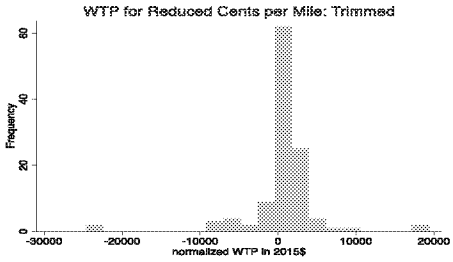
- Prior EPA studies indicate that consumers seem to be accepting of the technologies currently being used to meet the standards
- Industry comments have expressed concerns over acceptance of the future fleet related to vehicle cost increases as well as the degree of electrification required
  - More electrification means increases in vehicle cost, in addition to questions of consumer willingness to change technologies
- EPA continues to pursue access to a consumer satisfaction database to further assess consumer satisfaction, as some commenters suggested
- EPA is open to any new data/information on this issue

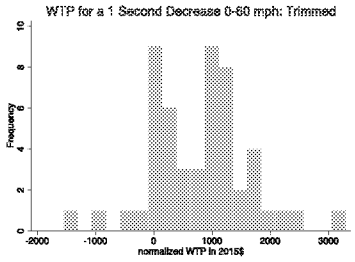
Affordability

- In comments and recent research, some key questions have arisen:
  - Are the standards regressive (i.e., putting disproportionate burden on low-income households)?
  - How will potential vehicle price increases affect consumer access to the vehicle market?
- Regressivity: 3 recent studies
  - 2 studies (Davis & Knittel; Levinson) found regressivity without accounting for fuel savings from the new technologies
  - 1 study (Greene & Welch) that accounts for fuel savings found that fuel economy improvements are progressive
- Vehicle price increases
  - Average vehicle transactions prices have increased in recent years
  - Seeking information to help identify contributors to price increases in addition to the standards (e.g. buying larger vehicles, or technologies such as safety features and connectivity that add to costs)
  - How might higher vehicle prices affect access to credit?

Willingness-to-pay for vehicle attributes

- A factor in understanding demand for vehicles includes the role of vehicle attributes in the buying decision
- EPA has been developing estimates of consumers' willingness to pay for vehicle attributes
  - See, e.g., presentation at the Society for Benefit-Cost Analysis annual meeting https://benefitcostanalysis.org/sites/default/files/public/C3.1%20Helfand%20et%20al%20WTP%20for%20vehi%20char%2020170325.pdf
  - To date, estimates for attributes show very wide ranges
  - We are trying to understand why there is so much variation





Vehicle sales

- Some auto industry comments encouraged EPA to quantify effects of the standards on vehicle sales
- The key variable appears to be the role of fuel economy in consumers' vehicle purchase decisions
  - Estimates in published literature range from significant undervaluation to overvaluation, with no clear central value
- Sales estimates are very sensitive to this assumption
  - e.g., "A Macroeconomic Study of Federal and State Automotive Regulations," Carley et al.
- How can the effects of the standards be separated from the effects of broader macroeconomic changes?

Figure 9.4a. Impact of Consumer Valuation of Fuel Savings on Car Sales by Model Year.

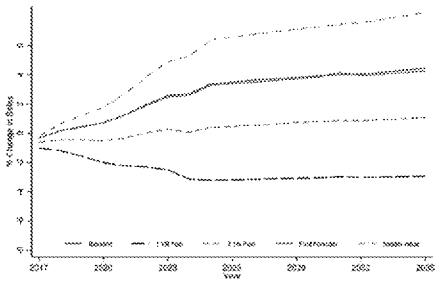
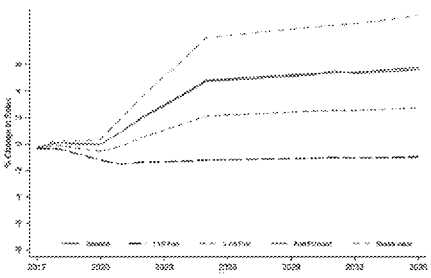


Figure 9.4b. Impact of Consumer Valuation of Fuel Savings on Truck Sales by Model Year.



Employment and Economy-wide impacts

- Several recent studies addressed employment and economy-wide impacts:
  - CAR, "The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy"
  - Indiana University: "A Macroeconomic Study of Federal and State Automotive Regulations"
  - Blue-Green Alliance, "Supplying Ingenuity II: U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technologies"
- Auto industry comments on employment analysis suggested fuller quantification
- EPA's work on employment impacts to date has focused on the auto sector
  - Broader employment effects depend on the state of the macroeconomy
- EPA is exploring the use of economy-wide models to estimate broader macroeconomic effects
  - EPA has convened a panel of experts through the Science Advisory Board on economy-wide modeling to review these models, and expects a final report later this year
  - See https://yosemite.epa.gov/sab/sabproduct.nsf/0/07E67CF77B647342852575B0004F87ED!OpenDocument

Questions/Discussion

Appointment

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 4/10/2017 3:22:20 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Homeister, Nancy (N.L.) [nhomeist@ford.com]; Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Kargul, John [kargul.john@epa.gov]; Newman, Kevin [Newman.Kevin@epa.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; McDonald, Joseph [mcdonald.joseph@epa.gov]
CC: Glodich, Jeffrey (J.M.) [jglodich@ford.com]; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]; Caffrey, Cheryl [caffrey.cheryl@epa.gov]

Subject: Meeting with Ford regarding MTE
Location: AA-Room-Office-C126-ConfRoom/AA-OTAQ-OFFICE

Start: 5/22/2017 6:00:00 PM
End: 5/22/2017 8:00:00 PM
Show Time As: Busy

http://epawebconferencing.acms.com/mte-ford/

Conference call information:

Conference Line/Code / Ex. 6

Agenda:

1. Introductions
2. Update on MTE
3. Technical Exchange
4. Next Steps

Appointment

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 4/13/2017 1:30:57 PM
To: Charmley, William [charmley.william@epa.gov]; James Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]

Subject: HD discussion
Location: I will call Jim at his desk number

Start: 4/13/2017 7:30:00 PM
End: 4/13/2017 8:00:00 PM
Show Time As: Busy

Appointment

From: Iffland, JoNell [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=269C8731E7C6417482F8A8DDCCFC4887-IFFLAND, JONELL]
Sent: 3/31/2017 1:48:28 PM
To: Charmley, William [charmley.william@epa.gov]; Helfand, Gloria [helfand.gloria@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
CC: Robin Moran [Moran.Robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Jeff Alson [Alson.Jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [huang.hsing-hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Lie, Sharyn [Lie.Sharyn@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green [Kevin.Green@dot.gov]; Ryan Keefe (ryan.keefe@dot.gov) [ryan.keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]; Hoyer, Marion [hoyer.marion@epa.gov]; Burch, Julia [Burch.Julia@epa.gov]

Subject: Meeting with John Graham Conference Line/Code / Ex. 6
Location: C126

Start: 5/17/2017 1:00:00 PM
End: 5/17/2017 4:00:00 PM
Show Time As: Busy

Message

From: Moran, Robin [moran.robin@epa.gov]
Sent: 11/15/2016 12:23:44 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]
CC: Russell.Krupen@dot.gov [russell.krupen@dot.gov]; Katz, Ken (NHTSA) [Ken.Katz@dot.gov]
Subject: RE: Draft Scoping Notice for 2022-2025 CAFE EIS

Thank you Jim, we'll start taking a look.

Best,
Robin

-----Original Message-----
From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Monday, November 14, 2016 4:00 PM
To: Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Moran, Robin <moran.robin@epa.gov>
Cc: Russell.Krupen@dot.gov; Katz, Ken (NHTSA) <Ken.Katz@dot.gov>
Subject: Draft Scoping Notice for 2022-2025 CAFE EIS

Hi Bill, Mike and Robin,

Please see the attached draft scoping notice for the MYs 2022-2025 CAFE EIS. The text parallels recent scoping notices. We welcome EPA review and request your feedback by COB Friday, November 18. Please cc: Russell Krupen and Ken Katz on your response.

Thanks in advance for your feedback.

Jim

Message

From: Yanca, Catherine [yanca.catherine@epa.gov]
Sent: 11/14/2016 10:39:59 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
Subject: RE: Draft of EPA's Proposed Determination Technical Support Document: Part 3 of 3
Attachments: Ch 99-Appendices.docx

Part 3 of 3.

From: Yanca, Catherine
Sent: Monday, November 14, 2016 5:33 PM
To: 'Tamm, James (NHTSA)' <james.tamm@dot.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Subject: Draft of EPA's Proposed Determination Technical Support Document: Part 2 of 3

Part 2 of 3.

From: Yanca, Catherine
Sent: Monday, November 14, 2016 5:30 PM
To: 'Tamm, James (NHTSA)' <james.tamm@dot.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Subject: Draft of EPA's Proposed Determination Technical Support Document: Part 1 of 3

Hi Jim,

Attached is the latest draft of the Technical Support Document for the MTE Proposed Determination. Our leadership is still reviewing the FR Notice, and we will send it as soon as we are able.

I'm sending this in three parts due to file size.

Thanks,
Cay

Catherine (Cay) A. Yanca
Assessment and Standards Division
US EPA Office of Transportation and Air Quality
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4769

Message

From: Chris Nevers [CNevers@autoalliance.org]
Sent: 12/8/2016 6:22:46 PM
To: Mccarthy, Gina [McCarthy.Gina@epa.gov]
CC: Charmley, William [charmley.william@epa.gov]; grundler.chris@epa.gov; McCabe, Janet [McCabe.Janet@epa.gov]; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; rebecca.yoon@dot.gov; Kevin.Green@dot.gov; Ryan.Harrington@dot.gov; james.tamm@dot.gov; shoshana.lew@dot.gov; Hebert, Annette@ARB [annette.hebert@arb.ca.gov]; Lieske, Christopher [lieske.christopher@epa.gov]
Subject: Request to withdraw the Proposed Determination/ extend the comment period
Attachments: Alliance FINAL P.D. Ext. Ltt. 12-08-16.pdf

Dear Administrator McCarthy,

The Alliance of Automobile Manufacturers hereby requests that the EPA withdraw its Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation. If EPA declines to grant our request for withdrawal, we respectfully request an extension of the comment period on the Proposed Determination from the current 30 days to a total of at least 120 days. The bases for these requests are set forth in the attached letter. This letter has also been submitted to the appropriate docket EPA-HQ-OAR-2015-0827.

Thank you for your prompt consideration of these important requests.

Sincerely,

Chris Nevers
Vice President, Energy and Environment
Alliance of Automobile Manufacturers
248-794-5002

AUTO ALLIANCE
DRIVING INNOVATION®

December 8, 2016

Gina McCarthy
Administrator
Environmental Protection Agency
Office of the Administrator 1101A
1200 Pennsylvania Avenue, N.W.
Washington DC 20460

Christopher Lieske
Office of Transportation and Air
Quality Assessment and Standards
Division
Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105

Submitted electronically to www.regulations.gov
Docket ID No. EPA-HQ-OAR-2015-0827

Reference: Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation

Subjects:
(1) Request for Withdrawal of the Above-Referenced Proposed Determination; or
(2) If Request (1) is Denied, Request for Extension of the Public Comment Period on the Above-Referenced Proposed Determination to 120 Days

Dear Administrator McCarthy and Mr. Lieske:

I am writing on behalf of the Alliance of Automobile Manufacturers ("Alliance"), an

association representing 12 leading manufacturers of cars and light trucks,[1] to request that EPA withdraw its Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation ("Proposed Determination")[2]. If EPA declines to grant our request for withdrawal, we respectfully request an extension of the comment period on the Proposed Determination from the current 30 days to a total of at least 120 days. The bases for these requests are set forth below.

Background: The Midterm Evaluation Rule and EPA Actions to Date

The Midterm Evaluation ("MTE") process is codified in EPA regulations at 40 C.F.R. 86.1818-12(h). This regulation provides that EPA will conduct a review of the appropriateness of the model year 2022-2025 motor vehicle greenhouse gas standards that were promulgated in 2012, based on an administrative record. The purpose of the MTE is to ensure that the assumptions underlying the model year 2022-2025 standards remain valid, taking into account various relevant factors listed in the regulation and in the preamble to the regulation. The MTE was put in place because standards for motor vehicle fuel economy and greenhouse gas emissions[3] had never before been set so far into the future.[4] The regulation put in place by EPA at 40 C.F.R. 86.1818-12(h) reflected a general consensus among the stakeholders that a checkpoint was needed to review the relevant data and ensure that the most temporally distant standards continued to make sense in light of more recent developments. This process reflected principles of good government by enabling all the parties to have a transparent assessment of how circumstances may have changed in the interim, without prejudging or predisposing any particular outcome.

As part of the 2012 joint final rule, EPA committed to publish a draft Technical Assessment Report ("TAR") no later than November 15, 2017 and to accept public comments on it. There is no date by which EPA is required to issue a Proposed Determination on the appropriateness of the model year 2022-2025 greenhouse gas ("GHG") standards, only the date by which a

[1] Alliance members are BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, and Volvo Cars USA. For additional information, please visit http://www.autoalliance.org.

[2] Even though the Alliance disagrees with EPA's assertion that the Proposed Determination is an "adjudication" and not a rulemaking, we will not debate that issue in this letter but instead will address it in our formal comments which will be submitted on or before the comment deadline.

[3] EPA's motor vehicle greenhouse gas standards are issued jointly in conjunction with closely –related motor vehicle fuel economy standards issued by the National Highway Transportation Safety Administration, under an arrangement that is often referred to as the "National Program" or "One National Program." See, e.g., "EPA and NHTSA Propose to Extend the National Program to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks," EPA-420-F-11-038, November 2011, found at https://nepis.epa.gov/Exe/ZyPDF.cgi/P100CVIJ.PDF?Dockey=P100CVIJ.PDF.

[4] The process set forth in EPA's rules was based on an attempt to balance competing goals in an effort to determine the optimal timing for a Midterm Evaluation. On one hand, it was desirable to allow for the passage of as much time as possible in order to allow for the collection of relevant data closer to the model year 2022-2025 period. On the other hand, the Midterm Evaluation had to be completed in time for EPA to promulgate new standards for the 2022 model year if necessary. The timing was designed to facilitate a thorough assessment on a complex administrative record and provide full and fair opportunity to public stakeholders to participate transparently in the process.

Final Determination must be issued. The deadline for a decision on the appropriateness of the model year 2022-2025 GHG standards is April 1, 2018. The Final Determination is final agency action that is subject to judicial review. If EPA's Final Determination is that the model year 2022-2025 GHG standards are no longer appropriate, EPA committed to undertake rulemaking to promulgate revised standards for those model years.

EPA released the draft TAR in July 2016. In spite of the fact that this timing could have allowed for a generous public comment period without endangering the regulatory deadlines for the Midterm Evaluation, EPA only allowed a 60-day period for the public to review and comment on over 1,200 pages of TAR material. EPA rejected requests from the Alliance and others to extend the comment period to 120 days, which would have been a far more appropriate interval for the development of comments given the volume of material involved, not to mention the magnitude of the standards.

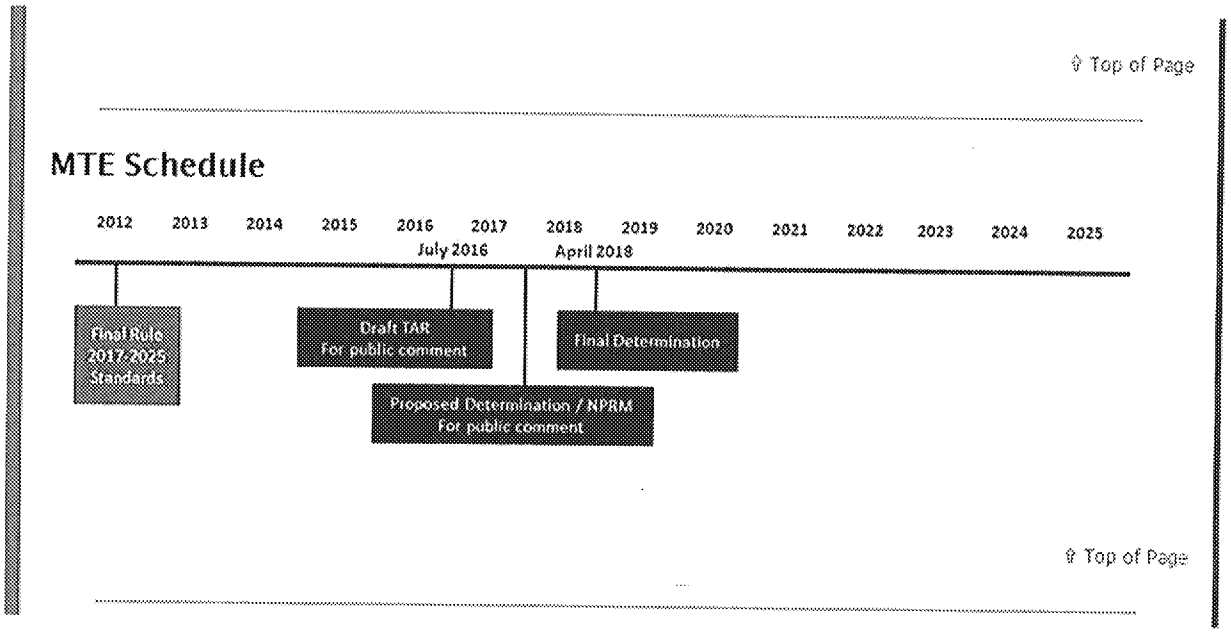
When I testified before the House Energy and Commerce Committee on September 22, 2016 concerning the MTE, I made it clear that the draft TAR comment period was inadequate and that the Alliance would need considerably more time to assess, analyze, comment and develop the administrative record.

> The Alliance believes considerably more technical work needs to be done, both in more accurately projecting the level of technology that will be required for compliance and in developing an understanding of consumer acceptance of those technologies, before the agencies move forward with either a proposed determination or NPRM. The Draft TAR largely ignores consumer acceptance (a 27-page chapter in a 1,200-page document) and contains several technical and modeling errors that lead to an overly optimistic view of both technology effectiveness and cost to manufacturers and ultimately consumers. Thus, the Alliance continues to conduct an extensive review of this vast technical report and currently expect it will be necessary to submit additional comments after the September 26th deadline. We hope the agencies will fulfill their commitment to continue to consider new data and information after the approaching deadline and, specifically, we look forward to working with the agencies to better inform the MTE by improving agency modeling efforts as well as understanding the challenges related to consumer acceptance.

Consequently, the Alliance submitted comments to the draft TAR totaling 214 pages on September 26, 2016. Keep in mind, EPA personnel made representations to the industry that there would be ample time for further information exchange and dialogue after the close of the formal TAR comment period. In her joint response (with NHTSA) to the Alliance on August 22, 2016 explaining why the request for an extension of the TAR comment period was denied, EPA Assistant Administrator Janet McCabe stated that:

> The agencies will continue to consider relevant new data and information that comes to light beyond the Draft TAR and welcome ongoing feedback as we continue to update our assessments to inform the EPA Proposed Determination and the NHTSA NPRM, and we will make every effort to also consider public comments submitted after the close of the comment period.

More specifically, EPA told the Alliance and its member companies that it planned to publish the Preliminary Determination around mid-summer of 2017, which would allow for several more months of agency/industry interaction. This was reinforced by a timeline that was published on EPA's website and reprinted below. *The timeline, under the heading of "MTE Schedule" clearly indicated that the Proposed Determination would be published sometime in the middle of 2017,* with the Final Determination coming by April 2018, consistent with the regulations and EPA's representations to Congress, the public and other stakeholders.



On November 30, 2016, EPA abruptly changed course. With no advance warning other than morning phone calls to some industry representatives, EPA removed the above timeline from its website and issued a 268-page Proposed Determination, along with a 719-page Technical Support Document. EPA further announced that there would be a 30-day period for the public to comment on the roughly one thousand pages of material it had just released. Instead of having several more months to provide information for the administrative record and engage in a collaborative dialogue with EPA prior to the issuance of a Proposed Determination, the Alliance and its members were immediately and unexpectedly faced with the task of assembling separate comments on a Proposed Determination in an unreasonably short period of time. Of course, the

lengthy documents published by EPA in support of its Proposed Determination could not have been prepared overnight; they clearly had been under development for quite some time. In the weeks and months leading up to November 30, EPA representatives had numerous opportunities to inform the industry of its plans to take this action, but instead the agency chose to make a surprise announcement to the industry and other stakeholders.

EPA's Early Action Conflicts with the Long-Standing Commitment to a Single National Program

The Alliance initially observes that this November 30 action by EPA conflicts with the agencies' commitment to a harmonized single national GHG/Fuel Economy program in which EPA and NHTSA, along with California's Air Resources Board ("ARB"), would issue their draft TAR and subsequent MTE determinations at the same time. Such an approach allows for the review and comment on one determination, which simplifies the process for all involved.

Indeed, the preamble to the 2012 GHG Final Rule stated:

> In order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022–2025 standards concurrently.[5]

Clearly, EPA and NHTSA now are on different tracks. As the Alliance has stated publicly, and reiterate here, the two pillars of the joint 2012 GHG and Fuel Economy Rule, since the beginning, have been the concept of One National Program and the equally important commitment to a rigorous, fact-based MTE. EPA's early action has compromised both pillars: there is now neither a harmonized, single national program, nor the appearance of a credible midterm review.

By unilaterally issuing the Proposed Determination, EPA has ignored its own representation to all stakeholders that throughout the TAR and MTE process, all communication and action taken by the agencies and industry were to be (and for industry's part, have been) in coordination with each other.

Insofar as EPA's final determination and NHTSA's not-yet-proposed-or-final-rule are to be the "final" MTE actions, EPA's Proposed Determination precedes NHTSA's corresponding decision and final rule which not only flatly contradicts the agencies' 2012 commitment to undertake these actions concurrently but also fails to account for NHTSA's different approach, which has yet to be publicly released.

The Draft TAR revealed significant differences between EPA and NHTSA with respect to their analyses of costs, technology pathways and other factors. This raises the prospect that

[5] 77 Fed. Reg. at 62623 at 62628 (October 15, 2012) Rules and Regulations; *see also* "Light Duty Vehicle Greenhouse Gas Standards: 2025 and Beyond", presented to the Society of Automotive Engineers North American International Powertrain Conference, September 17, 2015, https://www.epa.gov/regulations-emissions-vehicles-and-engines/epa-presentations-regarding-midterm-evaluation-light-duty (last visited December 7, 2016).

NHTSA's eventual notice of proposed rulemaking may be substantially different and not at all harmonized with EPA's determination. The other prospect is that NHTSA may feel unduly constrained to align itself with EPA's determination regardless of the existence of facts and analyses that would suggest the need for a different outcome. Either way, the process now bears no resemblance to the coordinated effort that was envisioned for the midterm evaluation.

EPA now has put industry in the highly untenable position of having to comment on the Proposed Determination based on data from only one agency without being able to review and assess data updates and determinations by the other agency. As amply documented in the administrative record, many of the Alliance's previous comments were directed at these differences (and indeed, these differences are behind our pending harmonization petition to the agencies).

All along, the two key elements underlying the auto industry's efforts to cooperate with EPA, NHTSA and ARB on the joint 2012 GHG and Fuel Economy Rule have been: 1) the concept of maintaining a harmonized National Program; and, 2) the equally important commitment to a rigorous fact-based midterm evaluation. EPA now has jeopardized both elements by abandoning a coordinated process in favor of unilateral action, and by undermining the credibility of the midterm evaluation.

Primary Request: Withdraw the November 30 Preliminary Determination and Resume the Midterm Evaluation Process

In creating the Midterm Evaluation process, EPA stated that it would be "a collaborative, data-driven, and transparent process…" 81 Fed. Reg. 49,219 (July 27, 2016); *see also* 77 Fed. Reg. 62,784 (Oct. 15, 2012). EPA's recent actions, particularly the November 30 Proposed Determination, are wholly inconsistent with the notion of a "collaborative, data-driven, and transparent process." There is no legitimate justification for leading the industry and the public to believe that the process would follow a published timeline, then precipitously abandoning that timeline and accelerating the process without warning. On the contrary, such actions are the antithesis of "collaborative" and "transparent." Moreover, from a regulatory perspective, there is no change of circumstances that would compel a sudden need to finalize standards that take effect beginning in the 2022 model year. Under the 2012 joint final rule, an EPA Final Determination is not due until April 2018, almost 17 months from now. This means that there is more than enough time to allow for several additional months of record development ahead of the issuance of a reissued Proposed Determination, while remaining comfortably ahead of the regulatory deadlines set forth for the MTE. Indeed, in light of the truncated comment process on the draft TAR (itself 16 months ahead of schedule), and in light of the "MTE Schedule" that had been posted on the EPA website, the Alliance and its members had every reason to expect that there would be time to submit additional material to EPA. The Alliance and its members were in the process of preparing additional information for submittal to the Midterm Evaluation docket when we got word that the process was being short-circuited on November 30.

EPA's stunning change of course also belies its promise to "make every effort to also consider public comments submitted after the close of the comment period." EPA created an expectation that further comments would be accepted, then reversed course and brought the entire comment process to a sudden and unexpected end. Even the published timeline on the agency's own website remained unchanged until the day before the agency's announcement. At a minimum, EPA's actions in this matter create the appearance of an agency that is uninterested in a full, open and fair consideration of all data and information bearing upon the model year 2022-2025 standards, and that pre-determined the outcome of the Midterm Evaluation before allowing the process to play out as intended. The only way that EPA can hope to undo this appearance is to withdraw its November 30 Proposed Determination and resume the Midterm Evaluation process as previously envisioned.

In light of the above, the Alliance formally requests that EPA withdraw the Proposed Determination and all related materials published on its website on November 30. The Alliance further requests that the Midterm Evaluation process be reinstated in a manner that is more consistent with the timeline previously published by EPA.

Secondary Request: Extend the Comment Period on the Proposed Determination to 120-Days

If EPA does not grant the Alliance's primary request of withdrawing the November 30 Proposed Determination and resuming the Midterm Evaluation process, the Alliance formally requests that EPA extend the public comment period on the Proposed Determination from 30 days to at least 120 days from the date of publication in the Federal Register.

A comment period of only 30 days is wholly insufficient to ensure that the EPA conducts the Midterm Evaluation as "a collaborative, data-driven, and transparent process that will be a holistic assessment of all of [the] factors considered in standards setting, and the expected impact of those factors on manufacturers' ability to comply." 81 Fed. Reg. 49,219 (July 27, 2016); *see also* 77 Fed. Reg. 62,784 (Oct. 15, 2012). This timetable also threatens to deprive stakeholders of a meaningful opportunity to comment on the Proposed Determination, as EPA regulations and the Clean Air Act (CAA) require. The EPA Midterm Evaluation is subject to the procedural requirements in section 307(d) of the CAA, 42 U.S.C. § 7607(d). Those requirements apply to, among other things, "promulgation or revision of regulations under [section 202 of the CAA, 42 U.S.C. § 7521]." 42 U.S.C. § 7607(d)(1)(K). Under Section 307(d), interested parties must have an opportunity to submit both written and oral comments at a hearing, and the record must be kept open for thirty days after opportunity for oral comments. 42 U.S.C. § 7607(d)(5). *See* § 40 C.F.R. § 86.1818-12(h)(2)(iii) (requiring the Administrator to take into account "[p]ublic comment on whether the standards established for the 2022 through 2025 model years are appropriate under section 202(a) of the Clean Air Act"). *See also Bell Lines, Inc. v. United States*, 263 F. Supp. 40, 46 (S.D. W.Va. 1967) ("The thrust of our decision is that the requirements of the Administrative Procedure Act are fundamental to due process and that all administrative decisions shall include such findings and conclusions as are reasonably necessary to intelligently inform the parties involved of the

purport thereof, as well as the reasons therefor.").

As noted above, the Proposed Determination spans nearly 1,000 pages. It incorporates the findings of 1,099 separate studies. The sheer volume of new information in the Proposed Determination alone justifies this extension request. The public, key stakeholders and the Alliance's members require adequate time to understand the agency's technical model updates, assess the new conclusions, and respond to the request for comment.

In addition to the agency's abrupt short-circuiting of the Midterm Evaluation schedule, other factors militate in favor of a longer comment period including:

- The comment period begins before the EPA has published the Proposed Determination and the associated Technical Support Document ("Final TAR") in the Federal Register, which is the conventional and accepted means by which federal agencies notify interested parties of agency actions requiring public comment. For instance, the EPA published its Notice of Availability of Midterm Evaluation Draft Technical Assessment Report for Model Year 2022-2025 Light Duty Vehicle GHG Emissions and CAFE Standards in the Federal Register and appears to have tied the length of the comment period to the Federal Register publication date. *See* 81 Fed. Reg. 49,217 (July 27, 2016). It is unclear whether posting the Proposed Determination on the EPA's website will sufficiently notify the public or is legally adequate. The Alliance is concerned that running the comment clock from the date of the website posting will further hamper meaningful opportunities for comment and represents an arbitrary departure from the EPA's ordinary process for soliciting comment.

- The comment period includes a major holiday period during which most manufacturers are closed and/or critical staff are on vacation, which will further hamper stakeholders' ability to meaningfully evaluate and comment upon the Proposed Determination. As a practical matter, this means that the Alliance has effectively only three weeks to comment on a massive proposal.

- The 30-day comment period for the Proposed Determination is half as long as the 60-day comment period applicable to comments on the Draft TAR. *See* 81 Fed. Reg. 49,217 (comment period ran from July 27, 2016 to September 26, 2016). Yet the EPA has described the Draft TAR as merely "a technical report, not a decision document," (Draft TAR, p. 1-2) suggesting that the comment period for the Draft TAR would be comparatively short compared to more significant forms of agency action. *See* EPA Midterm Evaluation Website, https://www3.epa.gov/otaq/climate/mte.htm. The proposal constitutes a proposed action encompassing a much broader set of issues warranting comment. Accordingly, against the 60-day benchmark of the Draft TAR, EPA

should provide more, not less time to comment on its proposed action.

- EPA declined to meet with the Alliance to discuss our comments or address our concerns with the Draft TAR. This takes on special importance in that many of our comments were dismissed by EPA due to the purported lack of sufficient supporting information. More information or clarification of our comments could have been easily communicated before the Proposed Determination was finalized.

The Alliance also is concerned that the Proposed Determination and the Final TAR were not submitted for review by the Office of Management and Budget (OMB). EPA has said the Technical Support Document accompanying the Proposed Determination serves as the Final TAR.[6] As noted above, EPA's proposed action qualifies as rulemaking. Notice of a significant rulemaking document entering the OMB process is a strong indicator for stakeholders to finish work and prepare for a comment period. The purpose of OMB review is to ensure that agency decisions having major effects on the U.S. economy have benefit from input from the Office of Information and Regulatory Affairs within OMB. *See* Executive Order 12866, Sec. 6 (describing procedures for OIRA review of "significant regulatory action," defined as "any regulatory action that is likely to result in a rule that may [h]ave an annual effect on the economy of $100 million or more"). Plainly, the agency's decision is economically consequential by this standard. Also, in contrast to the process followed with the Proposed Determination, the related Draft TAR was submitted to OMB for review. It is illogical that EPA would feel required to submit the Draft TAR for OMB review and then subsequently fail to submit a related proposed decision document for review.

Additionally, the Alliance notes that California's ARB is pursuing its own midterm evaluation on an accelerated schedule. EPA and NHTSA should seek to be more transparent about their efforts to coordinate with ARB and should ensure the midterm determinations performed by the federal agencies and ARB are substantively and procedurally aligned. Since the ARB Midterm Review has been moved to February 2017 from December 2016, we fully expect EPA will include any relevant information presented at that ARB hearing in the EPA Final Determination or Notice of Proposed Rulemaking.

Finally, EPA's issuance of a Final Determination by January 20, 2017 (which appears to be the agency's intent), will not just be premature but will constitute a predetermination and flatly contradicts both EPA's and NHTSA's commitment in 2012 to undertake these actions

[6] Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation." U.S. Environmental Protection Agency. EPA-420-R-16-020, November 2016.

concurrently after a rigorous fact-based midterm evaluation.

Thank you for your prompt consideration of these important requests.

Sincerely,

Mitch Bainwol
President and CEO
Alliance of Automobile Manufacturers

cc:

Bill Charmley, EPA
Chris Grundler, EPA
Janet McCabe, EPA
Michael Olechiw, EPA
Rebecca Yoon, NHTSA
Kevin Green, DOT
Ryan Harrington, DOT
Shoshana Lew, DOT
James Tamm, NHTSA
Annette Hebert, CARB
Mike McCarthy, CARB

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 7/20/2017 9:27:49 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: RE: Please Call re: 2022-2025 CAFE EIS Scoping Notice
Attachments: CAFE Scoping Notice Desk Statements and QA 170720.docx

5:30 would work for me if you can adjust you schedule. Personal Matters / Ex. 6
Personal Matters / Ex. 6

Bottom line, we will be issuing the EIS Scoping notice tomorrow afternoon.
We wanted to forward the internal desk statements (one for NHTSA, and a potential desk statement for EPA) and internal NHTSA QA. We won't be issuing a press statement.

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Thursday, July 20, 2017 5:24 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: Re: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Jim

Does 6pm work? You can call me on my mobile number. I can do 5:30 if I move something around.

Sent from my iPhone

On Jul 20, 2017, at 5:07 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:

Personal Matters / Ex. 6
Personal Matters / Ex. 6. Do you have any time yet today?

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Thursday, July 20, 2017 5:03 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: RE: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Dear Jim,

Personal Matters / Ex. 6

Are you available between 6:30am and 8:30am tomorrow? If yes, let me know what time works and what number I can call you at.

Thanks
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Thursday, July 20, 2017 4:49 PM
To: Charmley, William <charmley.william@epa.gov>
Subject: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Hi Bill,
Please give me a call this afternoon or tomorrow morning. I'd like to give you a heads up on some content in the EIS Scoping notice NHTSA will be issuing tomorrow afternoon.

Also, thanks for your message on trailers. I'd like to touch base on that too.
Thanks.
Jim

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 7/24/2017 4:31:11 PM
To: Charmley, William [charmley.william@epa.gov]
CC: Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]
Subject: RE: NHTSA EIS scoping notice

Hi Bill, Mike and Robin,
Another update. I just heard we will delay posting the scoping notice on our website until tomorrow (not today). That will align posting on the NHTSA website with the notice being posted for inspection by the Federal Register, which will happen tomorrow.
Jim

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Monday, July 24, 2017 12:14 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Cc: Olechiw, Michael <olechiw.michael@epa.gov>; Moran, Robin <moran.robin@epa.gov>
Subject: NHTSA EIS scoping notice

Dear Jim –

Thanks for your email from Friday afternoon regarding the NHTSA scoping notice more likely being posted today (Monday). I let the communication folks in the EPA air office know.

Personal Matters / Ex. 6 If any other LD MTE topics come up during that time frame, please reach out to Mike or Robin.

Thanks
Bill

Message

From: Yanca, Catherine [yanca.catherine@epa.gov]
Sent: 11/14/2016 10:35:20 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
Subject: Draft of EPA's Proposed Determination Technical Support Document: Part 2 of 3
Attachments: Ch 3 Econ.docx; Ch 4 ComsumerIssues.docx; Ch 5 EPA's OMEGA Model.docx; Ch 2 Tech-2.3Modeling of Tech.docx

Part 2 of 3.

From: Yanca, Catherine
Sent: Monday, November 14, 2016 5:30 PM
To: 'Tamm, James (NHTSA)' <james.tamm@dot.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Subject: Draft of EPA's Proposed Determination Technical Support Document: Part 1 of 3

Hi Jim,

Attached is the latest draft of the Technical Support Document for the MTE Proposed Determination. Our leadership is still reviewing the FR Notice, and we will send it as soon as we are able.

I'm sending this in three parts due to file size.

Thanks,
Cay

Catherine (Cay) A. Yanca
Assessment and Standards Division
US EPA Office of Transportation and Air Quality
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4769

Message

From: Yanca, Catherine [yanca.catherine@epa.gov]
Sent: 11/14/2016 10:31:44 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
Subject: Draft of EPA's Proposed Determination Technical Support Document: Part 1 of 3
Attachments: Ch 2 Tech-2.1-2.2Overview-State of Tech.docx; 00-CoverTOCAcronyms.docx; Ch 1 Baseline.docx

Hi Jim,

Attached is the latest draft of the Technical Support Document for the MTE Proposed Determination. Our leadership is still reviewing the FR Notice, and we will send it as soon as we are able.

I'm sending this in three parts due to file size.

Thanks,
Cay

Catherine (Cay) A. Yanca
Assessment and Standards Division
US EPA Office of Transportation and Air Quality
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4769

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 11/14/2016 9:00:12 PM
To: Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]
CC: Russell.Krupen@dot.gov [russell.krupen@dot.gov]; Katz, Ken (NHTSA) [Ken.Katz@dot.gov]
Subject: Draft Scoping Notice for 2022-2025 CAFE EIS
Attachments: MY 2022-25 CAFE NHTSA Notice of Intent_11-8-2016_clean.docx

Hi Bill, Mike and Robin,

Please see the attached draft scoping notice for the MYs 2022-2025 CAFE EIS. The text parallels recent scoping notices. We welcome EPA review and request your feedback by COB Friday, November 18. Please cc: Russell Krupen and Ken Katz on your response.

Thanks in advance for your feedback.

Jim

Message

From: Erika Nielsen [enielsen@borgwarner.com]
Sent: 9/21/2017 6:37:04 PM
To: Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Jim Tamm [james.tamm@dot.gov]; Murphy, Caitlin (FELLOW) [Caitlin.Murphy@hq.doe.gov]; Garman, Sarah [Sarah.Garman@hq.doe.gov]; Gurpreet.Singh@ee.doe.gov
Subject: BorgWarner PDF Invite
Attachments: BW_'17 Ride n Drive Meeting Invite_9.21.17-V2.pdf

BorgWarner Propulsions Systems Stakeholders Meeting and Ride-n-Drive – September 26,2017

Please forward the invite attached as you see fit to various the agency contacts you would like to attend.

Webcast Link
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This link gives participants access to the live and/or archived event.

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Kind regards,

Erika Nielsen
Director, Global Government Affairs

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Message

From: Julia Rege [JRege@globalautomakers.org]
Sent: 10/5/2017 10:35:04 PM
To: Grundler, Christopher [grundler.christopher@epa.gov]; Charmley, William [charmley.william@epa.gov]; James C. Owens (j.owens@dot.gov) [j.owens@dot.gov]; Jim Tamm [james.tamm@dot.gov]; heidi.king@dot.gov; Cliff, Steve@ARB [Steve.Cliff@arb.ca.gov]; Annette Hebert (ahebert@arb.ca.gov) [ahebert@arb.ca.gov]; mike mccarthy [michael.mccarthy@arb.ca.gov]
CC: Lieske, Christopher [lieske.christopher@epa.gov]; Rebecca.Schade@dot.gov; Charles Haake [chaake@globalautomakers.org]; Amandine Muskus [amuskus@globalautomakers.org]
Subject: Global Automakers MTE Comments
Attachments: 2017-10-05 Global Automakers GHG-CAFE MTE Comments.pdf

All,

Please find attached the comments submitted by Global Automakers to the docket today on the "Request for Comment on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards" [82 FR 39551, August 21, 2017].

To view the attachments that accompany these comments, please visit https://www.globalautomakers.org/media/agency-comments/global-automakers-comments-on-the-mid-term-evaluation-for-the-greenhouse-gas.

Global Automakers is available to discuss these comments at any time. Thank you for your consideration of our comments.

Best, Julia

Julia Rege
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GlobalAutomakers

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October 5, 2017

Submitted electronically at regulations.gov and via electronic mail

Christopher Lieske
Office of Transportation and Air Quality
Assessment and Standards Division
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Rebecca Schade
Office of the Chief Counsel
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ATTN: Docket ID Numbers: EPA-HQ-OAR-2015-0827 and NHTSA–2016–0068

Dear Mr. Lieske and Ms. Schade

Please find attached comments from the Association of Global Automakers, Inc. on the "Request for Comment on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards" [82 FR 39551, August 21, 2017].

Thank you for your consideration of our comments. In the event of any questions regarding these comments, I can be reached at (202) 650-5555 or jrege@globalautomakers.org.

Sincerely,

Julia M. Rege
Director, Environment & Energy

CC: Christopher Grundler, EPA-OTAQ
William Charmley, EPA-OTAQ
James Owen, NHTSA
Heidi King, NHTSA
James Tamm, NHTSA
Steve Cliff, CARB
Annette Hebert, CARB
Michael McCarthy, CARB

GlobalAutomakers

Executive Summary

The Association of Global Automakers' (Global Automakers)[1] member companies are global leaders in the design, manufacture and sale of environmentally-friendly vehicles, and we support long-term efforts to reduce greenhouse gas (GHG) emissions and increase fuel economy.

In support of these goals, Global Automakers and our members came together with regulators from the United States Environmental Protection Agency (EPA), National Highway Traffic Safety Administration (NHTSA) and California Air Resources Board (CARB) and with other stakeholders to craft the "One National Program" (or "National Program") in 2009, to provide annual fuel economy and GHG emissions improvements for all light-duty vehicles. This National Program was continued in 2012 with rulemaking covering model years (MY) 2017-2025.

One critical aspect of the National Program is the Mid-Term Evaluation (MTE), an activity conceived six years ago that is currently in-process. It was established because the standards finalized in 2012 were dictating vehicle requirements more than ten years into the future, well in advance of product planning and development cycles. The agencies also recognized that assumptions used in setting the standards—such as technology cost, technology effectiveness, projected gasoline prices, and consumer demand for fuel-efficient technologies—may change in the ensuing years, and a mid-stream, updated evaluation of the appropriateness of the standards was warranted for the program's latter years.

Unfortunately, the MTE process was abruptly cut short at the end of the previous administration. This truncated schedule led to a hasty decision that left many critical questions unanswered and failed to remedy fundamental shortcomings in the agency's computer modeling efforts that serve as a technical underpinning to the standards. More importantly, EPA's rushed process came at the expense of important interagency coordination and much needed improvements to the National Program.

Global Automakers was one of the parties that asked EPA to reopen the MTE, in order to allow EPA to take a fresh look at *all* of the factors on which the standards were based and to account for the most up-do-date information concerning automakers' product planning, the cost and efficacy of technologies, and the impact of fuel prices on customers' purchasing choices.[2] It further allows EPA and NHTSA to coordinate their processes and provides an opportunity to address outstanding harmonization issues.

The following summarizes our major points related to harmonization, technology and modeling, consumer acceptance, and other issues raised in this MTE.

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[1] The Association of Global Automakers represents the U.S. operations of international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Global Automakers works with industry leaders, legislators, regulators, and other stakeholders in the United States to create public policies that improve motor vehicle safety, encourage technological innovation and addresses environmental needs. Our goal is to foster an open and competitive automotive marketplace that encourages investment, job growth, and development of vehicles that can enhance Americans' quality of life. For more information, visit www.globalautomakers.org.

[2] *See* Global Automakers letter to EPA Administrator, Scott Pruitt, on February 21, 2017 requesting that EPA withdraw the final determination. Docket ID No.: NHTSA-2017-0007-0003.

GlobalAutomakers

Harmonization

A key element of the National Program is the harmonization of overlapping regulatory programs, thereby reducing unnecessary and duplicative requirements, while allowing manufacturers to comply by producing a single fleet of vehicles. A consistent and harmonized National Program supports investment in more efficient vehicles that customers want and need now, while also accommodating the next generation of technologies. As such, the National Program needs to provide sufficient regulatory flexibility to manage these investments, while securing long-term environmental benefits and providing fuel savings for customers. There are three specific areas where harmonization can be improved:

1. Further harmonization is needed between EPA's and NHTSA's standards to make sure that when a manufacturer complies with one set of rules, it is also in compliance with the other set. As Global Automakers has noted,[3] there are differences between the two agencies' standards, primarily related to how credits are banked, accrued and applied, and these differences only serve to unnecessarily drive up costs. Several regulatory fixes can easily be applied and fill the compliance gap between the two federal programs, without impacting the overall programmatic targets. Alternatively, the agencies could consider adjustments to the regulatory targets to align these programs as well. Global Automakers urges EPA and NHTSA to take immediate action to improve alignment within the National Program.

2. The agencies use different models for each of the programs as well as different metrics for assessing technologies (e.g., EPA measures energy efficiency by looking at power-to-weight ratio while NHTSA measures tractive energy), which can lead to differing answers to the same questions. Harmonizing the models would help address this issue, but at a minimum, the agencies should seek to further align their metrics to help ensure more consistent modeling results.

3. Harmonization between the federal and California programs must be maintained. EPA, NHTSA, and California need to work together to maintain the One National Program as all parties committed to at its inception. Additionally, full harmonization cannot be realized so long as California and other states continue to enforce the Zero Emission Vehicle mandate, which forces automakers to use one of the most expensive technologies – electric drive technology – at a greater rate than would be required to meet the GHG regulation alone.

Technology

One of the foundational underpinnings of the standards is the agencies' technical modeling. There has been a lot of discussion about the modeling since the Draft Technical Assessment Report (Draft TAR), including the way the models work and assumptions inputted into each of the models. Upon request, Global Automakers and our members have worked with the Volpe Center to provide updated and

[3] "Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program," submitted by the Alliance of Automobile Manufacturers and the Association of Global Automakers to EPA and NHTSA, (June 20, 2016). Retrieved from: https://www.epa.gov/sites/production/files/2016-09/documents/petition_to_epa_from_auto_alliance_and_global_automakers.pdf.

revised assumptions to support improved outputs from the Volpe model, and we understand that the Volpe Center is contemplating use of these updated inputs.

We have also conducted ongoing work with the Alliance of Automobile Manufacturers (Auto Alliance) and a third-party contractor that has shown that the EPA modeling has significant structural problems, particularly with the agency's Lumped Parameter Model. These shortcomings have caused the agencies to overestimate the role that conventional technologies can play in achieving future GHG reductions. Necessary improvements to EPA's modeling activities include using quality checks, ceasing use of the Lumped Parameter Model, and moving away from 0-dimensional modeling steps. Correcting for these errors demonstrates that greater quantities of advanced technology (such as hybridization and electrification) will be required to meet the regulatory targets, at additional cost.

We have recently learned from EPA personnel that the agency is developing a new modeling approach and as part of it, plans to eliminate, for the most part, use of the Lumped Parameter Model. We think this is a positive step. However, EPA must provide stakeholders with adequate time to evaluate the updated modeling approach, ensure it is analytically robust, and provide meaningful feedback. If EPA is unable to do so in the time leading up to a MTE decision point, it may be necessary to reconsider EPA's use of a separate model from NHTSA. Should this be the case, EPA should remain involved in providing necessary inputs to the Volpe model to maintain a reliable, data-driven analytical process.

Global Automakers believes that in updating the agencies' modeling, assumptions and data, revised findings would support the conclusion that adjustments to the regulations are needed. This point is supported by our industry analysis. Adjustments could take numerous forms, including credit flexibilities that allow automakers to manage investments, build vehicles that consumers want and can afford, encourage innovation and continue on the path of annual fuel economy improvements and GHG emissions reductions.

Consumer Demand

As the agencies have recognized, "[c]onsumer acceptability is . . . an element of economic practicability, one which is particularly difficult to gauge during times of uncertain fuel prices."[4] Current trends indicate that consumers undervalue fuel-efficient technologies. Indeed, consumer demand for all high fuel-economy vehicles is stagnant, declining, or at best underwhelming.[5] Lower than expected gasoline prices are likely a factor in the sluggish or declining demand for high fuel-economy vehicles[6] There has also been an increased demand for trucks since 2012. This shows that consumer demand for fuel efficiency is not aligned with the increasing stringency of the standards and will create challenges as automakers implement technologies to meet the standards.

In addition, overall vehicle sales have leveled off in recent years, and early indications are that sales will be on the decline.[7] This suggests that the years between MY 2017–2025 will be more challenging than

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[4] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624, 62,668 (Oct. 15, 2012).

[5] E. Sunde, *U.S. Fuel Economy, State of the Industry 1Q 2016* (WardsAuto).

[6] U.S. Environmental Protection Agency (U.S. EPA). *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016* at p. 20. ("2016 Fuel Economy Trends Report").

[7] http://wardsauto.com/industry/us-sales-forecast-lowered-2017-despite-need-cut-inventory.

previously anticipated, potentially lowering available research and development funds at a time when the standards are seeing steep escalations in stringency.

Furthermore, the market has demonstrated that it is not ready to support costly hybrids and electric vehicles at the levels needed for compliance, with today's sales of electric vehicles barely over one percent of the U.S. new light-duty vehicle market. Sales of hybrid-electric vehicles peaked in 2013 and now hover around two percent of the market.

The Proposed and Final Determinations dismissed concerns about consumer acceptance, noting that consumers value fuel savings over the long term more than increased purchase costs in the short term; that fuel economy technologies have no "hidden costs" that will affect consumer demand; and that increased purchase prices of more fuel-efficient vehicles will have no adverse impact on low-income households. These issues need to be reconsidered. Any misalignment between the market demands and the requirements will result in less affordable consumer choices, slowed sales, reduced fleet turnover, diminished fuel savings, and potentially lost jobs.

Other Issues

Harmonization of MY 2021 Standards. Both agencies request comment on whether the 2021 standards should be included in the MTE. We support the agencies considering adjustments to MY 2021 if for no other reason than to address ongoing harmonization issues that industry has raised over the years, and more fully articulated in our June 2016 petition for rulemaking. Since a truly harmonized set of CAFE and GHG standards has not yet been achieved, reexamination of MY 2021 requirements is appropriate to address these concerns, particularly if efforts are not taken immediately to further align the two programs.

Global Automakers also addresses vehicle classification, regulatory streamlining considerations, ethanol-related test procedure adjustments, and octane in this section of our comments.

Looking Ahead

Even as we work on the regulatory process for this MTE, it is important to remember that much of the world and California are already looking ahead to 2030, and even to 2035 and beyond. The undeniable trend in both the market and in the regulatory environment is away from the use of fossil fuels and towards greater electrification of the vehicle fleet. At the same time, the industry is undergoing a transformational shift towards connected and automated vehicles, as well as the expansion of ride sharing models that will influence the underlying nature of the automotive business. These trends taken together promise a future of a more efficient and safer fleet of vehicles, and the need to invest in and encourage these technologies should not be ignored. As regulators look past the current MTE—and we would encourage them to do so—they should consider how to leverage these significant transformations in mobility to provide a light duty fleet that is cleaner, more efficient, and safer than ever before.

In the following comments, Global Automakers addresses the issues that the agencies should consider in the reopened MTE to help achieve the National Program's goals.

I. Introduction

The Association of Global Automakers (Global Automakers) appreciates the opportunity to provide these comments on the joint notice issued by the National Highway Traffic Safety Administration (NHTSA) and the U.S. Environmental Protection Agency (EPA), entitled "Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles" [82 Fed. Reg. 39551, August 21, 2017]. This notice is an important step in maintaining and strengthening the "One National Program" for motor vehicle fuel economy and greenhouse gas (GHG) emissions.

Global Automakers represents the U.S. operations of international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Our member companies design, build, and sell cars, light trucks and components in the United States. Our automaker members have invested $59 billion in U.S. facilities and directly employ nearly 100,000 employees located throughout the United States. Global Automakers' members have 25 manufacturing facilities in eleven states and built 4.7 million vehicles in the U.S. in 2016, a 41 percent increase in production in the last decade.

Global Automakers' member companies are manufacturing more fuel efficient and cleaner cars and trucks than ever before, with continued improvements underway. In 2016, our members manufactured 64% of the green vehicles sold in the nation. Through research and development at facilities in the U.S. and around the world, our members have engineered many fuel-saving innovations, including engine and transmission refinements, aerodynamic improvements, expanded use of lightweight materials, and reduced ancillary loads, among other technologies.

Our members also have brought to market dozens of alternative-fuel models, including plug-in hybrid-electric and battery-electric vehicles, which use electricity from the grid, and fuel cell electric vehicles, which use onboard hydrogen – converted to electricity via fuel cell – to propel the vehicle. Examples of these vehicles now in the market include the Toyota Mirai Fuel Cell, Honda Clarity Fuel Cell, Hyundai Ioniq battery-electric and plug-in electric hybrid, Nissan LEAF battery-electric vehicles, and Kia Soul battery-electric vehicle.

These technologies are integral to our members' long-term goal of providing low carbon transportation to their customers. To further that goal, members of Global Automakers also have supported the One National Program (ONP or National Program) from its inception.

Global Automakers appreciates the opportunity to contribute to the improvement of the ONP through the Mid-Term Evaluation (MTE). We especially welcome the agencies' reconsideration of the Final Determination, a substantive process that was hastily truncated earlier this year. The MTE reopening is the first step in completing the work already begun. It is also a necessary step in ensuring coordination between the three agencies that regulate vehicle emissions and fuel economy: EPA, NHTSA, and the California Air Resources Board (CARB). Global Automakers emphasizes that CARB has an important role to play in the ONP, along with EPA and NHTSA. Absent CARB's participation, it is all but impossible to achieve the National Program; manufacturers and consumers would be faced with a patchwork of unworkable standards that would skew vehicle sales and production. Global Automakers strongly requests CARB's continuing involvement in the ONP.

In addition to CARB, other stakeholders need to be actively involved (as they were before) to develop a consistent, creative and cohesive path forward that keeps the ONP intact. The industry needs a single set of standards so manufacturers can allocate their resources to new and innovative technologies, instead of efforts to comply with inconsistent standards. Investments in new technologies help keep American factories productive and generate American jobs in the very competitive global market for automotive manufacturing. Some recent research indicates there is potential for adverse economic impacts from the standards,[8] and this potential would be further aggravated if the ONP is not maintained.

The MTE reopening also allows for a more science-based and data-driven approach to the question of whether the standards remain appropriate or should be modified in some fashion. Global Automakers submitted detailed feedback on concerns we have with the agencies' Draft TAR that demonstrated the need for a more rigorous approach to this question.[9] In addition, modeling is one of the necessary tools in a scientific- and data-based approach, but to date, some of the models have lacked sufficient transparency to judge the integrity of their outputs. Global Automakers hopes that the extended MTE will allow the agencies to use the best and most recent data in a more transparent, and improved, modeling process.

Finally, the reopening of MTE allows the agencies to consider changes to industry trends and consumers' reactions to these trends, including the following:

- Sales trends, including a decline of vehicle sales in 2017;
- The increasing shift in consumer preferences from cars to light trucks;
- Gas prices, which are much lower than anticipated when the standards were adopted;
- The increasing availability of hybrid and electric-drive vehicles;
- Consumer demand, which has not increased for high fuel economy vehicles (and which may decline further as government incentives for their purchase decline); and
- New developments in connected, autonomous and shared vehicles.

Global Automakers appreciates the agencies' continued commitment to the fundamental goal of the National Program – a harmonized set of regulations that improve fuel economy and reduce GHG emissions, are cost-effective, and account for the needs of customers. Fundamental to this goal is a data-driven and objective MTE in which EPA, NHTSA, and CARB are fully aligned. As we detail in these comments, there are a number of factors that the agencies must fully examine in order to determine whether the standards out to model year (MY) 2025 remain appropriate in their current forms.

II. Importance of One National Program

Global Automakers supports the ONP to regulate vehicle GHG emissions and fuel economy. Until the first set of joint NHTSA/EPA rules, fuel economy was regulated solely by NHTSA through the Corporate

[8] Center for Automotive Research, *The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy*, (2016). ("CAR 2016 Study") at p. 51-52.
[9] *See* Global Automakers, *Comments to the Draft Technical Assessment Report*, (November 2016).

Average Fuel Economy (CAFE) program. In the early 2000's, CARB took action to regulate GHG emissions – a metric almost synonymous with fuel economy – leading the way for 12 other states to also adopt GHG regulations. After the Supreme Court's 2007 decision in *Massachusetts v. EPA*,[10] EPA moved to regulate GHG emissions from vehicles as well.

The possibility of three separate programs, resulting in 15 separate compliance requirements, raised concerns that automakers might have to manufacture different versions of vehicles to meet the differing standards throughout the country. Additionally, given that each of these regulatory programs is on a fleet-average basis, manufacturers would have been required to balance their light duty fleets in 15 jurisdictions.

To avoid this result, NHTSA, EPA and CARB worked together with manufacturers and other stakeholders to create the "One National Program." Through the ONP, the agencies also sought to address the concern that different standards at the federal and state levels would waste resources, add unnecessary friction in the system, discourage innovation, and diminish the benefits of all of the standards. As one of the Obama Administration's representatives reflected when describing the ONP adopted in 2009:

> [T]here was a significant likelihood that the regulators, acting independently, would produce inconsistent standards with different levels of stringency, along with duplicative or confusing compliance programs and incompatible enforcement policies, which could raise the costs to industry, and compromise the potential benefits of the new standards for consumers and the public.[11]

The ONP began when NHTSA and EPA issued joint fuel economy and GHG emission standards in 2010. CARB worked with NHTSA and EPA on the joint standards, and CARB amended its separate GHG emission regulations to include a "deemed to comply" provision whereby automakers could show compliance with state GHG emission standards by complying with EPA's GHG regulations.

In the Draft TAR, the agencies summarized the benefits of the ONP as follows:

> Under the National Program, consumers continue to have a full range of vehicle choices that meet their needs, and, through coordination with the California standards, automakers can build a single fleet of vehicles across the U.S. that satisfies all GHG/CAFE requirements.[12]

This description captures the foundation upon which ONP was built; the realization of this goal will enable manufacturers to maximize economies of scale and deliver efficient vehicles at lower cost.

While the rationale for the ONP remains strong, the promise of the ONP has not been fully met, as shall be discussed. Under the current regulations, it possible for a manufacturer's fleet to comply with one set

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[10] 549 U.S. 497, (2007).

[11] J. Freeman, *The Obama Administration's National Auto Policy: Lessons from the "Car Deal."* 35 Harv. Env. Law Review 343, (2011). p. 358.

[12] U.S. EPA, CARB, and NHTSA. *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025,* (July 2016). ("Draft TAR"). p. ES-1.

of federal standards but not the other. Further, the standards lack proper alignment, unnecessarily increasing complexity and regulatory burden. Efforts to harmonize the programs would help lower costs and enable greater environmental benefits than separate state-by-state programs.

III. The Importance of the Mid-Term Evaluation

Global Automakers applauds the agencies for reopening the MTE. Reopening this process is an opportunity to improve the national GHG and fuel economy programs by not only taking a fresh look at the parameters influencing policy direction – technology effectiveness, technology cost, gasoline prices, use of more recent baseline, etc. – but also by allowing consideration of more recent research that has been conducted since the January 2017 Final Determination.

The regulations finalized in 2012 provided for a decision on the MTE to be promulgated no later than April 1, 2018, and for the decision to be coordinated with NHTSA's fuel economy regulations for MY 2022-2025.[13] EPA accelerated this process when it issued a Proposed Determination concerning the appropriateness of the MY 2022-2025 standards, and then published a Final Determination three weeks later in January 2017, shortly before the end of the Obama Administration and nearly 15 months prematurely.[14] This truncated schedule—during which EPA purported to digest nearly 100,000 comments[15]—led to a hasty decision that left many critical questions unanswered and failed to remedy fundamental shortcomings in the agency's modeling. More importantly, EPA's rushed process came at the expense of much needed improvements to the National Program. As Global Automakers' President and CEO, John Bozzella, stated about the shortened MTE:

> It unnecessarily truncated public comment and prevented scrutiny of an important policy decision that will affect consumers, investment, public health and the environment. This can only undermine confidence in the objectivity of policymaking.[16]

It also prevented the agency coordination necessary to ensure proper alignment with NHTSA's *de novo* rulemaking on MY 2022-2025 CAFE standards, which was a fundamental promise of the MTE.[17]

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[13] NHTSA is prohibited from issuing fuel economy regulations for more than five model years, which prevented NHTSA from issuing regulations past MY 2021 when it finalized the 2012 rulemaking. 77 Fed. Reg. 62,624, 62,633 (Oct. 15, 2012).

[14] https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-5937.

[15] In contrast, EPA has yet to respond to any of our comments on the "Evaluation of Existing Regulations" (Docket ID No. EPA-HQ-OA-2017-0190, comment period closed May 15, 2017), noting insufficient time to review the over 400,000 comments received despite now having nearly four months to review the comments.

[16] Global Automakers. "Global Automakers Calls for Review of EPA's Final Determination on Light-Duty Vehicle GHG Standards." (Global Automakers Press Release, January 13, 2017).

[17] 77 Fed. Reg. at 62,633 ("In order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, ***if the EPA determination is that its standards will not change, NHTSA will issue its final rule concurrently with the EPA determination***. If the EPA determination is that standards may change, the agencies will issue a joint NPRM and joint final rule.") (emphasis added)

The reopening of the MTE allows the agencies to fully complete the MTE process. Now, the agencies can consider data that is undeniably relevant to the process, including the most recent data and developments in the automotive market, sales data and gasoline price data from 2016 and 2017. Some examples of this data include:

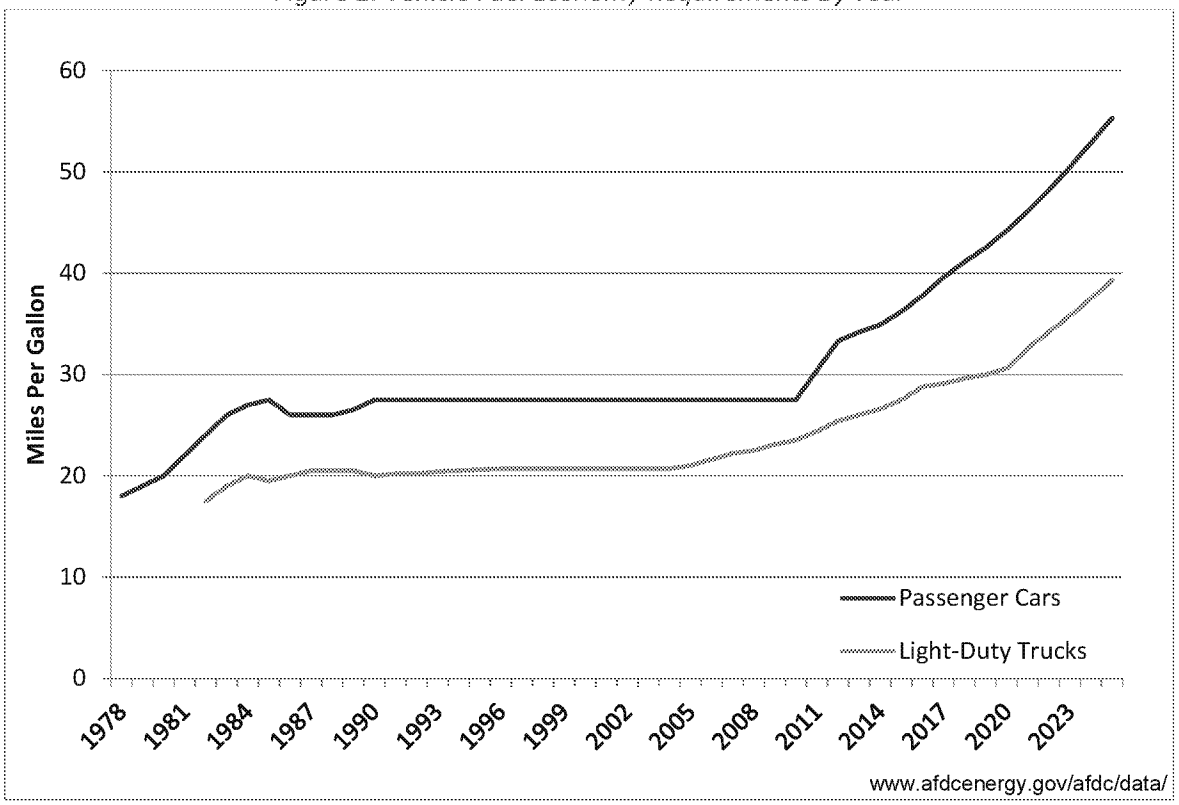
- Sales: In 2012, when the regulations were adopted, the industry was amid a robust recovery from the 2008 recession. That recovery continued until 2016, when auto sales peaked at 18.1 million vehicles.[18] The projection for 2017, however, is 16.9 million, a year-over-year decline of almost 7%.[19] This suggests that the years between MY 2017–2025 will be more challenging for the industry than previously anticipated, potentially lowering available funds for research and development while the stringency of the standards increases much more quickly than in the past. To illustrate this point, consider that overall fleet fuel economy increased at approximately 1.5% per year during the period between 2012 (fleet average of 23.7 mpg) and 2015 (fleet average of 24.8 mpg). From MY 2017 to MY 2025, the stringency of the standards will increase by approximately 5% per year – more than triple the rate seen in recent years.
- Gas prices: In 2012, the agencies relied upon an EIA reference price forecast of $3.86/gallon for gasoline in 2025 (in 2010 dollars). Today that projected price is $2.92/gallon[20] (in 2016 dollars), a real decrease of more than 30%. Low fuel prices have an undeniable impact on consumer demand for high fuel economy vehicles.
- Car/Truck Split: In 2012, the agencies projected a car/truck split of 67%/33% in MY 2025.[21] The split in MY 2015 was 57% cars/43% trucks.[22] This shift reflects the impact of lower gasoline prices on purchasing decisions and is evidence that fuel economy is not an overriding consideration for many buyers.
- Consumer Demand for Advanced Technology and High Fuel Economy Vehicles: From MY 2011 to MY 2016, the number of battery-electric vehicle (BEV) models increased from four to 12, and the number of plug-in hybrid-electric vehicle (PHEV) models has increased from one to 14.[23] Sales of these vehicles have also increased, slowly, but combined national sales of these vehicles still account for just over one percent of the market.[24] Over the same period, the number of hybrid offerings has increased from 30 to 33.[25] Yet sales of hybrids have decreased, peaking at 3.1% in 2013, and accounted for just 2.0% of the market in 2016.[26] More than 40 models of MY 2016 vehicles with at least one conventional gasoline or diesel variant have a combined label value greater than or equal to 30 mpg, compared to 20 models in MY 2011.[27] Yet, the overall

[18] http://www.autonews.com/assets/PDF/CA11136782.PDF
[19] http://wardsauto.com/industry/us-sales-forecast-lowered-2017-despite-need-cut-inventory
[20] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=12-AEO2017&cases=ref2017&sourcekey=0
[21] Draft TAR, p. ES-8.
[22] U.S. EPA. *2016 Fuel Economy Trends Report,* (2016). p. 4. Note that the per vehicle fuel economy is better year over year even though the car/truck split is not consistent with EPA's projections. *Id.*
[23] 2016 Fuel Economy Trends Report at p. 116.
[24] IHS Vehicle Registration Data, January-June 2017, (2017).
[25] 2016 Fuel Economy Trends Report at p. 66.
[26] IHS Vehicle Registration Data.
[27] 2016 Fuel Economy Trends Report at p. 115.

fleet fuel efficiency has improved slowly at less than 1% per year since 2011,[28] despite the fact that automakers are making more varieties of all types of fuel efficient vehicles available to customers. One reason for this is that consumers increasingly prefer to purchase trucks rather than cars. WardsAuto has created a "fuel economy index" that shows that sales of the highest fuel economy vehicles decreased in 2015.[29]

- Stringency: These developments – the decline in vehicle sales, lower gas prices, an increased preference for light trucks over cars, and sluggish demand for high fuel economy vehicles – are taking place as the stringency of the standards increase at an unprecedented rate, as the chart below illustrates for fuel economy standards. There is, simply put, a misalignment between the increasing stringency of the standards and the decreasing consumer demand for fuel efficiency.

Figure 1: Vehicle Fuel Economy Requirements by Year



Source: Alternative Fuels Data Center, afdcenergy.gov.

- Connected Vehicles, Autonomous Vehicles and Shared Vehicles: In 2012, all three of these trends seemed very far away, and the regulations ignored them as a result. We now know that connected vehicles, autonomous vehicles and shared-use vehicles will be on the roads in increasing numbers sooner rather than later, providing likely fuel savings through more efficient travel, reduced congestion and overall safer travel. The CAFE and GHG standards should be adjusted to address, or at a minimum consider, the potential benefits of these changes.

[28] 2016 Fuel Economy Trends Report at p. 4.
[29] E. Sunde. *U.S. Fuel Economy, State of the Industry 1Q 2016,* (WardsAuto), (2016).

The reopening of the MTE also enables the agencies to take a measured, science-based and data-driven approach to rulemaking. The rushed process undertaken in late 2016, combined with the opacity of certain elements of EPA's OMEGA model, has prevented Global Automakers and others from fully and meaningfully participating in the rulemaking process and the MTE. Global Automakers hopes that the additional time that the reopened MTE affords will allow for more transparency in the modeling and improved agency coordination.

IV. Harmonization

One of the major goals of the National Program has been the harmonization of three separate regulatory regimes that apply to motor vehicle fuel economy and GHG emissions: the CAFE program under the Energy Policy and Conservation Act (EPCA) administered by NHTSA, EPA's authority to regulate emissions under the Clean Air Act, and California's separate authority to regulate motor vehicle emissions. In combination, these programs would have resulted in an infeasible 15 separate compliance sets between the federal government, California and the Section 177 States.

Harmonization is critically important because of the economies of scale it enables, and the extent to which the standards are harmonized is one of the most important questions for the MTE.[30] Consumers, as well as manufacturers, benefit from the cost savings associated with a harmonized National Program.

One critical question that needs to be addressed in the MTE is how to maximize alignment and consistency between the two federal programs. With respect to the federal programs administered by EPA and NHTSA, the goal was to harmonize these two programs to the greatest extent allowable under their respective enabling statutes by:[31]

> [Allowing] automakers to produce and sell a single fleet nationally, mitigating the additional costs that manufacturers would otherwise face in having to comply with multiple sets of Federal and State standards.[32]

Contrary to the promise of harmonization, and despite EPA's recent assertions that it is constantly working to streamline and improve regulations,[33] the standards can result in a scenario in which a manufacturer could comply with the GHG regulations but not CAFE. That manufacturer would be required to pay fines under the CAFE program – an anomaly that should not result if the programs were

[30] 40 CFR 86.1818-12(h).
[31] *See Id*. at 25,328 ("The intention of this joint rulemaking is to set forth a carefully coordinated and harmonized approach to implementing these two statutes, in accordance with all substantive and procedural requirements imposed by law.").
[32] *See* Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324, 25,326, (May 7, 2010).
[33] Remarks from an EPA senior career staff person at the August 2017 Center for Automotive Research conference, entitled the Management Briefing Seminars, (2017).

in fact harmonized. The differences in these credit programs increase complexity which can hinder innovation while also adding cost.

As a more general matter, the National Research Council (NRC) recommended in a 2015 report on the fuel economy standards that "the agencies study the potential benefits, costs, and risks of establishing a standard based on a single metric that achieves both GHG and petroleum reductions in addition to continuing efforts to harmonize the two regulations."[34] The agencies have not followed the NRC's recommendation, although NHTSA's prior Administrator acknowledged that the GHG and fuel economy rules can be better harmonized.[35]

The reopening of the MTE allows EPA and NHTSA an opportunity to coordinate their rulemakings with an eye toward regulatory harmonization. While coordination alone does not guarantee that the standards will be harmonized, it does provide an opportunity to consider the issue and work to ensure that when a manufacturer complies with one set of rules, it is also in compliance for the other set of rules.

The NRC agreed and recommended that the agencies "consider how the credit markets are different between the CAFE and GHG rules, and what the implications of these differences are for the auto manufacturers."[36] Global Automakers addressed the ways in which the GHG regulations and the fuel economy regulations could be better aligned in its previous comments and in a petition to the agencies,[37] all of which are incorporated here by reference, including:

- EPA and NHTSA should calculate the fuel economy for a manufacturer's fleets for MYs 2010-2016 taking into account off-cycle technologies at the same levels and in the same way as EPA accounts for those technologies in the GHG program.
- EPA and NHTSA should calculate the fuel economy of a manufacturer's fleets for MYs 2010-2016 taking into account air conditioning efficiencies at the same levels and in the same way as EPA accounts for those technologies in the GHG program.
- NHTSA should apply the adjustment factor, beginning in MY 2011, when credits are carried forward or carried back within a compliance category, as well as when they are traded and transferred.
- NHTSA should reconsider its decision not to harmonize with EPA by failing to use the same, fixed Lifetime Vehicle Miles Traveled (VMT) values in the adjustment factor for MYs 2011-2016.
- NHTSA should revise the definition of the term "transfer" in 40 CFR 536.3 to be consistent with language in the 2010 preamble of the proposed rulemaking for 2017-2025 GHG/CAFE standards.

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[34] National Research Council. *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-duty Vehicles*, (June 2015). ("NRC 2015 Study"). Recommendation 10.12.
[35] Amend, J. M. "NHTSA's Rosekind Supports Regulatory Harmonization," WardsAuto (August 2016). http://wardsauto.com/car-management-briefing-seminars/nhtsa-s-rosekind-supports-regulatory-harmonization. Last accessed September 30, 2017.
[36] NRC 2015 Study. Recommendation 10.8.
[37] Alliance of Auto Manufacturers and Global Automakers. "Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program," (June 20, 2016).

- The agencies should allow manufacturers to manage their credit supply and use.
- NHTSA should adjust the minimum domestic passenger car standard for MYs 2012-2016 to reflect 92% of the required average passenger car standard taking into account the fleet mix as it occurred, rather than what was forecast. Doing so better aligns the overall CAFE performance values with real world results and EPA's calculations.
- EPA and NHTSA should provide for a default acceptance of petition for off-cycle credits, provided that all required information has been provided. Streamlining the process will further promote a more efficient and better harmonized National Program.

The differences between the CAFE regulations and the GHG emission standards only serve to unnecessarily drive up costs. The standards would be better harmonized, and less costly, if these discrepancies in the credit programs were remedied. As a Resources for the Future paper noted: "To the extent that there are differences between the agencies on how credits are granted, having the two different rules will make investment decisions for companies more difficult, which is likely to drive up costs."[38]

These points are fundamental to the petition submitted by Global Automakers and the Auto Alliance, outlining areas where the agencies should take immediate action to further harmonize their programs, consistent with their statutory authority. Several regulatory fixes can be easily applied to fill the compliance gap between EPA's and NHTSA's programs. Alternatively, the agencies can consider adjustments to the regulatory targets to align these programs as well. Therefore, Global Automakers urges EPA and NHTSA to take immediate action to improve alignment within the National Program. Global Automaker is committed to working with the agencies to address these concerns and to explore how to better harmonize the programs as part of the midterm evaluation.

Other impediments remain. First, California has stated that if the MTE results in a relaxation of EPA's standards, California may withdraw from the National Program. Should California do so, there would no longer be a single GHG standard in the country, but rather 13, each of which must be met separately within California and each Section 177 state.[39] Having 13 individual state programs is counterproductive and inefficient, and would likely lead to significant regional pricing discontinuities. The inability to average state obligations would, in all likelihood, create situations in which automakers must place incentives on certain models in one state, while providing no such incentive just across the border in a neighboring state. Thus, Global Automakers urges California, EPA and NHTSA to continue to work together during the MTE to provide nationwide benefits and improved fuel economy for all customers.[40]

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[38] Leard and McConnell. *New Markets for Pollution and Energy Efficiency*, Resources for the Future, (May 2015), RFF DP 15-116 p. 30-31.

[39] This is especially challenging given the significant differences in climate, population density and economies between the states that have adopted the California standards. Light trucks sell much better in Vermont, for example, than they do in California. Compare https://autoalliance.org/in-your-state/VT/ (23.25% pickups) with https://autoalliance.org/in-your-state/CA/ (15.7% pickups).

[40] In our comments to CARB's Midterm Review, Global Automakers pointed out that the suggestion in CARB's January 18, 2017 Staff Report that if the stringency of the federal GHG emission standards were to be substantially changed, ARB would reassess whether compliance with the national program would continue to be appropriate

The fact remains that a more robust and comprehensive set of benefits would accompany a national program.

The California ZEV Program

California's Zero Emission Vehicle (ZEV) mandate is another obstacle to harmonization. As Global Automakers explained in its comments on the Draft TAR and the Proposed Determination, the ZEV regulation forces automakers to use one of the most expensive technologies – electric drive technology – at a greater rate than would be required to meet the GHG regulation standing alone. As we have noted, the cost of reducing CO_2 emissions through electrification is over $300 per ton, compared to $67 per ton for non-electric technologies.[41]

The Draft TAR, Proposed Determination and Final Determination compounded this problem by including regulatorily-required ZEVs in the baseline for accounting for reduced GHG emissions, thereby making it appear that lower-cost technology could be used to meet the federal regulations. EPA responded that since these ZEVs were also excluded from the benefit calculation, the inclusion of the ZEVs in the baseline "necessarily also means that the calculated GHG benefits (the delta between the baseline and final standards) are also smaller."

EPA's response missed the point; by ignoring the cost of ZEV and starting with an artificially low GHG baseline, EPA has artificially lowered the cost of compliance. This underestimation is not "offset" by attributing lower GHG benefits to the GHG rule. EPA's use of artificially low costs taints its conclusions on the effect of the regulations on consumer demand, as well as its conclusions on the feasibility and practicability of the standards.[42]

EPA also argued that the Office of Management and Budget (OMB) guidance required it to include ZEVs in the baseline. As Global Automakers noted in its comments, OMB guidance requires EPA to consider alternative baselines and the effect of overlapping regulations.[43] The ZEV regulation required EPA to consider an alternative baseline – including the costs and benefits of ZEVs – as well as its impact as a regulation that overlaps the federal regulation.[44] These oversights should be remedied during this reopened MTE.

The Agencies' Modeling Methodologies

Harmonization can also be further aligned through the modeling used to support the program. The agencies use different models to address the overlapping issues of GHG reduction and fuel economy, as well as different metrics. As will be discussed in the Technology section below, EPA measures energy efficiency by looking at power-to-weight ratio, while NHTSA measures tractive energy, which tends to be

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was inconsistent with its July 28, 2011 Commitment Letter concerning the National Program. *See* July 28, 2011 Commitment Letter from Mary Nichols at 2 (stating that California committed to accepting compliance with EPA's MY 2017-2025 GHG standards "even if amended after 2012.")

[41] *See* Global Automakers Comments on the Proposed Determination at A-8.

[42] *See* pp. 16 herein. For example, the payback period is directly affected by the costs that are attributed to the regulation.

[43] *See* Global Automakers. *Comments on Proposed Determination* at 18-19, citing Office of Management and Budget Circular No. A-4, "Regulatory Analysis," at p. 15.

[44] *Id.*

more reliable. These differences between modeling approaches can lead to differing answers to the same questions. Harmonizing the models could certainly address this issue, but at a minimum, the agencies should seek to further align their metrics to help ensure more consistent modeling results.

The EPA uses the ALPHA model, along with a Lumped Parameter Model (LPM) and an accounting model known as OMEGA, while NHTSA uses the Volpe model, which incorporates data from Argonne National Laboratory's Autonomie model. While the two federal agencies have different statutory authorities, those authorities do not compel them to use two different models. This divergence adds unnecessary complexity, work and expense without additional benefit. The value of having two separate models to answer the same question is not entirely apparent; the most problematic element of this is that this practice has led to inconsistent results.

While each of the models has merits, the Volpe model used by NHTSA has the benefit of a historical development through several iterations to identify and remedy bugs and to address inconsistencies. Further, this model seems to provide a more transparent and discrete step through of each of the modeling scenarios. While NHTSA has acknowledged deficiencies in certain technical assumptions/constructs in 2017, the agency has engaged with industry to coordinate and work to update assumptions and data in the Volpe model, including design cycles, investment constraints, industry data and historical learning. NHTSA has also been working to incorporate market constraints and potential impacts on jobs and the economy as part of their analysis. It is expected that this updated data and improved modeling capabilities will be part of the next Volpe data run that has yet to be published.

By contrast, EPA uses three different models to generate its regulatory estimates. These models are complex, difficult to understand, and lack transparency regarding inputs and decision-making functions. They also replicate results that integrate complicated direct cost estimates (which are highly sensitive to assumptions), the use of short- and long-term indirect cost multipliers (ICMs), and numerous learning curves. At the same time, EPA has played an important role generating publicly-available information through its engine mapping and tear-down analyses. These data should not be isolated to EPA's modeling process; they should be integrated into the Autonomie model, which then feeds into the Volpe modeling process.

Additional comments regarding the models can be found in the Technical and Modeling Section of these comments.

V. Technology and Modeling

In the Draft TAR and Proposed Determination, Global Automakers identified modeling inconsistencies that led the agencies to over-predict the GHG reductions and fuel savings that various technologies could provide. The consequences of this are not trivial. Longstanding issues associated with EPA's modeling approach appear to have been maintained throughout the MTE process to date, and Global Automakers is concerned that these ongoing errors will impact the new analysis for this MTE. Correcting for these modeling errors—including updating the agencies' modeling, assumptions and data—would result in a conclusion that adjustments to the regulations are needed. Adjustments could take numerous

forms, including credit flexibilities that allow automakers to manage investments, build vehicles that consumers want and can afford, encourage innovation and continue on the path of annual fuel economy improvements and GHG emissions reductions.

EPA has acknowledged that its modeling approach delivers an imprecise assessment of technology effectiveness:

> ...this modeling process is a simplification, as are all models, and mapping different vehicles in the baseline fleet to the same exemplar will produce both small over-estimates and small under-estimates of technology effectiveness, depending on how close the baseline vehicle is to the exemplar used in the LPM. However, on a fleet-wide average, these small over-and under-estimates of technology effectiveness tend to average out.[45]

In the Proposed Determination, EPA updated its assumptions using newly-collected data from industry, suppliers, teardowns, engine mapping, and other agencies (among other sources) and implemented improvements to the model. However, EPA continues to assert that their model's incorrect estimates "tend to average out." Throughout the MTE process, multiple stakeholders' have documented concerns that EPA's modeling framework yields biased results. Many of the issues that we identified and commented on in the Draft TAR and the Proposed Determination have not been addressed.[46] Moreover, some of the original analyses that led to the over-projections of the implementation rates and the efficacy of fuel economy technologies have remained embedded in the modeling work.

EPA's Lumped Parameter Model (LPM) is of particular concern due to its simplified technology effectiveness projection process. The LPM propagates fundamentally flawed content into the ALPHA and OMEGA models and therefore cannot accurately assess the efficacy of fuel economy technologies.

Finally, it is critical that agencies use the most up-to-date data to provide the best analysis. In the Proposed and Final Determination, EPA did not use the most recent available data for the baseline (MY 2016). This decision not to use the most updated technology information available for each class of vehicle led to an incorrect establishment of the null vehicle. We understand that EPA is updating its baseline fleet, and thus, we request that the agency share this data as early as possible to allow companies to review the baseline data for accuracy.

We have also recently learned that EPA plans to abandon its reliance on LPM in favor of another modeling approach. Global Automakers looks forward to reviewing these new findings and modeling processes as they are made available. We expect that these updates will address the concerns raised both previously and in these comments with respect to the LPM model, transparency, providing quality checks, the technology selection process, and technology effectiveness.

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[45] U.S. EPA. *Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Technical Support Document, Appendix A,* at 38-42, (November 2016).

[46] *See* Global Automakers. *Comments to the 2016 Proposed Determination*, (December 2016).

Industry Analysis of EPA Model Demonstrates Severe Deficiencies

A. Continued Issues with the Lumped Parameter Model

EPA updated the data and assumptions within the LMP to provide more accurate predictions of powertrain efficiencies for the analysis for both the Draft TAR and the Proposed Determination. While the agencies continue to update the models "to be more accurate, efficient, transparent and cost-effective than relying on contractors,"[47] issues still remain. For instance, the ongoing inclusion of problematic historical assumptions have not been removed from the LPM modeling.[48] The results produced by using these assumptions raise concerns and show that a deeper evaluation of all LPM technology pathways is necessary.

Since the release of the Draft TAR in June 2016, Global Automakers and the Auto Alliance have contracted with Novation Analytics to evaluate EPA's changes to the LPM and to understand if such changes have produced more robust results. The primary method to evaluate the LPM results has been to explore the plausibility of the technology effectiveness estimates from the ALPHA outputs through the Novation model.[49] Using the same inputs through the two modeling processes should produce similar outputs; therefore, any inconsistencies between the two would raise plausibility concerns. Copies of the study conducted by Novation Analytics and a presentation provided to EPA are attached to these comments as Appendix A and B.

In short, Novation Analytics' analysis of the LPM model was conducted by generating an alternate regression model, which could then be used to assess EPA's Proposed Determination claim that the LPM produces unbiased estimates of technology effectiveness on average across the light-duty fleet. This alternate regression model is populated using EPA's published ALPHA vehicle simulation data. While this data was used to focus on the plausibility of the LPM results, one challenge of using the ALPHA data was that the publicly available data only covered 18% of the projected MY 2025 fleet. Despite being limited to only 18% of available vehicle data, this data was used to populate the alternate regression model and was then used to generate efficiency, fuel consumption and tailpipe CO_2 emissions to compare against the LPM results.

The results from this comparison of LPM and ALPHA results indicate that despite EPA's changes to the LPM since the 2012 Final Rule, the LPM continues to over-project technology effectiveness for various technologies that the EPA suggests can be deployed to achieve the MY 2025 GHG standards. Of note, the effectiveness estimates for the Atkinson engine appear to demonstrate the highest level of overestimation, and as part of EPA's recent work, EPA suggests that much of the MY 2025 fleet will rely on this technology as a cost-effective approach for meeting the regulatory requirements. As these

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[47] Draft TAR, at 5-256, (November 2016). https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf.

[48] *See* Global Automakers. *Comments to the Draft TAR*, and *Comments on the 2016 Proposed Determination*. Docket Number: EPA-HQ-OAR-2015-0827.

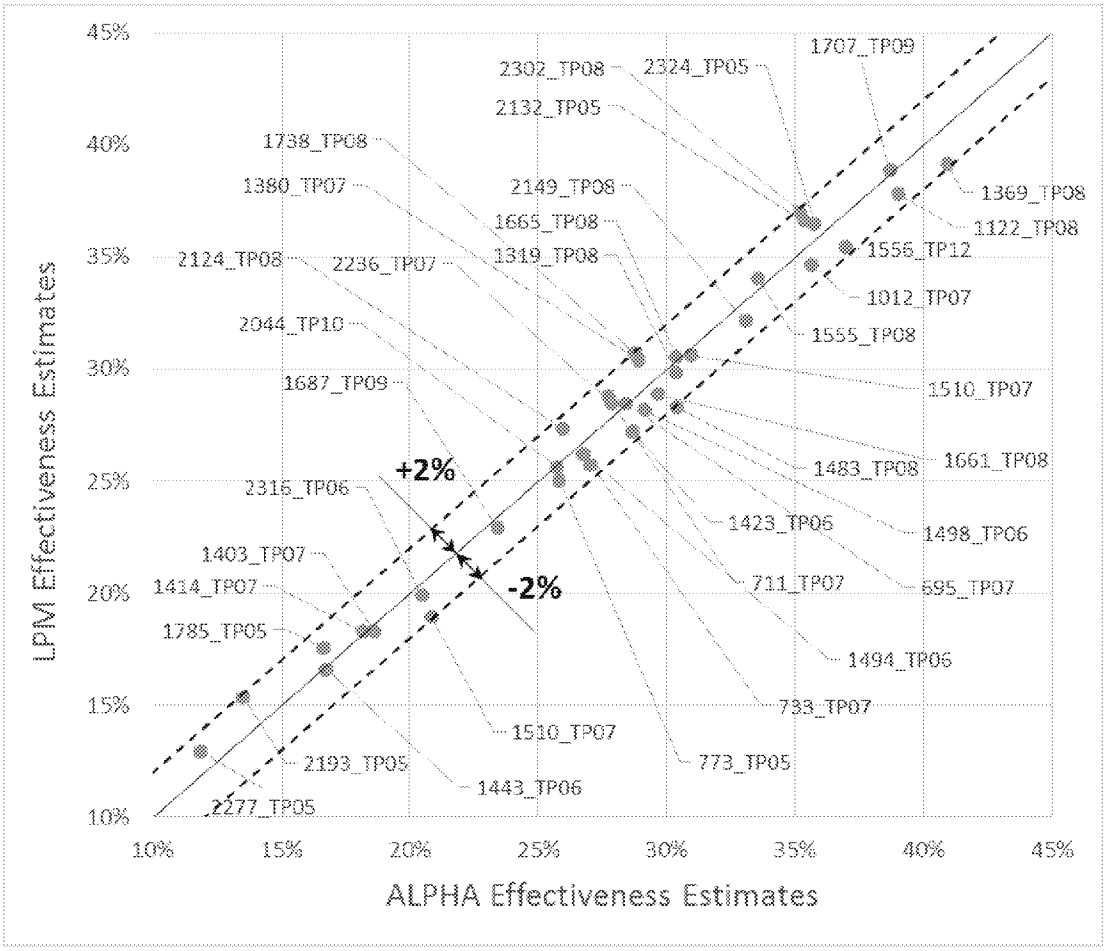
[49] Following a meeting between EPA, Global Automakers, the Auto Alliance and Novation Analytics on September 21, 2017, we understand that EPA is moving to eliminate the LPM, for the most part, from its modeling package. We agree with EPA's decision and provide further comment regarding the use of new modeling at the end of this section.

findings demonstrate, "…the EPA's updated LPM is still a source of error in EPA's projection of technology effectiveness."[50]

The most salient example of this comes from the analysis of EPA's Figure 2.100 in the Technical Support Document (TSD) for the November 2016 Proposed Determination.[51] The figure attempts to address industry's concerns about pervasive modeling bias in the LPM calibration using the ALPHA simulation. EPA explains that the figure "confirms that the LPM is able to reliably replicate the effectiveness values generated by the physics-based ALPHA model (within 2%) over a wide range of vehicle classes, technologies, and powertrain efficiency values."[52] In trying to replicate Figure 2.100, however, industry was not able to locate the data in any of the regulatory files and had to specifically request this data from EPA.

[50] Novation Analytics. *Technology Effectiveness - Phase II: Vehicle-Level Assessment (version 1.0)*, (November 2016) at 7. Retrieved from: https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2015-0827-4089&attachmentNumber=3&contentType=pdf. ("Phase II Study")
[51] U.S. EPA. *Proposed Determination - Technical Support Document*, (November 2016) at 2-286. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf.
[52] *Id*.

Figure 2: Reproduction of EPA's Figure 2.100 from the Proposed Determination's Technical Support Document



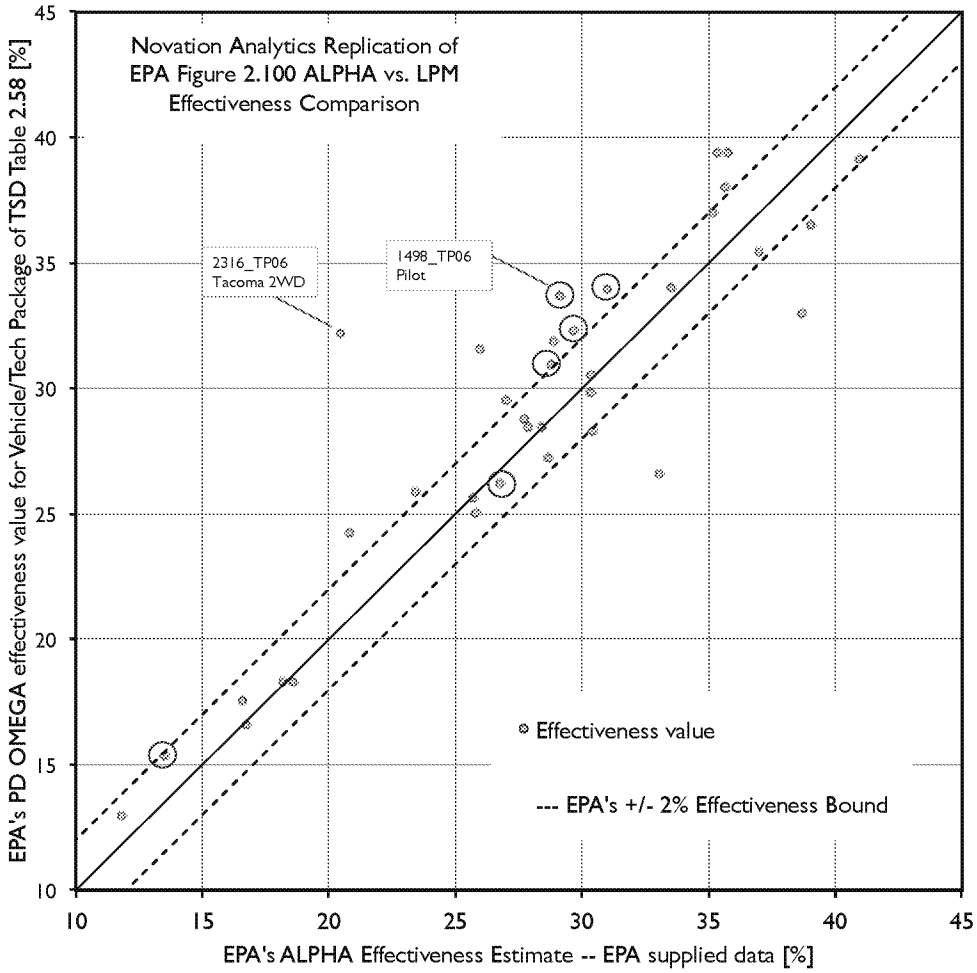
Source: EPA. Proposed Determination, Technical Support Document. Figure 2.100

Novation Analytics replicated Figure 2.100, using data supplied by EPA, and the replicated results are shown below in Figure 2. In Figure 2, ±2% effectiveness threshold lines are shown, consistent with EPA's Figure 2.100. Since EPA's GHG regulation is specified in terms of absolute CO_2 targets, a 2% variance in effectiveness would equate to 6 grams/mile in terms of absolute tailpipe CO_2 differences. Therefore, a 2% variance in effectiveness becomes a larger absolute CO_2 difference at higher effectiveness values. The replicated results show that 17 of the 36 vehicles exceed a 2% effectiveness variance.

Absolute CO_2 error increases non-linearly and equates to 3.6% error for a 45% technology package effectiveness, nearly double the stated effectiveness error when viewed in the absolute CO_2 domain. Novation Analytics' analysis indicates a much wider variation in LPM/OMEGA effectiveness versus ALPHA effectiveness than portrayed in EPA's Figure 2.100 and shows that the inconsistency in technology assumptions is propagated from LPM to the OMEGA model. Specifically, the study confirms both over- and under-projections of the LPM exist, and these projections do not average out across vehicle segments; however, the source(s) of bias are not known.

As can be seen by comparing Figures 2 and 3 in this document, some data points seem to have been significantly revised. This raises a number of questions. For instance, what is the basis for the discrepancy between the Figure 2.100 and the data provided by the agency to industry? Which data points are correct, and what was the basis for the revision? Why were the updated data not made available in the docket? All of these questions support Global Automakers' ongoing concerns about data integrity and transparency throughout the MTE process.

Figure 3: Novation Analytics Replication of ALPHA versus LPM Effectiveness



Source: Novation Analytics, EPA Briefing, September 2017. See Appendix B.

In work previously conducted by Novation Analytics, called the Technology Effectiveness Phase II Study, Novation Analytics demonstrates that the LPM ignores a number of factors that impact the efficacy of fuel economy technologies:

> Engine displacement and vehicle load, which are first-order determinants of powertrain efficiency, are not used as parameters in the model. Instead, the LPM uses a crude distinction of vehicle class (e.g., small car, standard car, large car, small MPV, large MPV, truck) with simple linear regressions of torque, road load at 50 mph, and equivalent test

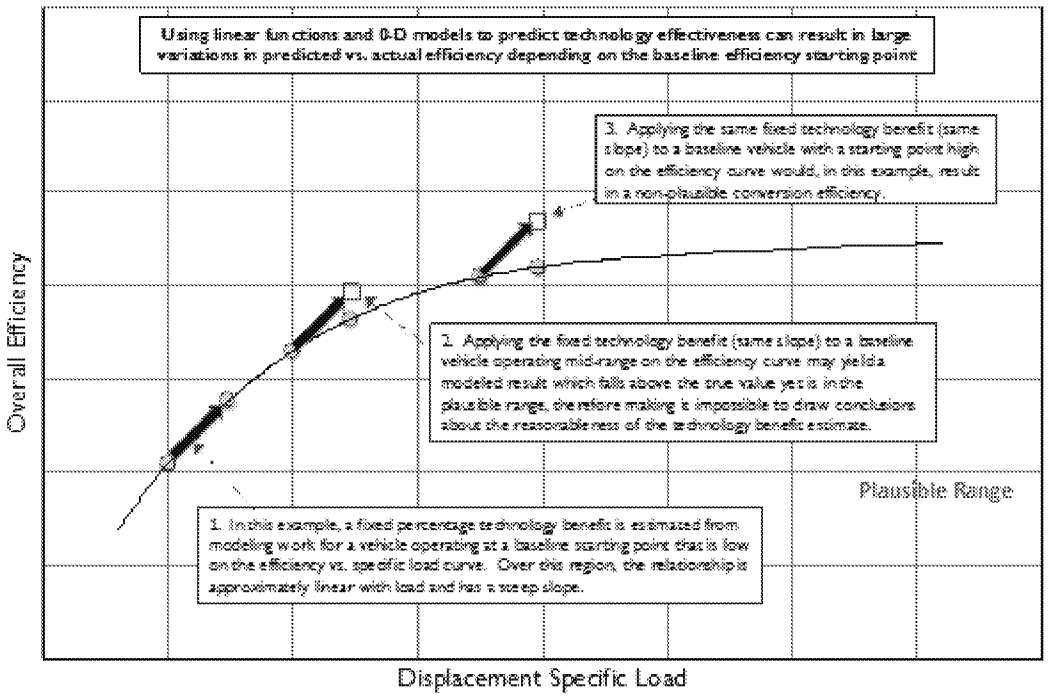
> weight (ETW); these parameters alone will not adequately model powertrain efficiency... In treating all products within these vehicle categories as equal, the LPM does not recognize the inherent variability of efficiency within the light-duty fleet.[53]

In this same study, Novation Analytics also noted that fuel efficiency does not increase in a linear fashion. As the vehicle load increases for a specific engine displacement, fuel efficiency gains become smaller.[54] The LPM does not take this relationship into account – it assumes the relationship is linear. As a result, for vehicles that are already operating at a high efficiency level, the LPM over-predicts the technology effectiveness as technologies are implemented. Novation Analytics explained:

> Since the agencies model all technology effectiveness as a percentage reduction of CO_2 or fuel consumption versus the baseline performance, then those vehicles with baseline efficiency (MY 2008 or MY 2010) higher along the conversion efficiency spectrum will be pushed even higher through the agencies' modeling process.[55]

Novation Analytics illustrated this problem in Figure 3 below:

Figure 4: Technologies in Vehicles can have Major Variations in Predicted vs. Actual Efficiency



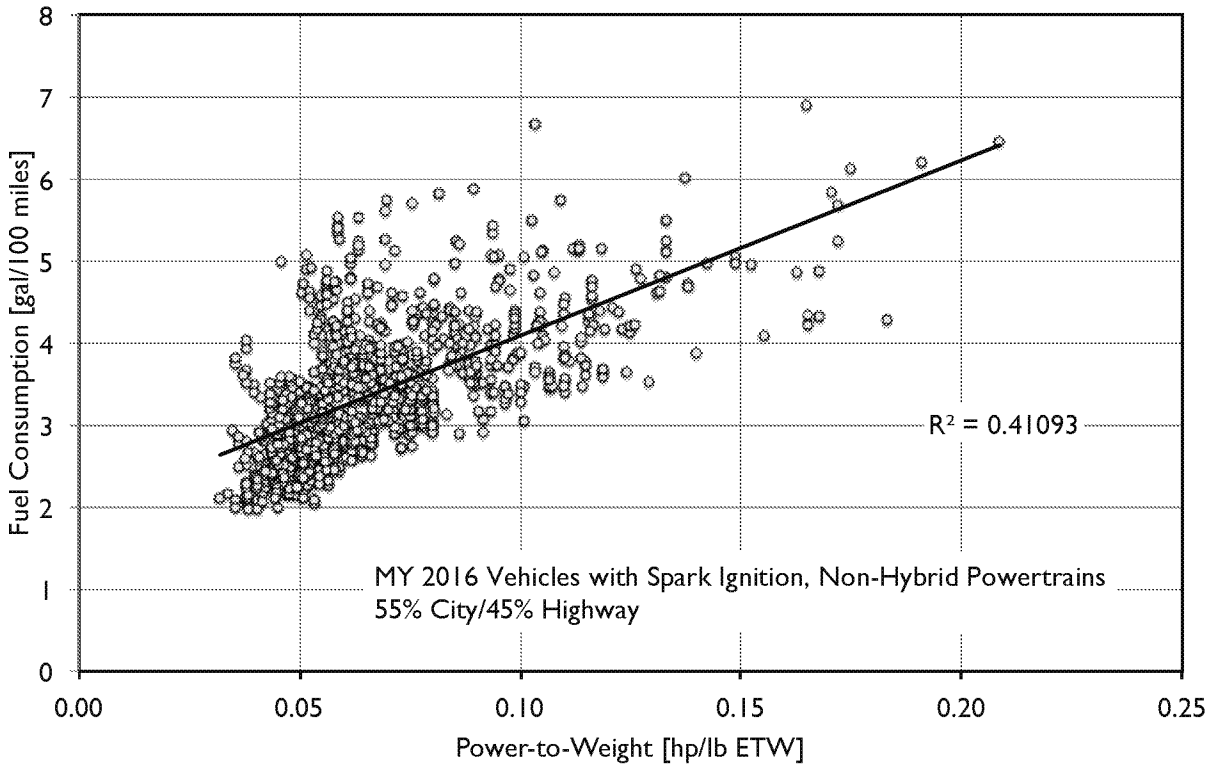
Source: Novation Analytics Phase II Study.[56]

In the response to comments on the Proposed Determination, EPA attempted to address the issue of the LPM's lack of engine displacement by using power-to-weight ratio and road load horsepower as a metric for energy use. However, power is not a robust substitute for engine displacement due to the

[53] Novation Analytics. "Phase II Study," (November 2016) at 42.
[54] Novation Analytics. "Phase II Study," (November 2016) at 35.
[55] Novation Analytics. "Phase II Study," (November 2016) at 40.
[56] Novation Analytics. "Phase II Study," (November 2016) at 39.

vast range of engine configurations and features. As shown in Figure 5, power-to-weight ratios do not capture tractive energy, because the power-to-weight ratio provides only a linear correlation of 0.41093, which demonstrates high variation in fuel consumption (and CO_2 emissions) across the fleet. While the categorization captures some of the additional variation, the overall correlation remains weak.

Figure 5: Power-to-Weight versus Fuel Consumption[57]



Source: Novation Analytics. EPA Technical Briefing.

The exact process and data used by EPA to calibrate the LPM from full vehicle simulation results remains unclear when compared with similar full-scale vehicle analyses like the ones conducted by Novation Analytics. Therefore, it is important that an examination of processes to develop the modeling steps be undertaken in order to pinpoint the source(s) of the translation bias. Although EPA claims that the LPM was calibrated based on thorough testing and modeling with the ALPHA model, the materials provided with the Proposed and Final Determination only cover 18% of the projected vehicle fleet with regards to specific combinations of powertrain technology presented by EPA in the MY 2025 OMEGA pathway. It is unclear how EPA calibrated the LPM for the remaining 82% of the projected vehicles. EPA's failure to publicly share the data for such a large percentage of vehicles raises questions about the quality of data.

We now understand that EPA is updating its modeling approach and moving to eliminate the LPM. We agree with EPA's decision and believe it represents a move in the right direction to a more accurate, transparent, and real-world accounting of the vehicle fleet. As EPA works to develop a new model or modeling methodology, we hope that the agency will be cognizant of the problems seen historically and

[57] Novation Analytics. *EPA Technical Briefing*, (September 2017) at slide 17.

work to avoid repeating those shortcomings in its new modeling approach. It is important for the agency to share information about the new modeling process as soon as possible and provide public review of the model for analytic robustness. Global Automakers is willing to review the latest modeling to ensure it is ready for use. In the event there is insufficient time for proper review of the new modeling, then EPA and NHTSA must determine whether it is appropriate to use two separate models for MTE decision-making. Regardless, both agencies should remain involved in contributing to a reliable, data-driven process.

B. OMEGA Modeling Issues

While the LPM continues to be the main source of concern with EPA's modeling process, the OMEGA model would also benefit from improvements to make sure it properly accounts for industry costs and business considerations. For example, it appears to largely ignore real-world constraints, such as a product launch cadence, implementation, intellectual property and manufacturer technology plans. On a technical level, it seems to incorrectly apply mass reduction, aerodynamics and tire improvements.

One of the areas of concern that remains despite repeated flagging is the importance of using the most up-to-date sets of data that contain real-world vehicles. This allows OMEGA to apply costs in a manner that is more consistent with manufacturing realities. While many iterations of data must be analyzed, comparing assumptions to reality would be a simple method to ensure quality control and to reduce questions of complexity.

Some of the Proposed Determination's OMEGA data files contain what appear to be mistakes. Take EPA's modeling of electronic power steering (EPS), for example. In the Proposed Determination, EPA's baseline fleet does not include EPS for several models, which in fact used this technology. This contradicts the agency's own MY 2014 baseline analysis, which showed approximately 80% penetration of EPS within the fleet. It therefore does not make sense that one model year later, the fleet would transition from 80% to 0% use of EPS.

Errors in the latest OMEGA files are not limited to EPS. Other incorrectly-applied technologies include aerodynamic designation (on Civic HF) and VVT application (on multiple Honda and Acura models). While this point reflects feedback from just one of our member companies, we believe it is reasonable to assume that similar errors exist throughout EPA's data set, across all vehicle manufacturers.

An investigation of the modeling has shown that nearly every Atkinson 2 (ATK2) application also assumes cooled exhaust gas recirculation (cEGR). The OMEGA model prediction of 44% penetration rate by MY2025 inherently assumes ATK2 engine development is currently occurring at all OEMs. This adds two expensive, intellectual property-constrained technologies to the vehicle mix that do not represent market realities. The subsequent assumptions yield $32/% to $35/% cost-effectiveness values (dollar per percent FC/GHG reduction). "Futured" non-hybrid ATK2 engine technology is highly speculative. These types of speculative assumptions have real cost implications in the OMEGA modeling and should be investigated prior to the next iteration.

C. Transparency of the Modeling Process

Increasing modeling transparency allows for a fairer assessment of costs that integrate a diverse range of inputs including complicated direct cost estimates (which are highly sensitive to assumptions), the use

of short- and long-term indirect cost multipliers (ICMs), and numerous technology learning curves. As noted in our previous comments, there were dramatic changes in the overall modeling results for technology penetrations and vehicle costs from the Draft TAR to the Proposed Determination.[58] It remains unclear in the response to comments and in the Final Determination how EPA arrived at these technology penetration rate changes. These types of significant revisions in the course of such a short time period suggest that considerations of investment, research and development and technology maturity may have been overlooked in the modeling process, as well as leading to questions of how the model can yield notably different results in such a brief period of time.

A key step in stakeholders' evaluation of the EPA's modeling process is to use the publicly available models with the full range of inputs to confirm repeatability. However, only 18% of all vehicle data used as inputs to the ALPHA modeling was made available in the EPA's public sources. Additional data had to be specifically requested subsequent to the publication of the Draft TAR and Proposed Determination. This lack of publicly available data highlights transparency concerns, which Global Automakers has raised on several previous occasions.[59]

Further, a complete, full explanation of the assumptions feeding into the model has still not been provided to the public. While requests have been made for additional information to better understand the inputs and assumptions made, the information has been provided in a piecemeal fashion. A fully documented model compendium, or a series of workshops regarding the steps in the analysis process, would be helpful for public review.

Other Concerns with EPA's Modeling

A. Technology Selection Process

The technology selection process in the LPM makes incorrect assumptions about the availability and effectiveness of the various technologies and the appropriate lead time for introduction of technologies. As a result, EPA incorrectly projects the performance of technology and relies heavily on the promise of unproven technologies that we do not believe are sufficient to meet the requirements. These include, but are not limited to, overestimations in the penetration of certain technologies, such as Atkinson 2 at 44% in MY 2025. A penetration rate of 44% would require that all components be readily available to all manufacturers, who wish to install these types of engines on their vehicles. It appears that the model assumes that automakers would be able to conduct all of the research and development, tooling, safety and reliability testing, etc. necessary to incorporate the ATK2 at a rate fast enough for compliance. This assumption ignores fundamental development and production realities. Further, no analysis of potential supply chain issues and availability of parts for these innovative technologies has been conducted or shared publicly. As mentioned in previous comments, barring a post-hoc evaluation, it is difficult to maintain confidence in the agency's optimism about the wide consumer acceptance, supply availability, safety and learning for new, unproven technologies such as the broad application of naturally aspirated Atkinson cycle engines.[60]

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[58] *See* Global Automakers, *Comments on 2016 Proposed Determination,* (December 2016) at 24-25.
[59] *See* Global Automakers. *Comments to the Draft TAR* and *Comments to the 2016 Proposed Determination*.
[60] *See* Global Automakers. *Comments to the Draft TAR: Appendix A: What Technologies will it Take to Achieve the Standards?* (June 2016).

Further, there appear to still be over-projections of technology effectiveness for a number of SI non-hybrid powertrains, and particularly for the ATK2 engine-based powertrains that represent approximately 20% of the projected MY 2025 sales volume. The currently over-projected efficiency estimates for technologies, such as the ATK2, will lead to an incorrect calculation for tailpipe CO_2 emissions for the MY 2025 fleet for the technology path indicated in the Final Determination. This incorrect assumption has consequences on cost and ultimately consumer acceptance.

B. Technology Effectiveness Assumptions

The agencies need to carefully consider the efficacy of the fuel economy technologies they forecast. If, as in the past, the agencies have over-projected fuel economy benefits from technology and technology packages, they also will have underestimated the amount of technology needed to meet the standards, and therefore the cost of meeting the standards as well. Issues such as the amount and extent of the application of advanced technologies and consumer concerns about payback period, perceived reliability, and impacts on driving behavior must all be addressed more thoroughly in this next iteration of modeling.

In both the Draft TAR and the Proposed Determination, optimistic conventional technology assumptions yielded high compliance modeling penetration rates for conventional technologies and thus lower reliance on electrification technologies. There is a reliance on the ubiquitous deployment of conventional technologies, which are assumed to be very cost-effective (e.g. dual clutch transmissions (DCTs) for the 2012 Final Rulemaking and non-hybrid ATK2 engines for the MTE). Thus, there remain some questions regarding the EPA assumptions and analysis of improvements.

Transmissions have been, and are still, some of the most cost-effective technologies in the GHG and CAFE analyses based on their cost and efficacy assumptions, but Global Automakers questions some of these results. For example, EPA assumed GHG reductions of 7.9% – 11.6% for "futured" 8-speeds over current 6-speeds.[61] This 4.4% year-over-year improvement over the current state-of-the-art 6-speed transmissions is based on input from a single supplier. DCT is another example of miscalculating costs. This transmission has been kept in the mix and "futured," keeping costs down even though the technologies are no longer core technologies used by manufacturers. These types of assumptions yield $17/% to $31/% cost-effectiveness values (dollar per percent FC/GHG reduction).[62]

EPA places heavy reliance on a small number of yet-to-be-proven technologies – 48-volt mild hybrid (MHEV), for example. EPA placed a similar reliance on DCT and P2 in earlier technical analyses, which did not achieve the results that EPA projected. EPA seems to be repeating the same mistake. It is important that technologies are accurately assessed in this MTE so as not to repeat the mistakes made previously. This reliance overlooks consumer acceptance, brand identity, and intellectual property considerations.

C. Objective Assessment of Technologies

It is important for the agencies to recognize that for many different reasons, such as product planning cycles, proprietary technology and market positioning, not all technologies are available to, or used by, all manufacturers equally. The universal best-in-class (BIC) technology applications coupled with highly

[61] U.S. EPA. *Proposed Determination: Technical Support Document. Figure 2.24,* at 2-48.
[62] U.S. EPA. *Proposed Determination: Technical Support Document. Tables 2.60 and 2.61,* at 2-288-289.

optimized packages are not feasible in a high volume/competitive production environment. The application of technology packages, optimized for exemplar vehicles, to a single fleet ignores the real-world constraints that OEMs face in a high volume/competitive production environment. This lack of application of market realities to the modeling process is what yielded the major market share of ATK2 engines in the agencies' assumptions. Considerations of competition should be built into the model's assumptions in order to account for the many constraints (e.g., consolidation of vehicle platforms and engine families) that limit the "economies of scale" that are assumed to lower costs and enable cost learning.

Package optimizations are in conflict with industry-wide vehicle platform and engine consolidations, technology development timeframes, etc. that enable many of the "economies of scale" based cost and cost learning assumptions. Automakers must carefully evaluate unique component variations and associated costs to optimize capital, R&D, and certification costs. For example, engine families and displacements have historically been shared across many platforms and have been stable for multiple redesign cycles (10+ yrs.). The assumptions imply that OEMs will need to invest in resizing engine displacements at every vehicle redesign (+/- 5yrs) and maybe even at vehicle refresh cadence. This seems ambitious and does not correlate to either the rates seen in the marketplace nor to information provided by manufacturers.

In developing an updated model, EPA should pay specific attention to ensuring that objective, real-world constraints are placed on the model's technology selection assumptions.

D. Cost Learning Assumptions

The model's cost learning assumptions are either incorrect or non-identified. The agencies should consider – and quantify, in terms of penetration rates and overall compliance cost – what will happen if, as in the past, agency technology effectiveness projections prove to be overly optimistic. The consequences of over-projecting the fuel economy benefits of technology are serious. It leads to an underestimate of the technology needed to meet the standards and to the corresponding cost of compliance, which ultimately impacts prices and affordability for customers. If the projections are inaccurate, manufacturers will have to use a higher levels of hybridization and/or electrification to comply with the standards, leading to additional costs in the regulation and higher prices for customers.

The agencies' calculations appear not to have accounted for the lead time (and the associated costs) necessary to implement technologies projected in the Proposed or Final Determinations. Motor vehicle product planning entails the coordination of three different development cycles: (1) models, which are generally updated every 5 years, on average, (2) powertrains, which are updated approximately every 10 years, and (3) platforms, which can remain in use up to 15 years. With these long development cycles manufacturers do not rapidly change machining processes and simultaneously upgrade multiple models with a brand-new powertrain technology.

Further, EPA reduces indirect costs each year because they are a percentage of direct costs, which decrease each year because of learning. Indirect costs are further decreased when the indirect cost multiplier switches to long-term (e.g., reduction between MY 2018 and MY 2019 and between MY 2024 and MY 2025). While this is consistent with the amortization of costs over time, the methodology used by EPA does not seem robust.

EPA has grouped all technologies into three broad categories (low, medium and high complexity) and then treated them as if individual technologies within these categories will have exactly the same ratio of indirect costs to direct costs. This is an oversimplification of a complex set of discrete manufacturing decisions that do not accurately account for synergies or the addition of cost from new technologies. EPA also states in the Proposed Determination that "the ICM estimates have not yet been validated through a direct accounting of actual indirect costs for individual technologies."[63] In the modeling, these assumptions of technology availability has led to significant total cost reductions are projected for technologies already assumed to be "mature," for example 14.2% for TRX12 and 14.0% for TRX22. For the increasingly complex technology packages that are applied to vehicles through MY 2025, the lack of comparison and validation of costs with real-world data is concerning.

The modeling should evaluate a set of technologies to detail the inconsistencies between the year of introduction, the year of technology "maturity", continuous cost reductions, continuous improvement ("futuring"), technology turnover, etc.

Many of the technology packages are not fully accounted for in real world dollars which can lead to incorrect assumptions of cost. Moreover, many of the packages assume use of technologies that are neither widely used nor readily available to the full market. The lack of availability of technology means that the cost savings from economies of scale, as were assumed by the agencies, are out of phase with market realities. In order to remedy the misalignment with market realities, the agencies should clearly define their cost metrics and consult with manufacturers for any outstanding cost questions as data is available.

E. Costs Underestimated for the Level of Technology Needed

Industry has raised concerns, on several occasions, that EPA's modeling has consistently underestimated the costs associated with technologies and the amount needed. A quality check at every step of the process needs to be done with real-world data that has been supplied by manufacturers. One of the most important examples of these overly optimistic assumptions is the FEV, Inc. cost assumption that technologies would be mature when produced in large volumes (450,000 units or more for each component or subsystem).

To our knowledge, there has never been a study of whether manufacturers would able to employ the technology at the volumes assumed in the FEV analysis with fully-learned costs. There is also the potential for stranded capital if technologies are introduced too rapidly for some indirect costs to be fully recovered. While EPA has requested that FEV conduct supplemental tear-down analysis results to validate the costs for the MY 2022-2025 time-frame for fully mature high sales volumes (<450,000 units), Global Automakers urges the agency to conduct further transparent analysis to fully consider the costs of the program.

The application of the FEV Engine Technologies contractor's costs in the OMEGA and Volpe models is not always consistent with the bounding assumptions used to develop the FEV costs. Explicit bounding assumptions that are not strictly enforced in the OMEGA (or Volpe) model can lead to optimistic compliance cost estimates. FEV cost applications ignore the fact that many existing or recently applied

[63] U.S. EPA. *Proposed Determination*, at 2-224. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf.

technologies would continue to be used in production absent regulation. Constant "futuring" of technologies and frequent optimization of technology sizing (e.g., engine displacement) assumes frequent replacement of technologies, also no company can afford the variation of displacements inferred by EPA's modeling.

Global Automakers requests that the agency document the cases where 450,000-unit annual thresholds are assumed to be met for early introductions of FEV-costed technologies. It is important to evaluate and track if (and when) stranded capital cost are being applied, and determine whether stranded capital costs need to be developed for all technologies. In conjunction, with the analysis of these costs, the accounting of the next steps of how stranded capital may affect vehicle price should be conducted.

Other real-world disparities have been documented in previous comments by Global Automakers[64] that should be addressed include, but are not limited to:

- Decisions regarding the implementation of engine technologies entail long-term investments across vehicle classes and need to be analyzed in light of the major cost implications to manufacturers in terms of abandoning product development, retooling factories, and the inability to recoup stranded capital.
- The development, testing and roll-out of these technologies requires major economic investment by manufacturers and significant lead-time.
- EPA continues to focus on a specific vehicle technology, the ATK2 engine used by the Mazda SKYACTIV-G, and as a result leaves out critical assessments of other technology pathways.
- A full-scale assessment of the research and development and manufacturing costs that would be required to convert to this engine technology indicates the lack of a reasonable and rigorous cost/benefit analysis in the modeling.
- Electric vehicle costs including battery cost, infrastructure support costs, and associated manufacturing support that would be incurred.

MY 2016 and MY 2017 Fleet Data

Final volumes are available for all manufacturers' fleets through the end of MY2016, and preliminary results for MY 2017 are available through mid-model year reports. These model years represent the most up-to-date production volumes and a true vision of market realities and their impacts on GHG emissions and fuel economy. This baseline data provides an important cross-check between agency assumptions and the vehicles that are available in the market.

Industry contracted with Novation Analytics to collect and aggregate final model year 2016 and mid-model year 2017 fleet data, as we have done for each model year since 2012.[65] This data, combined with the past five years of market data, shows the following critical takeaways:

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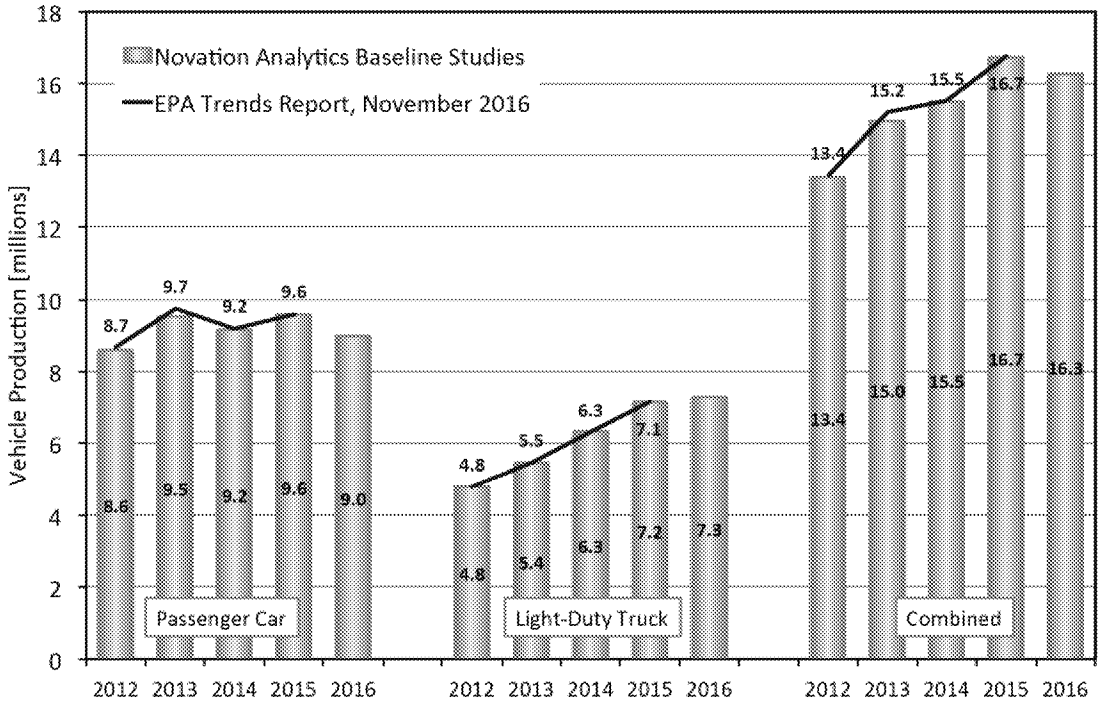
[64] *See* Global Automakers, *Comments to the 2016 Proposed Determination.* December 2016.
[65] See Appendix C of these comments.

- MY 2016 vehicle production decreased by 0.4 million units compared with the previous MY 2015. This decrease occurred primarily in the passenger car fleet. See Figure 6 below.

Figure 6: Vehicle Production

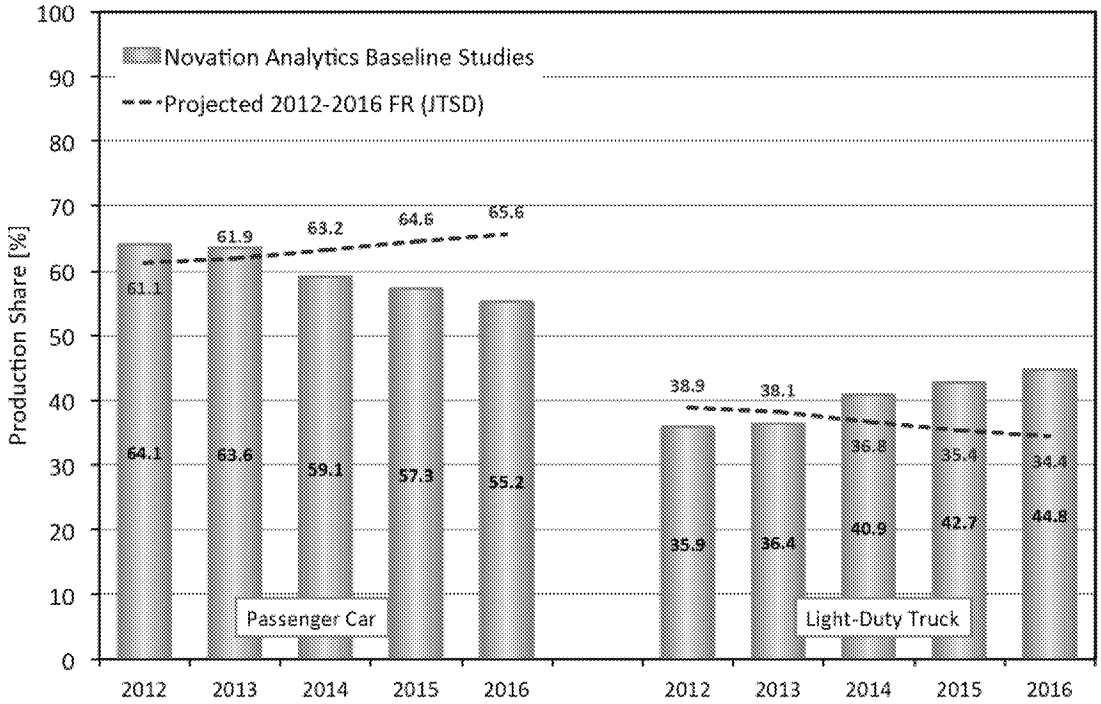


Source: Novation Analytics MY2016 Baseline Study.

- As reflected in Figure 7, below, the share of passenger cars continues to drop as a share of the new light-duty vehicle market, decreasing to 55.2% of the total production.[66]

[66] Novation Analytics. *MY 2016 Baseline Study - Final Volumes*. September 2017. ("MY2016 Baseline Study") *See* Appendix C of these comments.

Figure 7: Production Share, Actual vs. Projected (without credits)

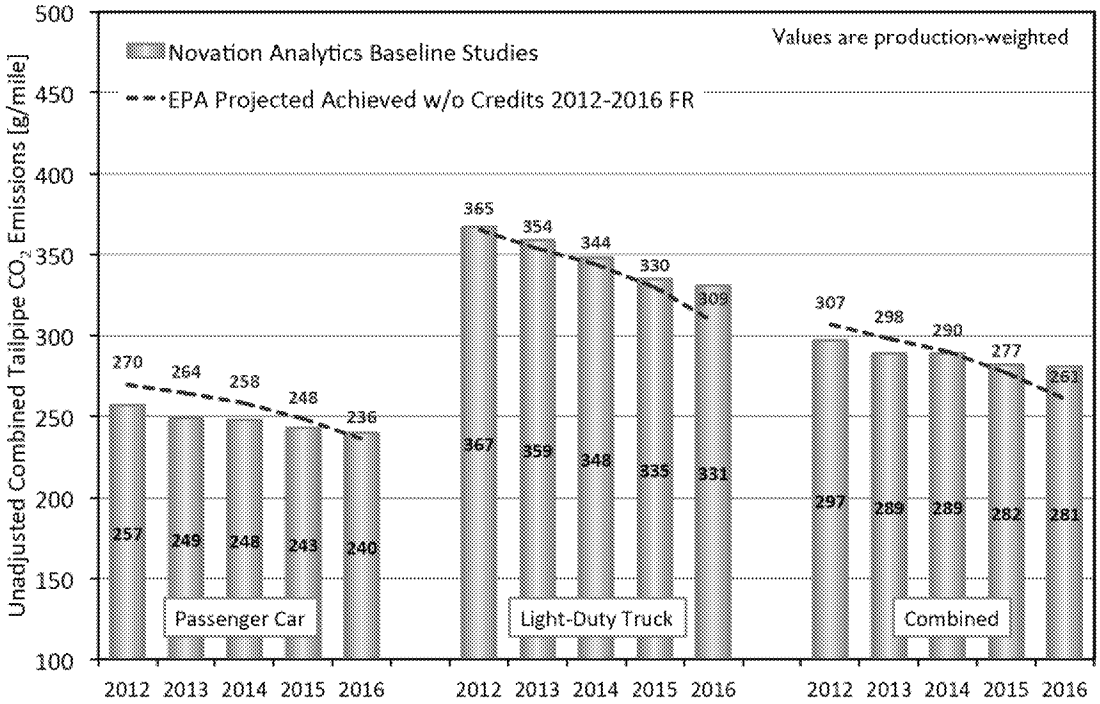


Source: Novation Analytics MY2016 Baseline Study.

- As shown in Figure 8, below, for the second model year running, neither the passenger car nor the light-duty truck fleet has achieved the CO_2 footprint standard without the use of credits.[67] Further, and of critical importance, for the first time since the start of the National Program, the MY 2016 passenger car fleet under-performed the tailpipe CO_2 performance as projected by the EPA in the final rule.

[67] Novation Analytics. "MY2016 Baseline Study," at 18.

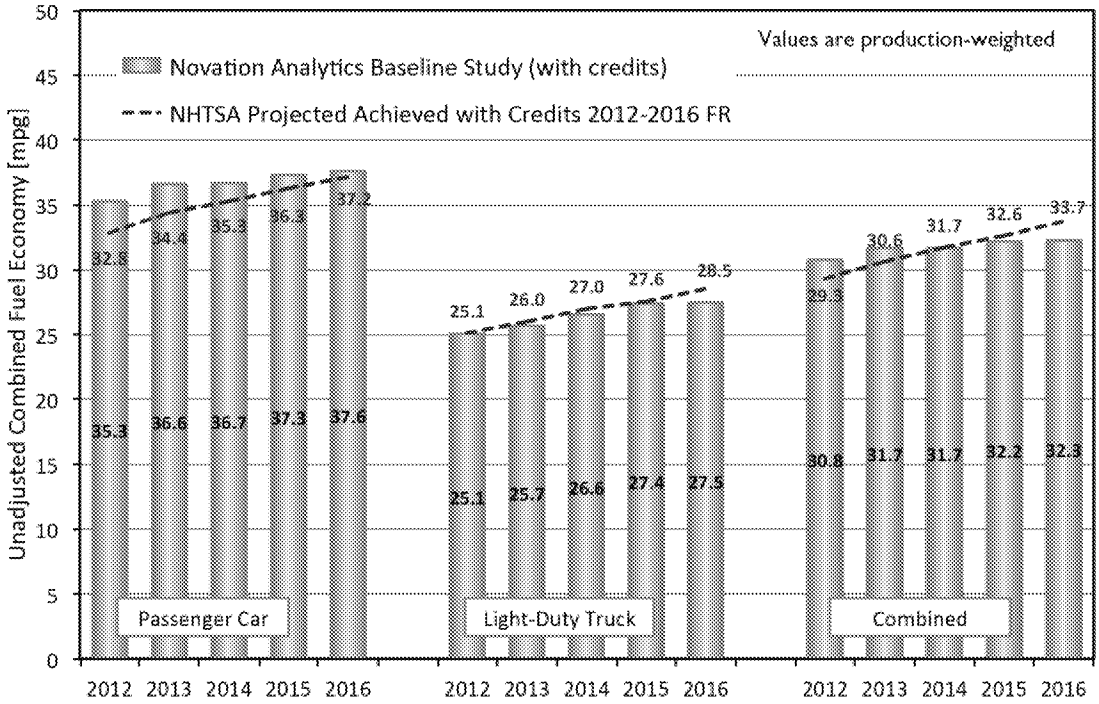
Figure 8: Fleet Flue Economy - Projected vs. Actual (without Credits)



Source: Novation Analytics MY2016 Baseline Study.

- As shown in Figure 9 below, even with accounting for the use of credits, the year-over-year passenger car fleet improvement has continued to slow, and the light-duty truck improvements has completely stalled. This means that the fleet overall falls short of the agency's projected performance for MY 2016.

Figure 9: Fleet Fuel Economy - Projected vs. Actual (with Credits)



Source: Novation Analytics MY2016 Baseline Study.

Based on use of mid-model year 2017 data to project year-end results for MY 2017, we are seeing similar trends continue into this next model year, see Figure 10 below. Three specific trends are notable: ongoing consumer preferences shifting from cars to trucks, stability in the car and truck fleet footprints, and modest gains in 2-cycle CO_2 and fuel economy, without accounting for credits. Even with credits factored into the preliminary estimated fleet mid-model year data, the following trends occur. Passenger cars may not meet either the GHG nor CAFE standard for MY 2017, currently estimated at a 5 g/mile or -0.1 mpg gap. Light trucks will likely miss both the GHG and CAFE standards for both MY 2016 and MY 2017, with compliance gaps in MY 2017 estimated to be 12 g/mile or -0.8 mpg.

Figure 10: Novation Analytics Baseline Study

		MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	MY 2017
Production	[millions]	13.406	14.967	15.506	16.736	16.268	16.401
Passenger Car Share	[%]	64.1	63.6	59.1	57.3	55.2	52.4
Light Truck Share	[%]	35.9	36.4	40.9	42.7	44.8	47.6
Passenger Car Footprint	[ft2]	45.6	45.9	46.0	46.1	46.1	46.3
Light Truck Footprint	[ft2]	54.3	54.7	54.9	53.9	53.7	53.7
Passenger Car GHG Standard	[g/mile]	266	260	252	241	230	219
Passenger Car 2-Cycle CO2	[g/mile]	257	249	248	243	240	237
Passenger Car GHG Credits	[g/mile]	10	11	14	13	11	13
Passenger Car GHG Compliance Value	[g/mile]	247	239	234	230	229	224
Passenger Car GHG Performance to Standard	[g/mile]	19	21	18	11	1	-5
Light Truck GHG Standard	[g/mile]	348	340	331	313	298	295
Light Truck 2-Cycle CO2	[g/mile]	367	359	348	335	331	330
Light Truck GHG Credits	[g/mile]	22	22	27	25	15	23
Light Truck GHG Compliance Value	[g/mile]	346	337	321	310	316	307
Light Truck GHG Performance to Standard	[g/mile]	2	3	10	3	-18	-12
Passenger Car CAFE Standard	[mpg]	33.1	33.6	34.3	35.5	37.0	39.0
Passenger Car 2-Cycle Fuel Economy	[mpg]	34.5	35.7	35.8	36.6	37.0	37.4
Passenger Car CAFE Credits	[mpg]	0.8	0.9	0.9	0.7	0.6	1.5
Passenger Car CAFE Compliance Value	[mpg]	35.3	36.6	36.7	37.3	37.6	38.9
Passenger Car CAFE Performance to Standard	[mpg]	2.2	3.0	2.4	1.8	0.6	-0.1
Light Truck CAFE Standard	[mpg]	25.3	25.8	26.2	27.5	28.7	29.2
Light Truck 2-Cycle Fuel Economy	[mpg]	24.2	24.8	25.6	26.6	26.9	26.9
Light Truck CAFE Credits	[mpg]	0.9	0.9	1.0	0.8	0.6	1.5
Light Truck CAFE Compliance Value	[mpg]	25.1	25.7	26.6	27.4	27.5	28.4
Light Truck CAFE Performance to Standard	[mpg]	-0.2	-0.1	0.4	-0.1	-1.2	-0.8

Source: Novation Analytics, MY2017 Baseline Study.[68]

While we understand that EPA and NHTSA have both updated their baselines to include MY 2016 data, it may also be beneficial to include the early MY 2017 in that data. The current situation of performance and credits must be re-evaluated by the agencies to begin the models at accurate starting places to then determine the correct levels of technology deployment, cost and consumer acceptance assumptions for this rulemaking. It is only when using the most up-to-date data that accurate assumptions can begin to be made.

The Volpe Model

NHTSA's Volpe model for fuel economy standards was developed in the mid-1970s to respond to the first requirements of oil consumption reduction. This model has benefitted from decades of refinement,

[68] This study is not yet complete and therefore is not yet publicly available. It will be released publicly once it is finalized. The values in the table represent estimates based on preliminary mid-model year data for 2017.

updates, and external stakeholder evaluation to result in a robust and well-reviewed model. Further, the model has a thorough and complete set of accompanying documentation. This time has allowed for the writing, editing, and rewriting of the accompanying compendium of information that is both concise and detailed. Such a level of detail establishes a precedent for excellent documentation that can be used by all interested stakeholders. Various scenarios for technology interaction have been able to be tested and issues of transparency have been flagged. This process has allowed for the agency to create a truly detailed and transparent process that is understandable and repeatable for members of the public.

When the model is run by outside members of the public, the results pass plausibility tests and are repeatable, two key aspects to scientific methods that should characterize all modeling. The Volpe model's many previous users allow for these plausibility checks to continue to be tested throughout each iteration of the model.

The model benefits from having developed over many iterations a robust graphical user interface (GUI) that allows for an ease of use for the public without a detailed technical background of modeling execution. Allowing for a more intuitive interface allows for a greater number of users to test the model, find errors and present their findings in a clear and consistent manner.

Finally, NHTSA continues to reach out to all OEMs to proactively confirm inputs into the Autonomie part of the model. This confirmatory step creates an important cross check between real-world and theoretical data and serves the purpose of having the most up-to-date data. Additionally, the fact that NHTSA has an established process for manufacturers to provide data creates consistency year-over-year and creates accountability for all stakeholders in the process.

A. Other NHTSA Considerations

In reviewing the standards set during the 2012 rulemaking, the agencies (specifically NHTSA) must consider the effect of other motor vehicle standards. The application of various technologies may work on paper, but there are other real-world concerns that go beyond cost that need to be taken into account. Many of these issues have been discussed in the sections on mass reduction and consumer acceptance, but the considerations have not been fully accounted for in the modeling. For example, safety regulations can limit a manufacturer's options when it attempts to decrease vehicle weight. Other studies have shown that mass reduction can reduce crashworthiness and increase repair costs.[69] As additional technology is added to vehicles, there are questions about how they have been accounted for in the modeling. This information must be clearly stated in the development documentation for models, as well as in the assessment of the impacts of additional technology on overall vehicle safety.

Global Automakers is pleased to see the agencies taking on considerations that have been previously expressed by industry during this MTE. As the agencies develop new modeling techniques, it is critical to include a comprehensive set of inputs to provide the most robust, science-based, data-driven and transparent information. It is only then that the agencies can apply their best judgment to determine the impact of the standards on cost, consumer acceptance and safety.

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[69] Carley, S. et. al. *Rethinking Auto Fuel Economy Policy: Technical and Policy Suggestions for the 2016-17 Midterm Reviews*, School of Public and Environmental Affairs, Indiana University (February 2016), p. 39. https://spea.indiana.edu/doc/research/working-groups/fuel-economy-policy-022016.pdf. Last accessed September 19, 2017.

Mass Reduction

EPA and NHTSA continue to project that mass and load reduction will play a significant role in reducing GHG and improving fuel economy across the fleet. Since the 2012 Final Rulemaking, the agencies and other researchers have continued to study mass and load reduction. It appears that the agencies have addressed in the Draft TAR and the Proposed Determination at least some of the concerns that have been raised regarding the previous mass and load reduction analyses. For example, EPA has updated the baseline from which mass reductions are calculated to MY 2014 and has made more vehicle-specific determinations regarding mass reduction potential.[70] NHTSA also has performed more vehicle-specific determinations for mass reduction and aerodynamic drag.[71] These changes help to improve the agencies' analysis.

However, neither the Draft TAR nor the Proposed Determination thoroughly accounts for a number of real-world constraints on mass and load reduction, including (but not limited to) the following factors:

- New materials must be extensively tested and qualified before being incorporated into vehicles. It generally involves a five-step process that takes three to four years:

Figure 11: Steps to Vehicle Incorporation

1. 3 to 6 months: procure materials for test.
2. 6 months: preliminary characterization of materials: mechanical and strength tests, joining studies, microstructure analysis
3. 12 to 18 months: detailed characterization of materials, strain rate behavior, fracture testing, formability analysis, reliability/fatigue testing, environmental durability
4. 12 to 18 months: production readiness analysis. Validate CAE models, repair capability strategies, develop material specifications, identify sourcing strategies and qualify suppliers
5. 3 to 6 months: Finalize material qualifications. Document material development results.

Total lapsed time for qualification is three to four years.

Source: Jay Baron, PhD, "Identifying Real World Barriers to Implementing Light weighting Technologies and Challenges in Estimating the Increase in Costs" Center for Automotive Research ("CAR 2016 Study") pp. 6-7.

Even after a new material is qualified, a stable and plentiful supply must be ensured before it can be used in mass production, which can add another several years to the process of introducing a new material.

- The current trend for automakers is to develop global platforms using the same parts in several different vehicle models made in multiple locations. This trend limits the extent to which a manufacturer can optimize an individual vehicle model. This finding is supported by the NRC 2015 Study, which observes:

> Auto companies use many parts across multiple models or vehicle platforms and cannot, for practical reasons, optimize every part on every model of vehicle to

[70] Draft TAR, p. 5-394.
[71] Draft TAR, p. 4-65.

maximize mass reduction. The sharing of parts is done for many reasons, including cost, quality, risk mitigation, and resource management. Similarly, some new materials/parts cannot be integrated easily into existing manufacturing facilities.[72]

- Sunk costs and manufacturing infrastructure limit the speed with which mass and load reduction technology can be introduced.

  The introduction of a new vehicle model traditionally carries over a significant portion of the previous model design and equipment (and supporting supply chain/infrastructure). Fifty percent carryover from one model to the next would not be unusual. Some material changes (e.g., steel to aluminum or aluminum to composites) would call for a complete overhaul – at least for the system or subsystem being changed.[73]

Changes in materials also can require changes to manufacturing equipment, tooling and methods. Abrupt changes in materials can therefore increase manufacturers' stranded costs.

- Lightweighting is cost-constrained – not technology constrained – as premium vehicles tend to have more advanced materials because the pressure to minimize cost is less as compared with conventional automobiles. There is no single cost estimate (such as cost per pound) that can be applied uniformly across the entire vehicle fleet.[74]

- Proof of concept studies don't constrain for real-world factors such as the development process, cost of changing over manufacturing equipment, global platforms and consumer demand. Conflicting evaluations on cost arise when these factors are not properly accounted for.

- Some materials, such as carbon fiber, present expensive and difficult maintenance challenges. Carbon fiber parts are difficult to assess as the damage can often not be seen through visual inspection and more costly processes such as thermal, ultrasonic or x-ray imaging must occur.[75]

- Manufacturers must satisfy customers' and regulatory requirements. Many mass reduction technologies have unintended consequences that customers will not accept. For example, light-weighting technologies can increase noise, vibration and harshness (NVH) to levels unacceptable to customers. In addition, safety regulations can limit a manufacturer's options when it attempts to decrease vehicle weight. Other studies have shown that mass reduction

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[72] NRC 2015 Study, p. 220.

[73] Baron, J. *Identifying Real World Barriers to Implementing Lightweighting Technologies and Challenges in Estimating the Increase in Costs*, (January 2016) ("CAR 2016 Lightweighting Study"), p. 14.

[74] National Research Council. *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-duty Vehicles*, (June 2015).

[75] McKinsey & Company. *Lightweight, heavy impact*, (February 2012) at p. 17.

can reduce crashworthiness and increase repair costs.[76] As the CAR 2016 Lightweighting Study noted:

> Given the competitive importance of ride and handling performance, automakers are very sensitive to technologies that affect this metric. Substituting advanced materials may be structurally sufficient, but adversely affect ride and handling, thus requiring various countermeasures to mitigate this unintended impact.[77]

Global Automakers urges the agencies to address these real-world constraints associated with vehicle lightweighting.

VI. Consumer Acceptance

All stakeholders agree that the benefits promised by the standards will be realized only if consumers purchase the types of efficient vehicles required under the standards. Stakeholders disagree, however, about whether consumer demand for fuel efficiency will grow at the pace assumed by the regulations. This disagreement is fundamental; meeting regulatory targets, and attaining the full benefits of the ONP, depends on consumer buy-in.

Others have commented that the current standards are appropriate and feasible because the benefits of the regulation greatly outweigh the costs, both on a societal basis and for consumers individually. They have argued that consumers will value fuel savings over the long term more than increased purchase costs in the short term, and that fuel economy technologies have no "hidden costs" that will affect consumer demand. They have also claimed that the increased purchase prices of more fuel-efficient vehicles will have no adverse impact on low-income households.

The fact that regulations are needed suggests that market forces alone are inadequate in delivering necessary fuel savings and emissions reductions.[78] Were this not to be the case, consumer demand would simply drive the changes that the regulations impose. But the evidence is to the contrary. Market data shows that while vehicles meeting the standards are on the market now, demand for them is flat or growing slowly. There is little reason to believe that the demand for these vehicles will increase by orders of magnitude in the next eight years.

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[76] Carley, S. et. al. *Rethinking Auto Fuel Economy Policy: Technical and Policy Suggestions for the 2016-17 Midterm Reviews*, School of Public and Environmental Affairs, Indiana University (February 2016), p. 39. https://spea.indiana.edu/doc/research/working-groups/fuel-economy-policy-022016.pdf. Last accessed September 26, 2016.

[77] CAR 2016 Lightweighting Study, p. 10.

[78] In the Proposed Determination, EPA speculated that the regulations would provide benefits aside from fuel savings and carbon reduction by increasing social learning about fuel economy technology, reducing risk for manufacturers and promoting innovation. *See* Proposed Determination at pp. A-36, A-37 to A-40. Global Automakers addressed these speculative rationales in previous comments. *See* Global Automakers *Comments on Proposed Determination* at p. 41.

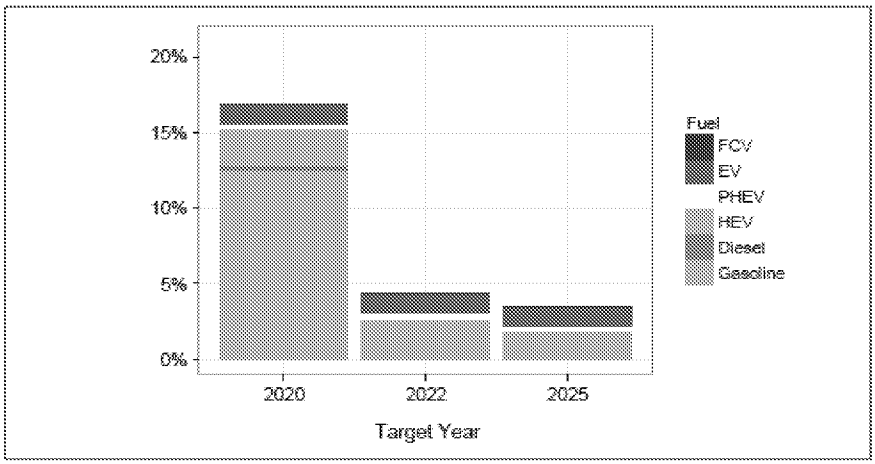
Global Automakers agrees that improvements in fuel economy benefit consumers and that carbon reduction is necessary. Automakers have an important role to play by offering more low-GHG emitting and advanced-technology vehicles. But Global Automakers urges the agencies to be clear-eyed and realistic as they evaluate consumers' appetite for fuel economy and the effects of fuel economy technology on the driving experience, particularly in a low gas price market that does little to sway vehicle purchase decisions. Stakeholders, including the agencies and Global Automakers, do themselves no favors by underestimating the magnitude of the challenge. Our goals for carbon reduction cannot be achieved by pretending that consumers in MY 2022-2025 will place a much higher value on fuel economy than they do in 2017.

The solution, Global Automakers believes, is to add more flexible compliance options, as discussed in Sections VII and VIII of these comments. Flexibilities will reduce costs for manufacturers and in turn, consumers. Flexibilities also will give manufacturers valuable time to innovate –innovation that is necessary if manufacturers are to serve both the demands of customers and the demands of the regulations.

Current Demand for Advanced Technology Vehicles is Low

As noted, Global Automakers recommends that the agencies rely on real-world market data to analyze consumer demand for fuel economy. We begin with EPA's 2016 Fuel Economy Trends report, which shows that less than 5% of MY 2016 vehicles meet the MY 2025 standards. All of those that meet the MY 2025 standards are advanced technology vehicles such as hybrid-electric vehicles (HEVs), plug-in HEVs (PHEVs), battery-electric vehicles (BEVs) or fuel cell electric vehicles (FCVs):

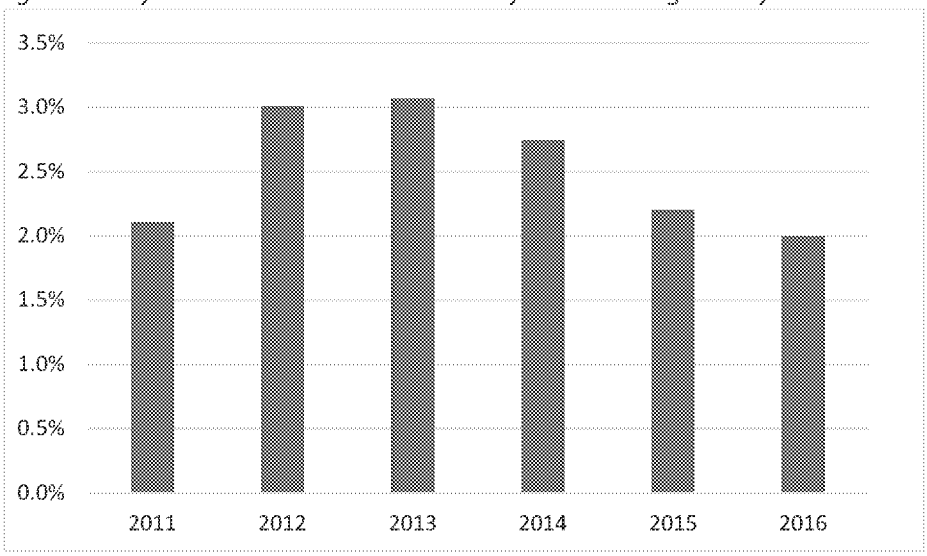
Figure 12: MY 2016 Vehicle Production that Meets or Exceeds Future CO_2 Emission Targets



Source: U.S. EPA, "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016," Figure 9.1 at p. 119.

Demand for these advanced technology vehicles is not strong. The market share of HEVs, a technology that has been available in the U.S. for more than 17 years, is at about 2%. That share has fallen in recent years, even though HEVs are just as convenient as gasoline-fueled vehicles and consumers are very familiar with them:

Figure 13: Hybrid Vehicle Sales as Percent of Total U.S. Light-Duty Vehicle Sales



Source: IHS Global New Vehicle Registration Data, 2011-2017.

While sales of BEVs and PHEVs have increased, they were less than one percent of the U.S. market in 2015[79] and have increased to just barely over one percent this year.[80]

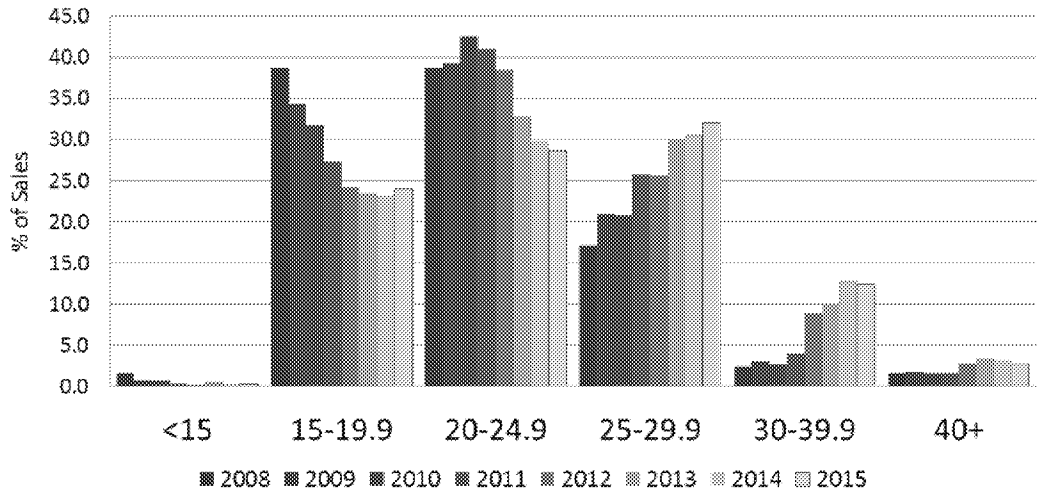
Consumer Demand for High Fuel Economy Conventional Vehicles is Low

In its earlier Final Determination, the EPA claimed that consumer acceptance of advanced technology vehicles is not relevant because only a small number of such vehicles will be needed to meet the regulation.[81] Even if that were true – and the analysis by Novation Analytics shows that it is not[82] – this argument does not stand up to scrutiny.

First, as noted above, none of today's conventional gasoline-powered vehicles meet the MY 2025 standards. Less than one percent of today's vehicles meet even the MY 2022 standards. While more gasoline-powered vehicles meeting the standards will certainly be available over time, the market data suggest that consumers will not demand them in the volumes that EPA projects. WardsAuto has created a "fuel economy index" that shows that sales of the highest fuel economy vehicles have decreased in recent years:

[79] Global EV Outlook 2016 at 37 (International Energy Agency).
[80] IHS Global New Vehicle Registration Data, 2011-2017. Meanwhile, fewer than 1,000 FCVs have been sold in the U.S. this year, though admittedly, these vehicles are only available in limited markets due to a lack of refueling infrastructure.
[81] U.S. EPA. *Final Determination* at 29.
[82] Novation Analytics. "Phase II Study," (September 21, 2016).

Figure 14: Market Share by Index Rating - 2008 to 2015



- In 2015, the two highest ranges lost share and the 15-19.9 range gained favor for the first time

Erin Sunde, Industry Analyst, WardsAuto

WARDSAUTO

Source: E. Sunde, U.S. Fuel Economy, State of the Industry 1Q 2016 (WardsAuto).

This trend has continued in 2017. There have been minor gains in overall fuel economy, but "[i]f the industry-wide 6-month trend continues into second-half 2017, the year will end with the smallest year-over-year improvement seen in the 10-year history of the index."[83]

Further proof of the low value that consumers place on fuel economy is shown in the increasing demand for trucks, which have lower fuel economy than passenger cars. Since 2012, when the standards were adopted, until 2016, the production share of passenger cars has dropped from 64.4% to 57.4%, while the production share of light trucks has increased from 36% to 43%.[84] This trend is expected to continue.

This is the opposite of what the agencies predicted when they adopted the standards. While the footprint-based approach is designed to account for consumer preferences based on vehicle class and size, significant increases in stringency in the coming years – for all passenger cars and the majority of light trucks – suggest an impending disconnect between regulatory and market demands. Simply put, an attribute-based framework is not a sufficient response to changes in vehicle purchasing habits. Data has shown that even within a vehicle category or model, consumers are not purchasing large numbers of the more fuel-efficient vehicles. OEMs pointed out in their comments to the Draft TAR that "fuel economy becomes a less important purchase consideration when judged against other attributes such as performance (e.g. power/torque) or luxury (e.g. infotainment systems) which may cause a consumer to

[83] http://wardsauto.com/industry/fuel-economy-index-shows-small-gain-first-half-2017.

[84] *Id.* 2016 Fuel Economy Trends report at page 4. Note that the per vehicle fuel economy is better year over year even though the fleet overall is not following projections.

opt for a lower fuel economy powertrain within the same vehicle model or a similarly sized model with more luxury content."[85]

The Standards Will Hurt Low-Income Consumers

In its comments on the Draft TAR, Global Automakers described how the standards will hurt low-income consumers.[86] Average new car prices continue to climb; in August 2017, the average was $34,646[87], still over half the median income.[88] We reiterate here that higher upfront prices make vehicles less affordable, and low-income consumers do not have the same access to credit as higher-income consumers. It is a market reality that, on the margin, some low-income consumers will be forced into the used vehicle market to purchase vehicles with low fuel efficiency. Demand for used cars, and the resulting increase in price, will bar some low-income consumers from the vehicle market entirely. As the Center for Automotive Research noted in a recent study:

> [H]igher prices and lower sales will, without question, result in an older operating fleet of private vehicles (the Cubanization Effect) and the result will be a loss of performance in both fuel consumption efficiency and safety, and many vehicle attributes for all Americans. It will also result in the loss of personal mobility, currently the highest in the world, across the American population which will not only lower the standard of living for American households but also reduce their productivity in the economy and especially the labor market.[89]

In summary, fuel savings will not accrue to consumers who cannot afford to purchase more fuel-efficient vehicles. This effect should be considered during this MTE.

The Impact of Low Gas Prices

Low gas prices also dampen demand for fuel economy. Gas prices are much lower than the agencies predicted when they adopted the MY 2017-2025 rules:

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[85] Toyota Motor North America, Inc. *Attachment I – Comments of Toyota Motor North America, Inc.*, (September 2016). p. 23-24.

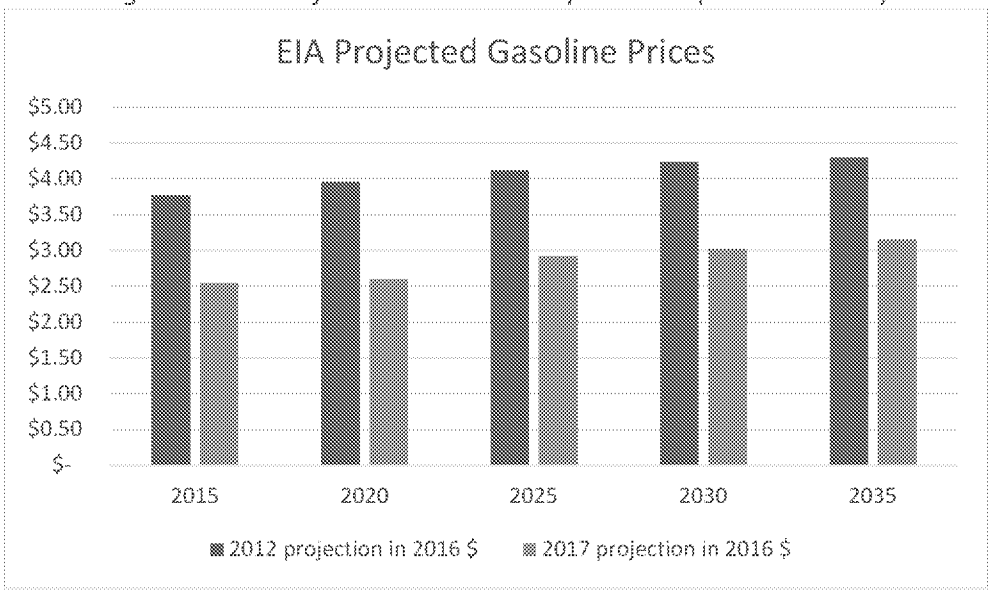
[86] Global Automakers. *Comments on Draft TAR*, pp. B-12 to B-14.

[87] https://mediaroom.kbb.com/2017-09-01-Average-New-Car-Prices-Up-Nearly-1-Percent-Year-Over-Year-Despite-Mixed-Results-For-Major-Automakers-According-To-Kelley-Blue-Book.

[88] In 2017, median household income was $59,309. https://www.nytimes.com/2017/09/12/business/economy/income-rebound-recession.html?mcubz=3&_r=0.

[89] Center for Automotive Research, *The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy*, (2016) at p. 55. ("CAR 2016 GHG/FE Study")

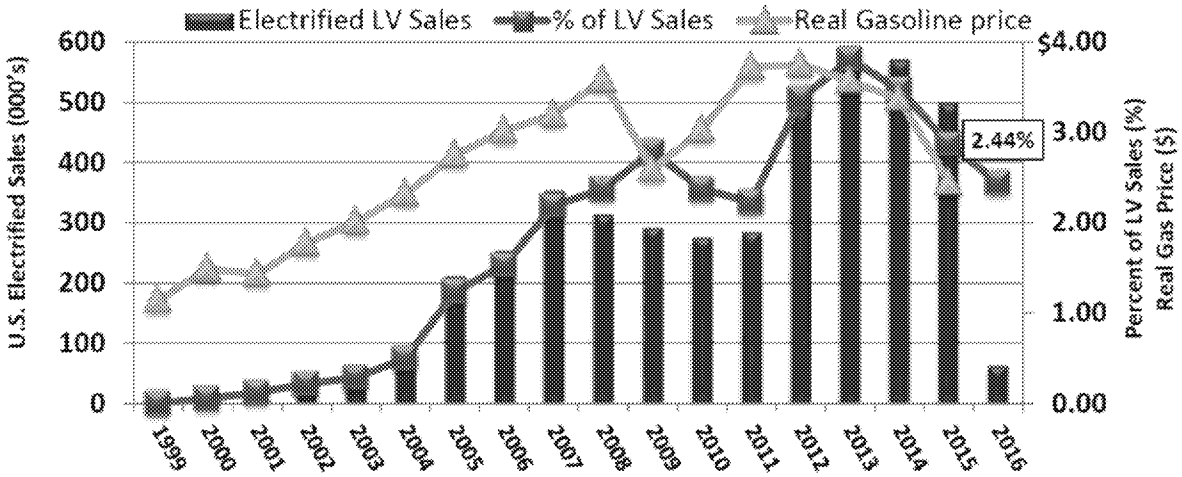
Figure 15: EIA Projected Gasoline Price per Gallon (in 2016 dollars)



Source: Annual Energy Outlook 2017, Energy Information Administration

In 2012, the agencies relied upon an EIA reference price forecast of $3.86/gallon for gasoline in 2025 (in 2010 dollars). Today that projected price is $2.92/gallon[90] (in 2016 dollars), a real decrease of more than 30%. EPA has acknowledged that gas prices affect demand for fuel economy,[91] and the data show a clear effect of gas prices on high fuel economy vehicles:[92]

Figure 16: U.S. Electrified Light Vehicle Sales and Take Rate 1999 - 2016 YTD



Source: Word's Automotive Reports, HybridCars.com and CAR Research; and EIA.
Note: Electrified vehicles consist of BEV, HEV and PHEV.

[90] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=12-AEO2017&cases=ref2017&sourcekey=0.
[91] See, e.g., *Draft TAR* at p. 3-13 ("low recent low gas prices may make hybrids less appealing to consumers.")
[92] CAR 2016 GHG/FE Study at p. 55.

As the agencies recognized in the 2012 rulemaking, "[c]onsumer acceptability is also an element of economic practicability, one which is particularly difficult to gauge during times of uncertain fuel prices."[93] That rule was based the assumption that fuel prices would be much higher than they are now and are expected to be in the future. EPA and NHTSA must therefore assess the extent to which updated data on expected fuel prices should impact the standards for MY 2022-2025.

The Agencies Should Better Assess Whether the Benefits to Consumers Outweigh Costs

EPA places much weight on its finding that consumers who finance vehicles may be able to recoup the additional upfront purchase costs through fuel savings. They note that purchasers who finance their loans will recoup (or "pay back") the additional costs within a year or so.[94] As Global Automakers has previously explained in our comments; this analysis assumes that consumers consider only two factors – vehicle price and fuel economy – when purchasing vehicles. Surveys show, however, that handling, ride, safety and utility, among other factors, are more important to customers than fuel economy.[95]

Similarly, EPA has not adequately analyzed whether fuel economy technologies impose hidden costs on consumers. EPA relied upon automotive reviews of fuel economy technologies in magazines, which it acknowledges may not represent the views of consumers.[96] EPA also ignores the lost opportunity cost that the standards impose by restricting consumers' vehicle options in the event manufacturers must eliminate options or choices to meet the standards.

In fact, EPA itself acknowledges that it cannot determine consumers' willingness to pay for *any* vehicle attribute, including fuel economy.[97] How then can EPA conclude that the standards provide a net benefit to consumers? If the true costs of the standards are unknown, how can the agencies definitively conclude that the benefits to consumers outweigh the costs? As two observers noted:

> The behavioral justifications offered by NHTSA and EPA offer very little evidence that consumers are causing self-harm in their vehicle-purchasing decisions and would thus accrue private benefits by having their options restricted.[98]

Again, this is not to suggest that the standards provide no benefits – they do. But it is not appropriate to assume that consumer demand will take care of itself based on an unjustified conclusion that the benefits of the standards outweigh the costs to individual consumers. In so doing, the agencies underestimate the challenges of the standards and overestimate their chances of success. It would be far better to acknowledge the significant hurdles that the regulations impose, and tailor them

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[93] 77 Fed. Reg. at 62668.
[94] U.S. EPA. *Final Determination* at p. 7.
[95] Strategic Vision. *2014 New Vehicle Experience Study*, (2014).
[96] U.S. EPA, *Response to Comments on Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation* at p. 131 (January 2017).
[97] U.S. EPA. *Proposed Determination* at pp. A-47 and A-51.
[98] Gayer and Viscusi, *Overriding Consumer Preferences with Energy Regulations*, (2012) at p. 23 (Mercatus Center, George Mason University, July 2012).

appropriately. As noted in Section VII and VIII below, Global Automakers believes additional flexibilities could provide a part of a solution.

VII. Other Policy Considerations

Harmonization of MY 2021 Standards

Both agencies request comment on whether the MY 2021 standards should be included in consideration of the MTE. The MY 2021 standards have a higher year-over-year increase in 2021 than other years of the program, and this jump creates a challenge for automakers. It would therefore be appropriate for the agencies to consider whether adjustments to those standards may be appropriate. At the very least, we would recommend that EPA and NHTSA amend their respective regulations to address the harmonization issues raised by Global Automakers and the Alliance in our June 2016 petition for rulemaking.[99] Both EPA and NHTSA have signaled a willingness to address these issues when they consented to review and consider the petition.[100] The evaluation of MY 2021 regulations is consistent with these previous commitments.

In addition, EPA's decision to use MY 2021 as the reference fleet for its modeling has also created concerns. EPA assumes the light-duty fleets in 2021 will be fully compliant with the standards for that year, and then assess the costs and feasibility of the more stringent standards for MY 2022-2025. But if there is a shortfall with respect to the MY 2021 standards, that will impact that actual cost and feasibility of meeting the standards in the subsequent years. Because industry compliance with the MY 2021 standards is highly dependent on product cadence, customer preferences, and model sales mix, EPA's assumption is questionable. This is especially true given recent projections by NHTSA showing that despite having adopted many fuel-efficient technologies, manufacturers, on average, are not expected to reach anticipated MY 2016 and 2017 CAFE targets.[101] Global Automakers' analysis of final MY 2016 and early MY 2017 data confirms this finding for both the CAFE and GHG programs.[102]

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[99] "Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program," submitted by the Alliance of Automobile Manufacturers and the Association of Global Automakers to EPA and NHTSA, (June 20, 2016). Retrieved from: https://www.epa.gov/sites/production/files/2016-09/documents/petition_to_epa_from_auto_alliance_and_global_automakers.pdf. We herein incorporate this petition by reference.

[100] 81 Fed. Reg. 95,553 (December 28, 2016) and email communications between William Charmley (EPA), Julia Rege (Global Automakers) and Chris Nevers (Alliance), where Mr. Charmley states, "I wanted to let you know what we [EPA] are thinking of regarding process going forward for considering the requests and get your input." (December 2016).

[101] National Highway Traffic Safety Administration. *Projected Fuel Economy Performance Report*. (February 14, 2017). Available at https://one.nhtsa.gov/CAFE_PIC/MY%202016%20and%202017%20Projected%20Fuel%20Economy%20Performance%20Report%20Final.pdf. (Last accessed August 16, 2017.)

[102] Novation Analytics. *MY 2016 Baseline Study* and *Early MY 2017 Baseline Study*. (September 2016). Study conducted for Global Automakers and the Auto Alliance.

Vehicle Classification

Global Automakers urges NHTSA to reconsider, in coordination with EPA, some changes it made for MY 2011 that moved two wheel-drive (2WD) SUVs into the passenger car fleet from the light truck fleet.

Light trucks currently include vehicles that are off-highway capable, which NHTSA defines as those that are (i) four wheel-drive (4WD) or are over 6,000 pounds gross vehicle weight, and (ii) meet four of five criteria relating to ground clearance.[103]

NHTSA also defines light trucks to include vehicles that have certain cargo-carrying capability. Before MY 2011, the regulations provided that light trucks included vehicles that have "[g]reater cargo-carrying than passenger-carrying volume."[104] Under a 1981 interpretation letter, NHTSA found that "two-wheel drive utility vehicles which are truck derivatives and which, in base form, have greater cargo-carrying volume than passenger-carrying volume should be classified as light trucks for fuel economy purposes."[105] This interpretation allowed 2WD variants of 4WD SUVs to be considered light trucks if the second row of seats was optional.

For MY 2011, NHTSA modified 49 CFR 523.5(a)(4) to require that the cargo-carrying capacity of a vehicle be determined with the second row of seats included, even if the seats are optional.[106] NHTSA stated that this change moved over one million vehicles from the light truck fleet to the passenger car fleet.[107] NHTSA did so in part because of a concern that manufacturers were gaming the classification system merely by listing the second row of seats as an option.[108] NHTSA rejected manufacturers' comments that the regulation was a change in NHTSA's longstanding practice, and NHTSA stated that it found it unlikely that manufacturers would shift production from 2WD to 4WD vehicles.

However, in the ONP rulemaking, NHTSA indicated that it might revisit the question:

> If it appears, in the course of the next several model years, that manufacturers are indeed responding to the CAFE regulatory definitions in a way that reduces overall fuel savings from expected levels, it may be appropriate for NHTSA to review this question again. NHTSA sought comment in the NPRM on how the agency might go about reviewing this question as more information about manufacturer behavior is accumulated, but no commenters really responded to this issue directly, although several cited the possibility that manufacturers might cease to build 2WD SUVs as a way of avoiding the higher passenger car curve targets in arguing that the agencies should implement backstop standards for all fleets. Since NHTSA has already stated above that it will revisit the

[103] 49 CFR 523.5(b) (2005).
[104] 49 CFR 523.5(a)(4) (2005).
[105] https://isearch.nhtsa.gov/gm/81/nht81-3.36.html. Last accessed September 30, 2017.
[106] 74 Fed. Reg. 14196 (March 30, 2009).
[107] 74 Fed. Reg. at 14204.
[108] 74 Fed. Reg.at 14421.

> backstop question as necessary in the future, we may as well add that we will consider the need to classify ''like'' vehicles together as necessary in the future.[109]

In fact, market data shows that 2WD SUVs are not keeping pace with 4WD vehicles. The relative market share of 2WD SUVs (also known as car-SUVs) and 4WD SUVs (also known as truck-SUVs)[110] since the reclassification of 2WD SUVs is consistent with the changing incentives, as shown in the following table:

Market Share	MY 2005	MY 2010	MY 2015	Percent Change from 2010 to 2015
Car SUV	5.1	8.2	10.7	30%
Truck/SUV	20.6	20.7	28.1	36%

From MY 2010, the year before the reclassification, to MY 2015, truck-SUVs gained 20% more market share than did car-SUVs (i.e., 36% is 20% larger than 24%).[111] This is a reversal from the previous five-year period, in which car-SUVs increased their market share from 5.1% in MY 2005 to 8.2% in MY 2010, while truck-SUV maintained an almost constant share (i.e., 20.6% in MY 2005 and 20.7% in MY 2010). This shift away from 2WD SUVs and towards 4WD SUVs reduces fuel savings.

One of the biggest challenges with these vehicles are that the 2WD and the 4WD versions of the same SUV are based on the same platform, with the same engine, the same technology and mostly the same utility characteristics (cargo space, off-highway clearance, etc.). While the 4WD is subject to the less stringent truck curves for determining a standard, the 2WD version is subject to the passenger car curves, which are far more stringent. As a result, a vehicle that is substantially the same, other than the transmission, must meet two very different standards. As a result, the car-SUV may act as a constraint on the passenger car fleet, while the truck-SUV is beneficial to the truck curve.

Global Automakers has thoughts on a regulatory solution that would address this concern. We are happy to discuss this with the agencies at the appropriate time.

Regulatory Streamlining

In response to the Executive Order 13777, issued on February 24, 2017, Global Automakers submitted comments on the potential for streamlining various regulations that would "reduce resources associated with existing regulations without compromising environmental benefits."[112] Global Automakers evaluated the breadth of EPA regulations that impact the automobile sector, looking for opportunities that significantly reduce costs to industry – estimated to have the potential to save $150-200 million

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[109] 75 Fed. Reg.at 25661.

[110] EPA defines "car SUVs" as "a car SUV type for those SUVs that do not meet the light truck definition and thus must meet the car GHG emissions and fuel economy standards." 2016 Fuel Economy Trends report at 18. EPA defines a "truck SUV" as "those SUVs that must meet the truck GHG emissions and fuel economy standards. ..." Id.

[111] See *2016 Fuel Economy Trends Report* at 20. EPA noted that the reclassification of 2WD SUVs to cars was "propagated back throughout the entire historical database." 2016 Fuel Economy Trends report at 14. The changes shown therefore reflect changes in market share rather than changes in regulatory definitions.

[112] Association of Global Automakers. *Comments in response to the U.S. Environmental Protection Agency's (EPA) Federal Register Notice, 'Evaluation of Existing Regulations'* under Docket ID No. EPA-HQ-OA-2017-0190. May 2017. https://www.regulations.gov/document?D=EPA-HQ-OA-2017-0190-41586.

annually across the industry – while at the same time preserving environmental benefits. These items include the off-cycle program, light-duty vehicle certification and test procedures, fuel economy labeling, and other EPA regulations. To date, these items have not been addressed. We incorporate those earlier comments here by reference and request that the agencies respond to our comments.

Ethanol Test Procedure Adjustment

Industry has been conducting tests to provide additional data regarding the E0-E10 test procedure modifications that were to be completed by the EPA. To date, no notice of proposed rulemaking nor share of the public data has been provided to industry. This is ever more concerning as the test fuel is set to change for MY 2019 vehicles and no guidance has been provided. Many manufacturers have already begun their production cycle for these vehicles and have had to continue without proper engagement or direction from the agency. This lack of direction risks to have manufacturers invest in vehicles and technologies that may not be relevant based on the updated fuel requirements. The agency needs to take action to publish data rapidly and to begin an open, science-based process that works with all stakeholders in order to avoid lost capital investments.

Octane

EPA has also asked for feedback on the use of higher octane fuels. Global Automakers has always supported that vehicle and fuels should be treated as a system. Thus, it is appropriate to consider the benefits of high octane fuel as part of the National Program. We believe that higher-octane fuel provides real world benefits by smoothing out variation in fuel economy on the road compared to laboratory testing. Additionally, as technology advances, higher octane fuel will likely be needed to support these new engine technologies. While it is important that the agencies not conflate octane and ethanol content, it may be of interest to the agencies to consider how ongoing development of renewable fuels may support the latest internal combustion engine technologies.

At a minimum, we encourage EPA to take action to eliminate sub-octane fuels from the market, because these fuels are problematic with today's fuel-efficient and clean-emissions technologies, and sub-octane fuels provide little to no benefit to the customer as a result. While we have worked with individual states to address this problem in the past, having a clear federal policy that discourages or ends the use of sub-octane fuels would help support a better marketplace for all vehicles.

VIII. Looking Ahead

The world does not stop in 2025, and in fact, much of the world and California are already looking ahead to 2030, 2035 and beyond. These efforts point to a lower carbon transportation sector, and ultimately electrification of the light-duty fleet. Vehicle electrification is not happening in isolation; we are seeing implementation of technologies that will lead to connected and automated vehicles. In addition, ride sharing models will influence the underlying nature of the automotive business. Taken as a whole, these three trends will likely provide a more efficient and safer future fleet of vehicles, and the need to invest in these technologies should not be ignored.

Global Automakers believes that EPA's MTE should consider how to support a transition toward deep decarbonization levels necessary to meet our mid-century climate goals. The "post-2025" regulatory

direction is critical, because these efforts require significant changes in customer behavior, infrastructure, and the overall auto market. They will also require billions of dollars of investment, which must come from profitable vehicles, as well as protect against the inevitable possibility of technology obsolescence and stranded investment.

By incorporating a longer look at where industry trends are going, the agencies can and should weigh priorities and consider how to properly balance all aspects of the regulation through MY 2025.

IX. Conclusion

EPA's reopening of the Mid-Term Evaluation was an important and necessary step in returning the MTE to the process that was agreed to by all parties back in 2012—a coordinated rulemaking between EPA and NHTSA that fully evaluates the most up-to-date information concerning the technologies needed to meet the standards, their costs, and their impacts on consumers. This is a significant opportunity for the agencies to reevaluate the models used to support the standards and the inputs to those models, to assess whether the market realities of today support the standards going forward, and to ensure that the two regulatory programs are harmonized as much as possible. Global Automakers believes that an objective evaluation of the relevant data will lead to the conclusion that adjustments to the regulations are necessary. Improving the National Program will ensure that the industry continues to reduce motor vehicle GHG emissions and increase fuel economy, and do so in a manner that is cost-effective and accounts for the needs of customers.

It is also important that the agencies look beyond 2025 as they chart a path forward in this Mid-Term Evaluation. The auto industry is currently undergoing the most significant transformations it has seen in decades, with rapid advances being made in vehicle automation and electrification, as well as ride-sharing. Regulatory requirements enacted today must consider how to provide appropriate and necessary flexibility to help industry manage the transition to a light-duty transportation sector that will likely look very different twenty years from now than it does today, and to invest in technologies that will make cars and trucks cleaner and safer than ever before.

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 12/6/2016 10:01:23 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: Would you have a few minutes to talk?

About meeting with Ford and follow-up thoughts.
I'm available – now until 5:15 (hard stop tonight)
Tomorrow (Wednesday) 9:30 – 10:00, 10:30 – 11:30, 1:00- 5:00

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 7/20/2017 9:30:17 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: RE: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Will do

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Thursday, July 20, 2017 5:30 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: Re: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Jim

Can you call me on my mobile at 5:35?

Sent from my iPhone

On Jul 20, 2017, at 5:28 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:

> 5:30 would work for me if you can adjust you schedule. Personal Matters / Ex. 6
> Personal Matters / Ex. 6
>
> Bottom line, we will be issuing the EIS Scoping notice tomorrow afternoon.
> We wanted to forward the internal desk statements (one for NHTSA, and a potential desk statement for EPA) and internal NHTSA QA. We won't be issuing a press statement.
>
> ---
>
> **From:** Charmley, William [mailto:charmley.william@epa.gov]
> **Sent:** Thursday, July 20, 2017 5:24 PM
> **To:** Tamm, James (NHTSA) <james.tamm@dot.gov>
> **Subject:** Re: Please Call re: 2022-2025 CAFE EIS Scoping Notice
>
> Jim
>
> Does 6pm work? You can call me on my mobile number. I can do 5:30 if I move something around.
>
> Sent from my iPhone
>
> On Jul 20, 2017, at 5:07 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:
>
> > Personal Matters / Ex. 6
> > Personal Matters / Ex. 6 Do you have any time yet today?
> >
> > ---
> >
> > **From:** Charmley, William [mailto:charmley.william@epa.gov]
> > **Sent:** Thursday, July 20, 2017 5:03 PM

To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: RE: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Dear Jim,

Personal Matters / Ex. 6

Are you available between 6:30am and 8:30am tomorrow? If yes, let me know what time works and what number I can call you at.

Thanks
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Thursday, July 20, 2017 4:49 PM
To: Charmley, William <charmley.william@epa.gov>
Subject: Please Call re: 2022-2025 CAFE EIS Scoping Notice

Hi Bill,
Please give me a call this afternoon or tomorrow morning. I'd like to give you a heads up on some content in the EIS Scoping notice NHTSA will be issuing tomorrow afternoon.

Also, thanks for your message on trailers. I'd like to touch base on that too.
Thanks.
Jim

<CAFE Scoping Notice Desk Statements and QA 170720.docx>

Message

From: Michael Hartrick [MHartrick@autoalliance.org]
Sent: 12/30/2016 5:05:30 PM
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Subject: Alliance of Automobile Manufacturers Comments on Proposed Determination and Technical Support Document (EPA-HQ-OAR-2015-0827)
Attachments: Alliance of Automobile Manufacturers Comments on Proposed Determination (2016-12-30).pdf; Attachment1_DefourGroup_Alliance_PD_Response_re_Regressivity_of_Standards.pdf; Attachment2_Novation_Analytics_MY2016_Baseline Study_20dec2016_v1.0.pdf

Dear Mr. Lieske,

Attached, please find comments from the Alliance of Automobile Manufacturers on the Proposed Determination and associated Technical Support Document. These comments and referenced attachments have also be submitted to via regulations.gov. Thank you for your time and consideration of these comments.

Mike Hartrick
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December 30, 2016

Christopher Lieske
Office of Transportation and Air Quality (OTAQ)
Assessment and Standards Division (ASD)
Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105

Submitted electronically to http://www.regulations.gov and via electronic mail

Docket ID No. EPA-HQ-OAR-2015-0827

Alliance of Automobile Manufacturers Comments on Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation

Dear Mr. Lieske,

I am submitting the enclosed comments and associated attachments on behalf of the Alliance of Automobile Manufacturers (Alliance)[1] in response to the subject Proposed Determination[2] and its associated Technical Support Document.[3]

The Alliance strenuously objects to the Proposed Determination, both procedurally and substantively and requests that EPA withdraw its premature Proposed Determination and recommit to a meaningful, comprehensive, and responsive Midterm Evaluation. Our request rests upon the following principles:

[1] The Alliance of Automobile Manufacturers, is an association representing 12 manufacturers of cars and light trucks. Alliance members are BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, and Volvo Car USA. For more information, please visit: www.autoalliance.org.

[2] "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation." U.S. Environmental Protection Agency. EPA-420-R-16-020, November 2016.

[3] "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation: Technical Support Document." Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. EPA-420-R-16-021, November 2016.

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- EPA's premature action conflicts with its long-standing commitment to a single national program;
- The Proposed Determination suffers from multiple, serious, procedural and substantive technical flaws; and
- The Midterm Evaluation process bypassed critical procedural requirements.

Alliance members' concerns are exemplified in the Proposed Determination and associated Technical Support Document: Not a single conventional MY 2016 vehicle currently meets the MY 2025 standards, including vehicles with the advanced conventional technologies described by EPA as enabling manufacturers to meet the future standards.

Your consideration of these comments and attachments is appreciated. If you have any questions on this matter, please contact me at (248) 357-4717, extension 103 or at MHartrick@autoalliance.org.

Sincerely,

Michael Hartrick

Michael Hartrick
Director of Fuel Economy & Climate
Alliance of Automobile Manufacturers

Cc.

Bill Charmley, U.S. Environmental Protection Agency
Michael McCarthy, California Air Resources Board
Robin Moran, U.S. Environmental Protection Agency
Michael Olechiw, U.S. Environmental Protection Agency
Jim Tamm, National Highway Traffic Safety Administration
Rebecca Yoon, National Highway Traffic Safety Administration

Alliance of Automobile Manufacturers
Comments on Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards Under the Midterm Evaluation
December 30, 2016

Introduction

The Alliance of Automobile Manufacturers[1] ("Alliance") hereby submits comments on the Environmental Protection Agency ("EPA") Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation[2] ("Proposed Determination") and the associated Technical Support Document[3] ("TSD").

The Alliance strenuously objects to the Proposed Determination, both procedurally and substantively and requests that EPA withdraw its premature Proposed Determination and recommit to a meaningful, comprehensive, and responsive Midterm Evaluation.[4] There is no legitimate reason to accelerate the Midterm Evaluation process by issuing a Final Determination more than one year in advance of the April 2018 endpoint described in regulation.[5]

Alliance members' concerns are exemplified by Appendix C of the TSD: Only 5% of the MY 2016 vehicle models compliant with the future MY 2022 standards are not hybrid, plug-in electric, or fuel cell vehicles. Not a single conventional vehicle, including vehicles with turbocharged-downsized engines, Atkinson cycle engines, advanced transmissions, stop/start, variable valve timing, direct injection, and other non-hybrid technologies, currently meets the MY 2025 standards. Even when additional credits are assumed at the levels estimated in the original MY 2017-2025 final rule,[6] only hybrid, plug-in electric and fuel cell vehicles meet the MY 2025 standards.

Because EPA has given interested parties only 24 days from the date of *Federal Register* publication to respond to over a thousand pages of complex analysis, these comments are necessarily limited to providing an overview of the Alliance's concerns. However, the Alliance

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[1] Alliance members are BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America and Volvo Car USA. For more information, please visit: www.autoalliance.org.

[2] "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation." U.S. Environmental Protection Agency. EPA-420-R-16-020, November 2016.

[3] "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation: Technical Support Document." Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. EPA-420-R-16-021, November 2016.

[4] If the Proposed Determination is not withdrawn by EPA, a meaningful, comprehensive and responsive Midterm Evaluation should entail a notice and comment period of at least 120 days on the Proposed Determination alone.

[5] *See* 40 C.F.R. 86.1818-12(h).

[6] 77 Fed. Reg. 62,624 (Oct. 15, 2012).

hereby renews its request to meet with EPA technical staff to discuss these comments and to provide any additional detail that EPA considers necessary to properly consider the Alliance's concerns.

The Alliance supports reducing greenhouse gas ("GHG") emissions associated with the operation of light-duty vehicles, but believes that reductions must be made in a manner that accounts for market realities. In October 2012, when EPA and the National Highway Traffic Safety Administration ("NHTSA") initially set GHG standards for model year ("MY") 2022-2025 vehicles, the MY 2025 endpoint was thirteen years in the future and the standards that EPA set were remarkably ambitious. EPA expected that the rule would create a transformed vehicle fleet capable of achieving an average 54.5 miles per gallon equivalent[7] depending on fleet mix, compared to an average 30.9 miles per gallon equivalent when the MY 2017-2025 standards were promulgated in 2012.[8] Less than 3.5% of today's light-duty vehicle production meets the MY 2025 standards.[9] EPA further anticipated that new technology costing $2,748 per vehicle would trigger this sea change in fuel economy starting with MY 2012.[10] This may well be the most consequential EPA decision for the auto industry since the modern Clean Air Act ("CAA") was enacted in 1970. Compliance with EPA's GHG standards for model years 2012-2025 was estimated to cost industry and consumers over $200 billion.[11] Thousands of jobs in the auto industry are on the line and EPA's mandated emissions reductions will dramatically affect the design, technology, and materials of virtually every new car going forward.

No agency had ever set standards for GHG emissions or fuel economy so far into the future, or with such tremendous consequences across an entire critical industry. EPA, NHTSA and all stakeholders understood in 2012 that no one could accurately project the circumstances impacting the technological and economic practicability and feasibility of these standards all the way out through MY 2025. Accordingly, EPA and NHTSA committed to a robust Midterm Evaluation process whereby the agencies would take a fresh look at whether to retain the MY 2022-2025 standards based on new technological developments, customer demand, market conditions and public input.[12] The agencies agreed to complete the Midterm Evaluation by April 2018.

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[7] 77 Fed. Reg. 62,627 (Oct. 15, 2012).

[8] "Greenhouse Gas Emission Standards for Light-Duty Vehicles: Manufacturer Performance Report for the 2015 Model Year." U.S. Environmental Protection Agency. EPA-420-R-16-014, November 2016. 53. (Fleet total compliance value of 288 grams per mile converted to miles per gallon with conversion factor of 8,887 grams CO_2 per gallon gasoline for consistency with prior 54.5 miles per gallon value.)

[9] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016." U.S. Environmental Protection Agency. EPA-420-R-16-010, November 2016. 118.

[10] 75 Fed. Reg. 25,348 (May 7, 2010) (Table I.C.2-6.); 77 Fed. Reg. 62,775 (Oct. 15, 2012). (Table III-8.).

[11] 75 Fed. Reg. 25,346 (May 7, 2010) (Table I.C.2-1); 77 Fed. Reg. 62,774 (Oct. 15, 2012). (Table III-6, Incremental Vehicle Program Cost).

[12] *See, e.g.,*76 Fed. Reg. 48,760 (Aug. 9, 2011) ("Mid-Term Review"); 76 Fed. Reg. 74,879 (December 1, 2011) ("Mid-Term Evaluation"); 77 Fed. Reg. 62,633 (Oct. 15, 2012); 40 C.F.R. § 86.1818-12(h).

The auto industry has always viewed the Midterm Evaluation as central to the viability and validity of the MY 2022-2025 standards. Virtually all auto manufacturers supported EPA's establishment of MY 2022-2025 standards back in 2011-2012. But manufacturers did so on the condition that the Midterm Evaluation comprehensively reassess the appropriateness of those standards and address the uncertainties inherent in long-term projections.[13]

EPA is now poised to complete the Midterm Evaluation, but has executed an accelerated and flawed assessment in a manner incompatible with the "collaborative, data-driven, and transparent process" that EPA promised.[14] In this comment letter, the Alliance highlights three of the most serious shortcomings, any one of which warrants invalidation of EPA actions upon judicial review.

First, EPA's Midterm Evaluation process has violated critical procedural safeguards at every turn, denying the public and stakeholders of a meaningful opportunity to comment on EPA's analysis. EPA completed the first stage of the Midterm Evaluation—issuance of a Draft Technical Assessment Report[15] ("Draft TAR")—in July 2016, but provided an inadequate period for interested parties to comment upon that 1,200-page document. EPA denied our request for extension to the comment period, then promised further dialogue and consideration after the Draft TAR comment window closed, but did not fulfill that commitment.

Instead, on November 30, 2016, EPA unexpectedly posted on its website a Proposed Determination that the MY 2022-2025 emissions standards stay unchanged, produced almost a thousand additional pages of analysis, and informed interested parties that they had only until December 30, 2016, to comment. EPA did not even publish the Proposed Determination in the *Federal Register* until December 6, 2016—resulting in an astonishingly short and manifestly inadequate 24-day comment period spanning a major national holiday. Worse still, EPA provided this extraordinarily brief window for comment after a long-standing public representation that EPA would not issue the Proposed Determination until mid-2017. Relying on those representations, the industry commissioned complex studies, which are critical to the Proposed Determination and will not be complete by the close of the comment period on December 30, 2016. EPA's analysis also rests upon the legally incorrect premise that the Proposed Determination is merely an adjudication, not a rulemaking, and therefore need not comply with rulemaking requirements. In addition, the Agency has failed, as required for CAA rulemaking, to afford interested parties a public hearing on its reassessment of the MY 2022-

[13] *See, e.g.*, 77 Fed. Reg. 62,636; *id.* at 62,652; Letter from Alan Mulally, President and Chief Executive Officer, Ford Motor Company to The Honorable Ray LaHood, Secretary, U.S. Department of Transportation and to The Honorable Lisa Jackson, Administrator, U.S. Environmental Protection Agency, July 29, 2011, https://www.epa.gov/sites/production/files/2016-10/documents/ford-commitment-ltr.pdf. Accessed December 5, 2016.

[14] *E.g.*, 81 Fed. Reg. 49,219 (July 27, 2016); 77 Fed. Reg. 62,784 (Oct. 15, 2012).

[15] "Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." U.S. Environmental Protection Agency, National Highway Traffic Safety Administration, California Air Resources Board. EPA-420-D-16-900, July 2016.

2025 emissions standards; there is no indication in the Proposed Determination that a public hearing is planned. By failing to submit its determination for routine Office of Management and Budget ("OMB") review, EPA also has declined to follow its standard procedure for such major actions.

Second, EPA has now repudiated the central premise of the Midterm Evaluation: that EPA and NHTSA would create a single, harmonized national GHG and fuel economy program. EPA had repeatedly committed to issuing its Proposed Determination as to whether to retain or amend MY 2022-2025 vehicle emissions standards at the same time as NHTSA issued a Notice of Proposed Rulemaking for MY 2022-2025 fuel economy standards. EPA also codified this commitment in its own regulations. *See* 40 C. F. R. § 86.1818-12(h). EPA's commitment was supposed to ensure that EPA and NHTSA closely coordinated to mitigate discrepancies in their analyses of costs, technology, pathways, and other critical features of the GHG/fuel economy program, so that industry and consumers would benefit from a sensible and predictable regulatory scheme.

EPA has now discarded that commitment by issuing its Proposed Determination at least six months in advance of when NHTSA will likely issue its proposed fuel economy standards. NHTSA's eventual proposed rule may substantially differ from EPA's determination—or NHTSA may feel unduly constrained to harmonize its proposal with EPA's prior determination regardless of countervailing facts and analysis. There is no way for EPA to have discharged its regulatory obligation to conduct the Midterm Evaluation by assessing "[t]he impact of the [GHG] emission standards on [NHTSA's] Corporate Average Fuel Economy standards and a national harmonized program."[16] Meanwhile, interested parties have spent considerable time and effort coordinating with both agencies under the assumption that the agencies were harmonizing as planned, and are now in the untenable position of having to comment on the Proposed Determination based on data from only EPA, without being able to review and assess NHTSA's data updates or determinations. This undertaking bears no resemblance to the coordinated effort that the agencies, stakeholders, and the public envisioned.

Third, EPA's conclusion that the standards should stay unchanged rests upon a host of problematic assumptions and technical analyses. Recent developments underscore that the MY 2022-2025 standards may not be appropriate or achievable with the technology mix suggested by EPA. It is expected that more technology will be needed which will add more costs to vehicles. Higher costs will further exacerbate consumer acceptance of future vehicles, especially with the current and forecasted low fuel prices through the MY 2022-2025 timeframe. EPA's analysis fails to satisfy important criteria that EPA itself imposed. And while stakeholders publicly provided input on problems with EPA's analysis after EPA issued its Draft TAR, EPA has ignored or dismissed much of those concerns, and continues to rely on unsound reasoning and flawed data.

The Alliance thus asks EPA to withdraw its premature Proposed Determination and to recommit to a meaningful, comprehensive, and responsive Midterm Evaluation. There is no

[16] 40 C. F. R. § 86.1818-12(h)

legitimate reason to accelerate this process. EPA is not required to issue a final determination until April 2018. As EPA noted when promulgating the 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards ("2012 Rule"),[17] "environmental and consumer organizations express[ed] concerns" that "the mid-term evaluation . . . could occur too early, before reliable data on the new standards is available."[18] Experience has borne out that concern: reliable data are still elusive, critical studies are not yet done, and EPA's own analysis acknowledges its incompleteness. EPA's sudden about-face to complete the Midterm Evaluation on an abbreviated timetable raises the specter that EPA is rushing to judgment solely to hinder the incoming administration. The Alliance urges EPA to reverse course to avoid the appearance of an agency uninterested in a full, open, and fair consideration of all data and information bearing upon emissions standards that will profoundly affect the future of the auto industry.

The Midterm Evaluation Process Bypassed Critical Procedural Requirements

1. The 60-Day Comment Period on the 1,200-Page Draft TAR Was Insufficient.

EPA failed to provide enough time for stakeholders and the public to comment on the Draft TAR and that procedural defect has undercut every ensuing step of the Midterm Evaluation process. The Draft TAR "inform[s] EPA's determination on the appropriateness of the GHG standards and . . . inform[s] NHTSA's rulemaking for the CAFE standards for MY 2022-2025."[19] EPA regulations accordingly required "[p]ublic comment on the draft [TAR]" and for EPA to consider those comments in evaluating the MY 2022-2025 standards.[20]

Yet, when issuing the Draft TAR, EPA and NHTSA deprived stakeholders of the opportunity meaningfully to comment on this critical document. On July 27, 2016, EPA and NHTSA published the Draft TAR in the *Federal Register*; it included more than 1,200 pages and incorporated dozens of newly available separate studies. But EPA and NHTSA provided for only a 60-day comment period, even though the timing of the Draft TAR's release could have allowed for a more generous comment period without endangering the regulatory deadlines for the Midterm Evaluation.[21] And EPA and NHTSA rejected requests from the Alliance and others to extend the comment period to 120 days.[22]

[17] 77 Fed. Reg. 62,624 (Oct. 15, 2012).

[18] *Id.* at 62,652.

[19] 77 Fed. Reg. 62,784 (Oct. 15, 2012).

[20] 40 C.F.R. § 86.1818-12(h)(2)(ii).

[21] *See* 81 Fed. Reg. 49,217 (Jul. 27, 2016).

[22] Letter from Chris Nevers, Vice President, Environmental Affairs, Alliance of Automobile Manufacturers to Chris Lieske, U.S. Environmental Protection Agency, Rebecca Yoon, National Highway Traffic Safety Administration, and Michael McCarthy, California Air Resources Board (August 1, 2016); Docket ID EPA-HQ-OAR-2015-0827-0928 and NHTSA-2016-0068-0022.

The Alliance and other stakeholders thus lacked sufficient time to review and comment on fundamental issues, such as EPA's modeling efforts and EPA's questionable projections of consumer acceptance.[23] EPA and NHTSA effectively acknowledged as much by promising to "continue to consider new data and information that comes to light beyond the Draft TAR" and to "make every effort to consider public comments submitted after the close of the comment period."[24] The Alliance thus expected that the industry would continue to conduct analyses bearing on the complex technical issues underpinning the Draft TAR for at least several more months. Instead, EPA has now magnified the problems with the short comment period for the Draft TAR by issuing an unexpectedly early Proposed Determination and providing only 24 days from publication in the *Federal Register* for comment.

2. EPA's Unprecedented 24-Day Comment Period on the Proposed Determination Is Manifestly Inadequate.

EPA abruptly changed course on November 30, 2016, and issued a 268-page Proposed Determination, along with a 719-page TSD. The Proposed Determination incorporates over 1.5 gigabytes of new modeling data, and contains a wealth of new data and analysis. Even duplicative material requires significant review and analysis, because EPA appears to have reasserted, without adequate explanation, various conclusions from the Draft TAR that commenters rebutted. Commenters must thus make further judgments about whether to bolster their prior points and speculate as to why EPA apparently rejected them. In addition, determining what EPA has responded to and what it has disregarded is quite time-consuming. Moreover, even before this, EPA had repeatedly committed to providing stakeholders with notice of the Proposed Determination and a meaningful opportunity to comment on it, and indeed committed to seeking such comment in its regulations.[25] Yet EPA issued the Proposed

[23] *See* Testimony of Mitch Bainwol, *Hearing on Midterm Review & Update on CAFE Program*, House Comm. on Energy & Commerce (Sept. 22, 2016).

[24] Letter from Janet G. McCabe, U.S. Environmental Protection Agency Acting Assistant Administrator and Paul A. Hemmersbaugh, Chief Counsel, National Highway Traffic Safety Administration, to Chris Nevers, Vice President, Environmental Affairs, Alliance of Automobile Manufacturers and Julia Rege, Director, Environmental and Energy Affairs, Association of Global Automakers (Aug. 22, 2016).

[25] *See* 40 C.F.R. § 86.1818-12(h)(2) (requiring public comment); 77 Fed. Reg. at 62,784 (Oct. 15, 2012) ("Up to date information will be developed and compiled for the evaluation, through a collaborative, robust and transparent process, including public notice and comment."); *id.* at 62,786 ("EPA will determine the appropriate course to follow based on all of the information, evidence, and views in front of it, including those provided during public notice and comment."); 81 Fed. Reg. 87,927 (Dec. 6, 2016) ("EPA will again consider public comments received on the Proposed Determination as it proceeds with the final step in the Midterm Evaluation, a Final Determination regarding the appropriateness of the MY 2022–2025 standards."); *id.* at 87,928 ("EPA requests comment on the Proposed Determination."); EPA, *Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas (GHG) Emissions Standards for Model Years 2022-2025*, https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg ("Step 2: EPA Administrator makes a Proposed Determination with opportunity for public comment."); Letter from Janet G. McCabe, Acting Assistant Administrator, EPA, and Paul A. Hemmersbaugh, Chief Counsel, NHTSA, to Chris Nevers, Vice President, Environmental Affairs, The Alliance of Automobile Manufacturers, and Julia Rege, Director, Environmental and Energy Affairs, Association of Global Automakers, EPA-HQ-OAR-2015-0827-1129 (Aug. 22, 2016) ("The Draft TAR and the public comment period are just the first step in the mid-term evaluation process, and there will be additional opportunities for public

Footnote continued on next page

Determination with no advance warning beyond morning calls to some industry representatives. Not only that: When posting the Proposed Determination on EPA's website, EPA informed stakeholders that they had only 30 days from the date of this internet posting—until December 30, 2016—to comment.[26] EPA took that position even though EPA did not publish the Proposed Determination in the *Federal Register* until December 6, 2016.[27] And EPA insisted on that abbreviated time window despite the Alliance's request to extend the comment period to 120 days.[28] This 24-day comment period is unprecedented in its brevity for such a complex and consequential action and clearly fails without good cause to provide interested parties with a sufficient opportunity to weigh in on the many complex issues underpinning EPA's Proposed Determination.

Only publication of proposed agency action in the *Federal Register* constitutes legally adequate notice.[29] The D.C. Circuit "has never found that internet notice is an acceptable substitution for publication in the *Federal Register*."[30] Indeed, EPA itself previously acknowledged this point—and every other recent comment period on EPA action has started from the date of publication in the *Federal Register*.[31] Thus, EPA has, at most, afforded interested parties a mere *24 days* in which to comment upon nearly a thousand pages of agency analysis and over 1.5 gigabytes of electronic modeling information (in compressed format)[32] on

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Footnote continued from previous page
input in the future. Under its regulations, EPA must seek public comment on a Proposed Determination regarding the appropriateness of the model year (MY) 2022-2025 standards.")

[26] *See* EPA, Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas (GHG) Emissions Standards for Model Years 2022-2025, https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg. (Accessed December 23, 2016.)

[27] *See* 81 Fed. Reg. 87,927 (Dec. 6, 2016).

[28] Letter from Mitch Bainwol, President and CEO of Alliance of Automobile Manufacturers, to Gina McCarthy, EPA Administrator, and Christopher Lieske, Office of Transportation and Air Quality Assessment and Standards Division, Dec. 8, 2016, at 7.

[29] *See* 5 U.S.C. § 553(b)-(c) (agencies must publish "[g]eneral notice of [the] proposed rule . . . in the *Federal Register*, unless persons subject thereto are named and either personally served or otherwise have actual notice thereof in accordance with law," and the opportunity to comment occurs only "[a]fter notice required by this section."); *accord* 42 U.S.C. § 7607(d)(5)(3) ("In the case of any rule to which this subsection applies, notice of proposed rulemaking shall be published in the *Federal Register*"). Even if the Proposed Determination did not qualify as a rule, there is no reason why notice short of publication in the *Federal Register* would adequately inform interested parties of other types of agency action.

[30] *Util. Solid Waste Activities Grp. v. E.P.A.*, 236 F.3d 749, 754 (D.C. Cir. 2001).

[31] *See, e.g.*, Approval of California Air Plan, 81 Fed. Reg. 89,407 (Dec. 12, 2016) (comments due Jan. 11, 2017); Outer Continental Shelf Air Regulations, 81 Fed. Reg. 89,418 (Dec. 12, 2016) (comments due Jan. 11, 2017); Proposed CERCLA Section 122(h) Cost Recovery Settlement for the Columbia Smelting and Refining Works Site, 81 Fed. Reg. 89,459 (Dec. 12, 2016) (comments due Jan. 11, 2017); Allocations of Cross-State Air Pollution Rule Allowances from New Unit Set-Asides for 2016 Control Periods, 81 Fed. Reg. 89,035 (Dec. 12, 2016) (comments due Jan. 11, 2017).

[32] *See* "Advanced Light-Duty Powertrain and Hybrid Analysis (ALPHA) Tool – ALPHA V2.1 Calibration Samples" U.S. Environmental Protection Agency. https://www.epa.gov/regulations-emissions-vehicles-and-engines/advanced-light-duty-powertrain-and-hybrid-analysis-alpha. (Accessed December 23, 2016)

one of the most consequential EPA rules ever for the automobile industry. And this 24-day period falls during a major holiday period during which many automobile manufacturers are closed for seven days within the comment period provided and critical staff are on holiday and vacation, which will further diminish stakeholders' ability to evaluate and comment upon the Proposed Determination. In effect, EPA has provided less than three weeks for comments on a key and last step before a final determination to provide input in the Midterm Evaluation process.

This is a woefully inadequate amount of time for the public, stakeholders, and the Alliance's members to understand the agency's technical model updates, assess the new conclusions, and respond to the request for comment. The Clean Air Act requires EPA to publish notice of a proposed rule in the *Federal Register* and to provide more than 30 days for comment on any rule regulating air pollution pursuant to CAA Section 202, which is the provision EPA invokes to justify the Midterm Evaluation.[33] And while the Administrative Procedure Act does not specify a minimum time for submission of comments in an informal rulemaking, the Administrative Conference generally recommends at least 60 days because 30 days is considered "an inadequate time to allow people to respond to proposals that are complex or based on scientific or technical data."[34]

EPA's extraordinarily abbreviated 24-day window for comment on the Proposed Determination is especially striking given that EPA has provided far longer comment periods at every prior stage of its evaluation of MY 2022-2055 vehicle emissions. EPA provided 60 days to comment on the 2012 Rule.[35] EPA later extended the comment period on the 2012 Rule by an additional 14 days (providing a 74 day comment period).[36] The 24-day comment period for the Proposed Determination is also less than half as long as the 60-day comment period applicable to comments on the Draft TAR, even though EPA described the Draft TAR as merely "a technical report, not a decision document" like the Proposed Determination.[37] EPA's unexpected decision to provide just 24 days of comment on the Proposed Determination is unjustifiable given that the 60-day comment period on the Draft TAR proved inadequate and prompted the Agencies to promise stakeholders further opportunity for comment. Nor has EPA provided such a short comment period for other recent and substantial agency actions. Quite the contrary: before the Proposed Determination, EPA provided between 31 and 102 days for comments on all of EPA's

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[33] *See* 42 U.S.C. § 7607(d)(3) and (5) (requiring EPA to publish notice of proposed rule in *Federal Register* and to keep record open for additional 30 days after holding a public hearing on proposed rule during comment period); *see also* 77 Fed. Reg. 62,786 (stating that EPA's authority to conduct the Midterm Evaluation comes from Section 202(a)).

[34] *Petry v. Block*, 737 F.2d 1193, 1201 & n.18 (D.C. Cir. 1984) (referring to Administrative Conference of the United States, A Guide to Federal Agency Rulemaking 124 (1983)).

[35] *See* 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 76 Fed. Reg. 74,853 (Dec. 1, 2011) (comments due Jan. 30, 2012).

[36] See 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Extension of Comment Period, 77 Fed. Reg. 2,028 (Jan. 13, 2012).

[37] *See* EPA Draft TAR at 1-2.

consequential proposed actions in 2016.[38] Major or complicated EPA rules have routinely had comment periods of at least 90 to 120 days.[39] With its lengthy technical analyses and extensive modeling, this Proposed Determination is an extremely complex rule based on scientific and technical data.

On December 22, 2016, EPA denied, in writing, the Alliance's request to either withdraw the Proposed Determination or extend the comment period.[40] EPA's rationale essentially is that the Agency continues to believe the Proposed Determination and the "30-day" comment period remain appropriate. As these comments explain in considerable detail, the Alliance strongly disagrees.

3. EPA Has Undermined the Integrity of the Notice and Comment Process by Misrepresenting the Timeframe for the Midterm Evaluation.

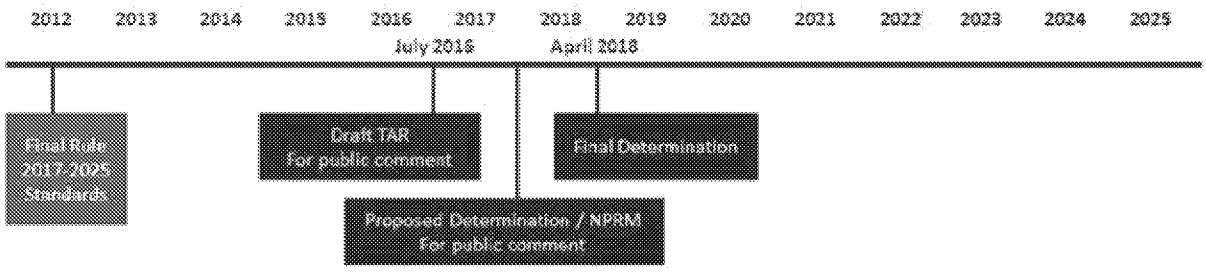
EPA further undermined the notice-and-comment process by inducing stakeholders to rely on EPA's repeated representations that the Proposed Determination would not issue until mid-2017 and then drastically pulling ahead of this schedule without notice. Indeed, until

[38] *See, e.g.*, Approval of California Air Plan, 81 Fed. Reg. 89,407 (Dec. 12, 2016) (comments due Jan. 11, 2017); Outer Continental Shelf Air Regulations, 81 Fed. Reg. 89,418 (Dec. 12, 2016) (comments due Jan. 11, 2017); Proposed CERCLA Section 122(h) Cost Recovery Settlement for the Columbia Smelting and Refining Works Site, 81 Fed. Reg. 89,459 (Dec. 12, 2016) (comments due Jan. 11, 2017); Allocations of Cross-State Air Pollution Rule Allowances from New Unit Set-Asides for 2016 Control Periods, 81 Fed. Reg. 89,035 (Dec. 12, 2016) (comments due Jan. 11, 2017); Proposed Consent Decree, Clean Air Act Citizen Suit, 81 Fed. Reg. 89,0894 (Dec. 9, 2016) (comments due Jan. 9, 2016); Second External Review Draft Integrated Science Assessment for Sulfur Oxides-Health Criteria, 81 Fed. Reg. 89,097 (Dec. 9, 2016) (comments due Mar. 20, 2017); Interstate Transport of Fine Particulate Matter: Revision of Federal Implementation Plan Requirements for Texas, 81 Fed. Reg. 78,954 (Nov. 10, 2016) (original comment period 32 days), *modified by* 81 Fed. Reg. 88,636 (Dec. 8, 2016) (extending comment period to Jan. 9, 2017); Approval of Air Quality State Implementation Plans; Nevada; Infrastructure Requirements To Address Interstate Transport for the 2008 Ozone NAAQS, 81 Fed. Reg. 81 Fed. Reg. 87,857 (Dec. 6, 2016) (comments due Jan. 5, 2017); Proposed Agreement and Order on Consent for Certain CERCLA Response Activities by Tenant as Bona Fide Prospective Purchaser, 81 Fed. Reg. 87,934 (Dec. 6, 2016) (comments due Jan. 5, 2017); Air Plan Disapproval; AL; Prong 4 Visibility for the 2008 8-Hour Ozone Standard, 81 Fed. Reg. 87,503 (Dec. 5, 2016) (comments due Dec. 27, 2016); Revisions to the Source-Specific Federal Implementation Plan for Four Corners Power Plant, Navajo Nation, 81 Fed. Reg. 86,988 (Dec. 2, 2016) (comments due Jan. 3, 2017). The only exception was EPA's simple rejection of an Alabama Air Plan proposal, which EPA issued in early December 2016. *See* Air Plan Disapproval; AL; Prong 4 Visibility for the 2008 8-Hour Ozone Standard, 81 Fed. Reg. 87,503 (Dec. 5, 2016) (comments due Dec. 27, 2016)

[39] *See, e.g.*, Federal Plan Requirements for Greenhouse Gas Emissions From Electric Utility Generating Units Constructed on or Before January 8, 2014, 80 Fed. Reg. 64,965 (Oct. 23, 2015) (91 days); Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 80 Fed. Reg. 4155 (Jan. 26, 2015), *modified by* 80 Fed. Reg. 22,964 (Apr. 24, 2015) (extending comment period to 120 days); Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,353 (July 30. 2008) (120 days); Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste, 68 Fed. Reg. 65,119 (Nov. 18, 2003) (121 days);

[40] Letter to Mitch Bainwol, President and CEO, Alliance of Automobile Manufacturers from Janet McCabe, Acting Assistant Administrator, U.S. Environmental Protection Agency (Dec. 22, 2016); Docket ID EPA-HQ-OAR-2015-0827-6006.

recently, EPA posted the following timeline on its website, showing the Proposed Determination in mid-2017:[41]



EPA deleted this timeline from its website on approximately November 30, 2016. EPA also repeatedly used the same timeline, with the mid-2017 date for the Proposed Determination, in numerous communications with stakeholders.[42] EPA planned that the Proposed Determination would issue at the same time as NHTSA initiated proposed rulemaking for the Corporate Average Fuel Economy (CAFE) standards, as set forth in the 2012 Final Rule.[43] By statute, NHTSA cannot issue standards for more than five years at a time.[44] Assuming a six-month period between the NPRM and the Final Rule, the comment period for the NHTSA's

[41] U.S. Environmental Protection Agency, Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas (GHG) Emissions Standards for Model Years 2022-2025, https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg#schedule (Accessed November 29, 2016)

[42] *See, e.g.*, EPA, Light-Duty Vehicle Greenhouse Gas Standards: 2025 and Beyond 24 (Sept. 17, 2015), available at http://www.epa.gov/sites/production/files/2016-10/documents/grundler-sae-naipc-2015-09-17-presentation.pdf; EPA, *Light-Duty Vehicle Greenhouse Gas Standards: Center for Automotive Research Management Briefing Seminar* 20 (Aug. 4, 2015), *available at* https://www.epa.gov/sites/production/files/2016-10/documents/grundler-car-mgmt-seminar-2015-08-04.pdf; Letter from Janet G. McCabe, Acting Assistant Administrator, EPA, and Mark R. Rosekind, Administrator, NHTSA, to Rep. Fred Upton, Chairman, H. Comm. on Energy & Commerce (June 2010, 2016) ("While the EPA regulations do not establish a deadline for the Proposed Determination, EPA anticipates that it will be issued in 2017.").

[43] EPA, Light-Duty Vehicle Greenhouse Gas Standards: 2025 and Beyond, supra, at 18; EPA, Light-Duty Vehicle Greenhouse Gas Standards: Center for Automotive Research Management Briefing Seminar, *supra*, at 15; 81 Fed. Reg. at 49,219 ("In order to align the agencies' proceedings for MYs 2022-2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022-2025 standard concurrently."); 77 Fed. Reg. at 62,633 ("In order to align the agencies' proceedings for MYs 2022-2025 and to maintain a joint national program, if the EPA determination is that its standards will not change, NHTSA will issue its final rule concurrently with the EPA determination."); *id.* at 62,652 (same); EPA, Draft TAR 5-180 (July 27, 2016) ("At the time of writing for this Draft Tar, the [vehicle weight reduction feasibility and cost study] is in peer review and will be finalized by the NHTSA NPRM and EPA Proposed Determination in 2017."); Memorandum from Janet G. McCabe, Acting Assistant Administrator, EPA, to Laura. Vaught, Associate Administrator, Office of Policy, EPA, EPA-HQ-OAR-2015-0827-1161 (June 13, 2012) (similar).

[44] *See* 77 Fed. Reg. at 62,627; 49 U.S.C. § 32902(b)(3)(B).

proposed 2022-2025 CAFE standards will last through mid-2017, as confirmed by NHTSA's own projections.[45]

The Alliance took EPA at its word. Auto manufacturers commissioned studies and collected data about the pace of technology, consumer attitudes, and other critical issues on the assumption that this information would need to be available by mid-2017. The Alliance and its members were in the process of preparing additional information for submittal to the Midterm Evaluation docket when we received word that the process was being short-circuited on November 30. EPA's surprise issuance of the Proposed Determination many months early thus caught the industry and other stakeholders by surprise, prejudicing any ability meaningfully to comment.

4. EPA Has Not Justified the Curtailed Comment Period.

EPA has offered no legitimate reason for leading the industry and the public to believe that the process would follow a published timeline, then precipitously abandoning that timeline and accelerating the process. While lead-time is certainly important to the automobile industry, under the 2012 joint final rule, an EPA Final Determination is not due until April 2018, almost 17 months from now. Moreover, MY 2022 is currently about 1,800 days away. No one, least of all the auto industry, has suggested that EPA needs to make an immediate decision or that there is insufficient time to allow several more months for comment. There is more than enough time to allow for several additional months of record development ahead of the issuance of a reissued Proposed Determination, while remaining comfortably ahead of the regulatory deadlines set forth for the Midterm Evaluation. Overriding all of this, EPA's actions suggest that the rushed timetable is dictated by the Agency's apparent desire to finalize the Midterm Evaluation before President Obama leaves office.[46]

5. EPA Mischaracterizes the Proposed Determination as Adjudication.

EPA claims the Proposed and Final Determinations entail no rulemaking and only involve adjudication, and that EPA thus need not follow further procedures designed to ensure public participation and guard against arbitrary agency action.[47] Specifically, EPA contends, if the Midterm Evaluation results in a decision to keep the existing standards as promulgated in the 2012 Final Rule, that determination is "adjudicatory" because no new "policy-type rules or standards" will emerge and "the current regulatory status quo" would be "unchanged and unaltered."[48] EPA's position is legally incorrect and also conflicts with EPA's prior

[45] NHTSA, Midterm Evaluation for Light-Duty CAFE, MTs 2022-2025, https://www.nhtsa.gov/corporate-average-fuel-economy/light-duty-cafe-midterm-evaluation (Accessed Dec. 22, 2016).

[46] Indeed, the day after the election, Administrator McCarthy's memorandum to EPA employees stated that EPA would be "running—not walking—through the finish line of President Obama's presidency," which has been widely interpreted as a push to rush as many final rules out as possible. Bob King and Nick Juliano, *Obama's agencies push flurry of 'midnight' actions*, Politico (Nov. 27, 2016), *available at* http://www.politico.com/story/2016/11/obama-regulations-231820.

[47] EPA Proposed Determination at page 3 n.14.

[48] *Id.*

characterizations of the Midterm Evaluation. EPA cannot reframe the Midterm Evaluation as agency adjudication in order to bypass fundamental procedural protections.

An agency "rule" is "an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy."[49] And when an agency formally reconsiders the basis for a prior rule, the agency's reaffirmation of the rule is a "new promulgation."[50] In other words, by reopening a prior rule and substantively reassessing the rule's validity, the agency has effectively promulgated a new rule—even if the result of the agency's reassessment is that the rule should remain unchanged. *Id.*[51]

EPA's Midterm Evaluation falls squarely within rulemaking. EPA is not simply declining to modify a rule. EPA has instead reopened the administrative record underpinning the MY 2022–2025 standards in the 2012 Rule, added thousands of pages to that record, and has made a proposed decision on the basis of that new record that the same emissions standards are appropriate. Moreover, the regulations governing the Midterm Evaluation require EPA to reassess the MY 2022-2025 standards using the hallmarks of notice-and-comment rulemaking. EPA must, for instance, provide public notice of the Proposed and Final Determinations, open the Proposed Determination to public comment, and respond to those comments in the final decision.[52] Furthermore, as EPA has acknowledged, the Midterm Evaluation record must look like the kind of record associated with rulemaking.[53] Nor is EPA merely adjusting underlying technical standards and resolving new factual issues. Rather, as the Proposed Determination reflects, EPA is reiterating and explaining the rationales behind the precise standards articulated in the 2012 Rule as if the agency were re-promulgating them anew. EPA has thus decided to re-impose particular legal requirements based on new developments and justifications.[54]

EPA's contrary characterization of the Midterm Evaluation as adjudication is untenable.[55] Agency adjudication involves the retrospective resolution of discrete factual disputes between identified parties on a case-by-case basis.[56] But EPA has not confined itself merely to resolving disputed facts in the Midterm Evaluation. Rather, the Proposed Determination applies those

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[49] 5 U.S.C. § 551(4).

[50] *Gen. Motors Corp. v. EPA*, 363 F.3d 442, 449–50 (D.C. Cir. 2004).

[51] *Accord, e.g.*, *Nat'l Mining Ass'n v. Dep't of Interior*, 70 F.3d 1345, 1352 (D.C. Cir. 1995); *Edison Elec. Inst. v. EPA*, 996 F.2d 326, 331–32 (D.C. Cir. 1993); *Pub. Citizen v. Nuclear Reg. Comm'n*, 901 F.2d 147, 150–51 (D.C. Cir. 1990); *Ohio v. EPA*, 838 F.2d 1325, 1328 (D.C. Cir. 1988).

[52] *See* 77 Fed. Reg. 62,784 (Oct. 15, 2012); 40 C.F.R. § 86.1818-12(h)(2).

[53] *See* 77 Fed. Reg. 62, 784 (Oct. 15, 2012) (record for Midterm Evaluation would be "the same kind of record that would be developed and before a court for judicial review of the adoption of standards" and "no less robust than that developed for the initial determination to establish the standards.").

[54] *See* 77 Fed. Reg. 62,785 (Oct. 15, 2012) (though the 2012 rules were final, EPA regulations enshrined the Midterm Evaluation as "a mechanism to evaluate and change [emissions standards] in the future, if appropriate.").

[55] *See* EPA Proposed Determination at 3 n.14.

[56] *See, e.g.*, *United States v. Fla. E. Coast Ry. Co.*, 410 U.S. 224, 245 (1973).

facts to the question of whether prospective legal rules are appropriate for an entire industry.[57] For example, the Proposed Determination "estimates that GHG emission decreases will total nearly 540 million metric tons (MMT) over the lifetimes of MY2022-2025 vehicles."[58] And the Proposed Determination evaluates the vehicle program cost and benefits throughout the entire industry.[59] These are all prospective determinations about the appropriateness of a legislative rule, not a retrospective determination between identified parties.

EPA's position is also self-contradictory. Elsewhere, EPA has asserted that its authority to conduct the Midterm Evaluation derives from Section 202(a) of the CAA.[60] But that provision only concerns the EPA Administrator's authority to promulgate rules regulating air pollutants, and belies EPA's claim that the Midterm Evaluation is pure adjudication.[61,62]

6. EPA Has Failed to Hold Required Hearings on the Proposed Determination.

The Clean Air Act also requires EPA to hold a hearing before issuing a Final Determination in the Midterm Evaluation, yet EPA has also failed to do this. Through Section 307(d) of the CAA, Congress imposed a host of procedural requirements on EPA, including that EPA must hold a hearing where interested persons can comment on proposed rules and that EPA must afford an opportunity for interested persons to submit "rebuttal and supplementary information" to the record for 30 days after the hearing.[63] And Congress clearly applied those requirements to the exact type of agency action at issue here: the "promulgation or revision of regulations under [section 202 of the CAA, 42 U.S.C. § 7521]."[64] Furthermore, the Agencies followed Section 307(d)'s requirements in promulgating the 2012 Rule: they held three public hearings across the country on the 2012 Rule and timed them to ensure that the record would be open for 30 days thereafter.[65] Yet, EPA has scheduled no public hearings on the Proposed

[57] *See* 77 Fed. Reg. 62,784 (Oct. 15, 2012).

[58] EPA Proposed Determination at 25.

[59] *See, e.g.*, EPA Proposed Determination Table IV.13, at 44 (collecting MY Lifetime Costs and Benefits).

[60] *See* 77 Fed. Reg. 62,786 (Oct. 15, 2012).

[61] *See* 42 U.S.C. § 7521(a).

[62] Alternatively, the Proposed Determination constitutes a reconsideration of the MY 2022-2025 standards, thereby triggering the procedural requirements in section 307(d). *See* 42 U.S.C. § 7607(d)(7)(B) (providing that in the event a person objects on the basis of new information that is of "central relevance to the outcome of the rule, the Administrator shall convene a proceeding for reconsideration of the rule and provide the *same procedural rights as would have been afforded had the information been available at the time the rule was proposed.*") (emphasis added). We recognize that EPA has opined that "the mid-term evaluation is not a reconsideration of the standards under [section 307(d)]." 77 Fed. Reg. at 62786. The Alliance believes, however, that the procedural requirements apply regardless of whether stakeholders raise concerns about the rule based on new information, as specified in Section 307(d)(7), or EPA itself agrees up front to revisit the MY 2022-2025 standards with a thorough review based on a new record.

[63] 42 U.S.C. § 7607(d)(5).

[64] *Id.* § 7607(d)(1)(K).

[65] 77 Fed. Reg. 62,624, 62,630 (Oct. 15, 2012).

Determination. EPA has no sound reason to refuse to acknowledge Section 307(d)'s applicability, and its refusal to hold a hearing further underscores the breakdown of the "collaborative, data-driven, and transparent process" that EPA promised.[66]

7. EPA Violated Requirements for Publication in the *Federal Register*.

Proposed EPA rules promulgated under the CAA must comply with Section 307(d)(3) requirements for publication in the *Federal Register*, yet EPA's publication of the Proposed Determination complied with none of them. EPA's notice of the Proposed Determination in the *Federal Register* spans less than two full pages. It includes no summary of "the factual data" on which the Proposed Determination is based, no summary of "the methodology used in obtaining the data and in analyzing the data," and no summary of "the legal interpretations and policy considerations" underlying the Proposed Determination.[67] Nor does it adequately incorporate the full Proposed Determination by reference.[68] And until EPA remedies this error, the Proposed Determination fails to adequately notify the public and industry of its rulemaking activity.[69] In sum, by failing to follow this procedural requirement, EPA has effectively whittled the comment period down even further, exacerbating the already egregious deficiencies in this notice-and-comment process.

8. EPA Should Have Submitted the Proposed Determination for OMB Review.

EPA's failure to submit the Proposed Determination to the Office of Management and Budget (OMB) presents yet another troubling procedural anomaly. Agencies, —including EPA, —have long been required to submit proposed rules to OMB for review, and to refrain from publishing final rules before addressing OMB's comments.[70] Section 307(d)(4)(B)(ii) of the Clean Air Act specifically requires materials submitted to OMB for such review to be included in the rulemaking record.[71] OMB review provides a critical check on agency action by independently assessing the validity of agency assumptions about the costs and benefits of consequential agency action. Indeed, EPA has characterized prior submissions of agency actions for OMB review as "routine."[72] And, notably, EPA submitted the Draft TAR for OMB review

[66] *See* 81 Fed. Reg. 49,219 (July 27, 2016); *see also* 77 Fed. Reg. 62,784 (Oct. 15, 2012).

[67] 42 U.S.C. § 7607(d)(3).

[68] *See* 79 Fed. Reg. 66,267, 66,267 (Nov. 7, 2014); 1 C.F.R. § 51.

[69] *Cf. Husqvarna AB v. EPA*, 254 F.3d 195, 203 (D.C. Cir. 2001).

[70] *See* Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (Sept. 30, 1993); Exec. Order 13,563, 76 Fed. Reg. 3821 (Jan. 21, 2011).

[71] 42 U.S.C. § 7607(d)(4)(B)(ii).

[72] K. Goldberg, *EPA Sends Clean Energy Incentive Proposal to White House*, Law360 (Apr. 27, 2016), *available at* http://www.law360.com/articles/789652/epa-sends-clean-energy-incentive-proposal-to-white-house ("Sending this proposal to OMB for review is a routine step . . . ."); T. Cama, *EPA Sends Methane Leak Rule for Final Review*, The Hill (June 24, 2015), *available at* http://thehill.com/policy/energy-environment/245959-epa-sends-methane-leak-rule-for-final-review (describing OMB review as a "routine step").

six weeks before publishing the Draft TAR in the *Federal Register*.[73] That not only gave OMB time to comment on the Draft TAR but also notified stakeholders that the Draft TAR was forthcoming.

EPA has now changed course and has declined to submit the Proposed Determination for OMB review. That omission is particularly striking because EPA indicated that the TSD accompanying the Proposed Determination serves as the final technical assessment report.[74] Having already submitted the Draft TAR for OMB review, it is virtually unheard of that EPA would not submit the final version for OMB review. Yet EPA has prevented OMB from reviewing EPA's reassessment of what is perhaps the most significant rule in the history of the automobile industry. EPA offers no justification for this abrupt reversal. Rather, it is manifestly apparent that EPA sacrificed this step-to meet a timeline of promulgating the Final Determination before Inauguration Day.

EPA's Premature Action Conflicts with the Long-Standing Commitment to a Single National Program

The 2012 Final Rule preamble stated:

> In order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022–2025 standards concurrently.[75]

And

> EPA and NHTSA will consult and coordinate in developing EPA's determination on whether the MY2022-2025 GHG standards are appropriate under section 202(a) and NHTSA's NPRM.[76]

The 2012 Final Rule's promise that the agencies would finalize their actions related to the MYs 2022-2025 standards "concurrently" is embodied in the Final Rule regulatory

[73] Memorandum to L. Vaught, Associate Administrator, Office of Policy, EPA, from J. McCabe, Acting Assistant Administrator, EPA (June 13, 2012), *available at* https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-1161.

[74] EPA Proposed Determination at 2.

[75] 77 Fed. Reg. 62,628 (Oct. 15, 2012). As recently as July 27, 2016, the Agencies quoted from this passage and reiterated this promise. *See* 81 Fed. Reg. 49219 (July 27, 2016) (announcing the release of the Draft TAR). Until recently, NHTSA's web site describing the Midterm Evaluation schedule explained that "NHTSA has a statutory obligation to conduct a comprehensive rulemaking in order to establish final CAFE standards for MYs 2022–2025. *The next step in the process after the Draft TAR is to issue a Notice of Proposed Rulemaking (NPRM) in conjunction with EPA's Proposed Determination or NPRM.*" NHTSA, CAFE Fuel Economy Standards and Midterm Evaluation for Light- Duty Vehicles, MYs 2022-2025, *available at* http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/ld-cafe-midterm-evaluation-2022-25 (accessed March 18, 2016) (emphasis added). As of Dec. 14, 2016, the sentence in italics omits any reference to EPA.

[76] 77 Fed. Reg. 62628 (Oct. 15, 2012).

requirement that, in evaluating the appropriateness of the MY 2022-2025 standards as part of the Midterm Review, EPA "shall consider . . . [t]he impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program."[77]

The agencies' promise to harmonize also is key to understanding the schedule that EPA and NHTSA developed for the Draft TAR and the deadlines for the Proposed Determination. Specifically, the Draft TAR was to be released "[n]o later than November 15, 2017,"[78] and a determination on whether the standards are appropriate was to be issued "[n]o later than April 1, 2018."[79] These deadlines were designed to allow EPA and NHTSA to coordinate *with respect to NHTSA's rulemaking*, given NHTSA's inability, per statute, to set CAFE standards more than five model years at a time.[80] By unilaterally issuing the Proposed Determination, EPA has ignored its own representation to stakeholders that the agencies would coordinate the Proposed Determination and NHTSA rulemaking on the MY 2022-2025 standards.

In addition, EPA has manifestly failed its obligation to "consider . . . [t]he impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program." EPA seems to believe that it has fulfilled this obligation merely by making its determination available in advance of NHTSA's rulemaking on the MY 2022-2025 standards.[81] However, under EPA's logic, *any* standards would be justified under 40 C.F.R. § 86.1818-12(h)(1)(vii), as long as NHTSA has notice of the standards in advance of its own rulemaking. EPA has replaced the collaborative process envisioned by the 2012 Final Rule with a rushed, unilateral determination.

EPA's approach compounds the harmonization difficulties that the Alliance and others have already noted. The Draft TAR revealed significant differences between EPA and NHTSA with respect to their analyses of costs, technology pathways and other factors. There are significant differences in the modeling outcomes of both agencies—differences that the Draft TAR attempts to paint as a virtue by asserting that the agencies' "independent analyses complement one another and reach similar conclusions."[82] To the contrary, these differing outcomes indicate that the agencies disagree about how manufacturers are able to comply with the MY 2022-2025 standards. For example, EPA estimates that Ford's cost to comply is $1,385

[77] 40 C.F.R. § 86.1818-12(h)(1)(vii).

[78] 40 C.F.R. § 86.1818-12(h)(3).

[79] 40 C.F.R. § 86.1818-12(h).

[80] *See* 77 Fed. Reg. 62,691 ("The National Program, of which this final rule is a part, covers 9 model years of standards—2017–2025—but NHTSA is directed by statute to set CAFE standards for ''at least 1, but not more than 5'' model years at a time.") (quoting 49 U.S.C. § 32902(b)(3)(B)).

[81] *See* EPA Proposed Determination at page 53 ("EPA believes that by providing information on our evaluation of the current record and our proposal to retain the current GHG standards for MY2022-2025, we are enabling, to the greatest degree possible, NHTSA to take this analysis and the GHG standards into account in considering the appropriate CAFE standards for MY 2022-2025.")

[82] *See* Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at xiii.

per vehicle,[83] while NHTSA estimates $2,878 per vehicle.[84] Also, the agencies differ by 43% in their assessment of the percentage of higher compression ratio, naturally aspirated gasoline engines automakers are expected to deploy to meet the MY 2025 standards.[85] Similarly, the percent of turbocharged and downsized gasoline engines differs by 21%, and the percent of stop-start technology differs by 18%.[86] These are not mere differences in how the automakers might choose to comply. Rather, they are differences in the two agencies' evaluation of the lowest cost approach to compliance; these assessments contradict each other and are incompatible, as the two agencies cannot both be correct.

The Alliance also requested that the agencies take more formal action to harmonize the programs.[87] The Alliance requested that EPA and NHTSA take joint action to (a) include off-cycle credits in fuel economy calculations, (b) revise 40 C.F.R. § 86.1818(k)(5) to provide for more flexible credit management, (c) correct the multiplier for BEVs, PHEVs, FCVs and CNGs, and (d) provide an improved off-cycle credit approval process. The Alliance also requested that NHTSA take a specific action to harmonize the CAFE program with EPA's program, including making the credit transfer definition more consistent with EPA's definitions and adjusting the minimum domestic passenger car standard.[88] EPA's rushed determination now precludes any coordination between the agencies on these important issues.

Finally, EPA's Proposed Determination repeats an error that has dogged the 2012 Final Rule from the start. In failing to estimate the costs of California's zero emission vehicle ("ZEV") mandate[89] ("ZEV Mandate") —a program whose costs have never been fully included in any regulatory analysis—EPA has presented a misleading picture of the costs of the national program. EPA asserts that it should only consider the costs that will result from the standards under review in the Proposed Determination. However, here, where compliance with EPA's GHG regulations presupposes manufacturer compliance with the ZEV mandate, and those costs have never been fully evaluated by any government agency, it is appropriate under EPA's own cost-benefit guidance to take those costs into account.[90] Otherwise, the cost assessment will

[83] EPA Draft TAR at 12-84 (Table 12.102, Ford Cost delta).

[84] *Id.* at 13-89 (Table 13.21, Ford Total Average Cost MY 2025).

[85] *Id.* at ES-10 (Table ES-3, comparing higher compression ratio, naturally aspirated gasoline engine technology penetration modeled for GHG and CAFE compliance).

[86] *Id.* at ES-10 (Table ES-3, comparing GHG and CAFE compliance for turbocharged and downsized gasoline engines and stop-start technologies).

[87] *See* Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 Attachment 6.

[88] *See id.*

[89] *See* 13 C.C.R. §§ 1962.1 and 1962.2.

[90] *See* National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, "Guidelines for Preparing Economic Analyses" (December 17, 2010) at 5-9. Cited authority states "[i]f a proposed regulation is expected to increase compliance with a previous rule, the correct measure of the costs and benefits generally excludes impacts associated with the increased compliance. This is because the costs and benefits of the previous rule were presumably estimated in the economic analysis for that rule, and should not be counted again for

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understate the true costs to manufacturers for achieving the future standards. This is particularly important where the costs of the ZEV Mandate are large enough to effectively dictate a particular pathway for achieving compliance at costs that can materially affect the feasibility of achieving the CAFE and GHG standards.[91]

The Proposed Determination Suffers from Multiple, Serious Procedural and Substantive Technical Flaws

1. EPA Has Not Adequately Addressed Alliance Comments on EPA's Interpretation of its Own "Guidelines for Preparing Economic Analyses".

In its comments on the Draft TAR, the Alliance addressed EPA's requirements for preparing economic analyses in the context of its treatment of battery-electric and plug-in hybrid electric vehicles to meet the ZEV Mandate.[92] In responding to the Alliance comments, EPA states that the Alliance comments are mistaken and that there is no issue because the costs and benefits of the vehicles associated with the ZEV Mandate are included in both the reference and control cases.[93] EPA has misunderstood the Alliance comments and has failed to respond substantively. The Draft TAR was clear that EPA included the vehicles in both the reference and control fleets in that analysis. The Alliance comments did not take direct issue with this aspect. Rather, the Alliance objected to EPA's (a) effective inclusion of GHG benefits (i.e. a lowering of other technologies required) at no cost; and (b) failure to consider the cost of the ZEV Mandate at any point in time as related to EPA's own requirements under its own "Guidelines for Preparing Economic Analyses".[94]

The Alliance recommends that EPA address these issues in support of a defensible analysis of actual compliance costs.

2. EPA Dismissed Comments Submitted by the Alliance as Lacking Sufficient Data, and Then Denied Requests for Meetings to Discuss Its Concerns.

At a number of points in the TSD, EPA notes difficulty in understanding or responding to Alliance comments submitted on the Draft TAR due to a lack of sufficient information.[95]

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the proposed rule." Here, no agency (not CARB, not EPA, not NHTSA) has fully estimated the costs of compliance with the ZEV program in all the states in which it applies.

[91] *See generally* Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at xi-xii.

[92] *Id.* at xii et seq.

[93] EPA TSD at 1-32.

[94] *See* Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at xii, particularly footnotes 30 and 31.

[95] *See, e.g.,* EPA TSD at 2-301 ("[The Alliance] did not share the test conditions…, procedures..., [etc.]"); TSD at 2-307 ("[The Alliance] did not provide sufficient information for EPA to determine with certainty…"); TSD at A-35

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EPA's position that the Alliance failed to provide sufficient detail or context in its comments on the Draft TAR is self-serving and arises from EPA's decision to provide an unreasonably short 60-day comment period on the Draft TAR. The Alliance made multiple attempts after submitting its comments to EPA, to schedule meetings for the sole purpose of discussing comments, any concerns EPA might have with them, and to provide additional detail and data as might be needed by EPA to fully consider them. In all, the Alliance reached out to EPA at least four times in October and November 2016 to request such meetings. These offers included asking if EPA needed "additional supporting data for any of [the Alliance] comments" and noting that the Alliance wanted "to be sure that none of [the Alliance] comments [were] dismissed as not having enough support."[96] EPA assured the Alliance that it "[understood] the [Alliance] comments and [had] no questions at [that] time."[97]

Under these circumstances, EPA cannot reasonably contend that it may dismiss Alliance comments without a response because the Alliance did not submit sufficient supporting data. It is not enough for an agency to (i) solicit comment on its complex analyses and proposals, (ii) unreasonably and without justification cut the comment periods short such that stakeholders do not have time to prepare and submit data addressing those analyses and proposal; and (iii) then respond to the stakeholder's comments claiming that the comments lacked sufficient supporting data. Such a process is inadequate and such a response is arbitrary and capricious.

3. EPA Incorrectly Dismissed Analysis Conducted by Novation Analytics Which Supports Concerns Raised in Alliance Comments on the Draft TAR.

EPA rejects in its Proposed Determination research prepared by Novation Analytics under contract to the Alliance and submitted to the docket in support of the Alliance's comments on the Draft TAR.[98] EPA's assessment of Novation Analytics' methodology and findings is incorrect. We incorporate by reference the Alliance's response to similar criticisms provided to the House Subcommittee on Commerce, Manufacturing, and Trade and Subcommittee on Energy and Power, Committee on Energy and Commerce.[99]

Footnote continued from previous page
("While [the Alliance] did not provide sufficient information to determine with any certainty which parameters are the ones that should be compared…").

[96] Electronic Mail from Michael Hartrick, Director of Fuel Economy & Climate, Alliance of Automobile Manufacturers to Michael Olechiw Director – Light-Duty Vehicles and Small Engines Center, U.S. Environmental Protection Agency. (November 3, 2016).

[97] Electronic Mail from Michael Olechiw, Director – Light-Duty Vehicles and Small Engines Center, U.S. Environmental Protection Agency to Michael Hartrick, Director of Fuel Economy & Climate, Alliance of Automobile Manufacturers. (November 3, 2016).

[98] *See, e.g.,* EPA TSD Appendix A.

[99] Bainwol, Mitch, Questions for the Record Response, Midterm Review and Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards for Motor Vehicles, Hearing, September 22, 2016. 10 et seq. Available at http://docs.house.gov/meetings/IF/IF17/20160922/105350/HHRG-114-IF17-Wstate-BainwolM-20160922-SD006.pdf. (Accessed December 15, 2016).

EPA staff did not raise any questions or concerns with the Novation Analytics studies even when offered that opportunity. EPA turned down an in-person meeting to discuss the Novation Analytics Technology Effectiveness Phase 2 report ("Phase 2 Report") [100] and instead one EPA staff person participated in a briefing via web conference on May 17, 2016, with the Alliance, Global Automakers, Novation Analytics and California Air Resources Board staff and then did not ask any questions about the Phase 2 Report. This does not come close to fulfilling EPA's obligation to have a full airing and consideration of these issues.

The Novation Analytics reports referred to by EPA in Appendix A of the TSD were jointly commissioned by both the Alliance and Global Automakers, Inc., which together represent virtually all light-duty vehicle production in the United States. The Novation Analytics reports were reviewed by the Alliance and Global Automakers member companies with broad agreement that the results correlated well with their internal technology benefit and compliance modeling data. The Alliance has encouraged its members independently to submit their confidential business plans to EPA as supporting data for the general industry view that EPA has significantly underestimated the level of technology required for compliance in MY 2025.

The Alliance recommends that EPA engage more closely with auto manufacturers and Novation Analytics to understand the actual content and importance of the Novation Analytics studies.

4. The Proposed Determination Violates EPA's Obligation to Assess the Economic Impacts of Its Standards.

We can think of no case in recent history where EPA has applied so little actual economic analysis to the consideration of such important standards. EPA's proposed action would impose a regulatory burden estimated to reach $200 billion by 2025, without any numerical estimate of the economic impacts to the automobile industry.[101] In particular, this approach is troubling since EPA previously included a projection and analysis of the likelihood of mass unemployment and bankruptcy for a large U.S. automaker based on connection with the promulgation of much less stringent standards.[102] The MY 2022-2025 standards are much more stringent and costly; as a result, they are much more consequential to the industry. By rushing and issuing prematurely a Proposed Determination without any quantified sales or employment analysis, EPA is greatly underestimating the impact of an inaccurate Midterm Evaluation on the future of the automobile industry.

[100] Electronic Mail from Chris Nevers, Vice President, Energy and Environment, Alliance of Automobile Manufacturers to Michael Olechiw, Kevin Bolon, Ed Nam, Robin Moran, Daniel Barba, Joseph McDonald, and John Kargul, U.S. Environmental Protection Agency. (March 28, 2016).

[101] 75 Fed. Reg. 25,346 (May 7, 2010) (Table I.C.2-1); 77 Fed. Reg. 62,774 (Oct. 15, 2012). (Table III-6, Incremental Vehicle Program Cost.).

[102] 74 Fed. Reg. 49,485 (Sept. 28, 2009).

It is absolutely inadequate for EPA to state that since sales have not decreased to date with the imposition of more stringent fuel economy standards, that there will be no effect (discernible or otherwise) of future standards on sales and no need for numerical quantification of sales or employment.[103] It is also inadequate to state that, in the event there is a sales decline and employment reductions, autoworkers will be able to find other work in other states and thus no numerical quantification of employment effects is necessary in a full-employment economy. This reasoning does not equate to the sort of rigorous economic analysis upon which decisions of this magnitude should be based.

EPA's own regulations and executive orders require that sales and employment impacts be quantified.[104] Until EPA quantifies the impact to sales and employment, EPA should not and cannot finalize the Proposed Determination.

5. EPA Ignores Its Own 2012 Final Rule Which Requires an Employment Analysis.

The Alliance offered extensive comments on the Draft TAR regarding employment.[105] Those comments also noted EPA's obligation to conduct a quantitative employment analysis. Further, they highlighted the Alliance's concern that the MY 2022-2025 standards have the potential to cost 100,000 to 1,100,000 jobs in the U.S. economy due to loss of vehicle sales.

In the Proposed Determination, EPA acknowledges the Agency's obligation to study employment.[106] This obligation arises from language in the 2012 Rule listing "[i]mpacts on employment, including the auto sector" as one of the factors to be considered in the Midterm Evaluation,[107] and the regulations cite "the impact of the standards on the automobile industry" as one of the factors the Administrator must consider in making her determination on the appropriateness of the standards.[108] Further, the President has emphasized the importance of considering such factors.

> The Presidential Memorandum regarding fuel efficiency standards, explained that the President sought a program that would "strengthen the [auto] industry and enhance job creation in the United States."[109] Further

[103] EPA Proposed Determination at p. A-95: "The total effect of the standards on motor vehicle employment depends in addition on changes in vehicle sales, which are not quantified; thus, we do not estimate the total effects of the standards in the regulated industry."

[104] Alliance Draft TAR comments, Docket ID EPA-HQ-OAR-2015-0827-4089, Appendix F: Economic Assessment: Employment Impacts, at145 et seq.

[105] *See generally* Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 145 et seq.

[106] EPA Proposed Determination at 3.

[107] 77 Fed. Reg. 62,784 (Oct. 15, 2012).

[108] 40 C.F.R. 86.1818-12(h).

[109] President Barack Obama, Presidential Memorandum Regarding Fuel Efficiency Standards, The White House, Office of the Press Secretary, May 21, 2010. http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards. (Accessed December 23, 2016).

> Executive Order 13563 states, "Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation."[110]

The fleet required to meet the MY 2025 standards under the Proposed Determination will result in higher retail prices,[111] and due to the elasticity of demand, it will reduce the number of vehicles sold.

A recent Center for Automotive Research ("CAR") study ("CAR Jobs Report") concluded that the MY 2022-2025 standards will potentially cause a loss of 100,000 to 1.1 million U.S jobs depending on total vehicle price increases (relative to current prices) related to the standards.[112] In response, EPA states without refuting those numbers, "[w]hile the 2022-2025 standards may have some effect on employment in the auto sector, this effect is likely to be small enough that it cannot be distinguished from macroeconomic and other factors affecting auto sector employment."[113] EPA also notes that "[t]he effects of the standards on employment are difficult to identify."[114]

Although EPA argues that a quantitative model is unnecessary, the Agency is nevertheless engaged in developing an economy-wide model to address employment impacts.[115] EPA has requested the Science Advisory Board (SAB) to review this modeling. We urge the EPA to maintain the original timing of the Midterm Evaluation, and use the time to refine and implement the model.

EPA suggests that future GHG standards won't impact sales (or therefore employment) because even with the current GHG standards the auto industry has recovered to pre-recession (and even record) sales and employment levels.[116] This conclusion is flawed. The industry's recovery resulted from a number of unusual factors, including the depth of the recession that created pent-up demand and the sharp fall in fuel prices. These factors are highly unlikely to recur in the near future. Further, the electrified powertrain technology believed by

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[110] President Barack Obama, Executive Order 13563 of January 18, 2011; *Improving Regulation and Regulatory Review, Federal Register* 76(14) (January 21, 2011): 3821-3823.

[111] EPA Proposed Determination at ES-4 (Table ES-1, per vehicle incremental cost increase of $800-$1,115). The Alliance believes that the incremental cost will likely be higher than those shown in the EPA analysis, but in any case, vehicle price increases are likely to occur with the addition of increasing levels of GHG control technologies.

[112] "McAlinden, Sean, et al, *The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy*, Center for Automotive Research, (Sept. 2016). Docket ID EPA-HQ-OAR-2015-0827-5803.

[113] EPA Proposed Determination at A-80.

[114] *Id.*

[115] EPA Draft TAR at7-6: "EPA is currently in the process of seeking input from an independent expert panel on modeling economy-wide impacts, including employment effects. For more information, see: http://yosemite.epa.gov/sab/sabproduct.nsf/0/07E67CF77B54734285257BB0004F87ED?OpenDocument."

[116] *Id.* at 26.

manufacturers to be required to meet future rules costs substantially more than the technology implemented to date.

The Alliance recommends that EPA not consider a Final Determination until a quantitative assessment of the MY 2022-2025 standard's impact on employment and where those impacts will occur can be made.

6. EPA Ignored Alliance Comments Regarding Employment Substitution Effects.

EPA's employment analysis explains that total employment is affected by the sum of employment changes due to the substitution effect and the output effect. In essence,

$$Employment_{total}\ \Delta = Employment_{Substition\ Effect}\ \Delta + Employment_{Output\ Effect}\ \Delta$$

Substitution Effect = The effect of regulation on labor intensity of production.
Output Effect = A decrease in production causes a decrease in labor demand.

EPA states: [117]

> In the Draft TAR (Chapter 7.4.2), we estimated this effect using the ratio of workers to each $1 million of expenditures in that sector. Though, as noted above, we received comments critical of our not quantifying the output effect, we did not receive comments on this approach to the substitution effect.

The Alliance did comment on EPA's substitution effect approach and recommended that EPA should reasonably conclude that significant declines in labor content are possible with the introduction of EVs and should adjust downward its substitution effects multiplier. [118] The Alliance also recommended that EPA should address factor shift effects due to reasonably anticipated declines in labor content of certain technologies, by, as an example, extrapolating and comparing the direct labor costs from the FEV teardown studies performed for fuel economy technologies considered in the 2012 FRM.

EPA's current approach does not correctly capture changes in "factor effects" where, due to historic secular trends that are occurring in the automotive industry (largely as a result of the extreme fuel economy increases required by the rules), the historic ratio of labor-to-parts-cost no longer is accurate. It is clear that some parts, particularly electrification technologies such as batteries and electric motors, will require significantly less labor than that EPA accounts for. The Alliance Draft TAR comments even included a chart (Figure F-1, page 149) as a reference highlighting the exceedingly small share of labor in the manufacture of an EV battery.

[117] EPA Proposed Determination at A-89:

[118] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 148.

In addition to the reduced labor content of the large consolidated parts used in EVs, the Alliance also pointed to changes occurring outside of the manufacturing process that would alter the historic share of labor, which the EPA should also take into account.[119] We noted one EV manufacturer's plans to create an assembly line that eliminates the use of human workers, and that same EV manufacturer's impacts on the way vehicles are sold and serviced.

As a result, EPA's statement that it expects that as a result of the increased costs of vehicles and parts, by itself, and holding labor intensity constant, employment would be expected to increase between 2021 and 2025 by a few hundred to perhaps 12,000 is likely in error.[120]

Therefore, the EPA should revisit its Proposed Determination and address these recommendations.

7. EPA Fails to Make the Necessary Sales Estimates.

The current state of low fuel prices, vastly different from the high prices that were predicted in the 2012 Rule, has resulted in a disconnect between customers' preferences and willingness to pay for fuel economy improvements. The projected vehicle fleet mix in 2025 has shifted from 67% passenger cars and 33% trucks to 52% cars and 48% trucks.[121] Customers consider a wide range of factors and vehicle attributes when making a purchase decision, including fuel economy. Strategic Vision New Vehicle Experience Survey data (NVES), a database of over 300,000 yearly customer responses about their newly purchased vehicle, shows that customers value fuel economy according to the current price of fuel, as shown in Figure 1. Although the priority that customers attach to fuel economy has varied, it has never, even in the period of high fuel prices, increased to greater than 6th place as a key consideration for purchase.

[119] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 150.

[120] EPA Proposed Determination at A-91.

[121] EPA Draft TAR at ES-8 (Table ES-1car/truck mix; 2012 Final Rule and AEO 2015 Reference).

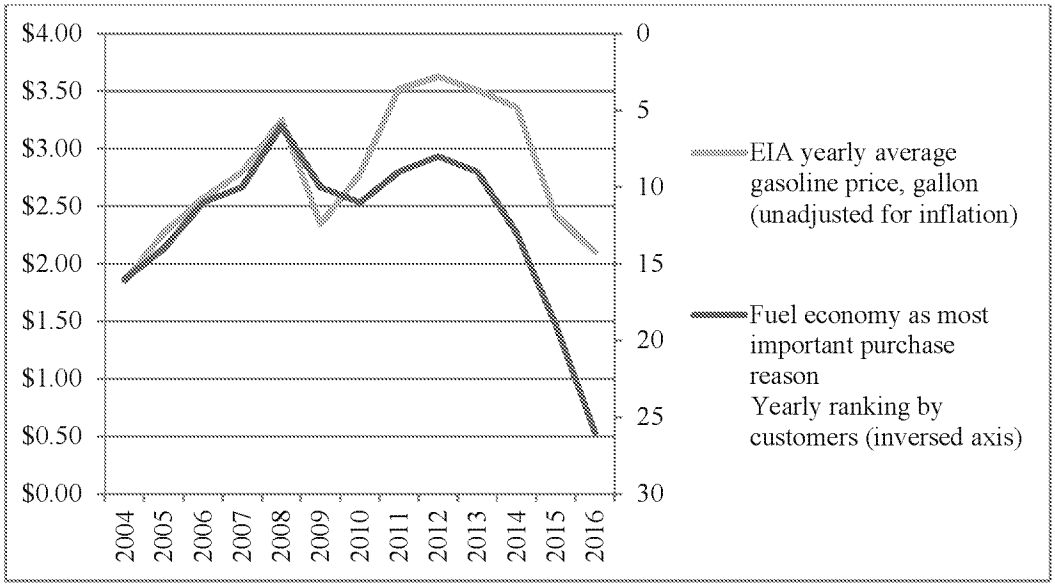

Figure 1: NVES Fuel economy as most important purchase reason versus gasoline price[122]

These data indicate that fuel economy in a low fuel price environment is not as high of a priority for customers. If customers do not consider fuel economy a top priority in their purchase decision process, it is also highly likely that customers are not performing any type of payback period calculations. Therefore, payback calculations of two to three years or even over the lifetime of a vehicle are not a priority in the customer's purchase decision process.

What customers are left to prioritize is the increased vehicle price as a result of the added fuel economy technologies necessary to meet the fuel economy standards. The Alliance has shown previously, and in these comments, that there are numerous flaws in the EPA modeling and additional and costlier technology will be needed than suggested by the Draft TAR and the Proposed Determination.[123] But even when using EPA's own cost estimates of technology (which also ignore the direct and opportunity cost impacts of electrification imposed by the California ZEV Mandate) EPA predicts that the cost of an average MY 2025 light-duty vehicle will rise by $875 as a result of the MY 2022-2025 standards.

EPA previously acknowledged a price elasticity for the demand of automobiles – that is, when price goes up, demand (sales) go down. In fact, as EPA and NHTSA reported at the time of the 2012 Rule, "[t]here is a broad consensus in the economic literature that the price elasticity of demand for automobiles is approximately –1.0, meaning that every one percent increase in the price of the vehicle would reduce sales by one percent…"[124]

[122] Yearly average gasoline prices, not adjusted for inflation, obtained from EIA's December 2016 Monthly Energy Review, Table 9.4 Retail Motor Gasoline and On-Highway Diesel Fuel Prices, yearly average EIA gasoline prices for all areas https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf (Accessed December 28, 2016).

[123] *See generally* Alliance Comments Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089.

[124] 77 Fed. Reg. 63,102 (October 15, 2012).

In the Proposed Determination, EPA disavows the applicability of this -1.0 elasticity of demand that it endorsed in 2012, calling it "old" and "…a short run elasticity estimate, which may not be appropriate for standards that apply several years into the future."[125] Accordingly, the Agency could have then used the long-term elasticity that was researched by CAR and provided to EPA in Table 14 of the CAR Jobs Report.[126]

Adopting a long-term elasticity value instead of a short-term elasticity value does not materially alter the fact that automobiles are a relatively inelastic good. As CAR notes in its Jobs Report:

> For most goods, the long-run elasticity is higher, as the ability to substitute other products increases over time. However, the only substitutes for a new vehicle is the purchase of a used vehicle or retaining a current vehicle (delaying purchasing), and the only source of used vehicles in the long run, is new vehicles. That both the short- and long-run elasticities are less than unitary defines motor vehicles as necessities (inelastic), reflective of the extreme importance of private vehicle ownership in the United States. In other words, an automotive consumer can choose to delay his/her purchase of a vehicle for only so long.[127]

CAR reports that the average long-run elasticity across its review of the literature is -0.72. EPA could use its preferred long-term elasticity, multiply it by the Agency's own vehicle price increase estimate and thereby arrive at a value for projected decreases sales in MY2025 relative to what would have occurred absent the MY 2022-2025 standards.

Notwithstanding such options, in the Draft TAR, EPA explains that, because the standards in place since MY2012 are national in scope, and because of their inability to control for other macroeconomic conditions, there is no way to identify a baseline for measuring the impact on sales.[128] Then, in the Proposed Determination, EPA cites "significant uncertainties involved in conducting a quantitative analysis"[129] as the reason for not quantifying an impact to vehicle sales.

The Alliance notes that EPA included estimates of sales decreases related to gasoline price increases in its analysis for the Draft TAR.[130] If EPA could do that for fuel prices, it should be able to do it for other factors as well. EPA states that the impact of the fuel economy

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[125] EPA Proposed Determination at A-40.

[126] McAlinden, Sean, et al., *The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy,* Center for Automotive Research (Sept. 2016).

[127] *Id.* at 27.

[128] EPA Draft TAR at 6-2.

[129] EPA Proposed Determination at A-40.

[130] *See* IHS-Polk Forecast and Report at Docket ID EPA-HQ-OAR-2015-0827-0403 and discussion thereof in Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 116.

standards on sales will be secondary to other broader economy-wide effects.[131] It is not at all clear how the Agency can make such a statement if they have no way to judge the effect.

The Alliance requests that EPA not prepare a Final Determination without a quantitative analysis of the impact of the standards under consideration in the Midterm Evaluation on light-duty vehicle sales.

8. EPA Misconstrues the Alliance Comments on Consumer Surveys (NVES).

The Alliance comments on the Draft TAR recommended that EPA obtain access to a consumer survey database such as Strategic Vision's New Vehicle Experience Study for insights on consumer fuel economy valuation.[132] The Alliance comments and EPA's responses in the Proposed Determination are reproduced, in part, below to illustrate this point.[133]

Alliance Comments on Customer Priorities and Preferences:[134]

> A key component of the Midterm Evaluation should be an assessment of customer priorities and preferences when making a new vehicle purchase.
>
> Strategic Vision conducts a comprehensive post-purchase survey of over 300,000 new car buyers each year, investigating the motivations driving customer choices. The 2015 NAS Report acknowledges that Strategic Vision provides "the most reliable information about consumer preferences." ["Cost, Effectiveness and Deployment of Fuel Economy Technologies for Light-Duty Vehicles." National Academy of Sciences, National Research Council to the National Academies. 2015. 325.]

Alliance Recommendations:[135]

> In addition to the customer acceptance issues described above, which the Alliance recommends the Agencies consider during the remainder of the Midterm Evaluation process, the Alliance has some additional specific recommendations to improve the Agencies' treatment of customer acceptance issues, discussed below....
>
> *Research NVES data to get better understanding of customer choices/decisions*

[131] EPA Proposed Determination at A-27. "EPA expects that any effects of the standards on the vehicle market will be small relative to market responses to broader macroeconomic conditions."

[132] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 143.

[133] EPA Proposed Determination at A-61.

[134] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 105.

[135] *Id.* at 143.

Strategic Vision's New Vehicle Experience Study (NVES) ["NVES." Strategic Vision. Accessed September 6, 2016....

The survey data can be mined and trended to infer, among other things:

- How new vehicle buyers rank fuel economy against other vehicle attributes
- What vehicle lines and segments customers choose when gasoline prices are high, or low
- What vehicle lines and/or segments customers buy given demographic and income characteristics
- Vehicle payment method, vehicle replaced, and future vehicle considerations

Access to similar data should give EPA insight into which types of customers are more likely to exit the pool of new vehicle buyers, or become unable to afford certain vehicle segments as new vehicle prices rise due to fuel economy requirements. Furthermore, this survey data would give EPA insight into customers' willingness to pay for fuel economy and/or willingness to compromise on vehicle choice. Finally, this data provides fresh evidence of how customers behaved during two critical periods in the automotive industry, including the 2008-2009 recession, which reflected a period of high gasoline prices, as well as the most recent 2014-2015 period of low gasoline prices. The latter period, with gasoline prices below $3/gallon, has added further downward pressure on smaller car segments and electric vehicle demand as customer favor larger segments and CUV/SUV mixes.

EPA's Response in Proposed Determination:[136]

Some market research firms conduct surveys of new vehicle buyers. These surveys, typically conducted a few months after purchase of a new vehicle, ask the buyer's views on a wide range of vehicle attributes. Several commenters encourage EPA to utilize such materials in its evaluation. Toyota, the Alliance of Automobile Manufacturers, and Fiat Chrysler specifically claim, incorrectly, that one company is endorsed by the NAS; instead, NAS commented that, "The most reliable information about consumer preferences comes from surveys of drivers who have made a recent new car purchase," and cite the one company as an example. [National Research Council (2015) ...

[136] EPA Proposed Determination at A-61.

> The Alliance, Global Automakers, the National Automobile Dealers Association, and Fiat Chrysler cite findings from Strategic Vision…that fuel economy may not be the primary consideration in consumers' vehicle purchase decisions.
>
> While it is likely that lower fuel prices are a major factor in this result, it is possible that standards have also contributed to this finding: the vehicles with attributes that they seek are now more efficient. The National Academy of Sciences, in reviewing a number of surveys of the role of fuel economy in vehicle purchases, observes that "while consumers value fuel economy, they do so in the context of other attributes they also value." [National Research Council (2015) …EPA and the NAS find that the role of fuel economy in consumer purchase decisions is not well understood. Though these commenters appear to have access to at least one of these sets of survey results, they do not otherwise provide insights from these results on consumer response to vehicles subject to the standards.

EPA neglected to access a consumer survey database of over 300,000 yearly responses from customers who recently purchases new vehicles even though the Agency acknowledged the usefulness and the necessity for EPA to access such a database in the Draft TAR.[137] Instead, EPA references a survey by Consumers Union,[138] which surveyed a general population sample with over 10 percent not even owning a vehicle.

The Alliance recommends that EPA rely on customer surveys which use data generated from surveys of recent purchasers of automobiles as opposed to general population or vehicle intender surveys.

9. Effects of the Fuel Economy Standards on Low-Income Households.

The Alliance submitted comments to the Draft Tar which included a literature review of studies on the impacts of higher fuel economy standards on low-income household affordability of used cars.[139] This review found that fuel economy standards have a disproportionate impact on low income households.

The Alliance commissioned Defour Group LLC to prepare a response to issues raised by EPA in the Proposed Determination regarding the effects of fuel economy standards on low-income households. The response is included in these comments as Attachment 1.

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[137] EPA Draft TAR, Section 6.4.1.3, Chapter 6: Assessment of Consumer Acceptance of Technologies, at 6-12.

[138] EPA Proposed Determination at A-30

[139] T. Walton, Defour Group. "The Impact of Future Fuel Economy Standards on Low Income Households." September 2, 2016. Attachment 11 to Alliance Draft TAR comments.

10. Advanced Technology Vehicle Incentives Remain Important.

EPA discusses Advanced Technology Vehicle incentives in the Proposed Determination, noting its belief that no change is required, but requests further comment.[140] The Alliance provided comments on several aspects of the advanced technology vehicle incentives in its comments on the Draft TAR, and hereby reaffirms its position that changes should be considered as described therein.[141] EPA's response to the Alliance Comments in the Proposed Determination was "...the MY2022-2025 standards remain appropriate with the credit and incentive provisions currently in place and EPA is not proposing any changes to these provisions as part of the Proposed Determination."[142] Such incentives remain important in supporting the development of technologies that are still in a very early market stage.

We further note that, although helpful, the advanced technology vehicle incentives are not likely to be enough by themselves to create a significant market for such vehicles and to make up the difference between the technology levels estimated by EPA for compliance and those estimated by automotive manufacturers.

The Alliance recommends that EPA extend Advanced Technology Vehicle incentives through at least MY 2025.

11. EPA Fails to Model Technology Benefits Consistent with Its Own Regulations.

EPA promulgated test procedures for light-duty vehicles describing specific methods by which they must be tested.[143] Automakers are required to follow these test procedures when applying for a Certificate of Conformity with the Clean Air Act prior to introducing vehicles into commerce. Given the requirement to follow the specified procedures in physical testing, manufacturers do the same in computer simulations of future technology. In contrast, EPA simulations are not consistent with these regulations, potentially resulting in inaccurate assessments of the benefits of future technology. Where these concerns have been raised in comments on the Draft TAR, EPA's inadequate response is to dismiss them without analysis as unimportant or inconsequential.

EPA regulations at 40 CFR § 86.129-00 and 40 CFR § 1066.805 (depending on vehicle model year) require all light-duty vehicle testing to be conducted at equivalent test weight ("ETW") "bins" which are each comprised of a range of loaded vehicle weights.

Comments submitted on the Draft TAR by FCA US LLC noted that EPA's modeling did not follow EPA regulations which require testing be conducted at ETW.[144] EPA dismissed these concerns noting that "EPA's approach of allowing mass reduction in continuous increments

[140] *Id.* at 32, A-103 and A-108.

[141] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at xiv and 174 et seq.

[142] EPA Proposed Determination at A-103.

[143] *See* 40 CFR Parts 86 and 1066.

[144] FCA US LLC Comments on Draft TAR, Docket ID EPA-HQ-OAR-2015-0827-4176 at 15.

(actually 0.5 percent increments in the OMEGA analysis) does not cause a systemic underestimation of costs, since cases where manufacturers may be getting less benefit from mass reduction than projected in our analysis would be offset by other cases where manufacturers may be getting more benefit." [145]

The Alliance disagrees with EPA's modeling approach which does not follow the Code of Federal Regulations. In the Proposed Determination, EPA alleges that a continuous function vs. the regulation's discrete bins will not cause a systemic underestimation of costs. EPA has failed to offer any evidence to support this claim. Even if such evidence were to be provided, the fact remains that the EPA OMEGA model is intended to demonstrate potential compliance pathways, but cannot since it fails to follow the regulations by which the vehicles modeled must be certified. As currently designed, EPA's modeling can show GHG improvements due to mass reduction that cannot occur when testing per the Code of Federal Regulations.

Similarly, engine technology modeling performed by EPA also does not follow regulatory requirements. As of MY 2020, EPA requires manufacturers to test vehicles for GHG emissions using a gasoline blended with ethanol.[146] However, instead of developing new baselines and technology modeling based on the new fuel for the Midterm Evaluation, EPA has chosen to continue modeling engine technology benefits using a test fuel only applicable to GHG certification through MY 2019.[147] EPA attempts to reason why this will not matter and to rebut auto manufacturer concerns provided in the Alliance's and others' comments to the Draft TAR. However, the fact remains that EPA has specifically chosen to continue modeling with fuel that does not match that required for testing in the timeframe covered by the Midterm Evaluation.

The Alliance recommends that EPA model future compliance in a manner consistent with its own regulations.

12. <u>EPA Provides Inadequate Response to Alliance Recommendations for Model Output Plausibility Checks.</u>

Given the broad range of concerns the Alliance has with the EPA technology benefit modeling, it requested that EPA apply three checks to its modeling outputs to determine whether the technology benefits modeled for specific vehicles exceeded plausible limits.[148] These checks were energy conversion efficiency, on-cycle-to-peak engine efficiency ratio, and city-to-highway cycle efficiency ratio with suggested specific numerical limits.

EPA acknowledged that "quality assurance processes are important for ensuring the validity of any modeling."[149] However, EPA declined to incorporate two of the suggested

[145] EPA TSD at 2-413.

[146] See 40 CFR § 600.117

[147] EPA TSD at 2-210. (Referencing Tier 2 Indolene fuel.)

[148] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 41.

[149] EPA TSD at 2-282.

checks entirely.[150] EPA cited concerns with the limits chosen, but provided no analysis of the limits suggested or what limits it would find acceptable. Nor did EPA provide any reason for rejecting the methodology recommended. Where EPA did accept a recommended plausibility check (energy conversion efficiency), EPA did not explain its reasons for disagreeing with the suggested limit, and did not provide an alternative.

The Alliance again recommends that EPA implement all of the recommended plausibility checks.[151]

13. EPA's Dismissal of the Alliance-Recommended Top Gear Gradeability Performance Metric is Based on Flawed Reasoning.

EPA dismisses the Alliance recommendation for applying a "gradeability" metric for maintaining top gear at 75 mph while climbing a given grade.[152] EPA purports to support its position with three arguments, none of which are adequate. First, EPA speculates that downshifts with eight-speed transmissions are less noticeable to the driver.[153] However, no support for this contention is provided. Second, EPA notes that a single example vehicle downshifted significantly during a highway cycle test. The example vehicle chosen was a sedan generally marketed as a performance vehicle and is not necessarily representative of the entire U.S. fleet.[154] Nor is the gradeability performance metric based on a highway fuel economy cycle test which does not even reach 75 mph. Third, EPA cites three magazine articles as commenting that top gear is not maintained in another example vehicle.[155] This is a misrepresentation of the cited articles. The articles describe that the example vehicle generally did not make use of the top gear of the transmission. The cited articles appear to be a better example of how a manufacturer has taken a gradeability metric into consideration and has avoided the use of a gear which cannot be maintained without excessive shifting given the torque of the engine in the example vehicle. In short, EPA has simply dismissed a design consideration that many manufacturers use in the development of powertrain systems as unimportant. Manufacturers are best situated to understand their own customers, and EPA's disregard for such considerations artificially allows more engine downsizing (i.e. efficiency) than manufacturers will reasonably expect to achieve in future vehicles using advanced transmissions.

The Alliance again recommends that EPA apply a top gear gradeability performance metric in its technology benefit modeling to avoid technology packages that will not be commercially acceptable. We invite EPA to discuss the specific methods individual

[150] *Id.* at 2-282.

[151] The Alliance recommends that EPA engage in discussions to consider plausibility checks with reasonable limits.

[152] EPA Proposed Determination at A-10. ("EPA does not believe this metric is appropriate for advanced eight-speed transmissions…")

[153] *Id.* at A-11.

[154] EPA TSD at 2-331.

[155] *Id.* at 2-331.

manufacturers use for this metric in order to inform its development of an appropriate measurement within its modeling.

14. EPA's Dismissal of Attachment 8 ("EPA ALPHA Samples Transmission Walk") is Premised in Part on a Misunderstanding of the Material Provided.

EPA states that the Ford simulation referenced by the Alliance assumed the same torque converter lockup strategy between transmissions whereas EPA's simulation did not.[156] This is incorrect. The referenced Ford presentation, included as Attachment 8 in the Alliance Draft TAR Comments clearly states that the torque converter lockup assumptions used by ALPHA were applied and that common torque converter lockup efficiencies was applied (not strategies). We further note that EPA has assumed 100% efficiency for a future torque converter without providing any supporting data.

EPA also implies that the Ford simulation referenced by the Alliance is not applicable because of differences between the Ford transmissions and the benchmark transmissions studied by EPA.[157] Both of the Ford eight-speed transmissions used in the Ford simulation contain similar design elements and have similar efficiencies to the EPA benchmark 845RE (ZF 8HP45) transmission.

The Alliance recommends that EPA reengage with manufacturers to better understand these technical concerns.

15. EPA Points to Past Performance as Indicative of Future Potential, but Neglects Key Considerations.

The most recent data available indicates that industry, on average, will not meet the MY 2016 requirements without using credits earned from past compliance margin.[158] The EPA should wait until the final MY 2016 GHG data is available (after March 31, 2017) and perhaps until early MY 2017 data is available before issuing any determination and reevaluate the efficacy of using the MY 2021 fleet as the reference fleet.

In EPA's assessment of the appropriateness of the MY 2022-2025 standards, EPA provides an evaluation of the existing fleet's progress toward meeting GHG standards.[159] The analysis describes the percentage of MY 2016 vehicles that meet the MY 2020 standards (approximately 21% assuming the theoretical generation of off-cycle credits) as a positive indication that the fleet is on track to meet MY 2025 targets. This analysis is misleading in that it does not closely examine the types of vehicles that are complying with the standards and are

[156] EPA Proposed Determination at A-10, Second paragraph, second bullet.

[157] *Id.* at A-10; Second paragraph, third bullet.

[158] *Novation Analytics MY 2016 Baseline Study*, December 20, 2016, prepared for the Alliance of Automobile Manufacturers and Association of Global Automakers.

[159] EPA Proposed Determination at 50.

subject to the Midterm Evaluation. It also fails to consider the shrinking compliance margins evident in recent compliance reports and updated projections. The analysis also focuses on MY 2020, a year not even under consideration in the Midterm Evaluation.

If EPA were to examine historical compliance data in the context of future compliance with the standards under consideration in the Midterm Evaluation, a completely different story emerges. Based on Appendix C of the TSD, only 5% of the MY 2016 vehicle models compliant with MY 2022 standards are non-hybrid, plug-in electric, or fuel cell vehicles. Not a single conventional vehicle, including vehicles with turbocharged-downsized engines, Atkinson cycle engines, advanced transmissions, stop/ start, variable valve timing, direct injection, and other non-hybrid technologies, currently meets the MY 2025 standards. Even when additional credits are assumed based on those estimated in the 2012 Rule, only hybrid, plug-in electric, and fuel cell vehicles meet the MY 2025 standards.

Compliance margins are also shrinking and the fleet is expected to already be at a deficit in MY 2016, just 5 years into a 14-year program. In MY 2014, manufacturers performed 13 g/mi better than their standards on average.[160] This compliance margin shrank to 7 g/mi in MY 2015.[161] At a manufacturer level, five manufacturers had either no compliance margin or actually generated debits in MY 2015.[162] According to a recent study by Novation Analytics examining MY 2016 fleet performance ("MY 2016 Baseline Study"), the expected MY 2016 fleet is projected to be at an 8 g/mi deficit.[163] This 8 g/mi deficit includes the use of credits. The early fleet compliance deficit suggests that using the 2021 model year as a reference for determining incremental costs toward 2025 model year compliance glosses over the fact that starting with the 2017 model year, the U.S. fleet will have a more challenging and costly path to 2025 model year compliance than assumed in the 2012 final rule. A full and thorough midterm review should closely reevaluate the efficacy of employing 2021 MY as the reference case fleet.

The full MY 2016 Baseline Study is provided as Attachment 2.

Important conclusions from the MY 2016 Baseline Study include:[164]

- Compared to the agency projections for the MYs 2012-2016 timeframe, the improvements in the passenger car and light-duty truck fleet 2-cycle tailpipe CO2 performance have been at a rate that is lower than the agencies anticipated. This has increased manufacturers' reliance on credits for compliance with the footprint standards.

[160] "Greenhouse Gas Emission Standards for Light Duty Vehicles – Manufacturer Performance Report for the 2015 Model Year." U.S. Environmental Protection Agency. EPA-420-R-16-014. November 2016. iii.

[161] *Id.*

[162] *Id.* at iv.

[163] *Novation Analytics MY 2016 Baseline Study*, December 20, 2016. 31.

[164] *Id.* at 50-51.

- The phase-out of FFV credits since MY 2015, particularly under the GHG program, has put pressure on fleet compliance with the standards. Additional A/C and Off-cycle credits and/or vehicle 2-cycle performance improvements must compensate for phased-out FFV credits.
- Even with the availability of credits, the light-duty truck fleet is projected to be at a deficit to the MY 2016 GHG footprint standards. With the loss of FFV CO_2 credit after MY 2015, net A/C and Off-Cycle credits generated by manufacturers in MY 2016 has not made up that deficit.
- The light-duty truck market share continues to increase at the expense of passenger cars, exposing more of its gap between actual performance versus agency projection. The resulting combined fleet performance has moved from compliance with the standards without credits, to requiring credits to comply, to underperforming relative to the standards even with current year credits generated.
- The gap between agency projections and actual performance is likely the result of over optimistic technology deployment assumptions on the part of the agencies. While manufacturers have exceeded agency expectations for certain technologies, such as spark ignition direct injection and high ratio-spread transmissions, other technologies have significantly lagged agency projections. Actual deployment of hybrids, for example, is much lower than projected.
- The over optimistic agency projected technology deployment rates can combine with agency assumptions on the technology's effectiveness as a key source of the agencies' over optimistic projected rate of 2-cycle tailpipe performance improvement. This is likely the case with agency's assumptions on hybrid technology.

The Alliance recommends that EPA cease pointing to past performance as indicative of future potential.

16. Premature Release of the Proposed Determination Precluded Consideration of More Current Data.

The premature release of the Proposed Determination precluded consideration by EPA of pending studies and more current information. EPA should return to the previously disclosed Midterm Evaluation schedule with a Proposed Determination sometime in mid-2017.

For example, the 2016 Baseline Study was one of the studies the Alliance intended to enter into the Administrative Record. Issuing the Proposed Determination early has led to a reliance on 2016 projections based on mid-model year data as explained in the EPA Trends Report, rather than on actual data which will be readily available on EPA's long-publicized timeline, and is inherently more reliable than projections.[165] In addition to using projections instead of actuals, EPA compounds the problem by cherry-picking projections from the Trends Report. For example, EPA relies on the projection of car market share increasing from 57.4% in MY 2015 to 62.1% in MY 2016. The MY 2016 Baseline Study predicts a car market share

[165] Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016- Trends Report, U.S. Environmental Protection Agency, EPA-420-R-16-010, November 2016. 5.

decrease to 55.7% in MY 2016.[166] The difference between EPA and Novation MY 2016 car market share projections, 6.4 points, is not a minor error in the Proposed Determination analysis. A 6.4 percent market share represents over 1 million vehicles and must be fully analyzed based on the record.

In addition to the MY 2016 Baseline Study, the Alliance also has undertaken or sponsored other studies that could not be completed before the close of the Proposed Determination comment period. These include an assessment of the plausibility of Draft TAR modeling results[167] (expected January 2017) and the second stage of an Indiana University study on fuel economy policy (expected February 2017). The Alliance also believes that additional analysis of the revised ALPHA, lumped parameter, and OMEGA models is warranted. Studies related to consumer acceptance and impacts of the MY 2022-2025 standards on sales and the economy also are clearly needed.

The Alliance recommends that EPA return to originally anticipated timelines for the Midterm Evaluation to allow for the consideration of additional data under preparation by stakeholders.

17. The Alliance Has Additional Concerns Regarding the OMEGA Optimization Model Used by EPA to Derive Costs and Benefits Associated with the MY 2022-2025 Standards.

The Alliance is concerned with the OMEGA model design and its resulting "optimized" output. OMEGA generally seems to deliver a level of fleet optimization that manufacturers cannot replicate. For example, the approximately 2,600 vehicles in the MY 2015 baseline fleet become approximately 7,200 in the MY 2025 fleet. This near tripling of combinations of technology is not realistic from a technology investment or vehicle sales perspective. In practice, manufacturers would not be expected to actually build a compliant fleet as modeled. Such departures from the more ideal perspective presented by EPA would naturally be expected to add additional costs which EPA fails to account for.

The OMEGA model also yields conflicting technology packages for some vehicles. For example, MY 2025 control fleet vehicle index 633 has two technology packages that are nearly identical except for in that one technology package uses a 12-volt stop start system and the other uses a higher voltage mild hybrid system. It is difficult to believe that a manufacturer would invest in both types of systems for a single vehicle in a single model year. Selling such a system could also be problematic. A customer would be asked to choose between what are identical vehicles that operate in what will be perceived to be almost identical fashion, but in the case of the mild hybrid system to pay ~$450 additional for what will amount to less than $100 of fuel savings per year. It is more likely that if the 12-volt engine stop-start system is not sufficient for

[166] *Novation Analytics MY 2016 Baseline Study* at 13.

[167] The Alliance notes that the accelerated timing of the Proposed Determination further limits the applicability of a study of Draft TAR modeling results and therefore has also expanded the study to assess a limited number of results from the Proposed Determination.

compliance, that the manufacturer will invest in the higher benefit mild hybrid system. Although this would theoretically allow less technology to be placed on a different vehicle, technology costs and benefits vary between vehicles and would not necessarily balance.

The Alliance recommends that EPA constrain its optimization modeling such that a given vehicle in the baseline fleet corresponds to a single vehicle in the MY 2025 reference and control fleets to avoid an optimized solution which is not practical to implement.

18. EPA States That It Has Executed Technology Benefit Modeling On a Performance Neutral Basis, but the Supporting Electronic Files Suggest Otherwise

EPA considers performance neutrality as important in modeling the benefits of future technologies so that they are compared on a consistent basis.[168] To meet this goal, EPA states that "ALPHA modeling runs generate effectiveness values which maintain a set of acceleration metrics within a reasonable window."[169] Within the ALPHA files generated in support of the Proposed Determination, there is a file for each "ALPHA Class" of vehicles (e.g. "LPW_LRL" and "Truck") named as [ALPHA Class]_LPM_matrix_selected_results_[date code].[170,171] Each of these files contains vehicle emissions and performance information including acceleration times. The ALPHA "Truck" class file shows 0-60 mph acceleration times averaging 15.9 seconds. In comparison, the most recent EPA Trends report indicates that pickup truck 0-60 mph acceleration times average around 8.5-9 seconds in MY2015 and have not been in the 15.9 second range since the early 1980's.[172] Modeling of what appears to be technologies that provide acceleration rates at little over half of what is observed in the baseline fleet is inconsistent with the premise of performance neutrality.

The Alliance recommends that, at minimum, EPA examine 0-60 mph acceleration times of exemplar vehicles for the 29 ALPHA vehicle types and verify that ALPHA model results used in the calibration of the lumped parameter model maintain performance consistency with the baseline vehicles.[173]

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[168] EPA TSD at 2-207.

[169] *Id.* at 2-208.

[170] See Advanced Light-Duty Powertrain and Hybrid Analysis ALPHA Tool, U.S. Environmental Protection Agency. . Accessed December 21, 2016. (Under the "ALPHA V2.1 Calibration Samples" heading, click the link to "ALPHA v2.1 Calibration Samples (ZIP)", open the 20161128_ALPHA folder, open the subfolder for each of the ALPHA classes.)

[171] Based on the file name convention, the Alliance assumes that these files contain the ALPHA model outputs used in calibrating the EPA lumped parameter model for use in technology benefit modeling.

[172] Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016, U.S. Environmental Protection Agency, EPA-420-R-16-010, November 2016. 36.

[173] This recommendation is made only in the context of EPA's stated intent to maintain performance neutrality. The Alliance reaffirms its previous comments on the Draft TAR describing concerns related to the availability of downsized engines, limits on engine displacement to vehicle mass ratio and top gear gradeability performance. (Alliance Draft TAR Comments at 33 et seq.)

19. The Alliance and Other Stakeholders Were Not Given the Opportunity to Adequately Review and Assess the ALPHA Model.

The ALPHA model, used to inform the Draft TAR and Proposed Determination, was peer reviewed with a report on the peer review findings published in October 2016.[174] Peer reviewers selected included representatives from National Laboratories, academia, and environmental advocates. Auto manufacturers and other stakeholders were not provided any significant opportunity to examine the model in detail before or during the abbreviated Draft TAR and Proposed Determination comment periods. Furthermore, when an Alliance contractor attempted to open the Matlab files provided by EPA in association with the Proposed Determination, license and encryption issues prevented preliminary examination. While we are sure that these issues can be resolved between EPA and the contractor, the fact remains that the 30-day comment period provided for the Proposed Determination was not sufficient to resolve these types of issues.

The Alliance recommends that EPA ALPHA modeling teams engage in discussions with stakeholders to better understand their concerns with the current ALPHA model.

20. EPA Incorrectly Attributes Alliance Concerns with the Technology to Meet the MY 2022-2025 Standards to an Alliance Belief That Only Existing Technologies Can Be Used For Compliance.

As described in its comments on the Draft TAR and herein, the Alliance and its members believe that the MY 2022-2025 standards cannot be met with the technology deployment rates modeled by EPA. EPA interpreted Alliance comments such as these as relying on studies prepared by Novation Analytics (which EPA did not agree with) and to manufacturer beliefs that only technologies available in the MY 2014 baseline fleet (and without subsequent improvements to those same technologies) would be available for compliance in MY 2025.[175] The EPA's interpretation of the Alliance comments is incorrect. Although the referenced Novation Analytics studies certainly support that a stronger mix of technology is likely to be required and that EPA modeling in the 2012 final rulemaking was suspect, our comments are not founded on the premises ascribed to the Alliance by EPA. Rather, the Alliance comments are based on the internal and fact-based analyses of its members. The Alliance expects that several of its members will be submitting their own confidential comments in response to the Proposed Determination to demonstrate this to EPA.

The Alliance recommends that EPA reengage with key stakeholders such as auto manufacturers to understand their concerns.

[174] Peer Review of ALPHA Full Vehicle Simulation Model, Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, EPA-420-R-16-013, October 2016.

[175] EPA Proposed Determination at 22.

21. EPA Fails to Provide Adequate Documentation of the Verification and Methodology for Calibrating the Lumped Parameter Model.

EPA relies upon its lumped parameter model ("LPM") to inform its optimization model of the GHG and fuel economy benefits of various future technology packages.[176] The specific processes by which EPA calibrates the LPM from benchmarking and simulation data is critical, particularly in light of the multiple changes in the tool from its first use in establishing MY 2012-2016 standards, to the Draft TAR, and now with additional changes for the Proposed Determination. EPA has not provided substantive documentation of how the LPM was calibrated from other models. Nor has EPA provided any documentation verifying the model's ability to accurately predict technology benefits other than in comparison to other EPA models.[177] Additionally, although the Proposed Determination and TSD discuss the lumped parameter model, the version used for the Proposed Determination was not directly provided on EPA's Lumped Parameter Model website.[178] Instead the model is a spreadsheet tab within a much broader spreadsheet without any clear directions in its use.

This lack of documentation and verification has prevented the Alliance from adequately assessing the accuracy and precision of the lumped parameter model's capabilities, particularly in the limited time provided for comment to the Draft TAR and Proposed Determination. The Alliance recommends that EPA fully document the spreadsheet version of the LPM or any other version of the LPM that is used to inform the OMEGA model. Such documentation would ideally include specific instructions for the model's operation, descriptions of the development and theory behind the model, method of calibration from the ALPHA model and other data sources, and verifications against both full vehicle simulation models and actual vehicles.

Given the LPM's critical role in informing the EPA's Proposed Determination, the Alliance further recommends that EPA provide such documentation and subsequent time for review and discussion with stakeholders prior to proceeding further with the Midterm Evaluation.

22. EPA's Response to Alliance Comments Regarding Atkinson Cycle Engine Technology Benefits is Inadequate.[179]

The Alliance provided significant comments to the Draft TAR detailing concerns of feasibility and effectiveness of the non-hybrid Atkinson engine technology packages including

[176] EPA TSD at 2-274.

[177] One potential validation would be to model the predicted technology benefits from technology added between a historical model year (e.g. MY 2008) and the present MY 2015 baseline and to compare predicted GHG emissions to those actually achieved by the MY 2015 vehicles.

[178] The LPM used to inform the Proposed Determination is located within the OMEGA model "Machine" files. The Alliance acknowledges that when this issue was brought to the attention of EPA staff, the staff provided a timely response and directed the Alliance to the appropriate file. The Alliance appreciates the responsiveness of the EPA staff in this instance.

[179] EPA Proposed Determination at 48; TSD at 2-308 et seq.

cooled EGR and cylinder deactivation.[180] EPA's response to these comments oversimplifies the requirements of introducing complex engine architectures to a large portion of the new vehicle fleet. EPA continues to overestimate the effectiveness of this technology and the ability of manufacturers to implement it in the time period covered by the Midterm Evaluation.

EPA has not sufficiently responded to comments regarding implementing 4-2-1 exhaust manifold in existing vehicle architectures.[181] EPA describes that a prior implementation of SkyActiv technology used a more conventional exhaust manifold.[182] Mazda itself describes the 4-2-1 exhaust manifold as a key enabler to realize the benefits of its second generation Atkinson cycle engine technology.[183] EPA also states that it does not believe that coordination with vehicle redesign is necessary.[184] However, Mazda describes the packaging of the 4-2-1 exhaust manifold as "[requiring] coordination with 'Skyactiv-Body'" activities.[185]

The Alliance also presented concerns with EPA's ability to demonstrate its modeled benefits of Atkinson, cooled EGR, and cylinder deactivation technologies.[186] The EPA response focuses on the availability the various technologies in example vehicles.[187] However, the EPA response is irrelevant because it ignores the primary concern of the Alliance comments – that there is no current example of combined Atkinson, plus cooled EGR, plus cylinder deactivation technology in the present fleet to verify EPA's modeled benefits and that EPA could not provide physical test results replicating its modeled benefits of these combined technologies.

The Alliance again recommends that EPA take caution when relying on unverified technology benefits to support conclusions regarding the practicability and feasibility of future standards and to engage in discussions with auto manufacturers regarding their methods for modeling future vehicles.

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[180] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 45 et seq.

[181] EPA TSD at 2-310.

[182] *Id.* at 2-310.

[183] Mazda. *What's All This Skyactiv nonsense anyway?* Dave Coleman, Presentation at Center for Automotive Research Management Briefing Seminars, August 2012. http://www.cargroup.org/assets/speakers/presentations/36/coleman_dave.pdf. (Accessed December 21, 2016.) 16.

[184] EPA TSD at 2-310.

[185] [185] Mazda, "*What's All This Skyactiv nonsense anyway?* Dave Coleman, Presentation at Center for Automotive Research Management Briefing Seminars, August 2012; http://www.cargroup.org/assets/speakers/presentations/36/coleman_dave.pdf. (Accessed December 21, 2016.) 16.

[186] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 45.

[187] EPA TSD at 2-309.

23. EPA Gasoline Turbocharged Direct Injected ("GTDI") Engine Maps Remain Optimistic in Comparison to Estimates of Similar Technologies by NHTSA and to Benchmark Data.

EPA assessments of engine technology benefits appear highly optimistic to manufacturers, even after considering further development and combinations of known technologies. To illustrate this point, the Alliance compared the EPA's 1.17 L GTDI engine with cooled EGR fuel map to the corresponding fuel map used by NHTSA in the Draft TAR for a 1.2L GTDI with cooled EGR. All fuel maps were scaled to a common displacement using the same process utilized for the EPA ALPHA model. Additionally, the NHTSA GTDI fuel map results were normalized for test fuel differences.[188] Figure 2 compares the normalized NHTSA fuel map to the EPA fuel map. The differences between the EPA and NHTSA maps are shown as percent difference. Positive values indicate regions where EPA estimates lower fuel flow (i.e. indicating higher efficiency) than NHTSA; negative values are regions where EPA estimates higher fuel flow. Overall, EPA projects 10-20% lower fuel flow than NHTSA in operating regions applicable to GHG and fuel economy compliance for the same set of technologies when compared on a normalized basis.

[188] The NHTSA GTDI fuel map utilized MY 2025 Tier 3 fuel properties (i.e. E10, regular grade octane) whereas the EPA fuel map relies on the use of outdated Tier 2 (E0, premium grade octane) fuel.

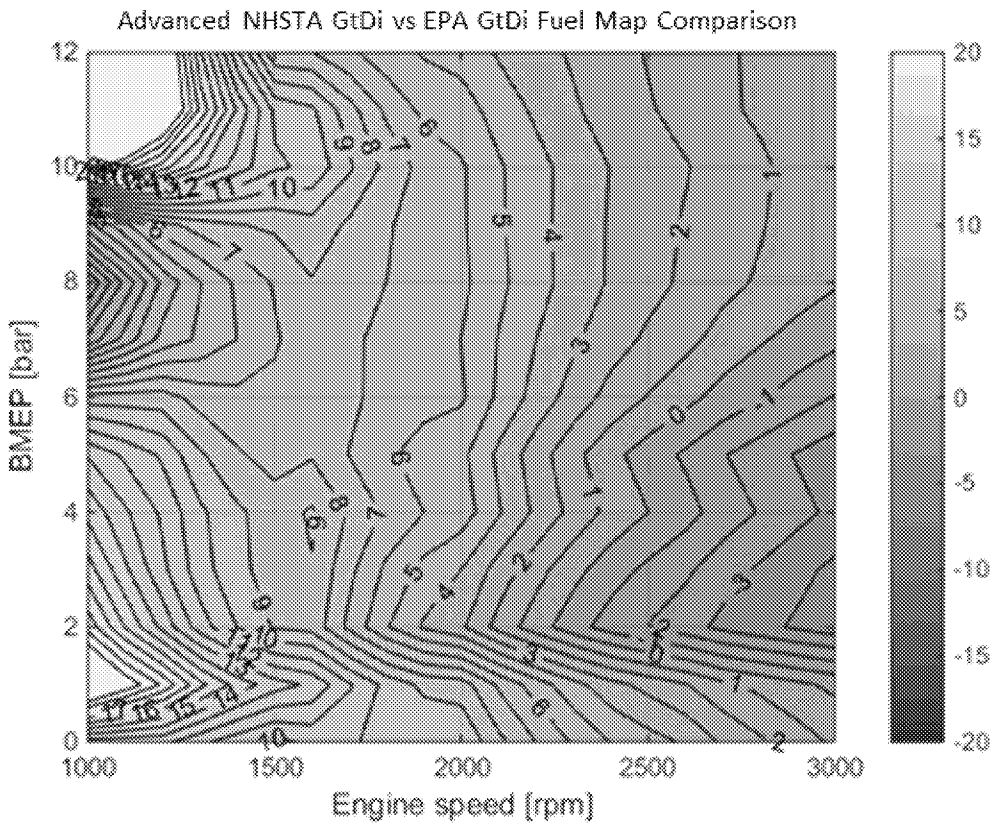

Figure 2: Comparison of EPA 1.17L GTDI plus cooled EGR engine fuel map to NHTSA 1.2L GTDI plus cooled EGR engine fuel map. Differences are shown as percentages. Positive values indicate lower fuel flow in EPA map.

The Alliance performed a similar analysis comparing the EPA 1.17L GTDI plus cooled EGR engine fuel map to the EPA benchmark 2.7L GTDI engine as shown in Figure 3. Fuel flow for the 2.7L engine was normalized for displacement using the same process applied by EPA in the ALPHA model. Again, the engine map used by EPA for ALPHA modeling shows 10-20% lower fuel consumption in the city / highway test cycle operation area. Even assuming that some portion of the difference can be attributed to the inclusion of cooled EGR on the 1.17L engine, the incremental difference challenges credibility.

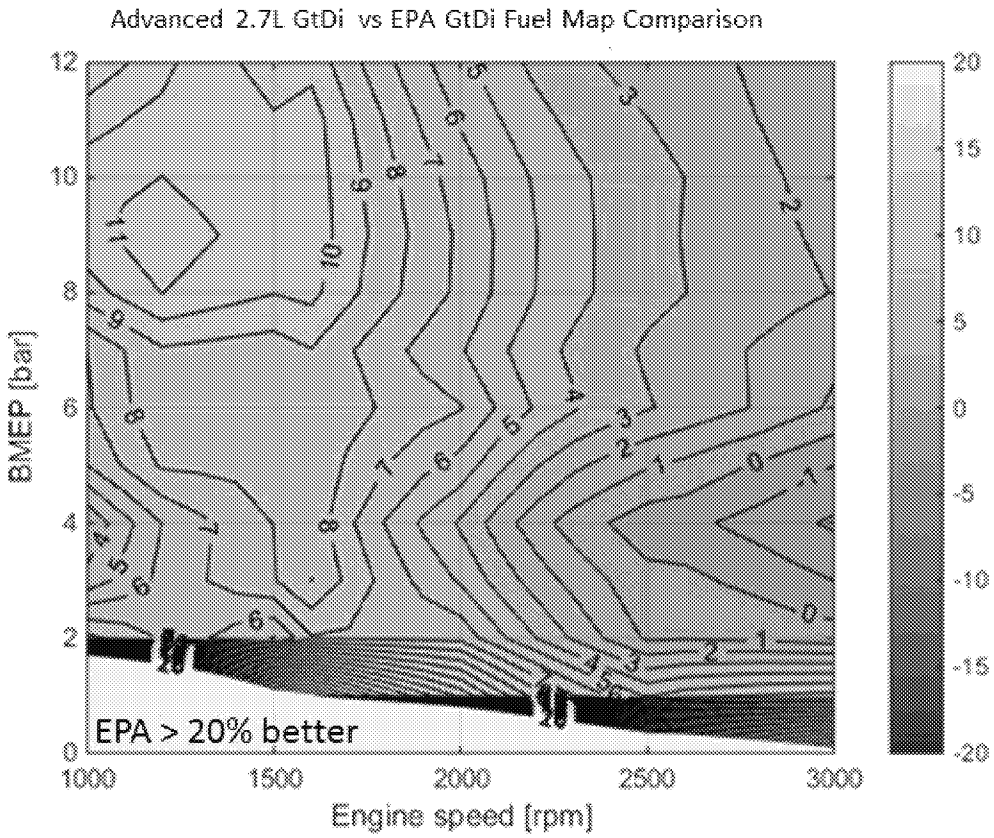

Figure 3: Comparison of EPA 1.17L GTDI plus cooled EGR engine fuel map to normalized EPA 2.7L benchmark GTDI engine fuel map. Differences are shown as percentages. Positive values indicate lower fuel flow in EPA map.

The Alliance additionally points out the both the future NHTSA and EPA engine fuel maps grossly underestimate engine fuel flow at light loads. When comparing the EPA theoretical future engine fuel map to the EPA benchmark engine (Figure 2), the future engine fuel flow at 1 – 2 bar BMEP is much greater than 20% better (i.e. lower fuel flow). The Alliance believes that this is due, at least in part, to model fitting error.

The differences described in Figures 2 and 3 make a significant difference to the ultimate technology benefits modeled in ALPHA. A vehicle with the properties described in Table 1 was simulated in ALPHA using the EPA 1.17L GTDI plus cooled EGR, the NHTSA (normalized) 1.2L GTDI plus cooled EGR, and EPA (normalized) benchmark 2.7L engine without cooled EGR fuel maps. Results of these simulations are shown in Table 2. The EPA 1.17 GTDI plus cooled EGR fuel map yields results 9% better than even the NHTSA map with nominally the same technologies. Similarly, the EPA map used in ALPHA simulations for the Proposed Determination yielded 11% better results than the benchmark engine.

Table 1: Vehicle properties for ALPHA model simulation example

ETW	3,750 lb
CdA	1.2 m^2
RRC x 1,000	7.2
Tire rev / mi	700
Transmission	EPA 8-speed automatic (see ALPHA model)
Final Drive Ratio	3.55

Table 2: Comparison of ALPHA results using vehicle properties from Table [x] and different fuel maps

Engine Map	Combined Unadjusted CO_2 (g/mi)
EPA 1.17L GTDI plus cooled EGR	180
NHTSA (normalized) 1.2L GTDI plus cooled EGR	198
EPA (normalized) 2.7L GTDI without cooled EGR	203

The Alliance comments regarding these comparisons are necessarily brief given the short period of time permitted for comment. We invite EPA to engage in a more thorough technical discussion of the methodologies applied in this analysis and industry concerns with the EPA 1.17L GTDI plus cooled EGR fuel map.

24. <u>There is a Great Need for Further Technical Discussion.</u>

Given the complex and technical nature of modeling future technologies, we recommend that EPA meet with technical experts from automotive manufacturers to have detailed discussions with the purpose of addressing fundamental disagreements in modeling of technology benefits. Such discussions do not lend themselves well to carefully coordinated workshop presentations and public-facing documents. Expert engineers from both EPA and the automotive manufacturers will be best suited to describing, in person, their varying viewpoints to gain an understanding of the concerns of both parties. There is no reason why engineers should not be able to come to substantially similar conclusions on the potential benefits of future technology development which will likely occur over the next five to eight model years.

25. <u>Further Technical Changes Are Necessary in the Proposed Determination.</u>

Modeling of future technologies and costs is a highly technical undertaking. In the Proposed Determination and TSD, EPA describes its response to many of the comments it received on the Draft TAR. In some cases, the analysis remains the same as described in the Draft TAR; in others EPA has chosen to modify its analysis. The resulting new analysis is described in the TSD, which encompasses over 700 pages plus supporting electronic files.

EPA provides an extensive list of what it considers key changes and updates in its analysis for the Proposed Determination.[189] Considering the complexity of some of these changes and the time allotted for review, the Alliance cannot provide adequate comment on these

[189] EPA TSD at 2-3.

modifications at this time and reserves its rights to supplement the Administrative Record as new information becomes available.

26. EPA's Response to Technology Lead-Time and Adoption Is Inadequate and Misleading.

In the TSD, EPA describes several "universal" comments to the Draft TAR.[190] Included among these are comments from auto manufacturers and their trade associations on lead-time required for technology development and adoption (i.e. phase-in across product lines). EPA states a belief that lead-time is adequate because the technologies considered are either currently in production, or will be commercially produced in the next several years.[191] EPA further asserts that lead-time is effectively measured from when the MY 2022-2025 standards were first promulgated (i.e. 2012).

Contrary to EPA's statements, many key technologies considered by EPA are not currently in production, e.g. non-hybrid Atkinson engines with higher compression ratios in combination with cooled EGR and cylinder deactivation, designed to run on regular grade U.S. market fuels. EPA's statement that some of these technologies will be commercially produced in the "next several years" is so vague as to be meaningless.

Furthermore, attributing technology development and adoption across the entire U.S. automotive industry based on single examples does not reflect the wide diversity of manufacturers, their product lines, their customers, and their resources to make such changes.

The Midterm Evaluation was conceived in order to mitigate the errors and uncertainty associated with setting standards so far into the future. As such, implications that lead-time can be measured from that original rulemaking are not accurate.

The Alliance recommends that EPA reconsider lead-time in the context of design and development of technologies on a manufacturer-by-manufacturer basis.

27. EPA Failed to Respond Adequately to Alliance Comments Regarding Concerns with Applying Atkinson Technology at the Projected Rates Across the U.S. Fleet.

In response to the Alliance comments regarding Atkinson technology penetration rates EPA describes Mazda's phase-in of its Skyactiv technology including Atkinson cycle engines.[192,193] The Alliance believes that this response is inadequate. The concerns presented by the Alliance are primarily related to auto manufacturers who have not already invested significantly in such technology, but who have instead invested in other alternatives. The

[190] *Id.* at 2-207.

[191] *Id.*

[192] Alliance Draft TAR Comments, Docket ID EPA-HQ-OAR-2015-0827-4089 at 50.

[193] EPA Proposed Determination at 48, n. 62.

example cited by EPA is for an auto manufacturer who has invested in this technology as a primary pathway to compliance since 2012, and which has a relatively small number of product offerings. This cannot necessarily be replicated by all auto manufacturers. The choice of this example suggests that EPA was unable or unwilling to refute the Alliance's broader concerns directly.

The Alliance recommends that EPA seek to better understand lead-time requirements associated with the design and development of new technology for individual manufacturers, investment constraints, and general practices for implementing technology across multiple vehicles.

28. EPA's Response to Stakeholder Comments Regarding the Use of Incorrect Test Fuels is Incomplete.

In response to Alliance and other stakeholders' comments expressing concern with EPA's use of higher octane, zero ethanol fuels in developing modeled technology benefits, EPA discusses how current engines are not typically knock limited in city and highway test cycle operation.[194] This response is incomplete. While EPA's statements that engines are not knock limited in city and highway testing for GHG certification may be true for some of today's engines, technical experts at automotive manufacturers believe that the future downsized engines described by EPA may very well be.

The Alliance recommends that EPA consider the impact of lower octane test fuels in the context of future downsized engines.

29. EPA did Not Address Safety Concerns and Did Not Coordinate with NHTSA on the Updated Safety Analysis.

The Alliance raised two major concerns over EPA's draft TAR safety analysis in the Alliance's Draft TAR comments. The first issue was the EPA's use of two highly correlated factors (mass and foot print) in a regression analysis. This can lead to non-physical results. Examples include possible fatality increases involving collisions with fixed objects and heavy vehicles. The second concern is the apparent disconnect between the EPA Draft TAR safety analysis and the NHTSA 2016 VOLPE Report.[195] Neither issue was addressed in the Proposed Determination.

The Alliance recommends the EPA coordinate with NHTSA on safety analyses and address the concerns as highlighted in the Alliance Draft TAR comments before making a Final Determination.

[194] EPA TSD at 2-211.

[195] 2016 Volpe Report (Table 3-7) and Table 8.7 of the Draft TAR.

30. EPA dismissed or ignored numerous other Alliance comments on the Draft TAR but the shortened comment period prevents us from providing further details at this time.

The chart below provides examples of comments made by the Alliance on the Draft TAR which were either dismissed or ignored by EPA in the Proposed Determination. For purposes of this chart only, Alliance Comments on the Draft TAR are abbreviated as **TAR Response** and EPA's Response to Comments in Proposed Determination is abbreviated as **PD**.

No.	Alliance Comments	EPA Response	Result
1.	EPA should make a quantitative estimate of sales impacts (TAR Response at xv, 115-116)	EPA has chosen for this Proposed Determination to continue with the qualitative approach that it used for setting the standards in the 2012 FRM, and in the Draft TAR, due to the significant uncertainties involved in conducting a quantitative analysis (PD at A-40)	Dismissed
2.	The Agencies should provide, in detail, the assumptions relied upon in estimating sales in 2025. (TAR Response at 116)	none	Ignored
3.	Employment substitution effects: The Alliance Draft TAR comments (page 148) did comment on EPA's substitution effect approach and recommended that EPA should reasonably conclude that significant declines in labor content are possible with the introduction of EVs and should adjust downward its substitution effects multiplier. The Alliance also recommended that EPA should address factor shift effects due to reasonably anticipated declines in labor content of certain technologies, by, as an example, extrapolating and comparing the direct labor costs from the FEV teardown studies performed for fuel economy technologies considered in the 2012 FRM. (TAR Response at 148)	Though we received comments critical of our not quantifying the output effect, we did not receive comments on this approach to the substitution effect. EPA states it expects, as a result of the increased costs of vehicles and parts and holding labor intensity constant, that employment would be expected to increase between 2021 and 2025 by a few hundred to perhaps 12,000. (PD at A-89).	Dismissed
4.	For the Midterm Evaluation, the Agencies (as well as Congress, state	None. Additionally, nowhere does EPA discuss vehicle affordability in	Ignored

	officials, and the general public) must evaluate how the slowdown in growth of disposable personal income, combined with the Federal Reserve's recent decision to begin increasing interest rates (thereby increasing the cost of capital), will impact customers' ability to afford the increasingly expensive technologies needed to meet the future CAFE and GHG standards. This analysis must take into account that other regulations will simultaneously have an impact on vehicle production costs and achievable fuel economy. (TAR Response at 119)	the overall context of price increases associated with its regulations between the MY 2015 baseline and MY 2025 endpoint.	
5.	Requested quality control checking parameters in the ALPHA output files. (TAR Response at 42)	EPA describes the inclusion of 150 columns of data and quality control parameters in ALPHA output files. (TSD at 2-271). However EPA fails to note whether ALPHA calculates the requested parameters and instead suggests that stakeholders modify ALPHA themselves. To even run the existing ALPHA model requires the purchase of a licensed software product (over $2,000).[196] Given the lack of time provided within the comment period to take such action, stakeholders have been deprived of a substantive response to this issue.	Dismissed
6.	Use of magazine articles to show consumer acceptance (TAR Response at 111). • Not clear if reviewers appropriately represent average customers' view of fuel efficiency technologies	EPA asserts that counting reviews in automobile enthusiast magazines is a proxy for determining customer acceptance of these technologies. (PD at 6)	Ignored

[196] Mathworks. Matlab Pricing and Licensing; Standard Individual License. https://www.mathworks.com/pricing-licensing.html?prodcode=ML&intendeduse=comm. (Accessed December 27, 2016.)

	• Unclear if strong conclusions can be made with only 30% of technologies studied having over 100 evaluations • Issues with simple majority methodology to determine if views were positive or negative (anything with more views positive must be acceptable) – manufacturers would find 40% negative reviews to be a serious issue.		
7.	California's ZEV costs are ignored by EPA in the Draft TAR. (TAR Response at xi, 180)	EPA dismisses the issues raised without thorough analysis. PD at A-109). Comment is acknowledged in TSD at 1-32).	Dismissed
8.	Green Car Loans: The Alliance discusses positions on green auto loans and how they are unlikely to significantly impact consumers' access to credit as an offset to higher prices (and subsequent loan amounts.) (TAR Response at 112)	EPA agrees that these loans do not "explicitly factor fuel savings into the calculation." However, EPA maintains that these programs provide a means to mitigate the effects of higher up-front costs to buyers. (PD at A-74). The EPA response fails to consider that a ¼ point adjustment in an interest rate, will not save buyers money up front. Additionally, these incentives do not apply equally across consumers as they are dependent on a consumer's credit score. It is inappropriate to state this benefit can be taken advantage of by all new car purchasers.	Dismissed
9.	Off-Cycle Credit Cap: The cap on the allowed number of off-cycle credits should be removed. (TAR Response at 69)	EPA asserts that the original reasoning for applying a cap has not changed. (PD at A-105)	Dismissed
10.	48V Mild Hybrid Credits: Mild hybrids have greater benefits than stop-start systems and should receive greater credit.	EPA asserts that no change is warranted. (PD at A-105)	Dismissed

11.	Off Cycle Credits: Expand the menu by comparing to EU technologies (TAR Response at 162 & 168)	EPA discusses issue. (PD at A-105-106)	Dismissed
12.	Criteria and Particulate Matter Emissions Compliance Effects on GHG: Manufacturers expect GHG emissions impacts associated with criteria and particulate matter emissions to have an effect on GHG compliance. (TAR Response at 30)	EPA discusses options for reducing criteria and particulate matter emission that do not degrade GHG, but nowhere analyze the costs or other implementation issues associated with them. (TSD at 2-269)	Dismissed

31. Light-Duty Vehicle Greenhouse Gas Regulation beyond MY 2025 Requires Dialogue at the Appropriate Time.

In the Proposed Determination, EPA discussed the need for dialogue with stakeholders regarding light-duty vehicle GHG emissions reduction past MY 2025.[197] While the Alliance does not disagree that such dialogue is necessary at the appropriate time, now is the time for EPA to focus on understanding concerns with the MY2022-2025 standards as part of the Midterm Evaluation. As discussed at length above, the Midterm Evaluation process has been short-circuited in a way that has hindered the ability of stakeholders to comment effectively and to engage in a meaningful dialogue with EPA on the MY 2022-2025 standards. Before worrying about the MY 2026 standards and beyond, EPA should reinstate the Midterm Evaluation process to correct the many procedural deficiencies described above.

Conclusion

The Alliance strenuously objects to the Proposed Determination, both procedurally and substantively and reiterates its December 8, 2016 request that EPA either withdraw the Proposed Determination or extend the public comment period to a minimum of 120 days. The Alliance again requests the EPA to reverse course and return to the Midterm Evaluation process as originally envisioned. Withdrawing the Proposed Determination, or issuing an updated proposal in mid-2017 could avoid the appearance of an agency uninterested in a full, open, and fair consideration of all data and information bearing upon emissions standards that will profoundly affect the future light-duty automotive industry and market.

[197] *Id.* at 63.

Defour Group Response to EPA Rejoinders to Defour Group / Alliance of Automobile Manufacturers Submission Regarding the Regressivity/Affordability of EPA's Proposed Fuel Economy Standards

By Tom Walton PhD and Dean Drake

December 30, 2016

Defour Group Response to EPA Rejoinders to Defour Group / Alliance of Automobile Manufacturers Submission Regarding the Regressivity/Affordability of EPA's Proposed Fuel Economy Standards

The following submission by Defour Group LLC (Defour) on behalf of the Alliance of Automobile Manufacturers (Alliance) responds to the Environmental Protection Agency (EPA) "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation"[1] rejoinders to Defour's September 21, 2016 comments, also submitted on behalf of the Alliance.[2]
As with the earlier submission, these comments are based on a broad consensus of research by mainstream economists on the benefits and costs of the nation's automotive fuel economy standards. Defour's September 21 comments drew three central conclusions:

1. Upward mobility for low-income households requires affordable and dependable personal on-demand transportation offered by used cars and light trucks.
2. The EPA's proposed 2022-2025 model year light-duty vehicle greenhouse gas standards are extremely costly and regressive – imposing the greatest costs as a percentage of income on the lowest income households who rely disproportionately on used vehicles.
3. The proposed standards will prove to be catastrophic for lower income and minority households. Contrary to popular opinion, fuel economy standards are much more costly and regressive than taxes on motor fuels, taxes that Congress has repeatedly rejected on grounds of excessive cost and disproportionately adverse, regressive impacts on low income households.

EPA replies that the concept of "access" to transportation is difficult to define and that the mobility provided by cars and light trucks is not the only way for low-income households to gain access to employment. EPA argues that the work by Mark Jacobsen that was the basis for Defour's conclusions regarding regressivity is based on the traditional flat-based fuel economy standards and that his findings are "mitigated" under the current footprint based standard. It notes that a recent paper by its consultant, David Greene, and co-authored by Jilleah Welch finds the standards to be progressive, not regressive.

We note that while "access" to employment and other economic and social necessities may be hard to define, more of it is preferred to less and that while there are other forms of transportation that can provide access for low-income households, the vast weight of mainstream economic research finds that personal, on-demand transportation provided by cars and light trucks, is critical to that effort.

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[1] "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation." U.S. Environmental Protection Agency. EPA-420-R-16-020, November 2016.

[2] See Alliance of Automobile Comments on the EPA Draft Technical Assessment Report, September 26, 2016, Attachment 11, Docket ID EPA-HQ-OAR-2015-0827-4089.

We show that two other recent independent, mainstream studies find that the newer attribute-based standards are also regressive and costly. We show that unlike Jacobsen's work and the work of the two more recent studies, the paper by EPA consultant Greene and colleague Welch fails to separate the benefits and costs of binding fuel economy standards from those of non-binding fuel economy standards, confusing one with the other and rendering Greene and Welch's findings meaningless.

Most importantly, we show that both the EPA and Greene and Welch rely on a model that ignores the "opportunity costs" of binding standards – costs imposed on auto buyers and especially on low-income buyers when GHG/fuel economy standards deny them the opportunity to purchase vehicles with other attributes they value more highly than fuel economy gains.

We note that the EPA is unable to explain the so-called "energy paradox," or why consumers are unwilling to pay for many of the fuel-economy technologies that the EPA's engineering analysis finds to be cost-beneficial. Backed by independent, mainstream economic research at Brookings, Resources for the Future, Georgetown and elsewhere (including the EPA), we show that there is really no paradox at all and that EPA's "conundrum" is explained by a model that fails to take into account the opportunity costs imposed by binding standards. We note that the EPA's assumption of significant consumer undervaluation of the fuel economy savings that can result from technological advances in automotive fuel efficiency lies well outside the findings of mainstream economic literature and that it violates Office of Management and Budget's (OMB's) guidelines for conducting benefit cost analysis. We agree with mainstream economists that "perhaps the main failure of rationality is that of the regulators themselves."[3]

Defour/Alliance Conclusion #1: Upward mobility for low-income households requires affordable and dependable personal on-demand transportation offered by used cars and light trucks.

EPA Response: "The Alliance emphasizes the importance of access to transportation for low-income households for economic mobility. EPA agrees this is an important issue. At the same time, as discussed in the TSD Chapter 4.3.1, there is no commonly accepted definition of an acceptable level of access to transportation to which everyone should be entitled. Access to transportation does not only involve vehicles; it also may involve access to housing in locations with jobs, mass transit, and other forms of mobility."

[3] Ted Gayer and W. Kipp Viscusi, "Overriding Consumer Preferences With Energy Regulations," Working Paper 12-21, Mercatus Center of George Mason University, July 2012.

Defour/Alliance Rejoinder: EPA doesn't say whether or not it agrees or disagrees with Defour's summary of the mainstream literature regarding the importance of personal, on-demand transportation to the upward mobility of lower-income households. The vast weight of mainstream research finds that access to cars and light trucks is critical to the efforts of lower income and minority households to escape poverty. This is one of the reasons that most mainstream studies show that costly and regressive GHG reduction/fuel economy standards would impede such access.

On page 4-43 of the Technical Support Document, EPA defines their concerns about affordability thusly:

"Given the prevalence of heavily subsidized public transit systems, including free rides for vulnerable populations, it seems that societies often consider access to transportation in some sense a basic necessity. However, it is not clear how to identify the socially acceptable minimum level of transportation service. It seems reasonable to assume that such a socially acceptable minimum level should allow access to employment, education, and basic services like the grocery store, but it is not clear where consumption of transportation moves from practical to luxury."

While some can argue that there might be a state of "too much" mobility, it should be clear that the income line delineating a "practical" level of mobility from a "luxury" level of mobility lies well above the population we were discussing.

EPA appears to confuse the *relevant* question of the importance of access with an *irrelevant* question as to whether there is an acceptable definition of access, and then noting that other forms of transportation may also provide access to employment that is comparable to what light-duty vehicles have to offer.

To be sure, there is no "commonly accepted level of access to transportation to which everyone should be entitled." But that is not the question. It should go without saying that it is "commonly accepted" – indeed, *universally* accepted -- that greater access to the mobility provided by increased access to transportation is a positive economic, cultural, and social good.

The question Defour/Alliance poses is to what extent does the access to jobs provided by personal transportation – provided by cars and light trucks – benefit low-income households. It is a question of positive, fact-based economic inquiry. The issue is not whether or how much access these groups should or should not acquire, or if an "acceptable level" of mobility for these families and individuals can be defined. Rather, the studies cited by Defour show that there is a positive correlation between access to dependable personal transportation and the ability of low income households to improve their economic condition. This correlation should hold even if more access to mobility is provided; the question of how much access to mobility is too much does not apply to households in the lowest income categories.

EPA argues that personal, individually owned vehicles are not the only source of increased personal mobility. True enough. But, once again, that, too, is not the question.

Rather, the question concerns the importance of *personal* on-demand transportation: both absolutely and in relation to other forms of transportation and to other means of lifting low income and minority households out of poverty. The question is whether EPA agrees or disagrees with the findings of numerous mainstream economic studies regarding the critical importance of light duty vehicles to low-income and minority families in their efforts to find goods jobs, good housing, good schools, and to otherwise increase their upward economic and social mobility. Researchers across the political spectrum have produced a wealth of studies supporting the relationship between access to dependable vehicles and the ability of households to rise from poverty, such as:

- Wendall Cox and Ronald D. Utt of The Heritage Foundation: "It is easy to see why cars can help close the unemployment gap. At average transit operating speeds of 15 miles per hour, a maximum "job shed" of 175 square miles can be accessed in 30 minutes. In reality, however, the actual job shed would be much less because of the necessity of transfers and limited service areas. On the other hand, a person with an automobile can expect to average 30 miles per hour and reach a job shed of 700 square miles in 30 minutes. This vastly increases employment and other opportunities, offering a better quality of life."[4]
- Evelyn Blumenberg and Margy Waller of The Brookings Institution: "Most welfare recipients do not have access to a dependable automobile, and research indicates that lack of access to an automobile is one of the most prevalent barriers to employment. Research further indicates that car ownership improves the likelihood that low-income people will get and keep work, and improves access to better jobs." [5]
- Steven Raphael and Michael Stoll at The University of California at Berkeley: "Raising minority car ownership rates to the white car ownership rate would eliminate 45 percent of the black-white employment rate differential and 17 percent of the comparable Latino-white differential".[6]

[4] Wendall Cox and Ronald D. Utt, "Transit Advocates Want the Working Poor to Use Bikes and Buses, Not Cars," Heritage Backgrounder #1687, September 10, 2003. Emphasis added.

[5] Evelyn Blumenberg and Margy Waller, "The Long Journey to Work: A Federal Transportation Policy for Working Families," Center for Urban and Metropolitan Policy, Brookings Institution, July 2003, p. 12.

[6] Steven Raphael and Michael Stoll, "Can Boosting Minority Car-Ownership Rates Narrow Inter-Racial Employment Gaps?" Working Paper W00'002, Berkeley Program on Housing and Urban Policy, Institute of Business and Economic Research, Abstract.

- Margy Waller and Mark Alan Hughes of the Progressive Policy Institute, a research organization affiliated with the Democratic Leadership Council (of the Democratic Party): "In most cases, the shortest distance between a poor person and a job is along a line driven in a car. Prosperity in America has always been strongly related to mobility and poor people work hard for access to opportunities. For both the rural and inner-city poor, access means being able to reach the prosperous suburbs of our booming metropolitan economies, and mobility means having the private automobile necessary for the trip. The most important response to the policy challenge of job access for those leaving welfare is the continued and expanded use of cars by low-income workers."[7]

- Rolf Pendall, The Urban Institute, Evelyn Blumenburg, The University of California at Los Angeles, and Casey Dawkins, The University of Maryland, studying low-income families in 10 cities participating in two federal housing voucher programs:

  "Housing voucher recipients with cars tended to live and remain in higher-opportunity neighborhoods—places with lower poverty rates, higher social status, stronger housing markets, and lower health risks. Cars are also associated with improved neighborhood satisfaction and better employment outcomes. Among Moving to Opportunity families, those with cars were twice as likely to find a job and four times as likely to remain employed."

Defour/Alliance Conclusion #2: The EPA's proposed 2022-2025 model year light-duty vehicle greenhouse gas standards are extremely costly and regressive – imposing the greatest costs as a percentage of income on the lowest income households who rely disproportionately on used vehicles.

EPA Response: "The Alliance of Automobile Manufacturers (Alliance) and the National Automobile Dealers Association (NADA) cite Jacobsen (2013) for the regressivity of the standards. Jacobsen's finding of regressivity is based on a flat standard (i.e., not an attribute-based standard); because a flat standard provides incentives for small, efficient vehicles, lower-income households have lower benefits because vehicles are smaller than they would otherwise desire. On the other hand, comments from Levinson and Killeen at Georgetown University argue that the footprint-based standards are more regressive than flat standards because they provide incentives for bigger, more expensive vehicles. Unlike Jacobsen, the evidence offered by Levinson and Killeen does not consider consumer tastes for larger vehicles. These results, combined, suggest that the footprint-based standard, which is intended to maintain fleet size diversity valued by consumers, may mitigate any regressivity of the standards."

[7] Margy Waller and Mark Alan Hughes, "Working Far from Home: Transportation and Welfare Reform in the Ten Big States," Progressive Policy Institute, August 1, 1999. See also Anne Kim, "Why People Need Affordable Cars," Blueprint: Ideas for a New Century, February 11, 2003.

". . . In contrast, Greene and Welch at the University of Tennessee provide an analysis indicating that the standards are progressive--that is, they help low-income households more than they help higher-income households. . . .Similarly, they find, when the costs of fuel-saving technology are included, that all income groups gain from the technologies; savings relative to income decreases, indicating progressivity; and the highest total dollar savings go to middle-income households. They do not consider these results definitive."

". . . Greene and Welch (2016), cited above, find that used vehicle prices depreciate faster than use of vehicles. Because price depreciates faster than miles used, the payback period for a used vehicle should be shorter than for a new vehicle. This finding is consistent with Consumer Federation of America's (CFA) statements that owners of used vehicles will have higher mileage and lower operating costs. Because low-income households disproportionately buy used vehicles, CFA expects that those households will capture a disproportionate share of fuel savings from resold vehicles."

". . . The Alliance's Defour Group paper, based on the assumption of significant increases in used vehicle prices, argues that used vehicle prices will increase faster than the fuel savings. Greene and Welch present findings that vehicle prices depreciate at a somewhat faster rate than the decrease in VMT. If so, then the payback period for used vehicles should become shorter with reduced fuel consumption, because the up-front cost will decrease faster than fuel savings."

Defour/Alliance Rejoinder: Part 1. Recent Research Supports Jacobsen's Findings

In addition to Jacobsen's finding that the historical, flat-based GHG/fuel economy standards are costly and regressive, two very recent, independent and mainstream studies of the current footprint-based GHG/fuel economy standards also find the current, footprint-based standards to be costly and regressive.[8] The latter studies consist of research by Professor Arik Levinson of Georgetown and the National Bureau of Economic Research (NBER) and a joint study performed by University of California, Berkeley Professor Lucas Davis and Massachusetts Institute of Technology (MIT) Professor Christopher Knittel. Their work provides powerful confirmation of Jacobsen's findings that, in the words of Professor Levinson, the standards "disproportionately burden lower income households" and "make poor households worse off."[9]

Nevertheless, because Levinson finds that for any given model year, the footprint-based standards reduce the bias against the larger vehicles that low-income and other used car buyers prefer, EPA contends that the more recent findings of Professor Levinson, in particular, "mitigate" any regressivity that Jacobsen may have found in his study of the traditional flat standard.

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[8] Arik Levinson, "Are Energy Efficiency Standards Less Regressive Than Energy Taxes?" October 17, 2016, at http://faculty.georgetown.edu/aml6/pdfs&zips/RegressiveMandates.pdf and Lucas Davis, and Christopher Knittel "How Regressive are Fuel Economy Standards?" Working Paper, Haas School of Business, University of California, Berkeley; Energy Institute at Haas and Sloan School of Management, Massachusetts Institute of Technology December 2016.

[9] Arik Levinson, op. cit. October 17, 2016, page 2

To be sure, within a given model year, the bias against the kinds of larger and less fuel-efficient vehicles that used car buyers prefer will be mitigated. But over time as the standard becomes progressively, indeed, exponentially more stringent, fewer and fewer large and fuel efficient used vehicles will be available, increasing their cost both absolutely and relative to the costs of smaller and more fuel efficient vehicles. These trends not only strengthen Levinson's results, they also validate and strengthen Jacobsen's methodology and findings.[10]

Most importantly -- indeed, decisively -- Levinson finds the current footprint-based standards also to be regressive, as does the other study by mainstream economists Lucas and Knittel.[11] Levinson, in particular, finds that "the richest households have more than 10 times the income as poor households, and would pay only about three times as much [for a an increase in a footprint-based standard that would save as much fuel and reduce as much carbon as 'a $0.29 cents per gallon carbon tax']."[12]

Levinson concludes that no matter how the regulators choose to configure the standards – flat- or footprint-based-- GHG/fuel economy vehicle mandates impose costs that exceed the benefits and that they are imposed disproportionately on low-income households.

Defour/Alliance Rejoinder, Part 2: The Footprint Based Standards Adopted in 2011 Are More Regressive and Costly than the Historical Flat-based Standards

Levinson finds that, contrary to EPA's assertions, "the switch [in 2011] to footprint based *exacerbated* the regressivity of the CAFE standards."[13]

It should also be noted that Jacobsen finds that the switch to a footprint-based standard has *increased* the costs relative to a flat-based standard. Not only is the footprint standard more regressive than the flat standard for any given level of greenhouse gas emissions reductions or fuel savings, it is also more costly.

Jacobsen notes that "the used fleet will never fully reflect improvements in new car fleet economy." He notes that this is "due to changing scrap rates," which "creates a used car fleet weighted more heavily toward large vehicles, and with a correspondingly low average fuel economy relative to new cars." This is the fleet – mainly a fleet of 15- to 20-year old and older cars and light trucks -- that is available to low-income households seeking to find jobs and otherwise improve their economic and social well-being.

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[10] While Levinson notes that footprint standards make it harder for small vehicles to meet the standards than larger vehicles, he finds that the predominant driver of regressivity is less driving and lower vehicle ownership by poorer than wealthier households. He in fact does consider tastes, finding, consistent with Jacobsen's research, that within a given stringency of standards, that larger efficient cars are favored more than smaller inefficient cars.

[11] *Id.*

[12] Levin, page 12.

[13] Levin, page 3., emphasis added. As Lucas and Knittel note, The reason is that Levinson "finds that high-income households tend to buy higher footprint vehicles, so they do relatively better under footprint-based standards, and thus footprint-based standards are even more regressive than regular standards."

In other words, and as pointed out in Defour's September 21 comments on the EPA's Draft Technical Assessment Report, relative to a no-standard baseline, mandated and binding increases in the GHG/ fuel economy standards permanently condemn low-income households to higher upfront vehicle purchase costs in order to get the larger, more powerful and less-fuel efficient vehicles they require.

Defour/Alliance Rejoinder, Part 3: GHG/Fuel Economy Standards Have Significantly Increased the Prices of the Older Vehicles on Which Low-Income Households Depend

EPA disputes these findings, arguing that there is no evidence that the standards increase the price of either new or used vehicles. But EPA's argument is based solely on new and used vehicle price trends without controlling for changes in other explanatory variables such as technological advance and the level of fuel prices. They ignore the evidence not only provided by Jacobsen, but also by every mainstream economic study that controls for such factors, as pointed out in Defour's September 21 submission.

EPA argues that used as well as new car prices have not risen following the ramping up of fuel economy standards in 2008.[14] In fact, both new and used vehicle prices – the focus of Jacobsen's analysis – have risen since that time, reversing a sharp downward spiral prior to 2008.

The impact on the kinds of used vehicles that lower-income buyers require has been especially adverse. Edmunds, for example, recently reported that "used in-demand vehicles are especially vulnerable to price increases as consumers look for cheaper alternatives to new vehicles." Jessica Caldwell, Edmunds Executive Director of industry analysis, notes that the 2016 average transaction price of new vehicles has increased by 2.7 percent from 2015 "to an all-time high of $34,077 per vehicle." (The estimate exceeds the 1.6% year-over-year increase in overall inflation as according to the BLS.)

[14] EPA also argues that new and used vehicle price trends have followed a steady, monotonic downward path both before and after the fuel economy standards were tightened in 2008. They note that Defour utilized nominal price trends to rebut this assertion. However, Defour's finding also stands when allowing for inflation-adjusted pricing trends. From 1995 to 2008, when the standards were not biding for new cars and barely binding for light trucks, the real or inflation-adjusted price of new vehicles fell by 33% and 42 % respectively, while following the sharp increase in the standards in 2008, new car and light truck prices as adjusted for inflation rose by 1% from their October 8 recession low and used car and light truck prices rose by 8% from their April 2009 recession low. As noted in the Defour submission; such sharp reversals of existing trends are not in and of themselves dispositive as many other factors such as the pace of technological progress and the state of the economy influenced their direction and change. The only data that matter are those which are drawn from the cited mainstream studies and which control for these other factors. Note: we used the cpi-chained index to adjust data in the period from 2008 to 2016. As the Bureau of Labor Statistics observes, it is the superior index for making such adjustments because, unlike the unchained index, it allows consumer substitution at the higher levels of aggregation. See United States Bureau of Labor Statistics, "Frequently Asked Questions about the Chained Consumer Price Index for All Urban Consumers (C-CPI-U)," at http://www.bls.gov/cpi/cpisupqa.htm.

Caldwell also notes that the "higher prices are putting a bit of a squeeze on the market for lower-cost, used vehicles" and that "Edmunds data shows that more people are looking for affordable vehicles [on Edmunds.com] than are actually sold, driving up values and demand."

To be sure, as noted in Defour's September submission; such sharp reversals of existing price trends are not in and of themselves dispositive as many other factors such as the pace of technological progress and the state of the economy influence their direction and change. The only data that matter are those which are drawn from the cited mainstream studies, which control for these other factors, and all of which confirm the adverse, upward impact of GHG/fuel economy standards on new, and especially used car prices.

EPA also cites a fourth, also recent study by David Greene and Jilleah Webb of the Howard H. Baker Junior Center for Public Policy, a study which Greene and Welch characterize as "inconclusive," but that finds the standards to be progressive.[15] The EPA finds this argument appealing, in part, because Greene and Welch "find that used vehicle prices depreciate faster than use of vehicles." EPA argues that "because [used vehicle] price depreciates faster than miles used, the payback period for a used vehicle should be shorter than for a new vehicle" and that "because low-income households disproportionately buy used vehicles . . . those households will capture a disproportionate share of fuel savings from resold vehicles."

But the regressivity of today's footprint fuel economy standards has nothing to do with the relative depreciation and use rates of used versus new vehicles. Rather, as Levinson finds, it is caused by a combination of less driving, and lower vehicle ownership by low-income versus high-income households.[16] This necessarily means that the increased cost of used vehicles occasioned by the proposed mandates will *increase* the required payback period for low-income households; that is, for those who are fortunate enough to still be able to afford the purchase of a car or light truck.

It is also important to understand that Greene and Welch's analysis conflates – mixes together – the impact of fuel economy increases caused by the standards with the impact of fuel economy increases driven by consumer demand in the marketplace. For that reason, it is not possible to derive from their work the net effect of mandates as opposed to markets. When increases are market-driven, the standard is not binding and the costs (net of benefits) of the standard are zero, in which case the issue of regressivity is moot. Conflating the costs of mandates with the benefits of consumer-driven increases in vehicle fuel economy tells us nothing about the regressivity of the standard, footprint or flat. Nor does it say anything about any impact on payback periods.

[15] David Greene and Jilleah Welch (2016). "The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States." University of Tennessee Baker Center Report 5:16, Docket EPA-HQ-OAR-2015-0827-4311.

[16] Levinson, page 12.and Table 2.

Most importantly, and as Levinson emphasizes, Greene and Welch start with the assumption that the fuel economy standards have *negative* (net) costs (positive net benefits), in which case the question of regressivity is, once again, moot: under their analysis everyone necessarily benefits regardless of income.

This is important because, as pointed out in Defour's September 21 submission, Greene and Welch's assumption of negative (net) costs of binding mandates goes against the vast weight of mainstream economic research. Mainstream economic studies find that mandated binding increases in GHG/fuel economy standards, regardless of their level of stringency, impose costs on auto buyers that exceed the benefits. These studies further find that increases of the magnitude EPA and NHTSA would set, will impose costs that vastly outweigh the benefits. And, as we have emphasized, all three extant and mainstream studies of regressivity find those costs – the costs of mandated increases – are disproportionately borne by lower income households.

Defour/Alliance Rejoinder, Part 4a: EPA's Rejoinder is Based on an Incomplete Model of Consumer Choice

Greene and Welch's findings beg the question: Why do their estimates, as well as those of the EPA and NHTSA in their Benefit Cost Analyses, lie so far outside the mainstream of economic research? The reason is that the Greene/EPA/NHTSA research methodology zeroes out the opportunity costs incurred by auto buyers when command-and-control regulations prevent these consumers from getting other desired vehicle attributes of greater value than that of fuel economy increases – such attributes as vehicle size, performance, and safety. Their "engineering models" do not incorporate the very substantial consumer welfare losses – a.k.a. "opportunity costs" when standards deny consumers these options.

The EPA, relying in part on a survey article by consultant Greene, argues that while in theory there could be such opportunity costs – that, in EPA's words, "adoption of these technologies [could] produce hidden costs (i.e. involves tradeoffs with other vehicle attributes valued by consumers)," (page A-54), "to date," they "<u>have not found evidence of inherent "hidden costs" of the technologies to vehicles.</u>" (EPA, page A-61)

EPA thus rejects the methodology of the majority of mainstream economic studies that, faced with limited incomes, rational auto buyers might not want to spend their money on fuel economy technologies. EPA argues that because their estimates show all of the proposed technologies "pay for themselves" there is no need for buyers to "trade off" the gains made possible by technological advances that increase fuel efficiency against other vehicle attributes that consumers with limited budgets might prefer. (EPA, page A-60). While EPA allows that such tradeoffs are possible in theory, it contends it has "included the costs of avoiding [such] adverse effects in their estimates." EPA further argues that the standards could "induce major innovations that may be used in part to mitigate those opportunity costs and . . . lead to ancillary benefits to consumers."

EPA further argues that professional automobile reviewers, "who have experience evaluating technologies and are expected to identify any potential drawbacks to consumers i.e., hidden [opportunity] costs if they exist," find that many, if not most of existing, fuel economy technologies now in use are good values for their readers. EPA notes that it performed two detailed studies of positive vs. negative professional reviews and found that "across all vehicle characteristics, there are more instances of fuel-saving technologies associated with lower probabilities of negative evaluations of characteristics than with increased negative evaluations" and that the negative evaluations can result from "faulty implementation" rather than a problem inherent to the technology. (pages A-55 and A-55 to A-60).

EPA notes that Consumers Union finds "a statistically positive correlation between rated fuel economy and overall satisfaction with the vehicles, controlling for year, mechanical problems, price, acceleration and CR's Road Test Score." (page A-61).

EPA points to the results of a survey it commissioned by Professor Greene that concluded that there is a wide range of estimates of consumers' willingness to pay (WTP) for alternative vehicle attributes, and argues that this renders any estimates of opportunity costs that economists use in the benefit/cost analyses to be unreliable as the basis for any reliable estimates of their magnitude.

EPA acknowledges that it is puzzled by consumers' failure to purchase the fuel efficiency technologies that pass their benefit-cost tests in the absence of a government mandate – the so-called "energy efficiency paradox" – but attribute this "conundrum" mainly to consumers' irrational undervaluation of the fuel economy gains that such technologies can deliver.

EPA claims that the mainstream economic research Defour cited in its September comments is based on outdated estimates of costs and benefits.

Defour/Alliance Rejoinder, Part4b: EPA Excludes Consumer Tradeoffs Among Vehicle Attributes

Each of EPA's arguments portrays an incomplete understanding of the concept of economic tradeoffs and opportunity costs. As noted by economists at Resources for the Future, Brookings, MIT, the Congressional Budget Office, most mainstream think tanks, and universities, and as explained in detail in Defour/NADA's comments on the proposed standards in February 2012, the issue is not just how valuable any specific fuel economy technology might be in and of itself or whether such a technology "pays for itself." Rather, for the consumer, the issue is whether or not the money spent on improved fuel economy could be better spent on other vehicle attributes such as utility and durability.

Even if the value of fuel savings of each and every one of the proposed fuel efficiency technologies were to outweigh their upfront costs – a claim Defour vigorously challenged in its 2012 submission on behalf of the NADA - auto buyers might nonetheless prefer to spend their limited incomes on other vehicle attributes that consumers find to be still more valuable than the value of fuel economy enhancements that those technological advances might make possible.

Auto buyers may prefer to spend their money on technologies that are fuel neutral (e.g., on technologies that enhance connectivity), on technologies that necessarily increase fuel consumption (e.g., on 4-wheel instead of 2-wheel drive), or, most importantly, on technologies that could be used to increase fuel economy but that buyers prefer instead to utilize to enhance other attributes such as increases in interior volume, performance, or safety.

It is this latter tradeoff or "opportunity" – the chance for consumers to utilize advanced fuel efficiency technologies to achieve objectives other than fuel economy gains even when the technology "pays for itself" -- that the EPA fails to address. It is just as important as the possibility that auto buyers' might not want to purchase a particular fuel efficiency technology in the first place.

Indeed, it is the *key* to understanding why EPA's responses to the Defour/Alliance commentary are not supported by mainstream economic analysis.

To quote the Congressional Budget Office:

"Vehicles' current level of fuel efficiency most likely reflects consumers' trade-offs between fuel economy and other characteristics that drivers want, such as vehicle size, horsepower, and safety. The same technologies that can be used to boost fuel economy can be used to hold fuel economy constant while increasing the vehicles weight, size, or power. . . . Raising CAFE standards would impose costs on both consumers and automobile producers by forcing improvements in fuel economy that car buyers may not want."[17]

As Defour noted in its February 2012 submission on behalf of the National Automobile Dealers Association, there are many real-world illustrations of this critical insight. For a diagrammatic exposition of this fundamental insight, please see the Appendix to the present paper, which is reproduced from that submission.

As we noted, the European experience with diesel technologies in the period prior to the implementation of their GHG/fuel reduction mandates – a period when high fuel taxes and thus fuel prices well above even the levels assumed in the EPA benefit/cost analysis, not to mention today's much lower levels – were the drivers for consumer-driven fuel economy gains, and provides a striking illustration of what happens when consumers prefer to spend their money on attributes other than fuel economy.

[17] Congressional Budget Office, *Reducing Gasoline Consumption: Three Policy Options* (November 2002), Chapter Two, page 10.

It is so informative because it occurs not only in the presence of such high fuel prices, but even when the value of the fuel savings benefits associated with fuel-efficient technologies exceed the upfront vehicle costs of the technology – even when, in the EPA's words, "the technology pays for itself."

Lee Schipper et al found that while diesel cars and light trucks sold in Germany in 2006 "had a technical advantage of 15% less CO_2 emissions per kilometer than gasoline-powered cars and trucks, the purchase of larger diesel vehicles virtually offset all of this advantage." They noted that some, but not all of this difference could be explained by self-selection, with people already planning to buy larger cars choosing diesels.[18] Whatever the exact breakdown, this example shows that even if, in the presence of heavy subsidies and incentives and fuel prices well in excess of those assumed in the EPA benefit/cost analysis, and even where consumers are willing to purchase vehicles with technologies providing potential fuel economy increases of 25% and more and with carbon dioxide emissions reductions of 15% and more, they nonetheless preferred to spend most of their limited budgets on improving performance and increasing size, instead of on reducing fuel consumption.

Increased size is not the only alternative available to auto buyers. Consumers may also prefer to take some or all of the improved hybrid fuel efficiency gains as improved performance. In that case, as President Clinton's Assistant Secretary of Energy for Domestic and International Affairs and former Brookings Senior Fellow, David Sandalwood, observed, "The fact that an engine is a hybrid does not necessarily mean it will achieve substantial fuel savings." This is because, in his words, "hybrid technology can also be used to improve acceleration," so that the net result could be only "somewhat better fuel efficiency than the standard internal combustion engines."[19]

General Motors' experience with light truck technology enhancements provides yet a third illustration of this phenomenon. When General Motors introduced a redesigned MY 2000 full-size pickup that increased full-size fuel economy by about 1 mpg, the company's product planners hoped that this would increase GM's light truck CAFE by 0.4 mpg versus the 1999 MY. But sales of full-size pickups increased by about 150,000 units in the 2000 MY, leading to a *decline* of 0.1 mpg for the overall light truck fleet. Light truck purchasers had chosen to take even more than the increase in fuel efficiency *not* in the form of increased fuel economy, *but rather* as larger payload and, in this case, towing capacity.

Each of these examples involved fuel economy technologies that, arguably, passed a benefit-cost test under the EPA's "engineering" methodology: the technologies "paid for themselves" in that the value of the potential fuel savings exceeded the cost of the fuel economy hardware.

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[18] The authors also found that higher mpg diesel cars were driven 40-100% more than gasoline-powered cars, but some of this was attributable to lower diesel fuel prices See, L. Schipper, Marie-Lilliu, and L. Fulton, "Diesels in Europe: Analysis of Characteristics, Usage Patterns, Energy Savings and CO2 Emission Implications," *Journal of Transport Economics and Policy*, 2002, 36(20), pages 305-340

[19] David Sandalow, *Freedom from Oil: How the Next President Can End the United States' Oil Addiction*, Brookings (2008).

But mandating that consumers take all of the increase in fuel efficiency in the form of increased fuel savings would not have passed the economist's cost-benefit test: it would not have offered rational auto buyers the biggest "bang for the buck" – it would not offer them the most value for their money. Forcing these consumers to forego those other more highly valued attributes -- attributes that provided still greater net (present value) benefits, still greater rates of return on their investments, and still shorter payoff periods per dollar spent out of their limited budgets as they themselves evaluated these alternatives -- would have made them worse off. And this is so even if the EPA's engineering analysis (correctly) concluded that their (and the auto manufacturers' investments in increased fuel economy) yields a positive "net present value."

Put another way, "energy efficiency," the single-minded objective of the EPA, does not equate to "economic efficiency." To quote Richard Newell, former Administrator for the Energy Information Administration, in his study of consumer choice in the market for household appliances, which insight applies with equal force to automobile and other durable consumer goods:

"Requiring consumers to purchase appliances with a higher level of efficiency based on a simplistic analysis could, in effect, impose extra costs on consumers. The result might be a higher level of energy efficiency but decreased economic efficiency, because consumers could be forced to bear costs that they had otherwise avoided."[20]

Unlike Greene and the EPA, mainstream economists include estimates of these opportunity costs in their benefit/cost analyses of fuel economy mandates. This, more than anything else explains why Greene and the EPA find positive net benefits in their *engineering* analyses, while mainstream researchers find negative net benefits in their *economic* analyses – costs that disproportionately impact the lowest income households.

Defour/Alliance Rejoinder, Part 4c: There is No "Energy Efficiency Paradox"

EPA acknowledges that it is unable to satisfactorily explain why consumers are unwilling to purchase many of the fuel efficiency technologies that pass the EPA's benefit-cost tests in the absence of a government mandate – the so-called "energy efficiency paradox." While EPA acknowledges that the evidence is contradictory, it nonetheless attributes this "conundrum" to consumers' irrational undervaluation of the fuel economy gains that such technologies have to offer. (EPA, pages A-27 to A-32)

[20] Richard G. Newell, "Balancing Policies for Energy Efficiency and Climate Change," *Resources*, Summer 2000, pages 15-16 (Emphasis added).

EPA cites a recent literature review by its consultant, Greene et al. The review is a follow-up on an earlier, similar review, which Defour critiqued in its 2012 response to the proposed 2017-2025 Model Year standards and where we cited seven major deficiencies in that analysis, and to which the EPA does not respond.[21] This time, Greene appears to have scaled back from his earlier findings, arguing instead that there is not enough information to determine the extent to which opportunity costs should be considered in benefit cost analyses.

EPA argues that while opportunity costs – the tradeoffs between fuel economy and other vehicle attributes of value – are possible in theory, EPA has "included the costs of avoiding [such] adverse effects in their estimates" and that the standards could "induce major innovations that may be used in part to mitigate the opportunity costs." But as just noted, by ignoring, instead of estimating and including the opportunity costs, the EPA has not assessed the full costs of the standards. EPA cannot address these costs if they don't know what they are.

Dr. Ted Gayer, the Joseph A. Pechman Senior Fellow at the Brookings Institution and co-director of the Brookings Institution's Economic Studies Program, and Vanderbilt University Distinguished Service Professor, Kipp Viscusi, commenting on the benefit/cost analysis used by the EPA to justify its proposed Model Year 2017 to 2025 standards, wrote:

"Even if EPA and NHTSA could demonstrate some form of consumer choice failure, these choices would need to be completely flawed to warrant counting the entirety of the private savings as net economic benefits. . ..

"Choosing a car other than a Toyota Prius, a Nissan Leaf, or a Chevrolet Volt is not an inexplicable quirk of individual behavior but generally stems from valuation of car attributes these models do not offer. . ..

"The economic puzzle . . . is why consumers are this remiss. How can it be that consumers are leaving billions of potential economic gains on the table by not buying the most energy-efficient cars? Moreover, how can it also be the case that firms seeking to earn profits are likewise ignoring highly attractive opportunities to save money? If the savings are this great, why is it that a very basic labeling approach cannot remedy this seemingly stunning example of completely irrational behavior? It should be quite simple to rectify decisions that are this flawed.

"It should be a red flag that something is amiss with an analysis that assumes such perplexing consumer and firm behavior that runs counter to the most rudimentary economic theory [See the Appendix to this submission for a diagrammatic exposition of the "rudimentary theory"] and our general sense that we do not live in a world in which people never make sound choices. [On the other hand] it might be that there is something that is incorrect or perhaps even irrational in the assumptions being made in the regulatory impact analyses. Indeed, upon closer inspection it is apparent that there is no empirical evidence provided for the types of consumer failures

[21] Thomas F. Walton and Dean Drake, "Willingness to Pay for MY 2025 Model Fuel Economy Standards: Government Estimates Vs. Economic Reality," February 2013, 2012. The study was commissioned by the National Automobile Dealers Association.

alleged. Even if some consumers do sometimes fall short on certain dimensions of choice, the magnitude and prevalence of such a shortfall is important and is never addressed in the regulatory assessments. Nor is there adequate consideration of the actual and potential role of informational remedies that have already been adopted."

Gayer and Viscusi then conclude:

"Perhaps the main failure of rationality is that of the regulators themselves. Agency officials who have been given a specific substantive mission have a tendency to focus on these concerns to the exclusion of all others. Thus, fuel efficiency and energy efficiency matter, but nothing else does. If other attributes matter, it is assumed they either are irrelevant or will be included at no additional cost in the post-regulation products. In effect, government officials act as if they are guided by a single mission myopia that leads to the exclusion of all concerns other than their agency's mandate."[22]

Consider as well the findings of the Congressional Budget Office in a 2002 study commissioned by the Senate and regarding the impact of proposals for earlier, much less stringent increases in the standard. The CBO, noting that many proponents of increased fuel economy standards were arguing that the market for fuel economy is inefficient because consumers either "lack information about vehicles' fuel efficiency (in other words they do not know what's best for them) or that producers lack an incentive to respond to consumers' preferences for fuel efficiency." The CBO concluded:

"Most economists do not believe that either assumption is valid. Vehicles' current level of fuel efficiency most likely reflects consumers' trade-offs between fuel economy and other characteristics that drivers want, such as vehicle size, horsepower, and safety. The same technologies that can be used to boost fuel economy <u>can be used to hold fuel economy constant</u> while increasing the vehicles weight, size, or power. Thus, the fact that producers have done the latter rather than the former in recent years suggest that they have responded to buyers' preferences by targeting available technologies toward other features that consumers desire. Raising CAFE standards would impose costs on both consumers and automobile producers by forcing improvements in fuel economy that car buyers may not want."[23]

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[22] *Gayer and Viscusi*, page 26. See also, as Paul Portney, former head of Resources for the Future, concluded with his RFF colleagues in the leading survey journal of mainstream economics: *"Perhaps it is not that consumers misperceive or overly discount fuel-saving benefits, but rather that engineering studies underestimate the true economic costs of actually adopting fuel-saving technologies.* The true economic cost is probably larger than the engineering cost estimates . . . for two reasons. First, it ignores the possible opportunity cost of not using fuel saving technologies for other vehicle enhancements. That is, by forcing automakers to apply their technical expertise to more fuel-efficient engines, tighter CAFE standards could mean fewer of the improvements to which consumers have responded enthusiastically in the past – including such things as enhanced acceleration, towing capacity and so on. It is the implicit value of these foregone improvements that ought to be compared with the fuel economy savings that tighter CAFE standards would bring."[22]

[23] Congressional Budget Office, "A CBO Study: Reducing Gasoline Consumption: Three Policy Options (November 2002), Chapter 2, page 2. (Emphasis added)

It is also important to note that the subset of the population on which our comments focus – low income households – have a much different set of economic priorities than the general population when it comes to transportation. EPA's assumed net benefits from more stringent standards are the difference between a higher up-front purchase cost and the present value of a stream of benefits (fuel savings). In that sense, fuel economy standards are a classic investment paradigm – a lump sum payment now that yields a stream of future dividends. People at the lowest income levels, however, have no extra money to invest.

As the studies, we have presented suggest, the people in this population need dependable transportation just to generate the income for basic needs and have little money to invest in that purchase. Any upward pressure on the purchase price of vehicles as a result of more stringent standards will, depending on the particular situation, force low income buyers to sacrifice other needed attributes of importance such as reliability, carrying capacity, safety, towing capacity, and many other attributes unique to their particular situations.

Defour/Alliance Rejoinder, Part 4d: EPA's Benefit/Cost Estimates Lie Well Outside the Mainstream

EPA references two specific studies of consumer evaluation: one that finds no under-evaluation and another that finds that consumers take into full account only 75% of the value of fuel economy gains achievable through fuel efficiency advances.

But, as we noted in our September 2012 submission, mainstream economic research, including that at the EPA itself, finds that even if consumers were to irrationally undervalue fuel savings, the undervaluation would have to be truly massive in order to justify even the much less stringent 2012 to 2016 Model Year regulations currently in place.

Indeed, Gayer and Viscusi find that of the EPA's $613 billion over-estimate of the benefits for the 2017-2025 Model Year standards, 87 percent are estimated to be private benefits to U.S. consumers, including $444 billion in estimated lifetime fuel savings, $71 billion for the value of increased driving, and $21 billion in refueling time value. Just $3.2 to $10.7 billion derives from GHG reduction benefits, with other EPA-estimated benefits from reductions in criteria pollutants at $8 billion and enhanced energy security at $24 billion.

This means that the benefits of the proposed standards, exclusive of those derived from its assumption of the $444 billion in fuel savings that consumers are unwilling to pay for, are outweighed by EPA's estimate of $192 billion in hardware costs, a deficit exceeding $55 billion and this is taking EPA's cost estimates as a given. Defour found in its 2012 submission that actual hardware costs at the consumer level were 60% higher than EPA's estimates, even when adopting EPA estimates of the underlying manufacturing costs.[24]

[24] *Id*, and Michael Whinihan, Dean Drake, and David Aldorfer, "Retail Price Estimates and Incremental Cost Multipliers: Theory and Reality," February 2012, Defour LLC, for the National Automobile Dealers Association.

Defour also found, based on research by economists at the Massachusetts Institute of Technology, that consumers would be willing to pay for only about 25% of the fuel economy savings generated by the mandated fuel efficiency technologies at retail fuel prices around $4.25 per gallon ($2016), and that they would be willing to pay for none of the fuel economy savings that might be generated from the mandated fuel efficiency technologies at or below around $2.30 per gallon ($2016) – the EIA's estimate of retail gasoline prices for 2017.[25]

Gayer and Viscusi conclude:

"With estimated costs of the regulation of $177 billion by NHTSA and $192 billion by EPA, this regulation clearly fails a [benefit / cost analysis] without the presumption of consumer irrationality and the resulting [estimated] substantial private benefits of mandating more fuel-efficient vehicles."[26]

In our September 2012 submissions, we also noted that earlier studies at Resources for the Future and the Congressional Budget Office (CBO) of far less stringent proposed standards came to similar conclusions, finding that mandating binding fuel economy increases would impose very substantial welfare losses on consumers and on the broader economy. We also noted that the EPA's own analysis estimated net negative social or externality costs – with increased safety and traffic safety externality costs resulting from the proposed standard exceeding the value of reduced GHG emissions and energy security savings.[27] We noted that these conclusions, as well as those of a vast economic literature, were supported by a survey of mainstream research by economists at Resources for the Future and which was published in the *Journal of Economic Literature*, a journal of the American Economic Association and the leading survey journal for economic scholars. The authors concluded:

"Whether higher fuel-economy standards would increase or reduce efficiency or have little effect remains unsettled. Kleit (2004) and Austin and Dinan (2005) find that costs from binding increases in standards of 3–4 miles per gallon would cost around $3–4 billion or more, assuming market adoption of all privately cost-effective technologies. <u>Higher fuel-economy standards significantly increase efficiency only if carbon and oil dependence externalities greatly exceed</u>

[25] Walton and Drake, page 10.

[26] Gayer and Viscusi., page 21.

[27] See, in particular, Fischer, Harrington, and Parry, "Should Corporate Average Fuel Economy Standards (CAFE) be Tightened?" *Energy Journal* (2007) at http://www.rff.org/documents/RFF-DP-04-53-REV.pdf at and Harrington, Parry, and Walls, "Automobile Externalities and Policies," *Journal of Economic Literature (2007), and* David Austin and Terry Dinan, "Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes," *Journal of Environmental Economics and Management* (2005), and William Pizer, Dallas Burtraw, Winston Harrington, Richard Newell, and James Sanchirico, Modeling Economy wide versus Sectoral Climate Policies Using Combined Aggregate- Sectoral Models." The energy journal: Energy Economics Educational Foundation Inc.- Boston, Mass. [u.a.]: Oelgeschlager, Gunn & Hain, ISSN 0195-6574, ZDB-ID 8643192. - Vol. 27.2006, 3, p. 135-168. and David Sandalow, *Freedom from Oil: How the Next President Can End the United States' Oil Addiction*, Brookings (2008). *The Journal of Economic Literature* article is a survey of the leading economic studies in the field, Emphasis added.

the mainstream estimates in Table 2, or if consumers perceive only about a third of the actual fuel-economy benefits" (Fischer, Harrington, and Parry 2006).[28]

Defour/Alliance Rejoinder, Part 4e: Behavioral Psychology Does Not Justify EPA's Views on Consumer Choice

As noted above, EPA and NHTSA cite literature in behavioral economics to the effect that there can be systematic consumer biases against rational decision-making. Gayer and Viscusi counter: "Among the list of justifications for the "paradox" are acknowledgements that it could be a consequence of EPA's miscalculation or omitted variables, in that "factors such as transaction costs and differences in quality may not be adequately measured" and "there is likely to be variation among consumers in the benefits they get from improved fuel economy." The behavioral justifications offered by NHTSA and EPA offer very little evidence that consumers are causing self harm in their vehicle-purchasing decisions and would thus accrue private benefits by having their options restricted .... [29]

Defour/Alliance Rejoinder, Part 4f: EPA Fails to Consider Less Costly and More Effective Alternatives

Gayer and Viscusi note that "Executive Order 12866 (signed by President Clinton and re-affirmed by President Obama in his Executive Order 13563) requires each agency to 'identify and assess available alternatives to direct regulation . . . such as . . . providing information upon which choices can be made by the public.'" If consumer irrationality and ignorance is the issue as EPA contends, the better approach might be to issue a regulation requiring better information.

Gayer and Viscusi ask:

"Why a rigid mandate is warranted rather than an informational regulation that would provide consumers with the guidance to make sounder choices. Indeed, in 2011 EPA did just that by issuing its Motor Vehicle Fuel Economy Label Final Rule. The mandated label for all new cars is quite extensive, including an overall mpg rating, a city mpg rating, a highway mpg rating, gallons/100 miles, driving range on a tank of gas, fuel costs in five years versus the average new vehicle, annual fuel costs, fuel economy and greenhouse-gas rating, and smog rating.

"These components of the label address the purported behavioral failures in that they (i) indicate the longer-term fuel costs, thus diminishing the effect of high discount rates, (ii) make the benefits of fuel economy salient and a less "shrouded" attribute, (iii) provide easy calculations of fuel economy, (iv) enable consumers to know the actual fuel-economy benefits rather than relying on rough rules of thumb, (v) make it clear that fuel economy is a valued vehicle attribute not a proxy for a less-expensive vehicle, (vi) make it easier for consumers to identify which vehicles provide fuel economy, (vii) provide diverse measures of fuel economy

[28] Harrington et al, *Ibid.*

[29] G&V, page 23.

that consumers can relate to their driving style, and (viii) make the fuel costs more apparent as an upfront cost similar to that of the sticker price.

"Indeed, the EPA label rule is directed at remedying all but a couple of the types of consumer choice failures that EPA claims account for the private benefits of fuel-economy standards. What is striking about the EPA analysis of the CAFE standard is that the EPA regulatory impact analysis does not even mention the existence of the agency's own new label rule."

They note, "This oversight goes to the heart of the CAFE standard analysis, as most of the benefits needed to justify the regulation relate to consumer choice failures targeted by the new labeling rule. If the label rule does not have zero economic benefits, then the EPA analysis of the fuel-economy standard necessarily overstates the benefits associated with the proposed CAFE standards. If the label rule is completely worthless and generates no benefits for consumer choice, then EPA was remiss in issuing the regulation and the OMB, the watchdog over all major new federal regulations, was remiss in permitting the agency to move forward with a rule other EPA assessments implicitly treat as worthless.

"We take an intermediate view with respect to the labeling regulation. Informational strategies have a productive role to play and should be the primary policy instrument used if the alleged market failure stems from a lack of information. Before EPA should consider other, more intrusive forms of intervention, it should demonstrate that private decisions are flawed and that informational remedies will not suffice. In general, agencies should examine less-restrictive regulatory alternatives before adopting highly intrusive technology-forcing standards. The proposed EPA fuel-economy label rule is not ideal, as Cohen and Viscusi discuss, but it is far superior to restricting the choices available to consumers. That a particular labeling approach may fall short should serve as an impetus for developing more effective informational policies rather than abandoning all labeling regulations because the particular policies implemented were not designed as well as they could have been. Informational regulations remain highly attractive, as they use a form of intervention that does not attempt to homogenize consumer choice or override the preferences of those who value a more diverse set of automobile attributes than mpg and cost."[30]

Whether such additional information is really necessary, of course, is a matter of debate. Auto buyers already have access to a vast quantity of detailed information, provided by a seemingly endless supply of sources, regarding fuel economy and fuel savings in a vast number of websites, both private and public, including the EPA mileage stickers.

If automotive buyers, who see pump prices and fuel costs every time they fill up a tank of fuel, cannot be trusted to pursue their self-interest, who else can? But if that is the EPA's (and NHTSA's) conclusion, then the agencies should adopt the far less costly and more effective alternative of providing the information that it finds to be in inadequate supply.

[30] *Id*, pages 23 -25.

Defour/Alliance Rejoinder, Part 4g: Defour's Submission is Based on Up-to-Date Research

EPA claims that Defour and the Alliance rely on engineering cost estimates that are older than those used in its 2012 cost-benefit estimates (page A-28). This is simply not true. While we do rely on studies predating those estimates, we also cite very recent, up-to date estimates and reviews of those estimates.

We also referred to a recent literature review by Arthur van Bentham of the Wharton School of Finance at the University of Pennsylvania and Mathias Raynaert of France's Toulouse School of Economics, which summarizes the conclusions of mainstream economists:

"[M]ost studies conclude that [fuel economy] standards are so expensive that their cost to society exceeds the value of the carbon saved.[31]

This is not to mention the studies we cited in our February 2012 submissions that commented on EPA's benefit/cost analysis in support of the proposed standards.

Most importantly, and as we have emphasized in this submission, Gayer and Viscusi, in their July 2012 evaluation of the EPA's (and NHTSA's) benefit cost/analysis, took explicit account of the EPA's (and NHTSA's) estimate(s) of the engineering costs.[32] They nonetheless found that the costs, inclusive of "opportunity costs" (consumer welfare losses when they are denied the attributes they wish to get in a vehicle) vastly outweigh the benefits, even including the sum total of GHG emissions reductions and other societal (externality) costs.

Defour/Alliance Rejoinder, Part 4h: The EPA Benefit/Cost Analysis Violates OMB Guidelines

As we noted in our September 2012 submission, and as Gayer and Viscusi's analysis of the EPA's proposed 2017-2025 model year mandates concludes, there is a lack of systematic evidence to support the Greene/EPA/NHTSA assumptions of myopic consumer or manufacturer behavior. Gayer and Viscusi also note that this assumption violates OMB guidelines for conducting benefit/cost analysis.

"Taken as a whole, the engineering and empirical literature on the energy-efficiency gap does not provide strong, credible evidence of persistent consumer irrationality, and the literature on behavioral economics with respect to energy efficiency is still limited and unable to consistently demonstrate the magnitude of the contribution of behavioral deviations from rationality. BCAs should therefore operate under a presumption that consumers and producers accrue net gains from any private market transaction in which they voluntary engage.

"This presumption of the validity of revealed preference is explicitly recommended in the Office of Management and Budget's (OMB) guidelines for conducting regulatory analyses, known as Circular A-4. In considering the example in which emission standards lead to fuel savings, the OMB states, "These fuel savings will normally accrue to the engine purchasers, who also bear

[31] Arthur Van Benthem and Mathias Reynaert, "Can Fuel Economy Standards Save the Climate," *The Economist*, Jul 16th 2015.

[32] Gayer abd Viscusi,

the costs of the technologies. There is no apparent market failure with regard to the market value."[33]

Defour/Alliance Conclusion #3: The proposed standards will prove to be catastrophic for lower income and minority households. Contrary to popular opinion, fuel economy standards are much more costly and regressive than taxes on motor fuels, taxes which Congress has repeatedly rejected on grounds of excessive cost and regressivity.

EPA response: The EPA draws no conclusions regarding the relative cost of the two approaches. Rather, they argue that they are not required to investigate relative costs and that Greene and Welch tentatively conclude that standards are progressive.

Defour/Alliance Rejoinder: Each of the aforementioned mainstream economic studies demonstrates that whether based on footprint or on a flat standard for all vehicle sizes, the nation's fuel economy standards are much more costly and regressive than a fuel tax achieving the same level of reduction in greenhouse gases or increase in fuel savings. Jacobsen finds that the footprint-based standard is more costly than the flat-based standard. Levinson finds that the footprint standard is more regressive than the flat standard and both are more regressive than a fuel tax.

Levinson concludes:

"Either of the two policies under consideration—taxes or standards—make poor households worse off. But the burden of energy taxes falls relatively less on poor households than the burden of efficiency standards."[34]

EPA says that it must comply with the law and the law does not allow the option of a fuel or carbon tax in lieu of the fuel economy mandate. But, as Gayer and Viscusi note, "Even if the regulations must by law be issued, there could be changes to the analysis to show the true economic burdens of the regulations. Indeed, OMB guidelines require that the agencies estimate the costs of not pursuing the optimal regulatory response due to legal constraints."[35]

[33] *Id.*, page 14.

[34] Levinson, page 2.

[35] Gayer and Viscusi, page 38. Emphasis added.

Conclusion

EPA contends that the Defour/Alliance submission on September 21, 2016 fails to demonstrate that the EPA's proposed fuel economy standards are regressive, both absolutely and relative to a fuel tax achieving the same level of greenhouse gas emission reductions and fuel economy savings. But the findings of the Defour Group and the Alliance are also those of every mainstream, independent economic study – of every study that takes into account the full costs and benefits of fuel economy mandates for American workers and consumers and especially for those in low-income households. The proposed increase in the stringency of the nation's GHG emissions and fuel economy standards will have serious adverse consequences for low income families and individuals by reducing their access to low cost dependable mobility.

By confining its analysis to a comparison of upfront vehicle costs to the fuel savings generated by the proposed GHG reduction/fuel economy mandates, EPA instead finds enormous net benefits for automotive consumers and is unable to explain the so-called "energy efficiency paradox" – why auto buyers do not demand the fuel savings on their own and in their own self-interest. It attributes this supposed conundrum to a supposed inability of these consumers to make rational tradeoffs between the value of increased fuel savings in comparison to the increased vehicle costs necessary to achieve those savings. The EPA also does not consider that the economic trade-offs made by low income households may be substantially different from those of higher income households.

In so doing, EPA ignores the very substantial "opportunity" costs that binding standards impose on auto buyers when vehicle technology mandates deny low income households access to a myriad of vehicle amenities they require. Mainstream economic studies take account of those opportunity costs, finding instead enormous negative net benefits for the kinds of mandates proposed by the EPA.

The solution to the supposed "energy efficiency paradox" is that there really is no paradox at all. To quote Brookings Gayer and Vanderbilt's Viscusi: "The assumption that the world outside the agency is irrational is a direct consequence of the agencies' view that energy efficiency is always the paramount product attribute and that choices made on any other basis must be fundamentally flawed. . .. Overriding market decisions to advance the preferences of government agencies will always make consumers and firms worse off unless one demonstrates that there are fundamental flaws which, if recognized, would lead people to make decisions in line with the regulations."

The EPA fails to make that case. There is no systematic evidence that, taken as a whole, car buyers under-value fuel economy enhancements that can be generated by technological advances – certainly not to the degree that is assumed in the EPA's Benefit/Cost Analyses and in the work by its consultant, Greene, on which it so heavily relies.

To quote Gayer and Viscusi:

"Taken as a whole, the engineering and empirical literature on the energy-efficiency gap does not provide strong, credible evidence of persistent consumer irrationality, and the literature on behavioral economics with respect to energy efficiency is still limited and unable to consistently demonstrate the magnitude of the contribution of behavioral deviations from rationality. BCAs should therefore operate under a presumption that consumers and producers accrue net gains from any private market transaction in which they voluntary engage. This presumption of the validity of revealed preference is explicitly recommended in the Office of Management and Budget's (OMB) guidelines for conducting regulatory analyses, known as Circular A-4. In considering the example in which emission standards lead to fuel savings, the OMB states, "These fuel savings will normally accrue to the engine purchasers, who also bear the costs of the technologies. There is no apparent market failure with regard to the market value.'"[36]

It is for good reason that OMB's Circular A-4 guidelines for conducting regulatory analysis explicitly require the EPA . . . to assume rational consumer behavior in their benefit cost analyses of proposed regulations -- a requirement the agencies continue to skirt in their regulatory proceedings."

It is time for EPA to stop violating these OMB guidelines, as well as the findings of the vast weight of the economics literature.

If and when it incorporates the opportunity costs imposed by the standards as done in mainstream economic research, it will find that the proposed standards are justified neither by benefits to the nation's consumers nor by any societal or externality benefits and that the standards can have only a "negligible effect on greenhouse gases."[37] It will look for other, far less costly and more effective ways to achieve the nation's energy policy objectives.

[36] *Id.*, page 14. Emphasis added.

[37] Gayer and Viscussi.

Appendix: The "Energy Efficiency Paradox" and the Rational Consumer

The NHTSA and EPA Preliminary Regulatory Impact Analysis (PRIA) notes that their estimate of $4,000 per vehicle lifetime or net present value fuel savings for an "achievable" 47 mpg fuel economy level in MY 2025, when gasoline is expected to cost $3.54 per gallon, is inconsistent with the choices of today's vehicle buyers who are willing to pay for no more than 30 mpg for the combined fleet with gasoline prices ranging between $3 and $4 per gallon[38]. They surmise that this disparity, what they call an "energy paradox," can be explained by consumer myopia -- by auto buyers' irrational undervaluation of the present discounted value of future fuel savings. They ask for comments on this issue.

Our explanation of the agencies' quandary is quite simple. The inconsistency between what their engineering model predicts and what consumers actually want arises from the agencies' misspecification of their model, based on an erroneous definition of consumer rationality. According to the agencies' definition, rational consumers should be willing to purchase more "fuel-efficient" [they really mean more "fuel economical"] vehicles so long as the present value of the discounted additional energy savings associated with the requisite technologies equals or exceeds their hardware costs.

That is not how rational consumers behave. Improvements in fuel efficiency technology represent either the ability to reduce the amount of fuel required to move a given amount of mass (or achieve a given level of performance) or the ability to move more mass (or increase performance) for a given quantity of fuel consumed. Consumers can choose to spend the same technology on any number of attributes besides fuel economy and the (net present discounted) value of each of those other applications can also exceed the cost of the associated hardware in an engineering sense. Thus, the question is not whether the value exceeds the cost for any one application such as increased fuel economy, but rather, of all the applications, which gives consumers their highest value for the money – i.e., which is cost-effective in an economic sense? Indeed, at $3.54 per gallon, as the following analysis demonstrates and as Figure 1, page 3 of the text in the 2012 Defour submission confirms, spending fuel efficiency technology advances on fuel economy increases is likely to be near the bottom of their list.

Indeed, because the current fuel economy standard is binding, it is very unlikely that increases in fuel economy can be achieved without substantially increasing the consumer and producer welfare (profit) losses associated with forcing consumers to spend the money on something they do not want.

The following figures illustrate the economic "postulates" that underlie consumer rationality. They provide the answer to the energy paradox, showing how fuel economy technologies can be "cost-effective" in a narrow engineering sense (with present discounted fuel savings equaling or exceeding the retail price equivalent for the increased hardware costs), yet irrational in an economic sense. We begin the discussion by first assuming that there are no restraints on consumer choice – no fuel economy or any other standards that limit what consumers can buy.

[38] All values in our 2012 submission were in 2009 dollars.

The economist's world is a world of tradeoffs, where at any point in time producing more of one thing, such as fuel economy cannot be achieved without producing less of something else, such as vehicle size. Figure 1 below assumes that there are two attributes of value to consumers, fuel economy and "size."[39] The curve labeled "production possibilities curve" or "PPC" illustrates a hypothetical set of maximum feasible combinations of these two attributes. For any point along the x axis – that is for any given quantity of vehicle size – this curve shows the maximum feasible level of fuel economy that could be achieved with that size of vehicle. Alternatively, for any point along the y axis – for any given level of fuel economy, it shows the "largest" possible vehicle that might be produced and sold.

Note that, consistent with practical reality, getting more fuel economy and moving in the northern direction, requires that vehicles be "smaller," a move in the western direction. Alternatively, a move in the eastward direction towards "larger" vehicles requires that fuel economy must decline.[40] Note, also, that the production possibilities curve is just another word for one level of fuel efficiency technology and that the technology can be applied to various combinations of fuel economy and size. Note, finally, this level of fuel efficiency is the level that is provided in a well-functioning, fully competitive market. Manufacturers that fail to provide this level simply are not able to survive amidst such competition.

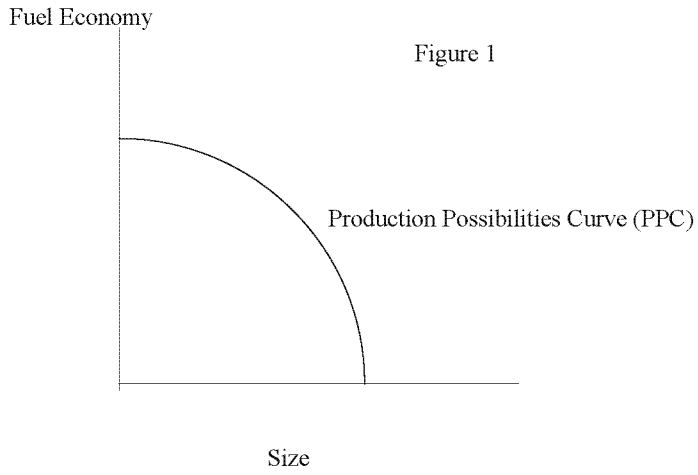
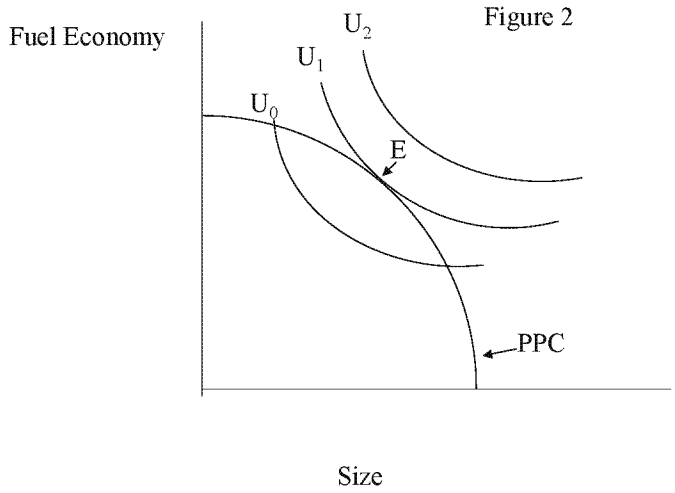


Figure 1

[39] Of course, in the real world consumers value many other attributes, including performance (0 to 60 acceleration time), safety, comfort, towing capacity, and so on. In this two dimensional layout, we can think of size as a proxy for all those other vehicle attributes.

[40] Note that the economists' law of increasing marginal costs of production implies the concave shape of the production possibilities curve. In this context, this law implies that for each additional unit of fuel economy, the producer, and ultimately the consumer, must give up larger and larger amounts of size and vice versa.

Economists also view consumers as being willing to exchange one good for another in varying proportions, as illustrated in Figure 2 by a series of isoutility curves now superimposed on Figure 1.[41] Each isoutility curve represents a constant level of consumer satisfaction. The greater the northeasterly distance from the origin the greater is the constant level of utility, so that U_2 represents the highest and U_0 the lowest level of constant utility or satisfaction.[42]



The consumers' optimum is reached where they can achieve the highest level of utility consistent with the feasible production set or production possibilities curve (PPC) as indicated by point E in Figure 2. This is the point where the additional utility or satisfaction obtained from spending a dollar on fuel economy just equals the additional utility derived from spending a dollar on size. Economists call this concept the "equal marginal principle" and it is a fundamental principle underlying their analysis of consumer and producer behavior. To quote MIT Professor Robert Pindyck and University of California Professor Daniel Rubinfeld:

"Only when the consumer has satisfied **the equal marginal principle** – i.e., *has equalized the marginal utility per dollar of expenditure across all goods* – will she have maximized utility."[43] (Boldface and italics in original.)

[41] For simplicity, we assume an aggregate consumer welfare function.

[42] The convex shape of each curve reflects the fact that consumers are willing to give up less and less "size" for increasing amounts of fuel economy and vice versa (what economists call diminishing marginal utility).

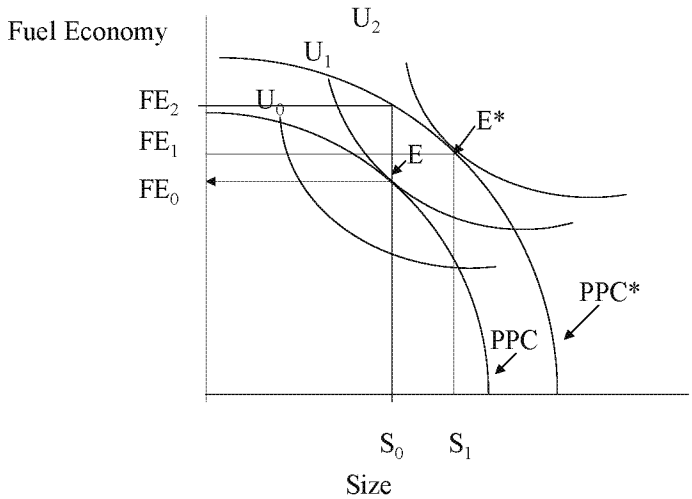
[43] Robert S. Pindyck and Daniel L. Rubinfeld, Microeconomics, (2001), p. 91.

Of course, this is the economists' operational definition of rationality, as contained in every basic text. In the present context, this principle requires that the added value or utility per each dollar spent be the same for all vehicle attributes.

Now suppose there is an outward shift in the production possibilities curve from PPC to PPC* – i.e., suppose there is an increase in the fuel efficiency technology applicable to cars and light trucks. Because consumers can spend improvements in fuel efficiency technology on either increased fuel economy or on size (a proxy for all other attributes of value), the production possibilities curve shifts outward in every direction.

Figure 3 shows the original hypothetical and unconstrained consumer equilibrium at point E, together with the new equilibrium at point E,* a point at which both fuel economy and "size" (again, a one-dimensional proxy for not just vehicle size, but also for performance, safety, and numerous other vehicle attributes that compete with fuel economy for the customers' limited budget) have increased as a result of the outward shift in the production possibilities curve. Note that in this hypothetical illustration the rightward or eastward increase in size from S_0 to S_1 is substantially greater than the upward or northward increase in fuel economy from FE_0 to FE_1. This is drawn this way because "size" is really a proxy for numerous other attributes besides fuel economy.

Figure 3



The answer to the agencies' "energy paradox" is that, contrary to their engineering model, rational, utility-maximizing and fully informed auto buyers will not be willing to spend all of the potential increase in fuel efficiency on increased fuel economy. This is so even though we are assuming that the net present value of the fuel economy savings from the new technology equals or exceeds the cost of the hardware (which has to be true for the new PPC to represent a maximum feasible set).

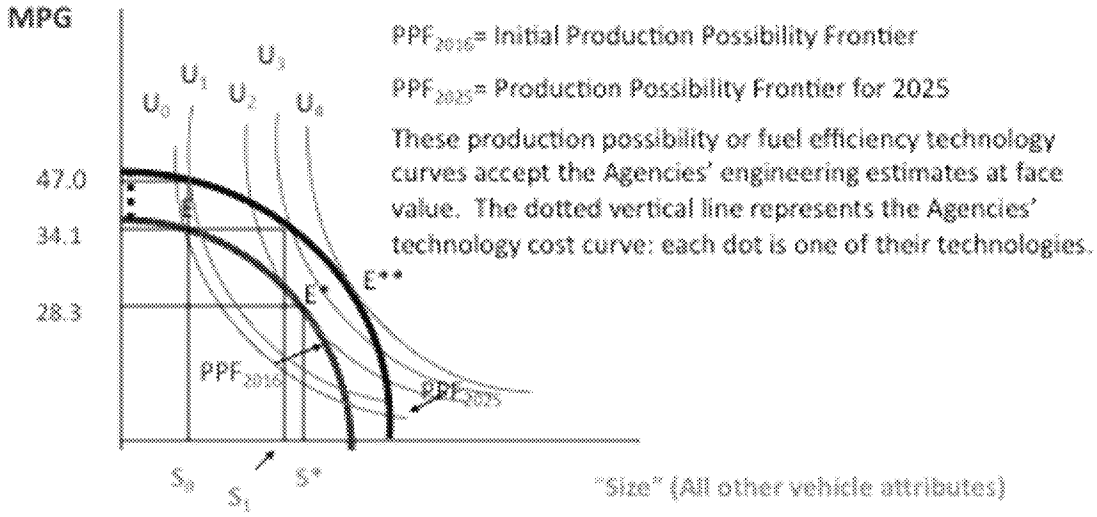
In other words, assume that the agencies' engineering analysis is correct and that FE_2 is the "achievable" level of fleet average fuel economy in MY 2025, or 47 miles per gallon. Assume further that, as in the agencies' engineering analysis, FE_0 is the baseline level of 34.1 mpg in MY 2016. The 12.9-mpg increase -- the vertical difference between FE_2 and FE_0 is the increase *if* consumers were willing to pay for 100% of the potential 12.9 mpg increase. It is "cost-effective" in the narrowly conceived engineering sense. But rational auto buyers are not willing to pay for 100% of the potential fuel economy increase. The 12.9-mpg increase in the fuel economy standard is *not* rational and cost-effective in an economic sense. That is because rational auto buyers will only be willing to pay for an increase to the unconstrained level, FE_1, a level that maximizes their utility (that puts them on the highest economically feasible isoutility curve), and which as shown in Figure 3 page 11 of the text of Defour's 2012 submission, the Energy Information Agency estimates to be just 35.3 mpg at $3.54 gasoline in MY 2025.

Finally, assume fuel efficiency technology advances as given by PPC_{2025} in Figure 4. Assume further that, initially, in MY 2016, consumers are free to choose the combination of fuel economy and other attributes of value and that 28.3 mpg is the free expression level. Thus, E* (28.3 mpg, S* size) on isoutility curve U_2 is the current optimum, or the point that satisfies the "equal marginal principle" for rational consumers.

Assume next that they are forced to purchase the MY 2016 mandate of 34.1 mpg, which puts them at Point E where "Size" is S_0 and their utility has been reduced to U_0.

In 2025, these still-constrained consumers would maximize their utility or satisfaction at point E,** which would entail an actual reduction in mpg to a level below the 34.1 mpg mandate in 2016. In other words, constrained consumers will be willing to pay to *reduce* fuel economy or mpg to just above the MY 2016 level of 28.3. Forcing them to take any of the mandated increase in fuel efficiency technology for MY 2025 as fuel economy will impose a loss of consumer welfare -- will force them onto a lower utility curve, or U_1, where they must take all of the technology advance in the form of fuel economy. This conclusion holds regardless of whether one accepts any or all of the proposed technologies on the dotted vertical line as cost-effective in an engineering sense.

Figure 4: Constrained Consumers Will Not Purchase More Fuel Economy



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MY 2016 Baseline Study

prepared for

Alliance of Automobile Manufacturers
Association of Global Automakers

December 20, 2016
- version 1.0 -

Disclaimer

The statements and conclusions in this document are those of Novation Analytics, LLC and not those of the Alliance of Automobile Manufacturers, the Association of Global Automakers, or its members.

Content

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- Database
- Fleet Composition & 2-Cycle Performance
- Fleet GHG & CAFE Program Credits
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- Performance to Future Model Years
- Conclusions & Recommendations

Motivation & Objective

Motivation

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- Fleet composition, 2-cycle performance, credit usage, and technology deployment assumptions made by EPA and NHTSA are a central component of the MY 2012-2025 U.S. light-duty GHG and CAFE standards.
- Manufacturer's performance through the complete MYs 2012-2016 standards program sheds light on the appropriateness of the starting point of the next phase of regulations (MYs 2017-2025) as well as informs the Mid-Term Evaluation review process.
- Combined with the MYs 2012-2015 results, this fifth year of the study provides additional trend information to support the mid-term review process and comments by the Associations and their members on the EPA Proposed Determination.

Objectives

- Conduct an independent annual assessment of fleet composition, 2-cycle performance, credit usage and technology deployment within the U.S. light duty fleet.
- Conduct fleet performance and technology deployment comparisons to identify differences between the actual values and those assumed in the MY 2012-2016 rules.

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Database

Vehicle Attribute Database

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- The vehicle attribute and performance database used for this assessment was generated, independent of this study, by Novation Analytics.
- The MY 2016 Novation Analytics database includes over 1,400 individual vehicle models and sub-configurations offered for sale in the U.S. market. The database combines all vehicle and powertrain specifications with certification test parameters and results, including road load coefficients, equivalent test weights, fuel economy, and tailpipe CO_2 emissions.
- All data included in the Novation Analytics database were obtained from public sources including manufacturer's consumer and media websites, EPA Verify queries, and certification documents.

Vehicle Production & Credits

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- To complete the objectives of this study, vehicle production and fleet credits (GHG & CAFE) were required for each model year.
- 2016 Mid-Model Year vehicle production forecast and fleet credits were collected from each manufacturer in a blinded format.
- The vehicle production forecasts and fleet credits supplied to Novation Analytics are confidential business information and are not shared with either Association or their members.

Vehicle Production Forecast Generation

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- The mid-model year 2016 forecasts summed to a volume of 15.2 million units, which is low compared to MY 2015 final volume of 16.7 million.
- Given the potential for inaccurate mid-model year forecasts, an enhanced forecast was required to obtain a more robust assessment.
- To enhance the MY 2016 production forecast, Novation Analytics obtained vehicle registration data from IHS-Markit for MYs 2015 and 2016.
- The fraction of MY 2015 registrations as of September 2015 to the final 2015 Model Year production was computed for both the fleet and individual manufacturers.
- The fraction was then applied, at the model, power source, engine, and driveline level, to MY 2016 registrations as of September 2016. This results in a MY 2016 production estimate for each model and sub-configuration.
- As the IHS-Markit data does not include accurate transmission information, the transmission fractions from the manufacturer mid-model year data were applied to generate the final data set.

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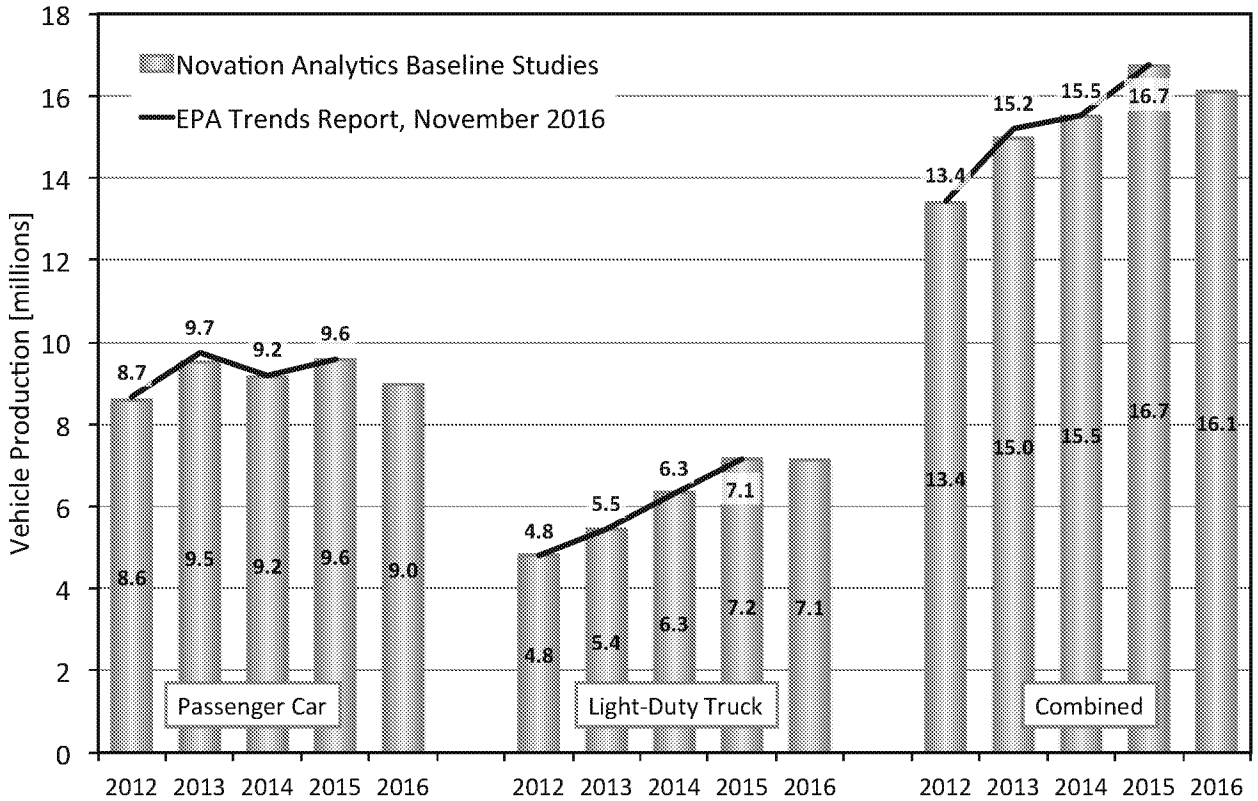
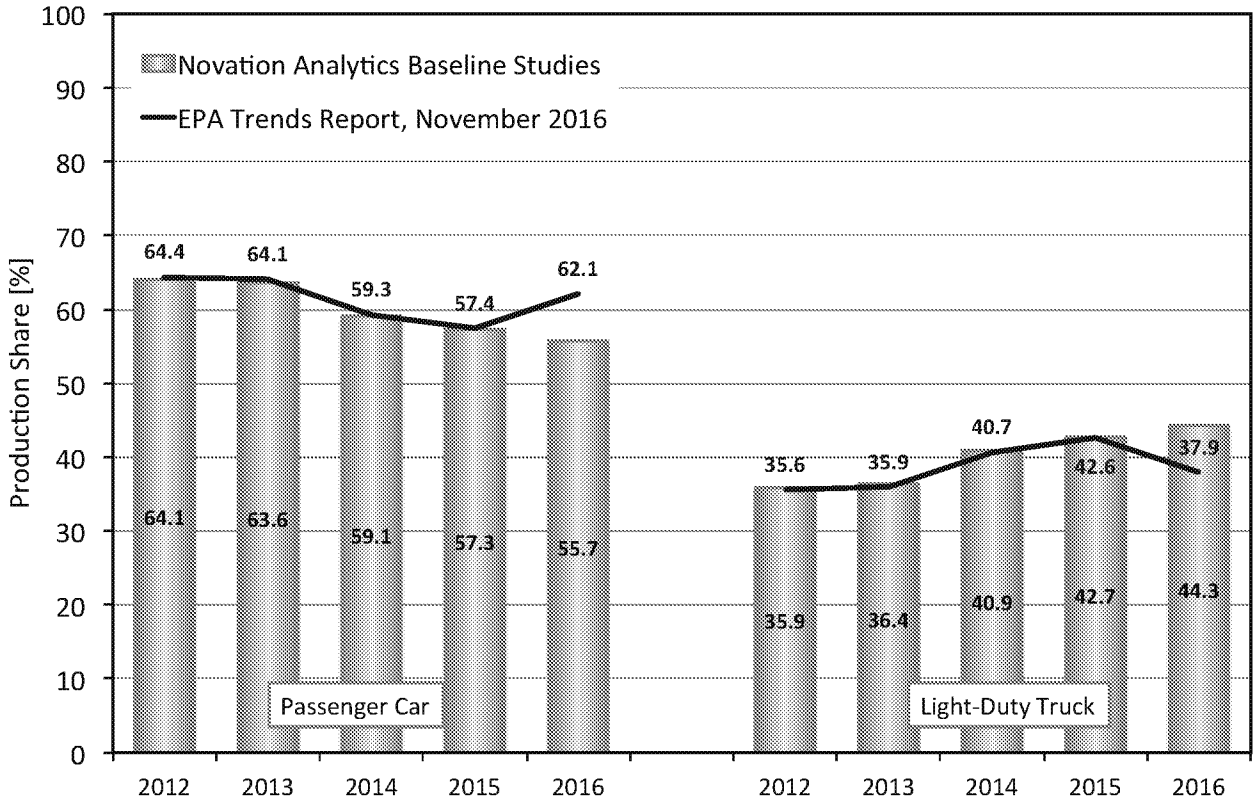
Fleet Composition & 2-Cycle Performance

Vehicle Production



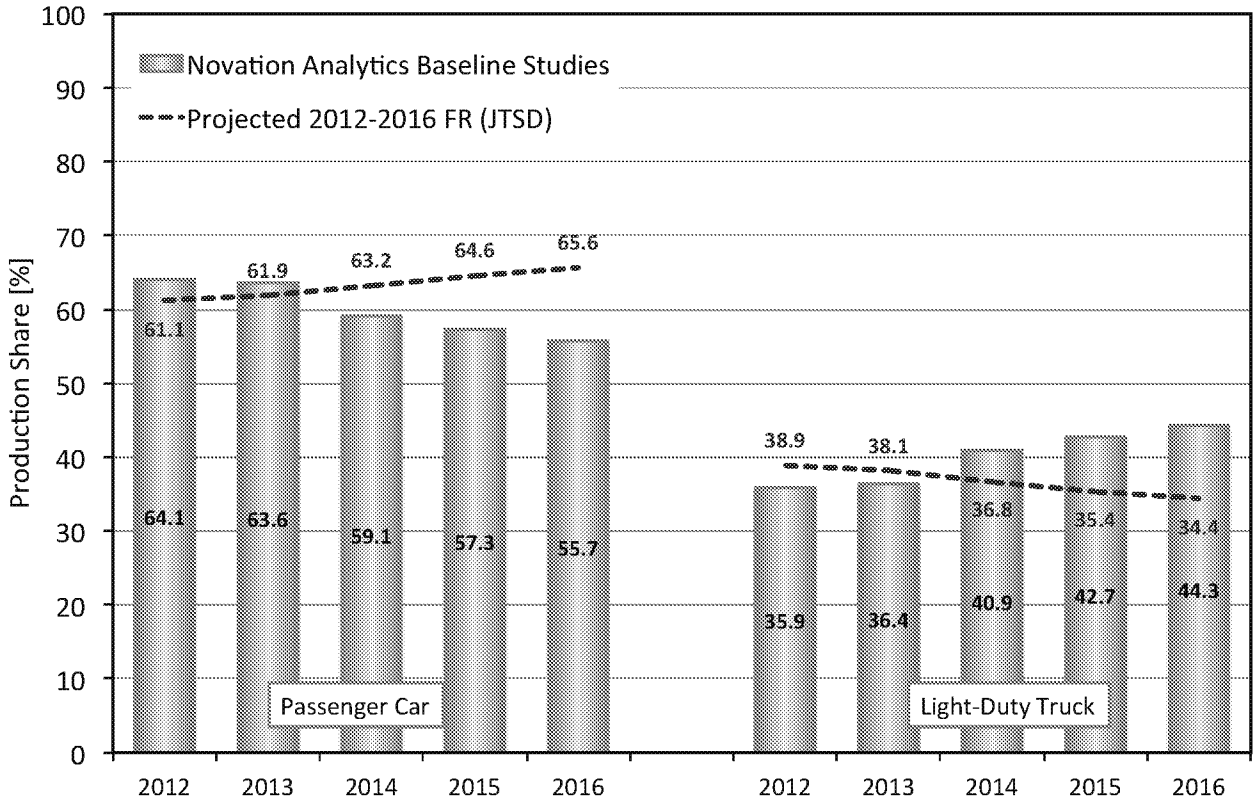
The MY 2016 production is estimated to decrease by over 0.6 million units compared to MY 2015. The majority of the sales decrease is attributed to the passenger car fleet.

Vehicle Production Share



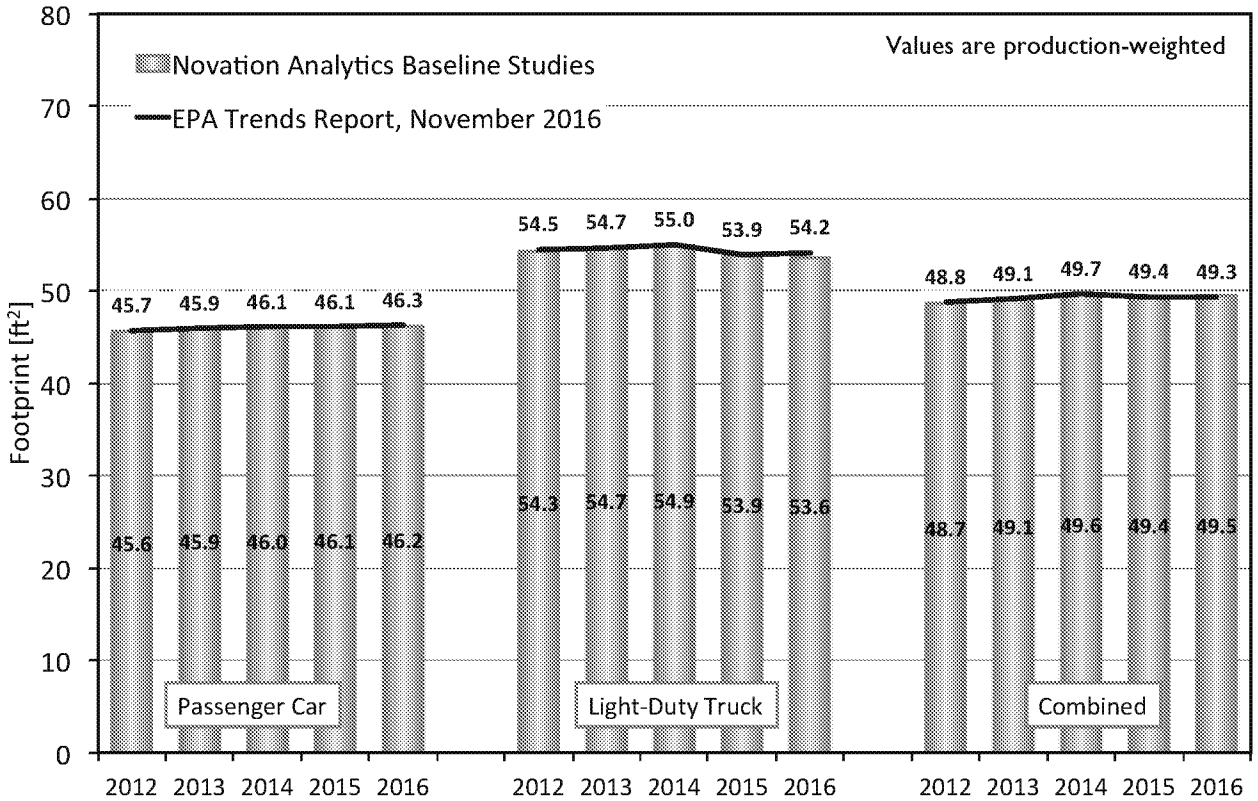
The share of passenger cars continues to drop. In MY 2016 the passenger car share dropped to 55.7%. This trend in passenger car/light-duty truck share was not reflected in the November 2016 EPA Trends Report.

Vehicle Production Share | Actual vs. Projected



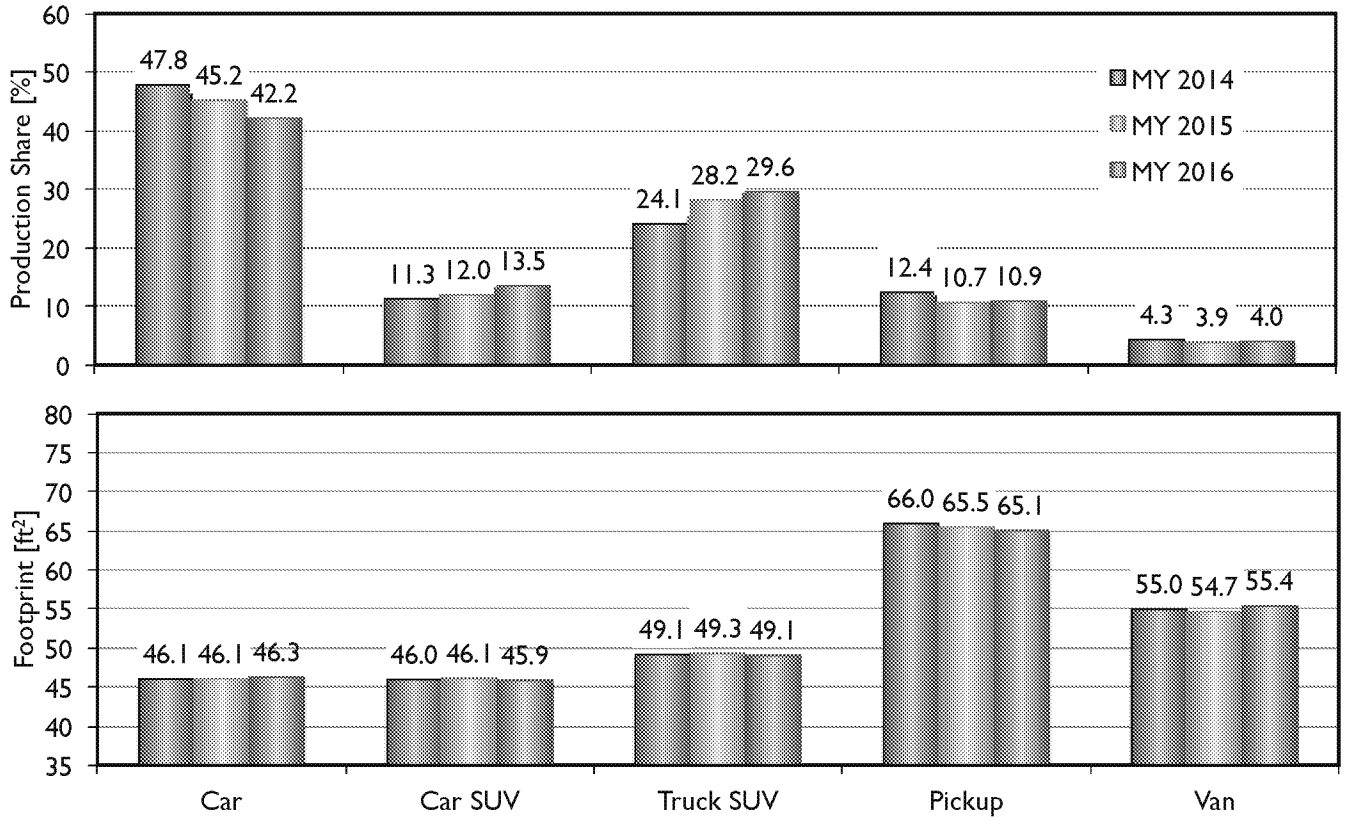
The production share of passenger cars and light trucks now differs by almost 10 percentage points compared to the projections used in the MYs 2012-2016 Final Rulemaking.

Footprint



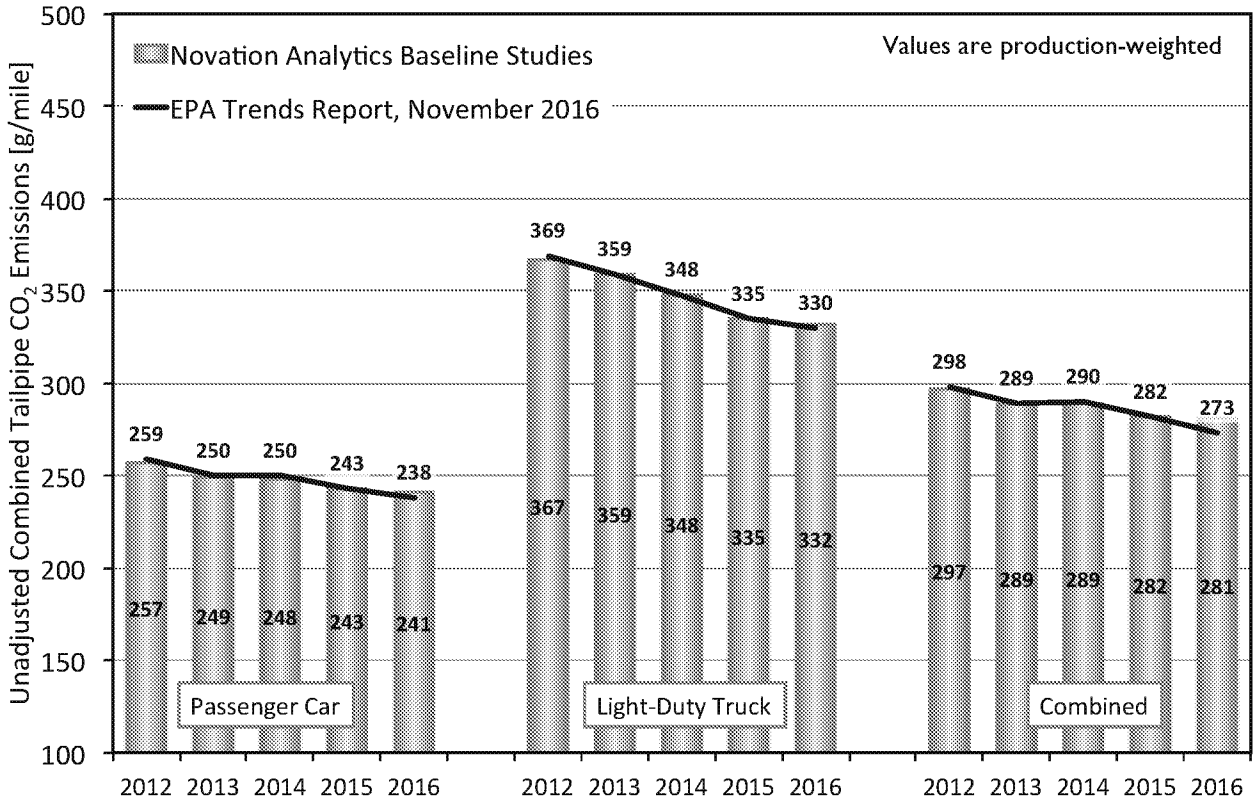
From MYs 2012 to 2016, the footprint of the passenger car fleet has increased by 0.6 ft^2, remaining relatively stable in the past 3 MYs. Conversely, the footprint of the light-duty truck fleet has continued to decline.

Footprint | Why the Drop in MYs 2015 and 2016?



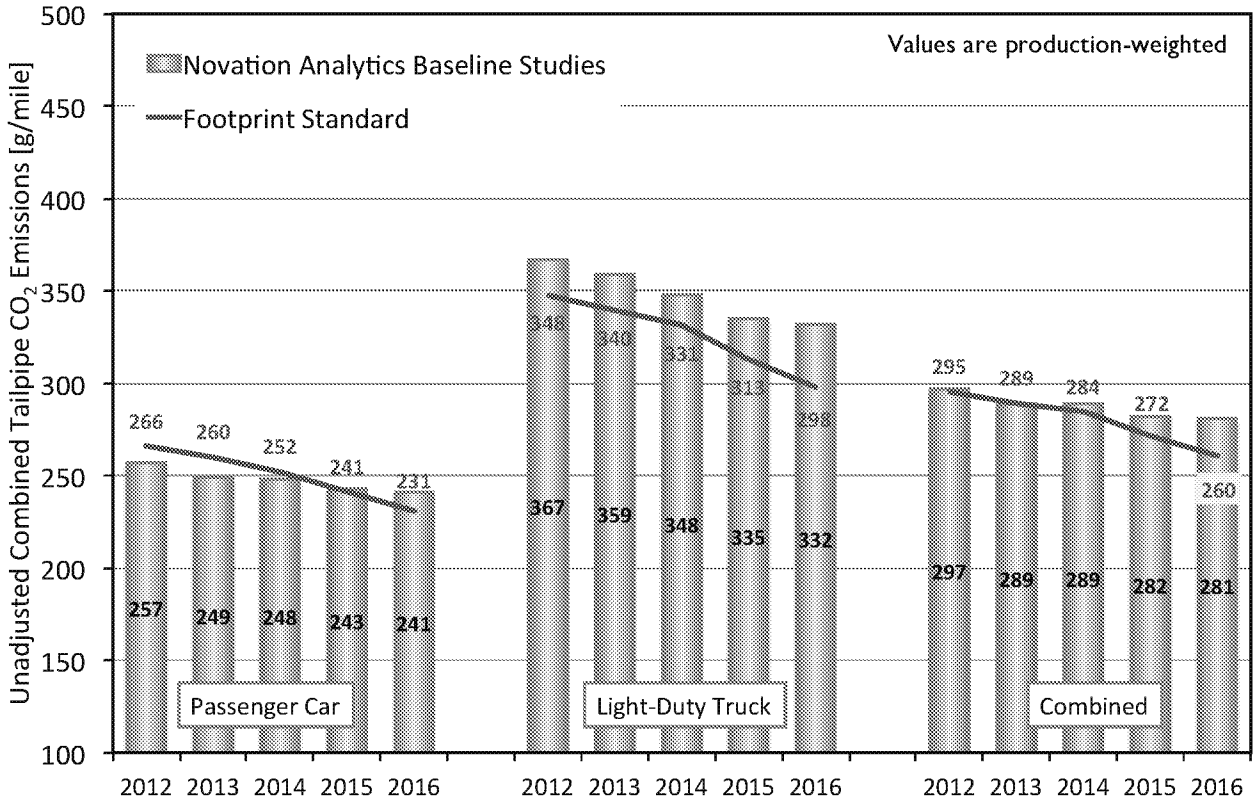
The 1 ft^2 drop in the production-weighted footprint of the light-duty truck fleet was due primarily to a mix shift within the fleet. Specifically, the share of SUVs increased, while that of pickups dropped. This shift in production share, along with the 16 ft^2 footprint difference between truck SUVs and pickups, resulted in an overall reduction in footprint. This trend continued in MY 2016.

Tailpipe CO_2 Emissions (2-cycle)



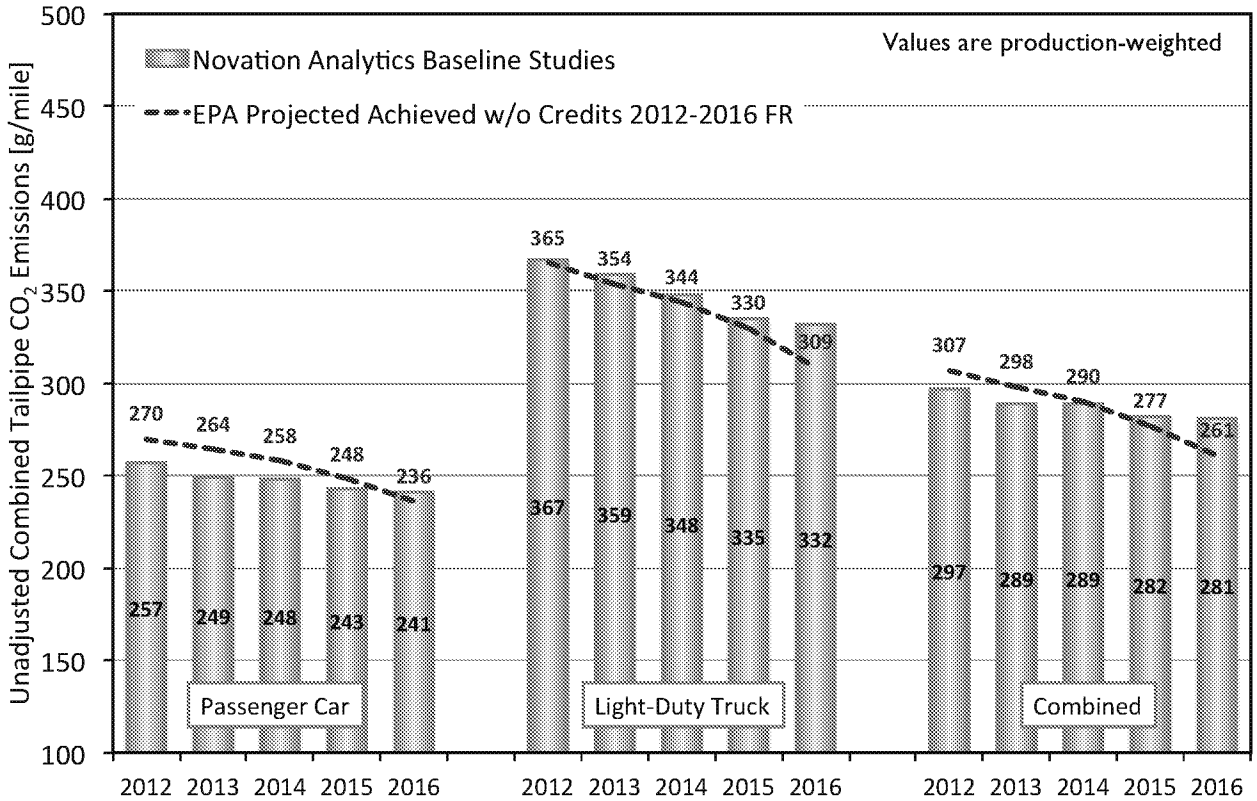
The combined fleet tailpipe CO_2 emissions dropped 1 g/mile from MY 2015 to MY 2016. The passenger car fleet improved by 2 g/mile, while the light-duty truck fleet improved by 3 g/mile. Both MY 2016 passenger car and light-duty truck fleet performance is worse than projected in the EPA Trends Report.

Tailpipe CO_2 Emissions (2-cycle) | Performance to Standard



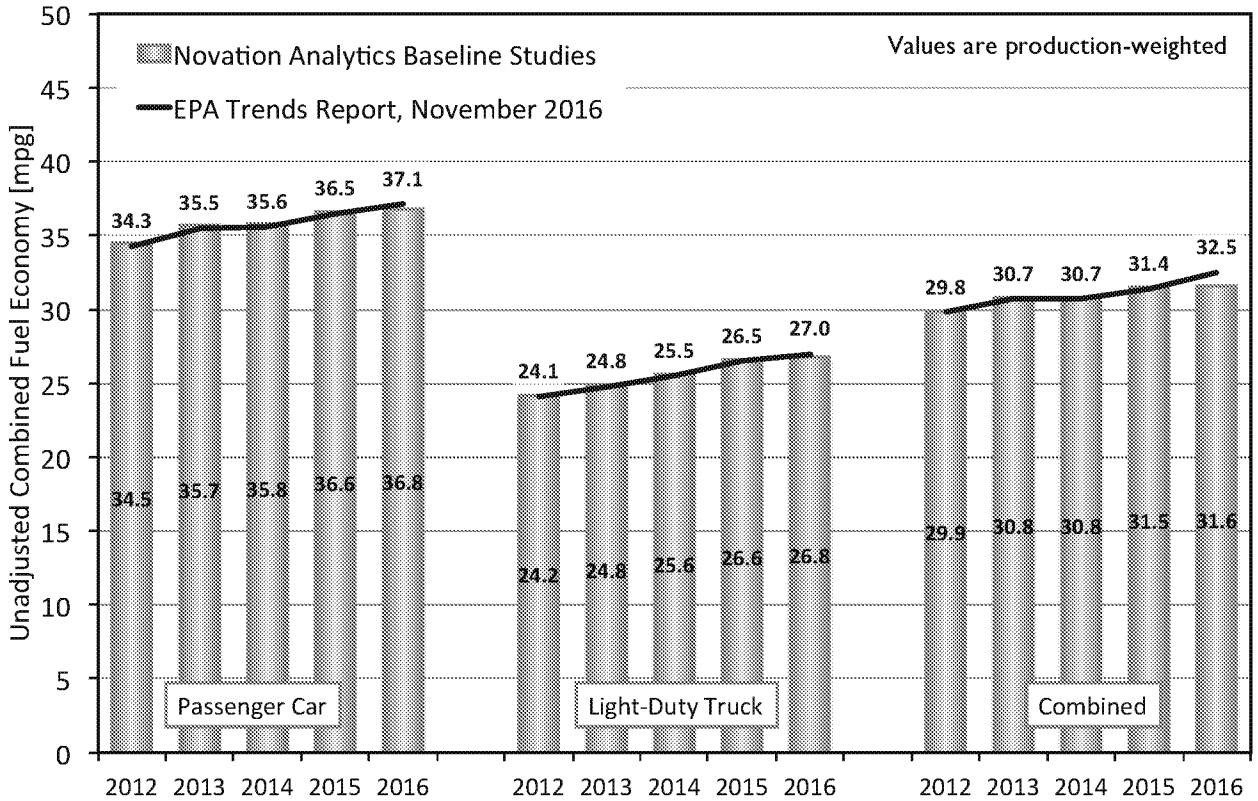
For the second model year running, neither the passenger car nor the light-duty truck fleet achieved the CO_2 footprint standard without credits. The passenger car basic debit has grown from 2 g/mile in 2015 to 10 g/mile in 2016. The light-duty truck basic debit has grown from 22 g/mile in 2015 to 34 g/mile in 2016.

Tailpipe CO_2 Emissions (2-cycle) | Performance to Projected



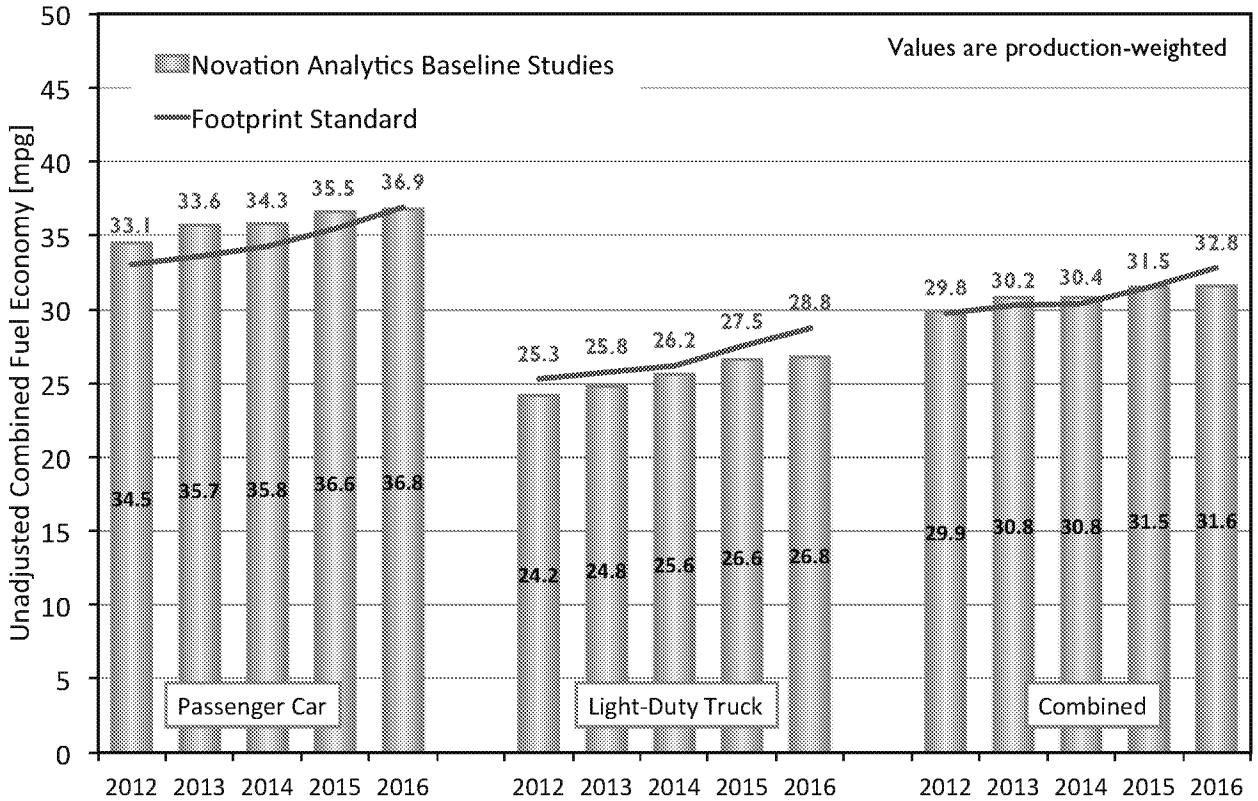
For the first time, the passenger car fleet under performed the tailpipe CO_2 performance projected by the EPA in the final rule. The light-duty truck fleet continues to under perform. As in 2015, the combined fleet under performed the standard, however the percentage has increased to more than a 7% deficit.

Fuel Economy (2-cycle)



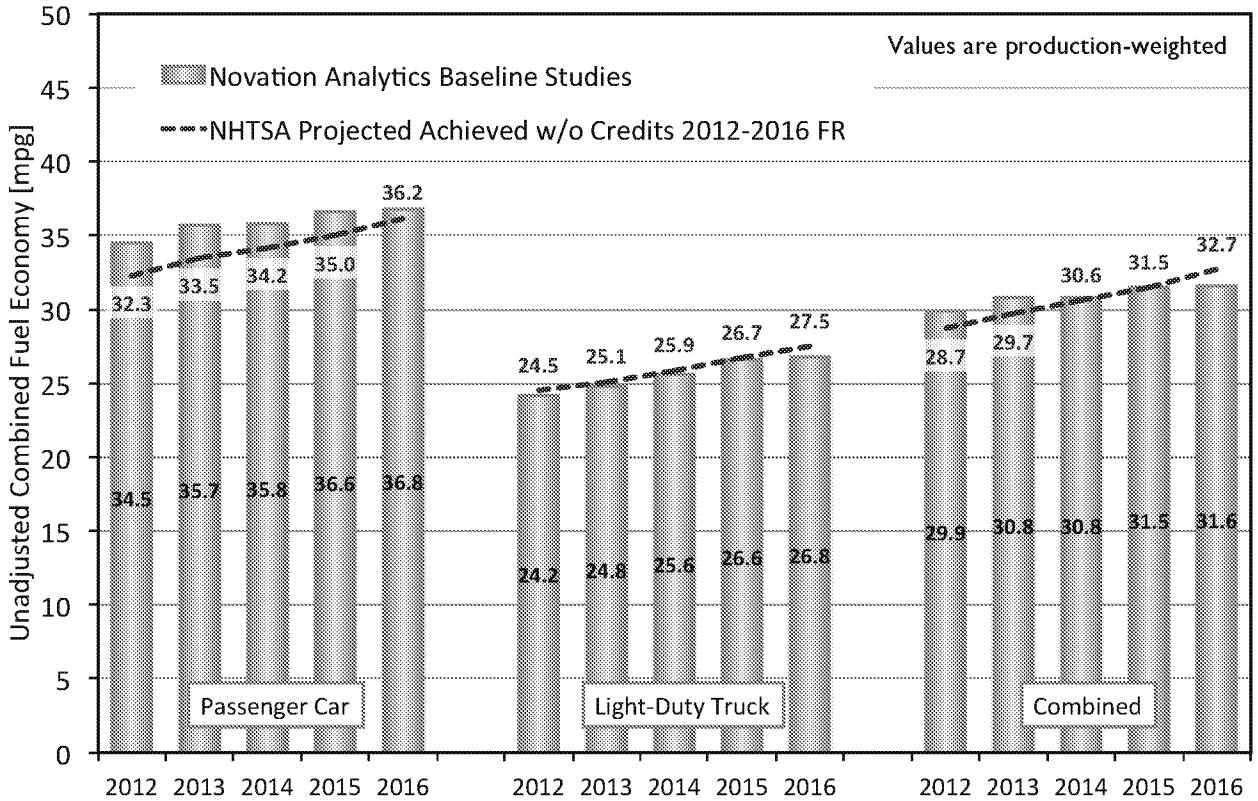
From MY 2015 to MY 2016 the fuel economy increased by 0.2 mpg for the passenger car and light-duty truck fleets. The combined fleet increased by 0.1 mpg, which reflects the continued mix shift to trucks as well. As with the CO_2 performance, the fuel economy performance is worse than reported in the EPA Trends Report.

Fuel Economy (2-cycle) | Performance to Standard



For the first time, the passenger car fleet under performs the footprint standard without credits. The light-duty truck fleet continues to require credits to comply. The combined fleet performance under performs the standard by 1.2 mpg.

Fuel Economy (2-cycle) | Performance to Projected



As with prior model years, the MY 2016 passenger car fleet over performs the NHTSA projection. The light-duty truck fleet under performs the projection by a wider margin than in prior model years. The combined fleet, which equaled last year's projection, under performs for the first time.

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Fleet GHG & CAFE Program Credits

Scope | Background

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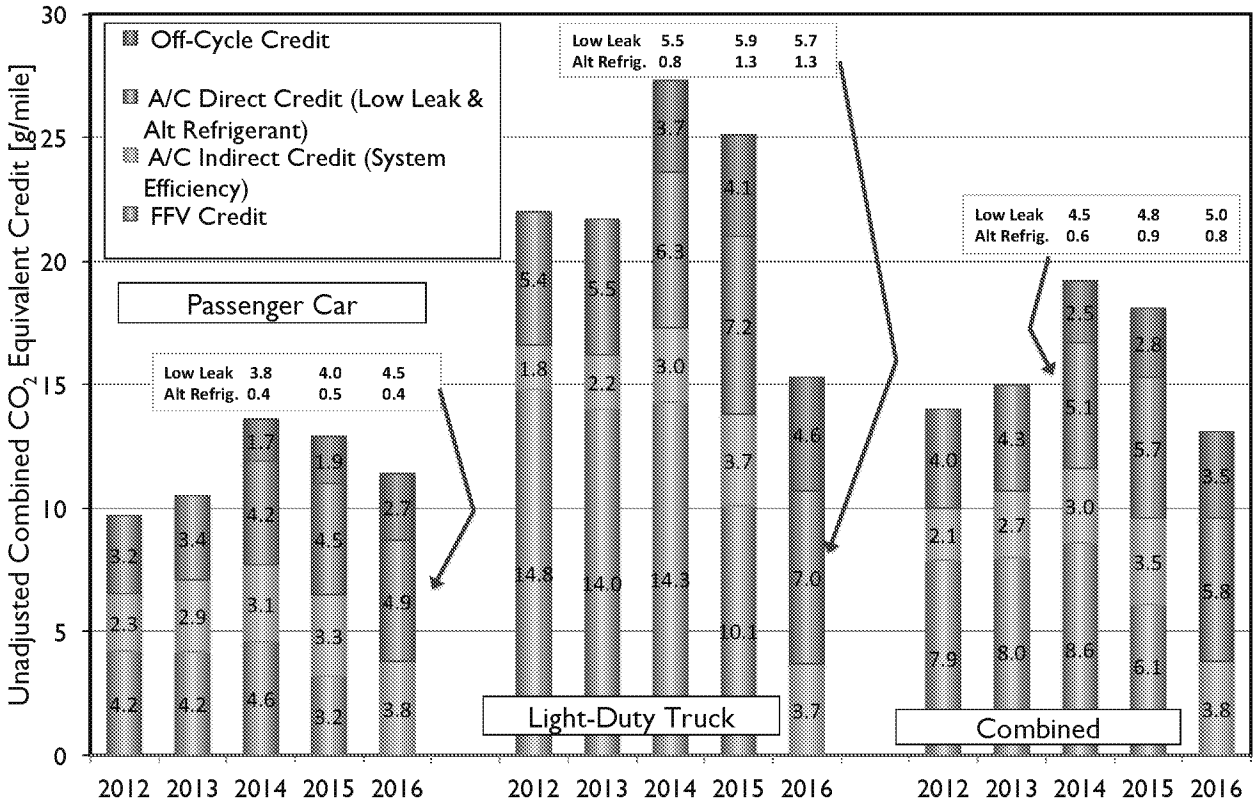
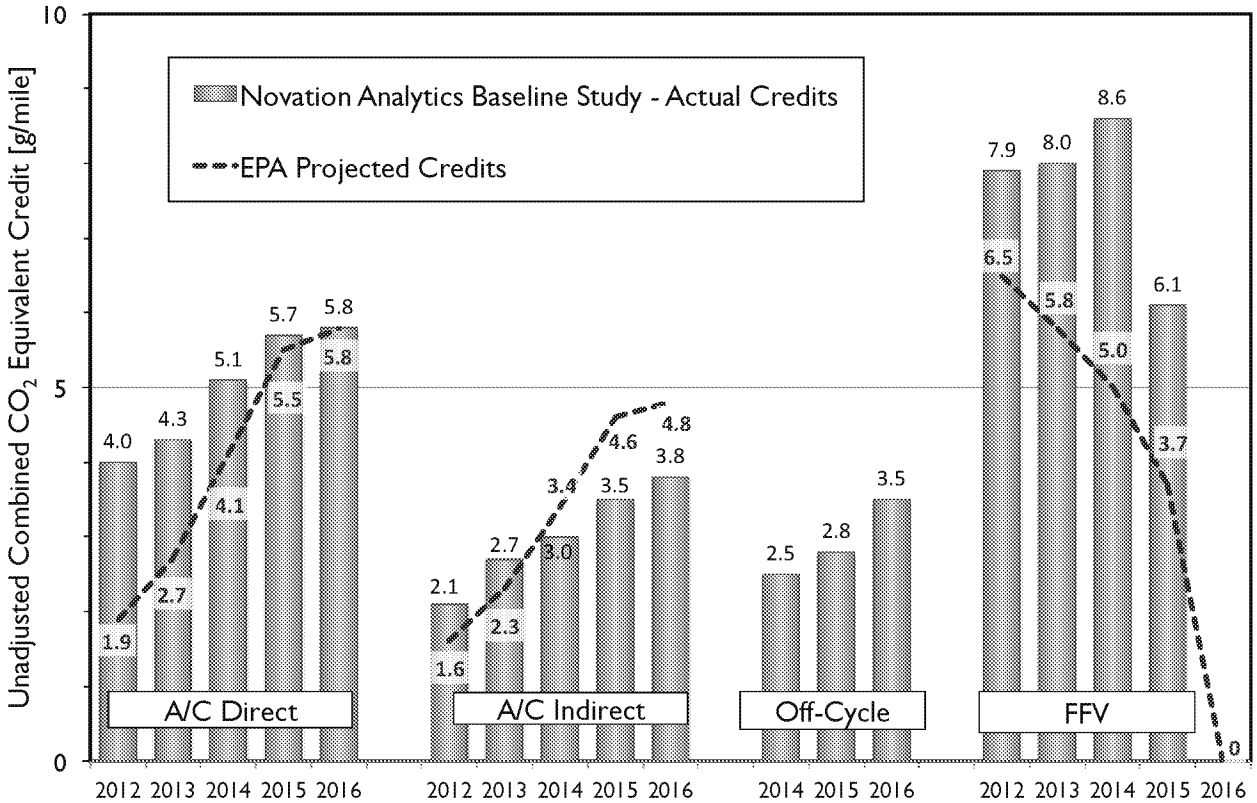
- Credit analysis was limited to CO_2/CAFE credits reported in the 2012-2015 production model years. Model year 2016 credit performance is a best estimate. For MY 2016, a majority of manufacturers were able to provide mid-model year based CO_2/CAFE credit estimates; for those manufacturers that were not, the MY 2016 credit performance was estimated based partly on prior years and trends.
- Analysis of OEM credit carry-forward, carry-back and averaging, banking and trading was outside the scope of this current study.
- Beginning with MY 2014, the Associations requested that A/C Direct credits (Low Leak & Alternate Refrigerant credits) be reported separately for analysis and tracking purposes. All member companies supplied separate A/C Low Leak and A/C Alternate Refrigerant credits for MYs 2014 and 2015 and these were either supplied or estimated for MY 2016. However, no attempt was made to obtain this additional detail for the model years 2012-2013.
- EPA's published projections of credits do not distinguish between types of A/C Direct credit, and are only provided in the final rule for the combined car/truck fleet for MYs 2012-2015. For MY 2016, EPA published separate passenger car, light truck, and combined fleet net credit projections.

CO_2 Equivalent Credit Detail



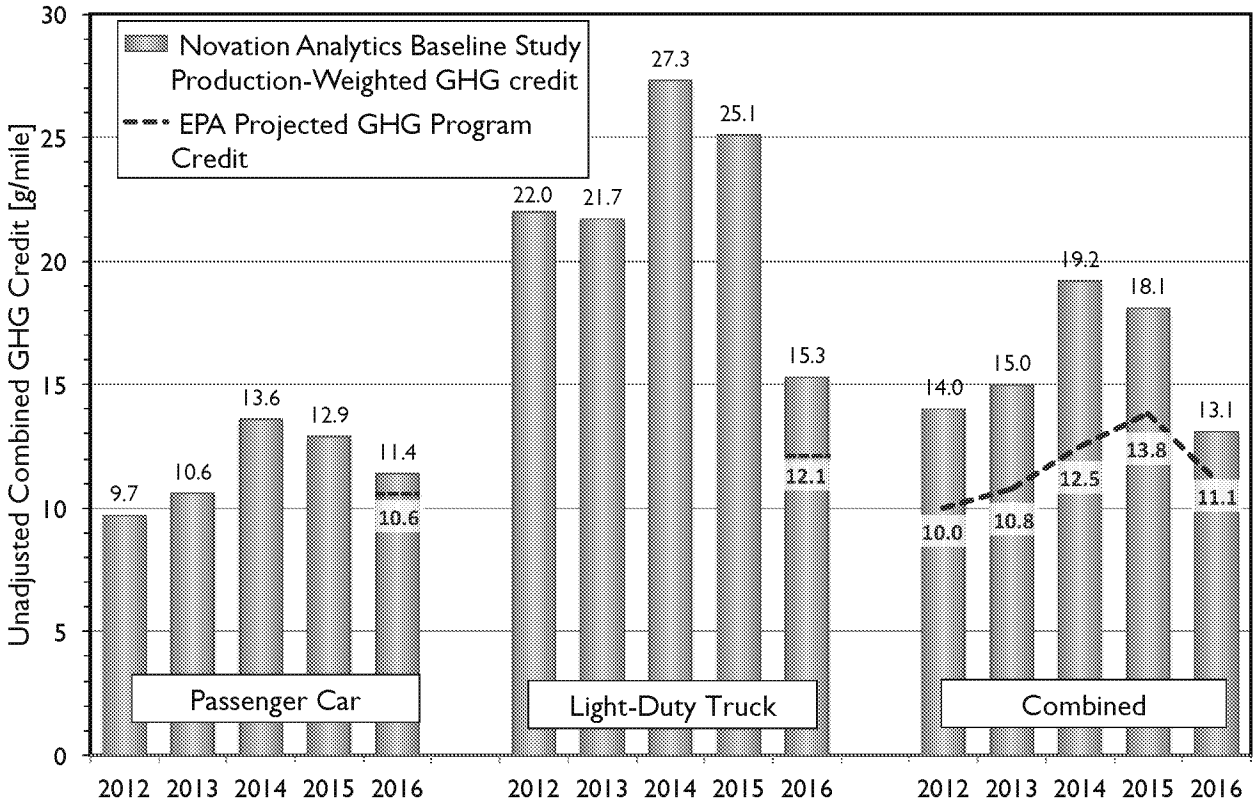
Total credits generated have been shrinking since MY 2014 with the phase-out of FFV Credits. Partially offsetting this, A/C Credit sources each continue to increase year-over-year and combined now provide the largest source of GHG program credits. Off-cycle credits are now in the range of A/C Indirect credits.

Combined Fleet Average CO_2 credits | Projected vs. Actual.



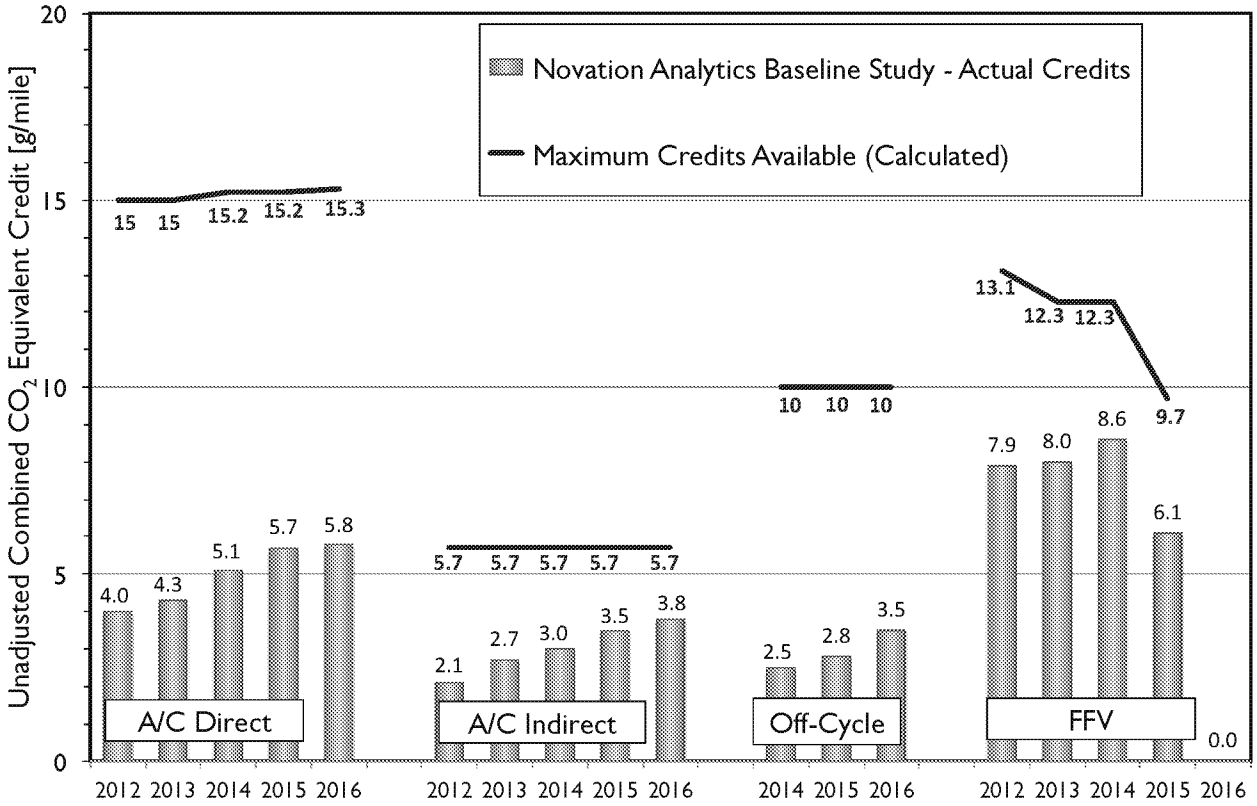
For the first time since MY 2012, A/C Direct credits no longer exceed EPA's projections. Off-cycle credits are growing to be a significant source; however, EPA did not publish projected off-cycle credit values for the MYs 2012-2016 Rulemaking. Consequently, EPA's projection of net credits would have excluded their impact. FFV credits are essentially phased-out for MY 2016; actual FFV credits using EPA's factor approach 0 g/mile.

Total CO_2 credits | Projected vs. Actual.



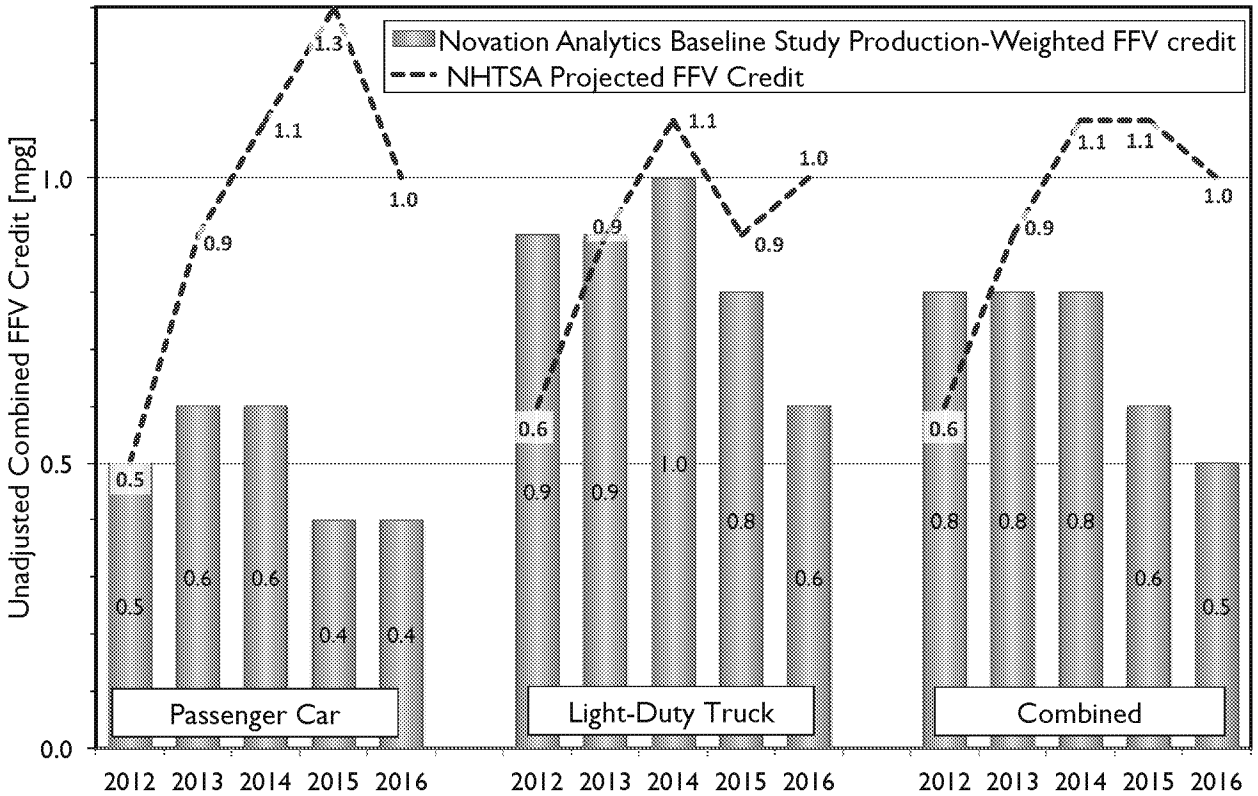
Total GHG program credits generated for the combined fleet have consistently outpaced EPA projections, but the loss of FFV credit in MY 2016 results in a narrower margin of credit over-performance. Whereas EPA only projected A/C and FFV credits in the 2012-2016 Rulemaking, the MY 2016 combined fleet also generated 3.5 g/mile of off-cycle credit. This masks the actual shortfall of A/C credits generated versus EPA projection.

Combined Fleet Average CO_2 credits | Maximum vs. Actual.



Additional potential of up to 18 g/mile versus MY 2016, on the basis of maximum theoretical A/C and off-cycle credits, points to potential sources of credits needed to offset phased-out FFV credits. Growth in A/C Direct credits as alternate refrigerants become widely implemented will be an increasingly important source to offset the loss of FFV credits. Off-cycle credit maximum is the combined maximum via the off-cycle credit menu.

CAFE FFV Credit | Projected vs. Actual.



Actual FFV CAFE credit has decreased since MY 2014 and is running below the maximum cap. NHTSA has over predicted FFV credits, especially passenger car credits. For MY 2016 the combined fleet is achieving half of the credit projected by NHTSA. NHTSA projections for MYs 2015 and 2016 appear odd given the statutory maximum credit of 1.0 and 0.8 mpg, respectively.

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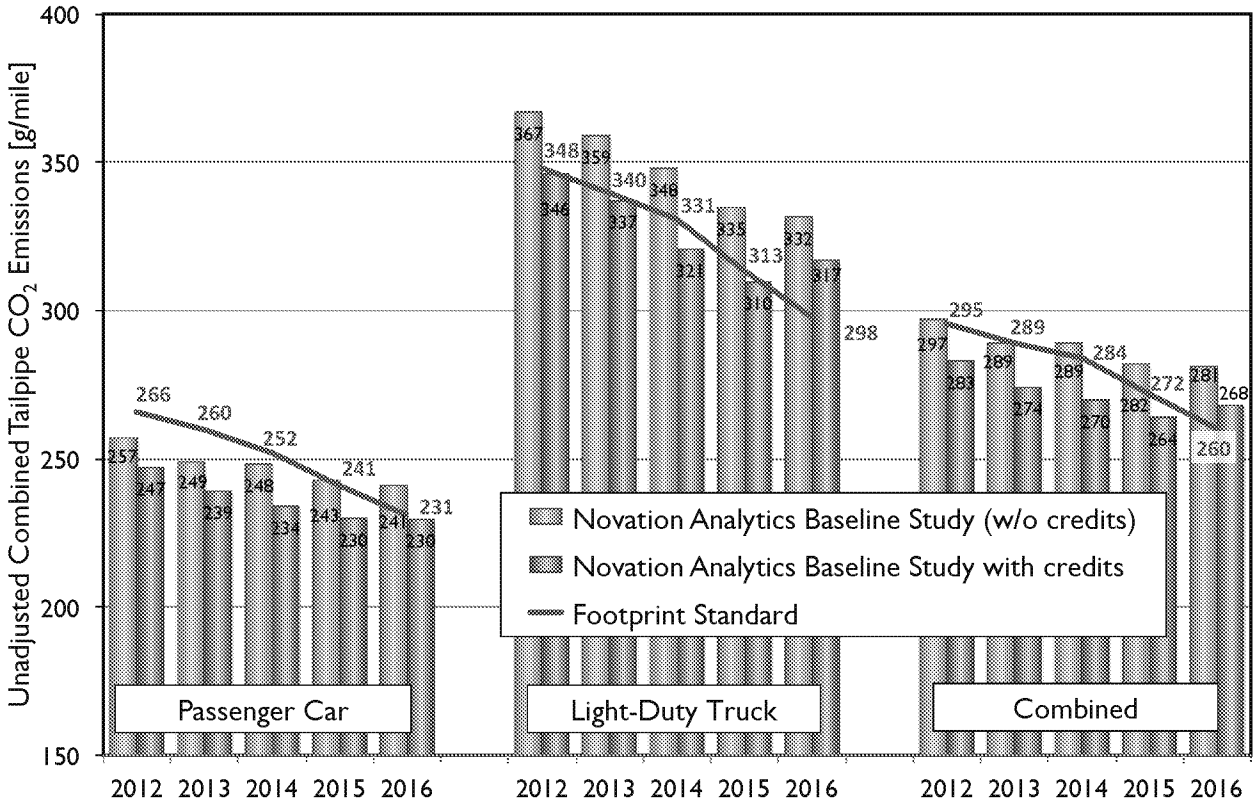
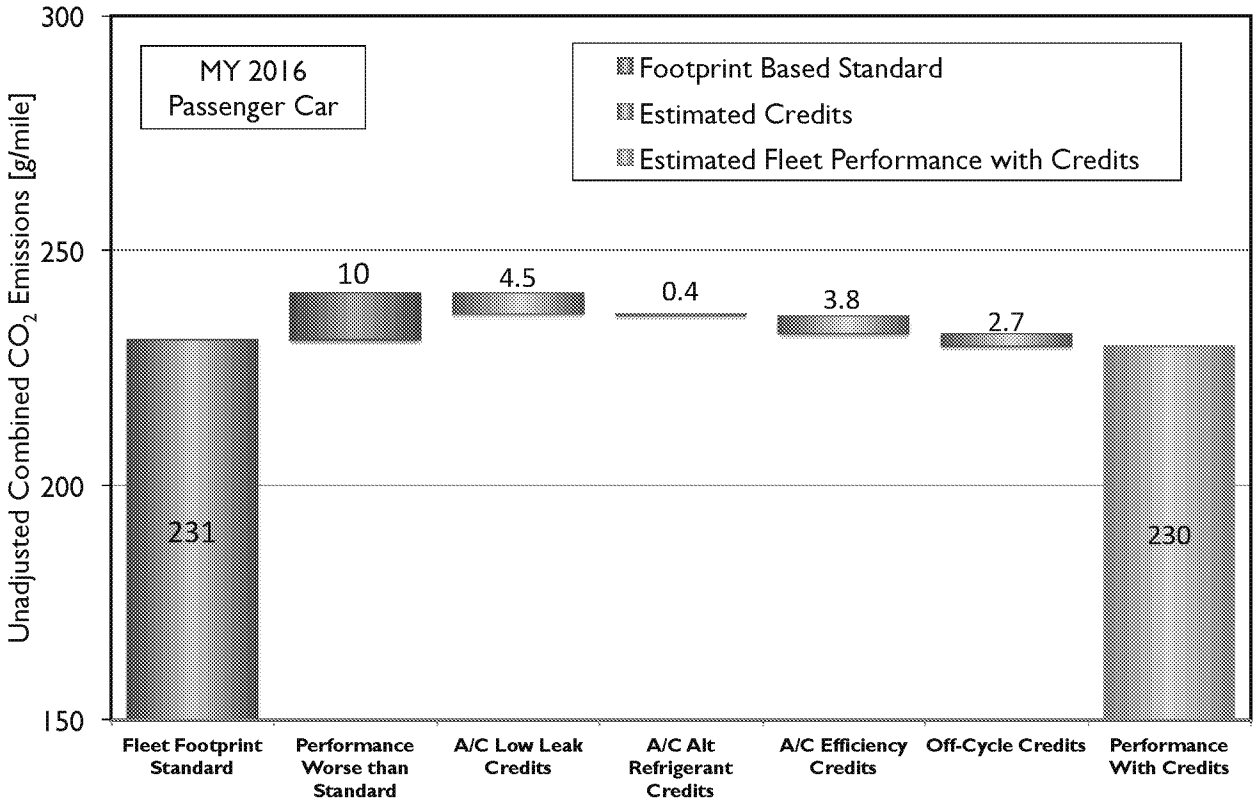
Fleet Compliance

CO_2 Emissions | Performance to Standard



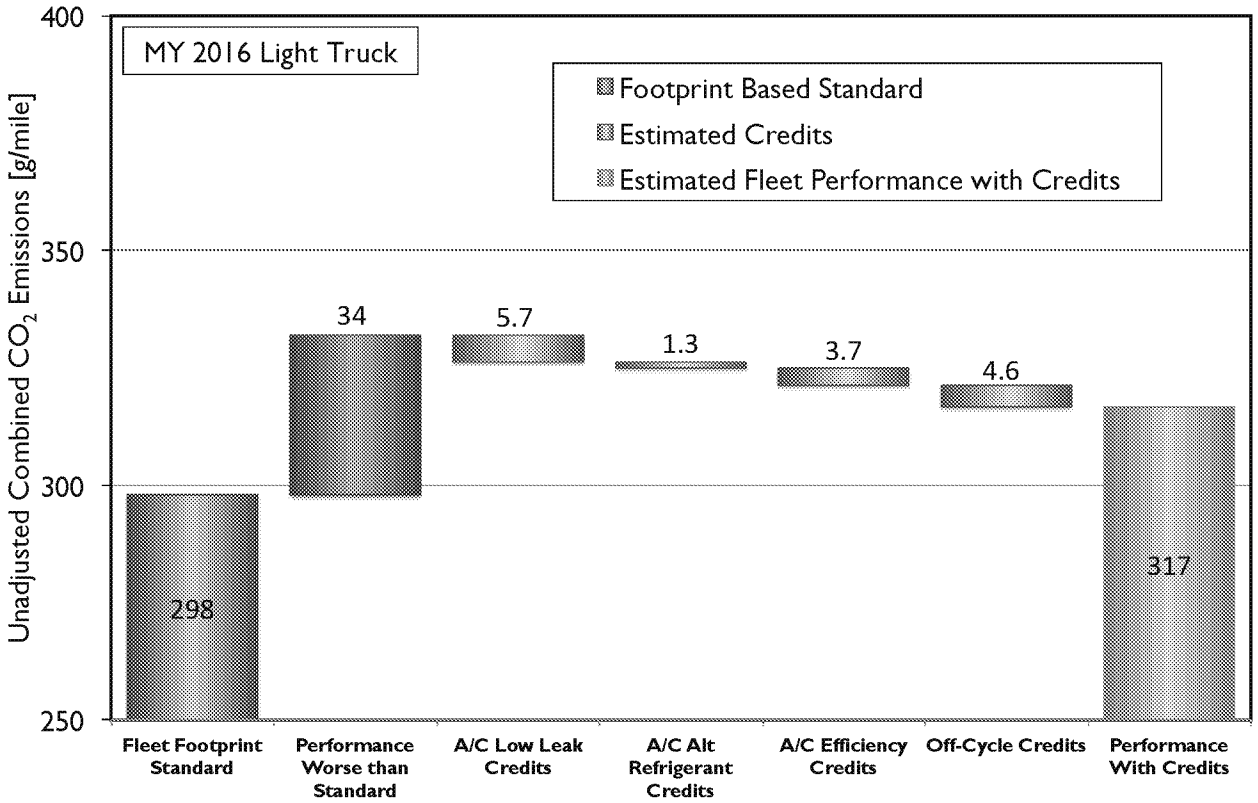
Beginning with MY 2015, credits have been required for the passenger car fleet to achieve the CO_2 footprint standards. The light truck fleet has required credits to achieve the CO_2 standards for all 5 years evaluated. Even with credits, the MY 2016 light truck fleet no longer achieves its respective CO_2 footprint standards and the combined fleet with credit is at an 8 g/mile deficit (3% above) versus the MY 2016 footprint standard.

MY 2016 Projected CO_2 Compliance Detail | Passenger Car



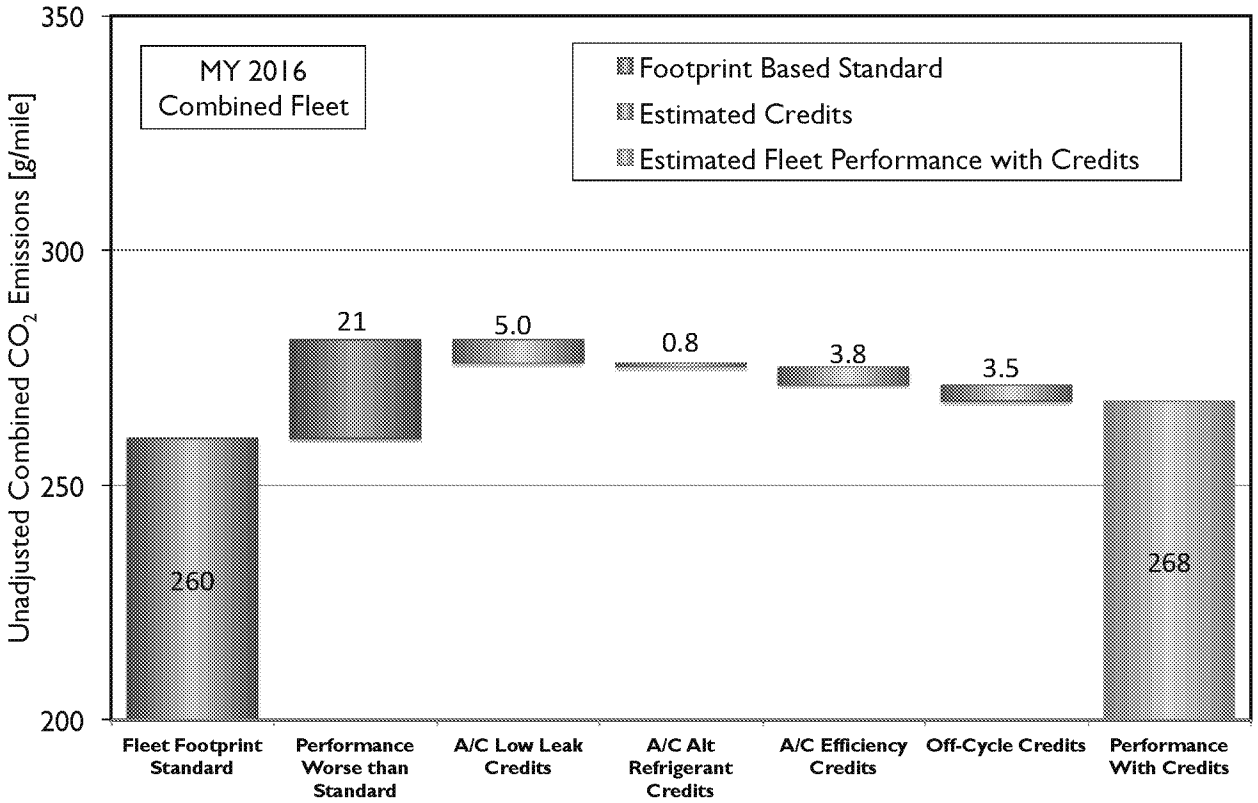
In MY 2016, the passenger car fleet tailpipe CO_2 performance (without credits) was at a 10 g/mile deficit to the CO_2 footprint standard. Net GHG program credits are estimated at 11g/mile, which offset the deficit with 1 g/mile margin of additional credit generated. This margin is much lower than in prior model years.

MY 2016 Projected CO_2 Compliance Detail | Light-Duty Truck



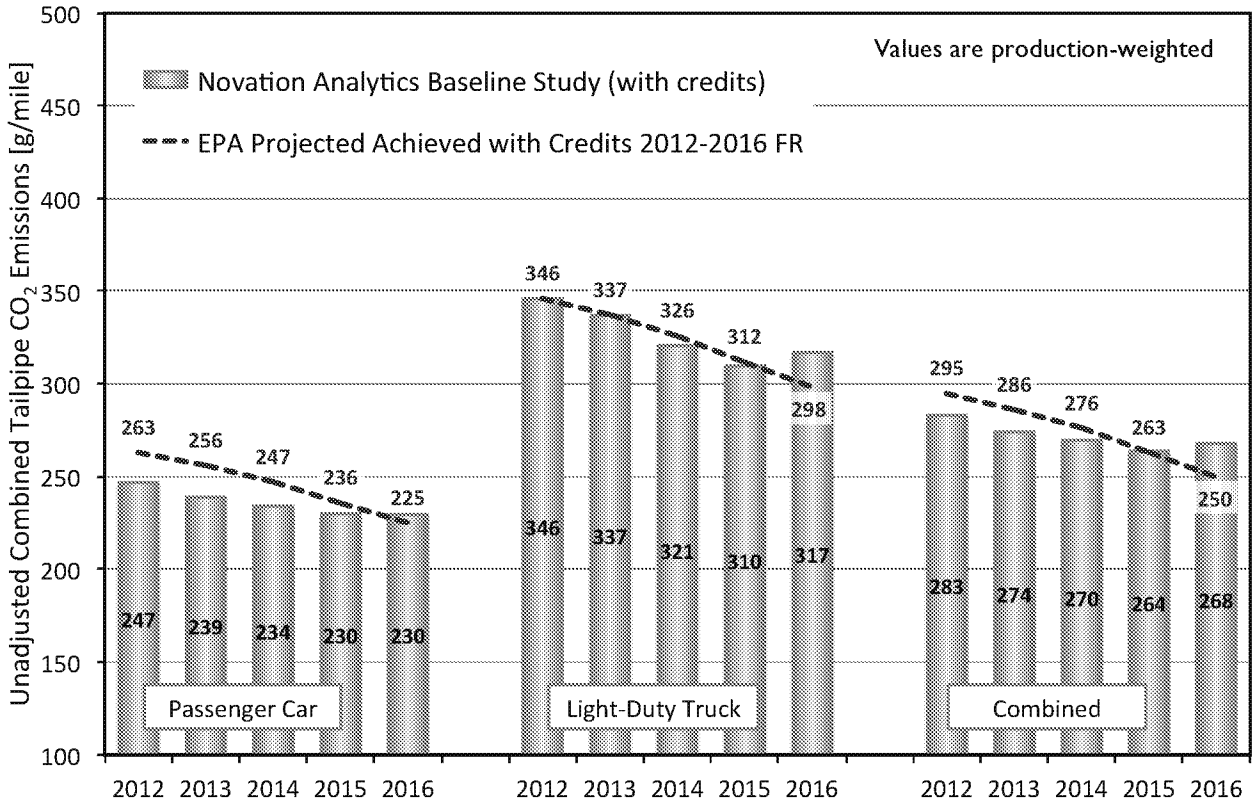
The 2-cycle performance of the MY 2016 light truck fleet was at a 34 g/mile deficit (11% above) the footprint standard. Net credits are estimated to be 15 g/mile, which falls short of offsetting this deficit. Absent the 10-15 g/mile FFV credit available in prior model years, light trucks are now significantly above the standard.

MY 2016 Projected CO_2 Compliance Detail | Combined Fleet



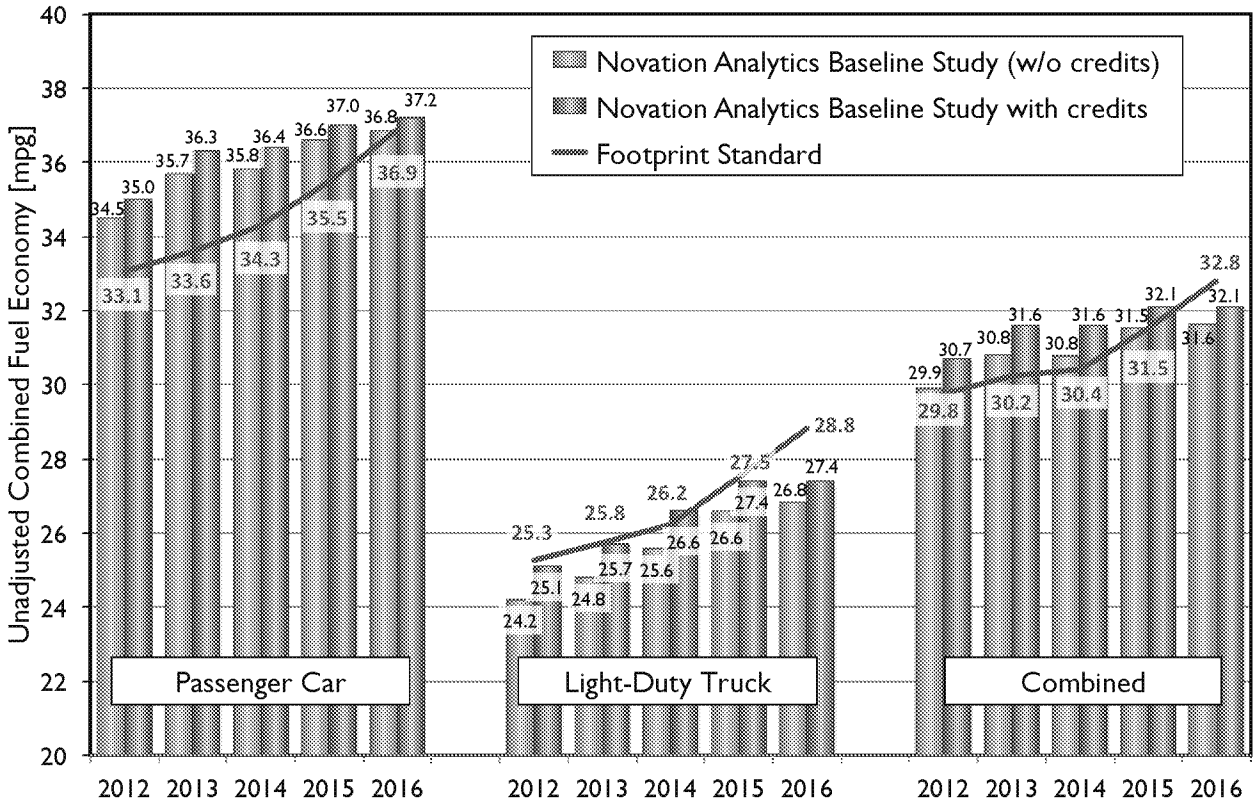
The 2-cycle tailpipe performance of the combined fleet was at a 21 g/mile deficit to the footprint standard (8% above the standard). Estimated net credits of 13 g/mile will fall short of offsetting this deficit on a combined fleet basis. The largest contributor to this is the light truck fleet deficit to its footprint standard.

Fleet CO_2 Emissions | Projected vs. Actual (with credits).



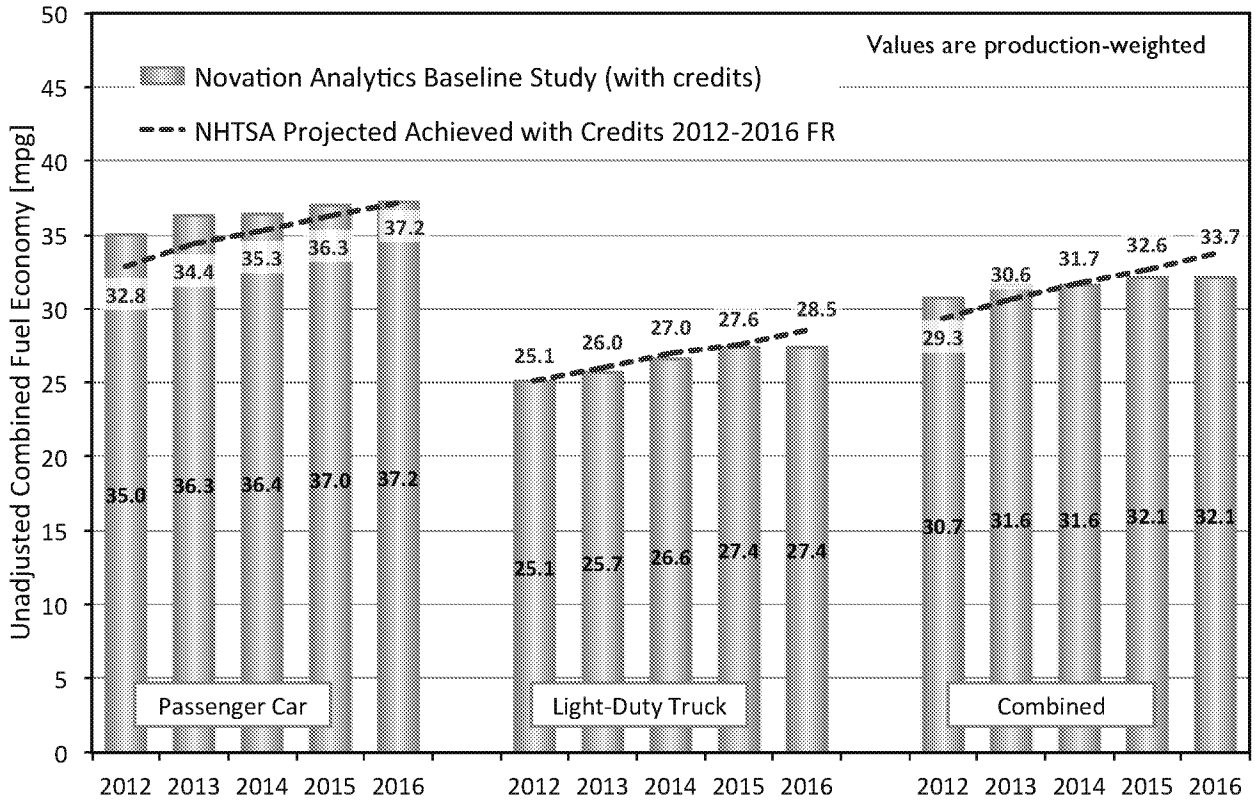
In MY 2016, for the first time the rate of improvement of the passenger car fleet with credit has stalled, and light truck net CO_2 emissions have increased year-over-year. Combined with the car/truck mix shift not anticipated by EPA, the combined fleet with credit is now underperforming EPA projections by more than 7%.

Fuel Economy | Performance to Standard



FFV credits have historically been vital for the light truck fleet to achieve CAFE standards. Beginning with MY 2015, the light-duty truck fleet falls short of the standard even with FFV credits. In MY 2016, the passenger car fleet generates only minimal credit, and the combined fleet does not achieve the footprint standard.

Fleet Fuel Economy | Projected vs. Actual (with credits).



The year-over-year passenger car fleet improvement has slowed and no longer overperforms vs. NHTSA projection with credit. The year-over-year performance of both the light truck fleet and the combined fleet, with credits, has stalled and now falls short of the agency's projected performance in MY 2016.

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Powertrain Technology Deployment

Technology Deployment | Key Parameters vs. EPA Reporting

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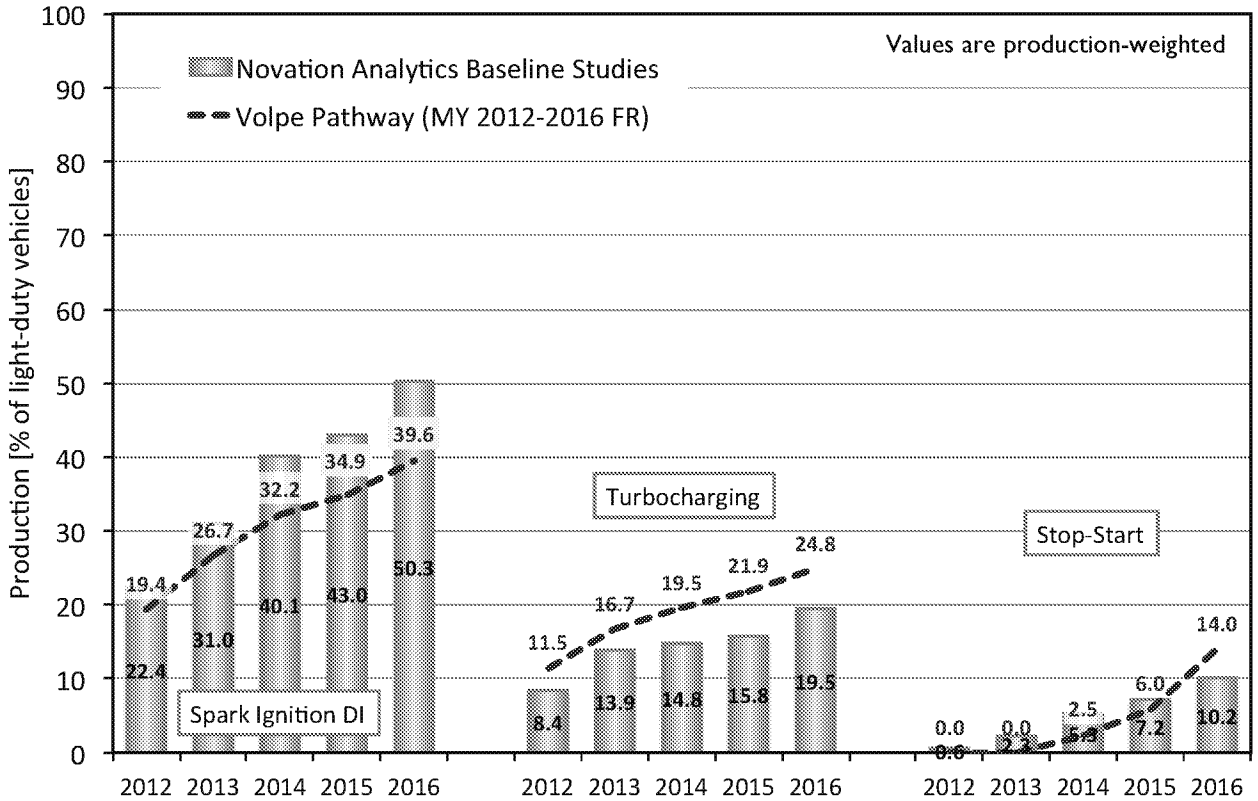
	Novation Analytics Baseline Studies						EPA Trends Report (November 2016)				
	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Production Actual [millions]	13.4	15.0	15.5	16.7	16.1		13.4	15.2	15.5	16.7	
Passenger Car Actual [%]	64.1	63.6	59.1	57.3	55.7		64.4	64.1	59.3	57.4	62.1
Light Truck Actual [%]	35.9	36.4	40.9	42.7	44.3		35.6	35.9	40.7	42.6	37.9
Passenger Car Tailpipe CO2 [g/mile]	257	249	248	243	241		259	250	250	243	238
Passenger Car Fuel Economy [mpg]	34.5	35.7	35.8	36.6	36.8		34.3	35.5	35.6	36.5	37.1
Light Truck Tailpipe CO2 [g/mile]	367	359	348	335	332		369	359	348	335	330
Light Truck Fuel Economy [mpg]	24.2	24.8	25.6	26.6	26.8		24.1	24.8	25.5	26.5	27.0
Combined Tailpipe CO2 [g/mile]	297	289	289	282	281		298	289	290	282	273
Combined Fuel Economy [mpg]	29.9	30.8	30.8	31.5	31.6		29.8	30.7	30.7	31.4	32.5
Spark Ignition [%]	95.8	94.9	95.6	95.9	97.2		95.5	94.8	95.7	95.9	95.1
Compression Ignition [%]	0.9	0.9	1.2	0.9	0.4		0.9	0.9	1.0	0.9	0.7
Spark Ignition-Electric Hybrid [%]	3.1	3.9	2.9	2.7	2.1		3.4	4.0	3.0	2.7	2.9
Electric [%]	0.1	0.3	0.3	0.5	0.4		0.1	0.3	0.3	0.5	1.3
Engine Displacement [L]	3.00	2.89	2.94	2.89	2.82		2.97	2.88	2.95	2.95	2.79
Cylinders	5.12	5.06	5.11	5.03	4.97		5.10	5.1	5.1	4.9	4.9
Turbocharged [%]	8.4	13.9	14.8	15.8	19.5		8.4	14.0	14.9	15.8	22.3
Spark Ignition Direct Injection [%]	22.4	31.0	40.1	43.0	50.3		22.6	30.7	37.7	42.2	48.5
Variable Valve Timing [%]	96.0	97.6	98.2	98.0	99.5		96.7	97.7	97.9	97.7	96.8
Variable Valve Lift [%]	16.3	14.9	15.7	16.4	17.6		-	-	-	-	-
Cylinder Deactivation [%]	8.1	7.8	10.6	10.5	10.4		8.1	7.7	10.7	10.6	3.9
Non-Hybrid Stop-Start [%]	0.6	2.3	5.3	7.2	10.2		0.6	2.3	5.1	7.2	9.2
Traditional Automatic [%]	80.3	77.8	74.2	70.3	71.6		83.4	80.4	76.7	72.3	72
Single & Dual Clutch Automatic [%]	4.2	3.5	3.8	2.9	3.1		1.1	1.4	1.6	1.4	3.5
Continuously Variable [%]	12.7	14.9	18.7	23.6	22.2		11.9	14.7	18.9	23.7	21.3
Single Clutch Manual [%]	3.6	3.4	2.8	2.7	2.5		3.6	3.5	2.8	2.6	3.1
Average Step Ratios			6.2	6.4	6.5		5.7	5.8	6.1	5.9	-
FWD	61.4	59.3	55.3	53.0	52.0		61.4	59.7	55.3	52.9	55.2
RWD	11.0	11.3	12.1	11.0	10.1		10.9	11.1	12.1	10.9	10.8
AWD / 4WD	27.6	29.4	32.6	36.1	37.9		27.7	29.1	32.6	36.1	34

Values greater than 5% between Novation Analytics and EPA Trends Report

Values greater than 3% between Novation Analytics and EPA Trends Report

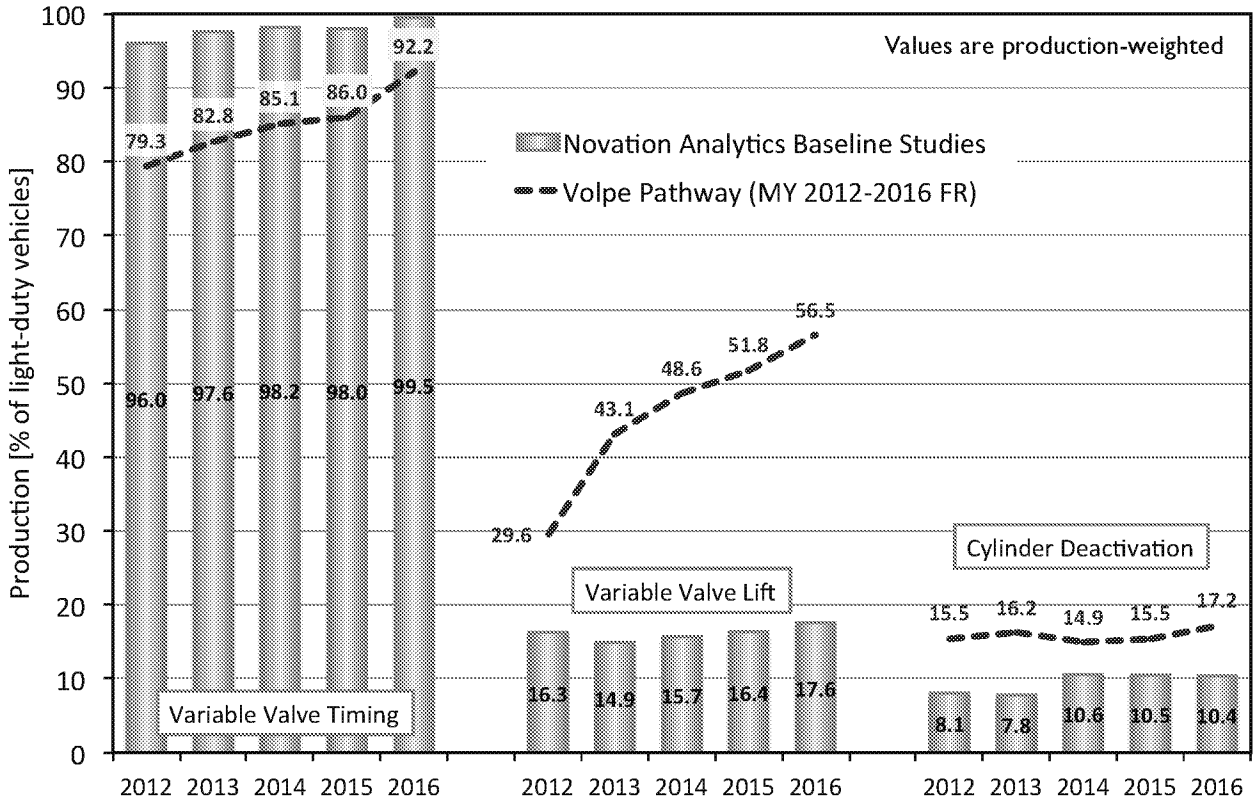
Except for dual clutch transmissions, the Novation Analytics baseline studies have, in the past, aligned well with the EPA Trends report for key technology parameters. For MY 2016, the November 2016 Trends Report used mid-model year data while the Novation Analytics baseline study forecasted MY 2016 final volume data based on IHS-Markit data and 2016 mid-model year data.

Technology Deployment | Actual vs. Volpe Pathway



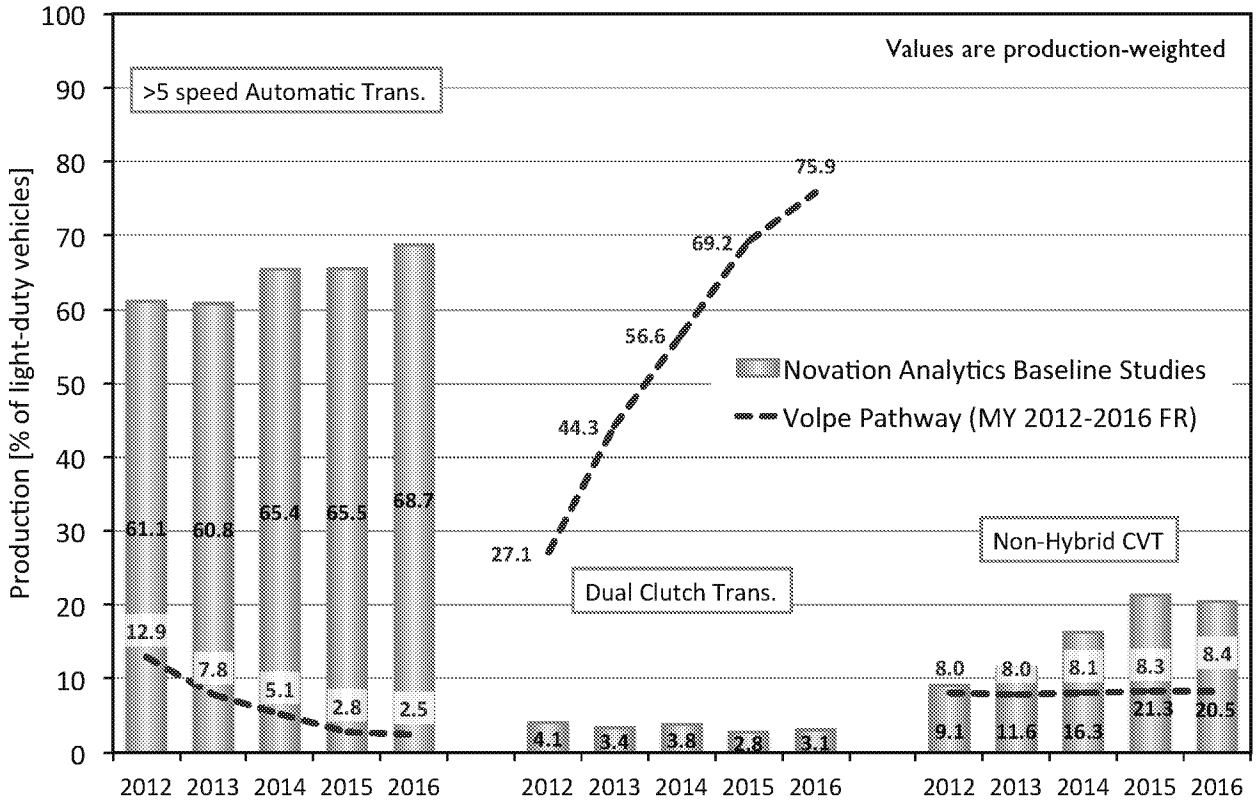
Manufacturers are deploying spark-ignition direct fuel injection at a faster pace when compared to the Volpe technology pathway for the MYs 2012-2016 Final Rule. The rates of deployment for turbocharging and stop-start are not keeping pace with the Volpe technology pathway assumptions.

Technology Deployment | Actual vs. Volpe Pathway



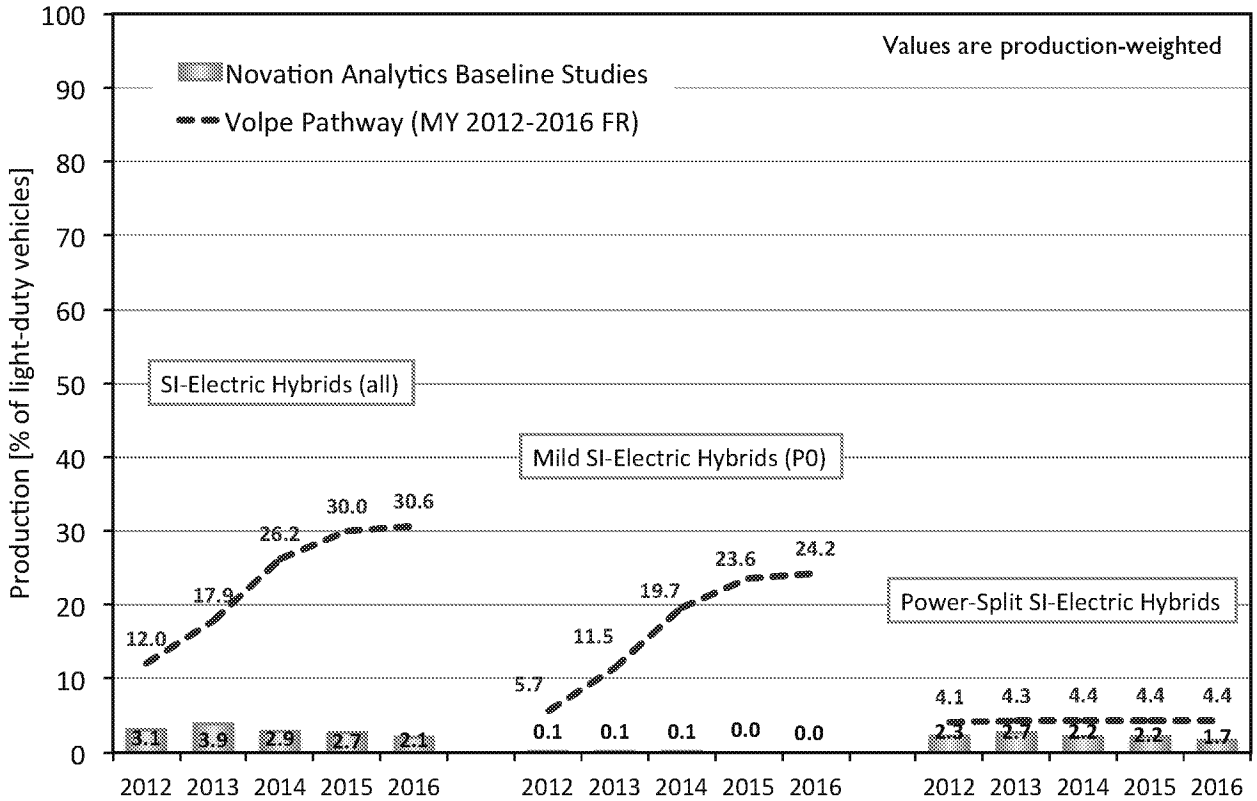
Deployment of variable valve timing continues to outpace the Volpe pathway with implementation occurring more than 5 years earlier than assumed. Actual use of variable valve lift is far lower than assumed by Volpe while cylinder deactivation deployment is ~60% of the assumed level.

Technology Deployment | Actual vs. Volpe Pathway



Transmission technology implementation is quite different than the Volpe pathway projected. High ratio spread automatic transmissions continue to be >65% of the market while the use of dual clutch transmissions remains around 3%, versus the pathway deployment value of 76% for MY 2016. CVTs have plateaued around 20% but are still higher than the Volpe projection of 8.4%.

Technology Deployment | Actual vs. Volpe Pathway



Spark ignition-electric hybridization is less than one-tenth of the Volpe deployment pathway. The majority of the Volpe pathway was mild hybrids in the form of belt-alternator-starter systems which continue to have very little market exposure. Power-split hybrids continue to be deployed at a rate that is approximately half of the Volpe pathway.

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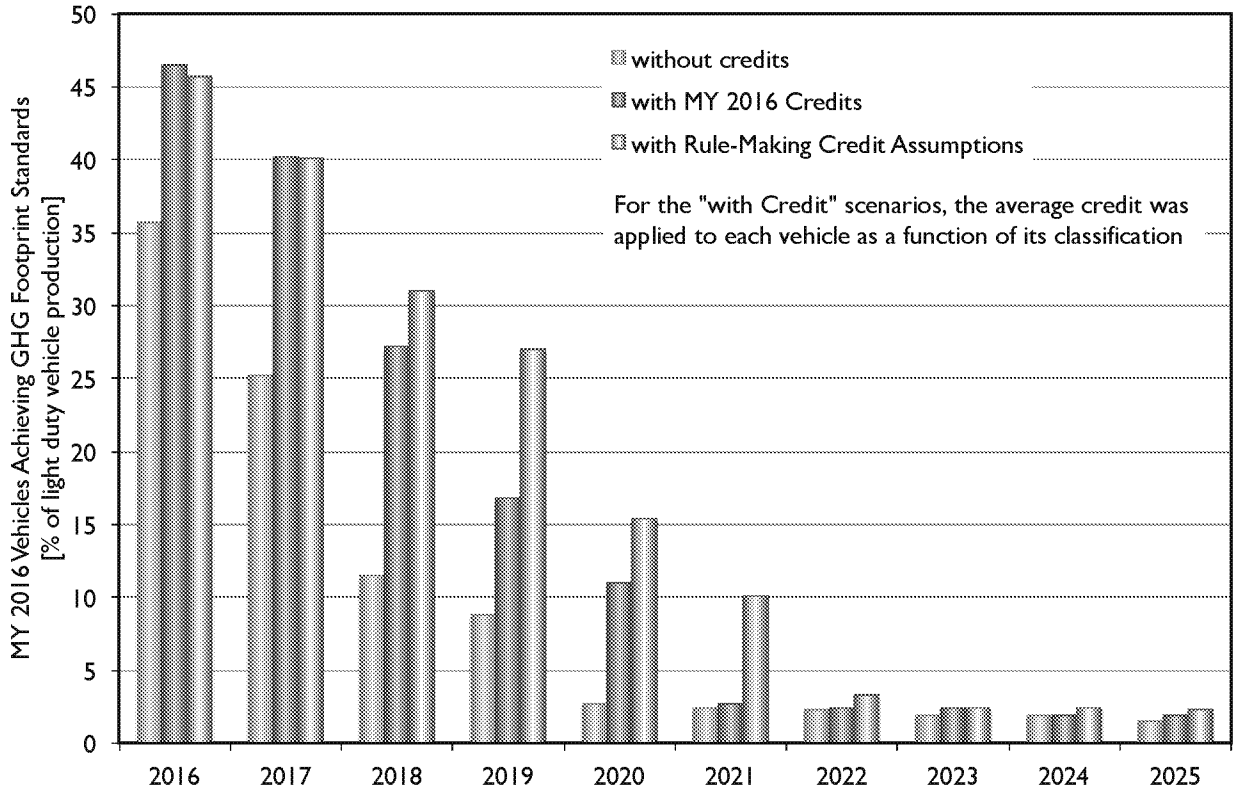
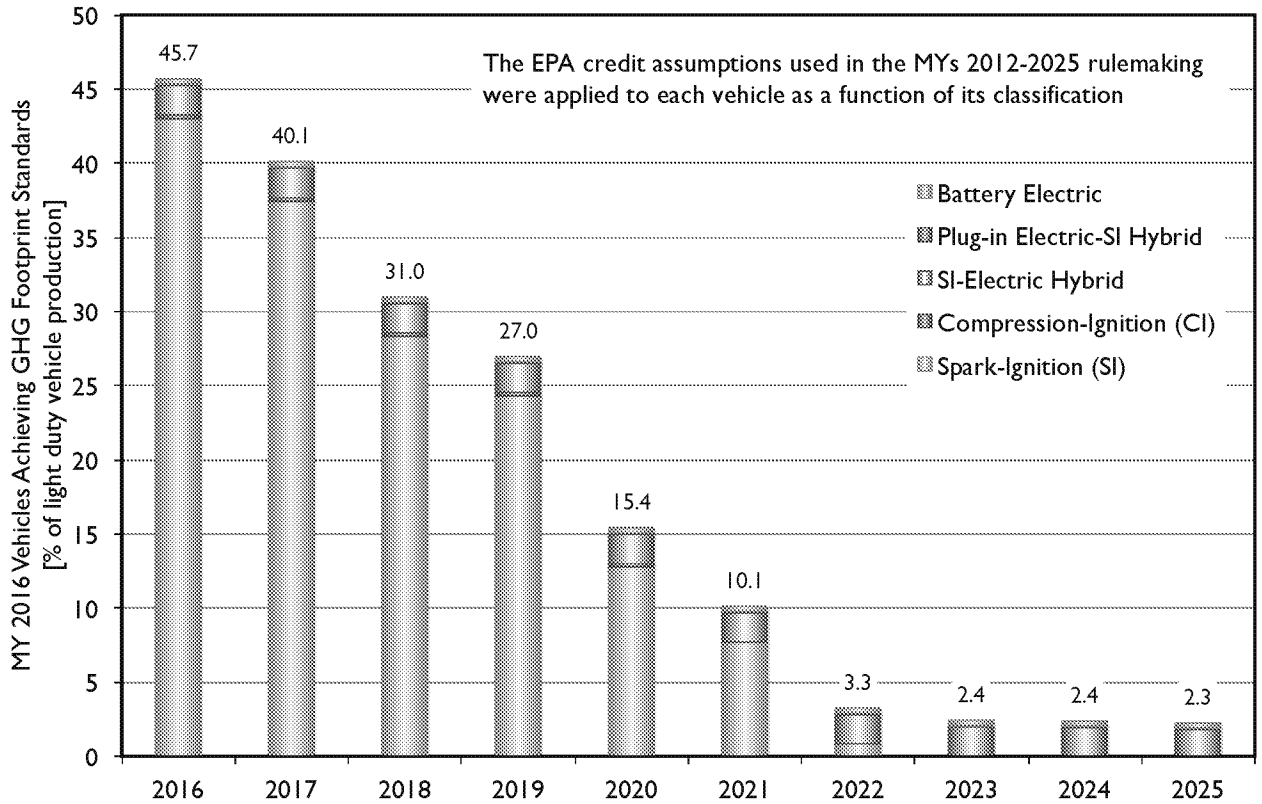
Performance to Future Model Years

MY 2016 Vehicles Achieving Future CO_2 Standards



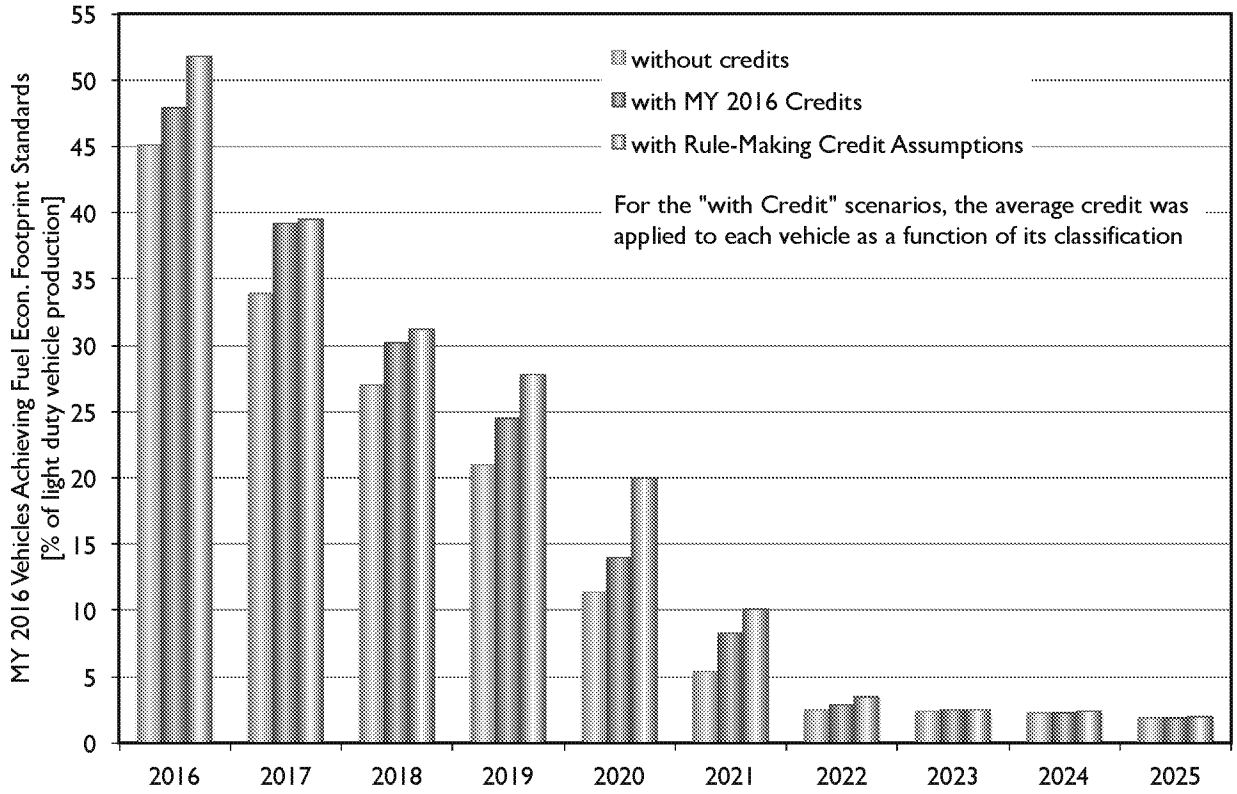
Assuming the application of credits, we estimate that less than 5% of the MY 2016 vehicles can achieve the MYs 2022 through 2025 GHG footprint standards without modification.

MY 2016 Vehicles Achieving Future CO_2 Standards



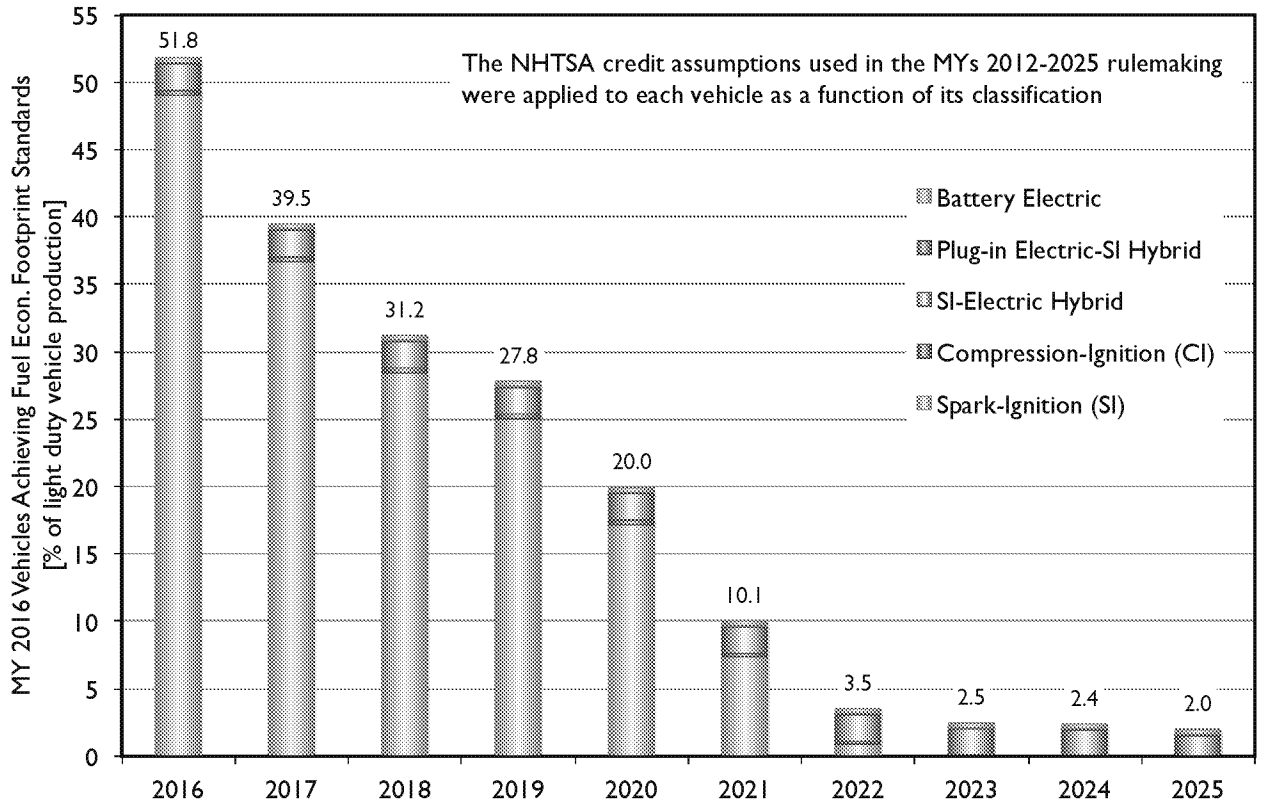
Assuming the application of credits, the only MY 2016 vehicles that can achieve the MY 2025 GHG footprint standards are SI-electric hybrids, plug-in hybrids, and battery electric vehicles.

MY 2016 Vehicles Achieving Future Fuel Economy Standards



Assuming the application of credits, we estimate that less than 5% of the MY 2016 vehicles can achieve the MYs 2022 through 2025 CAFE footprint standards without modification.

MY 2016 Vehicles Achieving Future Fuel Economy Standards



Assuming the application of credits, the only MY 2016 vehicles that can achieve the MY 2025 CAFE footprint standards are SI-electric hybrids, plug-in hybrids, and battery electric vehicles.

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Conclusions & Recommendations

Conclusions

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- Compared to the agency projections for the MYs 2012-2016 timeframe, the improvements in the passenger car and light-duty truck fleet 2-cycle tailpipe CO_2 performance have been at a rate that is lower than the agencies anticipated. This has increased manufacturers' reliance on credits for compliance with the footprint standards.
- The phase-out of FFV credits since MY 2015, particularly under the GHG program, has put pressure on fleet compliance with the standards. Additional A/C and Off-cycle credits and/or vehicle 2-cycle performance improvements must compensate for phased-out FFV credits.
- Even with the availability of credits, the light-duty truck fleet is projected to be at a deficit to the MY 2016 GHG footprint standards. With the loss of FFV CO_2 credit after MY 2015, net A/C and Off-Cycle credits generated by manufacturers in MY 2016 has not made up that deficit.
- The light-duty truck market share continues to increase at the expense of passenger cars, exposing more of its gap between actual performance versus agency projection. The resulting combined fleet performance has moved from compliance with the standards without credits, to requiring credits to comply, to underperforming relative to the standards even with current year credits generated.

Conclusions (continued)

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- The gap between agency projections and actual performance is likely the result of over optimistic technology deployment assumptions on the part of the agencies. While manufacturers have exceeded agency expectations for certain technologies, such as spark ignition direct injection and high ratio-spread transmissions, other technologies have significantly lagged agency projections. Actual deployment of hybrids, for example, is much lower than projected.
- The over optimistic agency projected technology deployment rates can combine with agency assumptions on the technology's effectiveness as a key source of the agencies' over optimistic projected rate of 2-cycle tailpipe performance improvement. This is likely the case with agency's assumptions on hybrid technology.

Next Steps & Recommendations

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- The Model Year 2016 CO_2 and CAFE performance projections in this Baseline Study update are based on the currently best available data obtained through manufacturer's mid-model year estimates and IHS-Markit registration data.
- Once final model year data is available for 2016, the results can be updated to provide a final set of results for MYs 2012-2016.
- Final MY 2016 data will be valuable in supporting comments on NHTSA's upcoming MYs 2022-2025 CAFE standards rulemaking.

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Questions?

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Michael Reale
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Message

From: Giedrius Ambrozaitis [gambrozaitis@autoalliance.org]
Sent: 7/19/2017 8:55:21 PM
To: Charmley, William [charmley.william@epa.gov]; Bunker, Byron [bunker.byron@epa.gov]; James.tamm@dot.gov; Wehrly, Linc [wehrly.linc@epa.gov]; French, Roberts [french.roberts@epa.gov]
CC: Michael Hartrick [MHartrick@autoalliance.org]
Subject: Alliance comments on EPA offcycle petition notice
Attachments: Alliance Comments to Alternative Method for Calculating Off-Cycle Credits Under the LD GHG Program.pdf

Hi Bill, Byron, Jim, Linc, and Rob,
Attached are our comments on the notice regarding offcycle credit petitions, as they were just submitted to regulations.gov. If you should have any questions, please contact Mike Hartrick.
Regards,
Giedrius

Giedrius Ambrozaitis
Alliance of Automobile Manufacturers
(248) 915-8836

AUTO ALLIANCE
DRIVING INNOVATION®

July 19, 2017

Office of Transportation and Air Quality
Office of Air and Radiation
U.S. Environmental Protection Agency

Submitted electronically to www.regulations.gov

Docket ID EPA-HQ-OAR-2017-0189

Comments on "Alternative Method for Calculating Off-Cycle Credits Under the Light-Duty Vehicle Greenhouse Gas Emissions Program: Applications From BMW Group, Ford Motor Company, and Hyundai Motor Group"[1]

Dear Sir or Madam:

The Alliance of Automobile Manufacturers[2] ("Alliance") herein submits comments on the subject Federal Register Notice ("FRN") regarding applications for alternative methods for calculating off-cycle credits.

The off-cycle credit program is an important part of the greenhouse gas ("GHG") and Corporate Average Fuel Economy ("CAFE") regulations. It recognizes the benefits of real and proven GHG and fuel consumption reductions beyond those measured with standard test procedures. Thus, it helps support flexible and cost-effective strategies, and also encourages investment in innovative and forward-looking technologies.

The Alliance recommends approval of the subject applications. However, we are concerned with the additional limits placed on the amount of credit which can be earned by the technologies, particularly in cases where the supporting data justifies additional credits. These caveats materially alter the written final regulations and therefore should be subject to full rulemaking procedures before adoption.

The Alliance Recommends Approval of the Applications

The Alliance recommends approval of the off-cycle credit applications by BMW Group[3], Ford Motor Company, and Hyundai Motor Group ("Applications") described in the subject FRN. For the reasons provided above, granting these requests is consistent with both the applicable regulations and the intent of the GHG program.

[1] 82 Fed. Reg. 27,819 (June 19, 2017)
[2] The Alliance of Automobile Manufacturers is an association representing 12 manufacturers of cars and light trucks. Alliance members are BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, and Volvo Car USA. For more information, please visit: www.autoalliance.org.
[3] Dr. Christian Cozzarin (BMW Group) to Linc Wehrly, U.S. Environmental Protection Agency. BMW Request for MY 2009-2013 Greenhouse Gas (GHG) Off-Cycle Credits. June 2, 2016. Retrieved from https://www3.epa.gov/otaq/regs/ld-hwy/greenhouse/documents/bmw-2009-2013-ghg-credits-2016-06-02.pdf. (Accessed September 28, 2016)

Alliance of Automobile Manufacturers
BMW Group • Fiat Chrysler Automobiles • Ford Motor Company • General Motors Company • Jaguar Land Rover • Mazda • Mercedes-Benz USA • Mitsubishi Motors • Porsche • Toyota • Volkswagen • Volvo
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Off-Cycle Credit Caps for Air Conditioner Efficiency Technologies and Thermal Control Technologies

The Alliance also requests that EPA re-examine and revise the positions it states on caps for off-cycle air conditioner efficiency credits and thermal control technology credits in the FRN. The statements in that Notice regarding the credit caps are inconsistent with the rulemaking record related to these caps, and would be counterproductive to the goal of reducing real world emissions through the use of these technologies. Re-examination of these caps is an important topic to include in any potential agency review of the GHG program, since strict imposition of the caps at the current levels will immediately inhibit further implementation of air conditioner efficiency and thermal control technologies, thereby disrupting product plans, delaying emission reductions, and raising the overall costs of the regulation.

Specifically, the following strict interpretation of these caps is stated in the FRN:

> "However, it is important to note that EPA regulations place a limit on the cumulative credits that can be claimed for improving the efficiency of A/C systems. The rationale for this limit is that the additional fuel consumption of A/C systems can never be reduced to zero, and the limits established by regulation reflect the maximum possible reduction in fuel consumption projected by EPA. These limits, or caps, on credits for A/C efficiency, must also be applied to A/C efficiency credits granted under the off-cycle credit approval process. In other words, cumulative A/C efficiency credits for an A/C system – from the A/C efficiency regulations and those granted via the off-cycle regulations – must comply with the stated limits." (p. 7)
>
> "Note that the regulations limit glass/glazing credits to 2.9 grams/mile for cars and 3.9 grams/mile for trucks, and that EPA will require that these caps be observed for all glass/glazing credits, regardless of the regulatory pathway by which those credits are claimed or granted. This is also true for the caps specified for the total credits from thermal control technologies (3.0 grams/mile for cars and 4.3 grams/mile for trucks). The technical and engineering reasons for these limits remain applicable and are not rendered moot because credits are granted through this public process." (p. 10)

In July 2016, the draft Technical Assessment Report for the midterm review first specifically raised the issue of applying the air conditioner efficiency credit caps to new air conditioner efficiency technologies granted credit though the off-cycle credit approval provisions. In its comments on the draft TAR, the Alliance responded at length in objection to strictly applying the cap to all new air conditioner efficiency technologies. These Alliance comments reviewed the 2009-2010 rulemaking history, whereby the air conditioner efficiency credits were created, noting that the credits were created for a defined list of technologies, and that the cap was created based on that same defined list of known technologies. These technologies, in combination, had been demonstrated on a test vehicle during the IMAC Cooperative Research program to deliver a 36.4% air conditioner CO_2 reduction. The cap was established (using a 40% reduction, or 5.7 grams CO_2 per mile) to correspond to this level of demonstrated performance of those specific technologies (with a small boost to account for optimized controls), accounting for the interactions of these technologies when used in combination. If not capped in this way, that specific list of credits for pre-2010 air conditioner technologies would have summed to a total of over a 50% reduction of the baseline air conditioner CO_2 emissions. The EPA analysis of the credits and the associated cap therefore concluded that: "These technologies, which, when

combined, can allow manufacturers to achieve the 40% reduction in CO_2 emissions." (Regulatory Impact Analysis, p. 2-43, EPA-420-R-10-009, April 2010).

At that time, within the analysis of air conditioner efficiency technologies in the Regulatory Impact Analysis, there was no discussion of additional air conditioner efficiency technologies beyond those being put onto the pre-approved credit list for the 2012-2016 rulemaking. The 5.7 grams CO_2 per mile cap created in 2010 was never considered to be the "maximum possible reduction in fuel consumption projected by EPA" for air conditioner efficiency technologies, and it was never referred to as the maximum feasible reduction. (In 2017, the cap was revised to 5.0 grams CO_2 per mile for cars and 7.2 grams CO_2 per mile for trucks, based on a new analysis using a new MATLAB/Simulink tool similar to EPA's GEM.) Indeed, when the off-cycle credit program was later established, additional new air conditioner efficiency technologies were specifically mentioned as eligible for off-cycle credits, based on a demonstration of their benefits. There was never an analysis by EPA or others, in 2010 or subsequently, which concluded that CO_2 reductions from vehicle air conditioner efficiency technologies greater than 5.7 grams per mile were not possible (nor the revised caps of 5.0 grams for cars and 7.2 grams for trucks).

We believed this issue had been resolved in the November 2016 Technical Support Document (TSD) for the Proposed Determination for the midterm review, but the statements in the FRN seem to represent a step backwards from the TSD. In the TSD (p. 2-190), EPA noted that off-cycle credit applications are decided individually on their merits based on factors that could include the consideration of synergies or interactions among applied technologies. EPA concluded that the caps are appropriate, unless information pertinent to a specific application causes a different conclusion, but that applicants can present, as part of the analysis supporting their application, evidence supporting the case that a different conclusion should apply to the application in question. The Alliance agrees it is reasonable to assess synergies and interactions between the new technologies and those already evaluated in establishing the pre-approved credit list, and that off-cycle credits for new technologies should only be granted for incremental real-world improvements. However, EPA should remain open to approving credits above the caps for additional air conditioner technologies if they receive reasonable justification, based on incremental real world fuel savings and emission reductions. This evaluation could also include reference to any thermal control technologies on the relevant vehicles, thereby avoiding EPA concerns that additional credits could seemingly take air conditioner emissions near zero. However, it should be noted that the current credit levels are not yet actually taking apparent air conditioner emissions to near zero. Starting with EPA baseline emissions of approximately 11.9 grams CO_2 per mile for cars and 17.1 for trucks, the current caps on indirect emission credits (5.0 and 7.2 grams, respectively) still leave up to 10.0 grams of CO_2 per mile of emissions to be reduced.

The evaluations in the current requests for off-cycle credits for the Denso air conditioning compressors with variable crankcase suction valve technology show that this technology gives incremental emission reductions beyond those from maximum use of technologies from the pre-approved credit list. Accordingly, off-cycle credits should be granted in this case above the caps.

In general, credit caps are counterproductive since they impede greater technology implementation. In the seven years since the mobile air conditioner indirect credit list was created, and over the five years since the thermal control credit list was created, there have been many new air conditioner efficiency and thermal control technologies presented in various technical forums and marketed by component suppliers, which

would reduce emissions significantly beyond the credit caps. Agency policies should try to encourage and incentivize rapid implementation of these improvements.

The caps on thermal management technology off-cycle credits are also becoming counterproductive as they start to limit the implementation of beneficial emission reduction technologies. They could be made less constraining if they were administered as fleet average credit caps, rather than per-vehicle caps. The detail of whether these should be fleet average or per vehicle caps was not specified in the regulation, and EPA has chosen to adopt the more restrictive interpretation that these thermal management credit caps should apply to each individual vehicle. This interpretation has proven to be particularly troublesome to implement since the database and accounting systems for compliance reporting have not typically been constructed to check whether credit caps have been reached on each individual vehicle. Checking the cap on each vehicle requires going back to each vehicle VIN to check the individual equipment level for each vehicle, which is a laborious task that can be expected to become increasingly difficult as rising technology implementation brings more vehicles to the cap. The EPA interpretation of how to implement thermal management credit caps should be revised to partially alleviate the counterproductive constraints from the caps by implementing the cap on a manufacturer fleet or model level average basis, instead of implementing the cap on each vehicle.

As a final note on this topic, we reiterate our view that EPA's estimate of baseline air conditioner energy usage was well below the estimates of others, such as researchers from the National Renewable Energy Laboratory. The Alliance continues to believe that this low baseline used by EPA, which was approximately half the baseline energy usage estimated by the other major sources, resulted in air conditioner efficiency and thermal control credits and credit caps that are far below the actual real-world fuel savings and CO_2 reductions resulting from these technologies. In a recent field test spanning two years, Ford compiled real-world data on vehicle air conditioner usage which shows substantially higher usage than assumed by EPA in creating its baseline. This study measured 45,300 passenger car trips spanning 467,100 miles and 14,000 hours, combined with 16,000 truck trips spanning 184,000 miles and 5,100 hours of operation. The results showed vehicle air conditioner usage during approximately 66% of operation when matched to EPA's profile of national temperature-weighted VMT. This is substantially more than EPA's baseline, which assumed operation closer to 40%. This is one additional body of data which supports increasing the baseline, caps and credit amounts in these provisions of the GHG program. Re-examination of these baseline emissions levels could be an important part of the midterm review since it could reset the caps and provide room for additional implementation of new technologies.

<u>High Efficiency Alternator Off-Cycle Credit</u>

The Alliance proposed that high efficiency alternators be put on the original list of pre-defined and pre-approved off-cycle credits during the rulemaking process in 2011 and 2012 that led to the 2014 off-cycle pre-approved credit list. In response, EPA/NHTSA agreed that off-cycle credits for high efficiency alternators were attractive, but asked for case-by-case applications for credits in view of the difficulty of assigning a default credit value at that time, especially given the lack of data for midsize cars, large cars and trucks. Since then, the issue has been analyzed extensively. Eco-innovation and off-cycle credit templates have been created in Europe and South Korea for high efficiency alternators. In the U.S., several applications for off-cycle credits for high efficiency alternators have been submitted to EPA, but the current request from Ford is the first to be moved to the public comment stage.

In order to accelerate progress in implementing this beneficial technology, we propose that EPA approve the current Ford credit request as the basis for an industry-wide template for credit for high-efficiency alternators. This would be similar to the Decision Document related to the Mercedes request for enhanced stop-start off-cycle credits. In that Decision Document, EPA laid out a formula and endorsed certain key variables to use in that formula (such as idle time) for any automobile manufacturer seeking a stop-start credit greater than the default amount on the pre-approved credit list. Establishing an industry-wide template for high-efficiency alternator credits would be a valuable step toward simplifying work in this area and improving the functioning of the off-cycle provisions of the regulation.

The subject applications also reveal opportunities for EPA to streamline the off-cycle credit application process and to provide greater certainty to manufacturers in applying technology and to its own staff in assessing applications. The current alternative method process is far too time and resource intensive, costly, and at risk for generating fewer credits than expected. The Alliance would like to provide some suggestions that would reduce both the Agency's and the manufacturer's administrative burden in completing the demonstration process. For example:

- For technologies already approved for use by other manufacturers, these technologies could be added to the menu list, thus shortening the application preparation time and minimizing EPA's review and approval timing. However, these technologies should not be subject to the fleet level 10 g/mi cap.

- For technologies of common interest among manufacturers, EPA could enable a 3rd party to conduct the review and approval process.

- Further efforts to simplify the process could consider expanding the list items, creating some special equation, and/or establishing some fundamental credits applicable to a manufacturer's application.

Thank you for your consideration of our comments. If you have any questions, please feel free to contact Michael Hartrick of my staff; Michael can be reached at (248) 357-4717 or at mhartrick@autoalliance.org.

Sincerely,

Chris Nevers
Vice President, Energy and Environment
Alliance of Automobile Manufacturers

cc: W. Charmley, U.S. Environmental Protection Agency
B. Bunker, U.S. Environmental Protection Agency
J. Tamm, National Highway Traffic Safety Administration
L. Wehrly, U.S. Environmental Protection Agency
R. French, U.S. Environmental Protection Agency

Message

From: Julia Rege [JRege@globalautomakers.org]
Sent: 7/19/2017 5:30:42 PM
To: Wehrly, Linc [wehrly.linc@epa.gov]
CC: Bunker, Byron [bunker.byron@epa.gov]; French, Roberts [french.roberts@epa.gov]; Charmley, William [charmley.william@epa.gov]; james.tamm@dot.gov; gregory.powell@dot.gov; michael.mccarthy@arb.ca.gov; annette.hebert@arb.ca.gov; Amandine Muskus [amuskus@globalautomakers.org]
Subject: Off-Cycle Comments - Global Automakers
Attachments: 2017-07-19 Off-Cycle Credit Comments FINAL.pdf

Linc,

Please find attached a copy of the comments submitted to docket EPA-HQ-OAR-2017-0189 today by Global Automakers on EPA's request for comments on the off-cycle credit applications.

Please let Amandine or I know if you have any questions.

Best, Julia

Julia Rege
Director, Environment & Energy
Association of Global Automakers, Inc. (Global Automakers)
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GlobalAutomakers

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GlobalAutomakers

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July 19, 2017

Submitted electronically to www.regulations.gov

Linc Wehrly
Director, Light-Duty Vehicle Compliance
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
2565 Plymouth Road
Ann Arbor, MI 48105
ATTN: Docket ID EPA-HQ-OAR-2017-0189

RE: Comments on "Alternative Method for Calculating Off-cycle Credits Under the Light-Duty Vehicle Greenhouse Gas Program: Applications from BMW Group, Ford Motor Company, and Hyundai Motor Group"

Dear Mr. Wehrly:

The Association of Global Automakers, Inc.[1] (Global Automakers) herein submits comments on the Environmental Protection Agency's (EPA) subject Federal Register notice, "Alternative Method for Calculating Off-cycle Credits Under the Light-Duty Vehicle Greenhouse Gas Program: Applications from BMW Group, Ford Motor Company, and Hyundai Motor Group" (Subject FRN) [82 Fed. Reg. 27819, June 19, 2017] regarding applications for alternative methods for calculating off-cycle credits for fuel saving technologies.

The off-cycle credit program is an important and critical part of the greenhouse gas (GHG) and Corporate Average Fuel Economy (CAFE) regulations. It recognizes the benefits of real and proven GHG and fuel consumption reductions beyond those measured with standard test procedures. Thus, the off-cycle credit program helps support flexible and cost-effective strategies for reducing GHG-related emissions, and it also supports industry investment in innovative and forward-looking technologies that provide real-world environmental benefits.

[1] The Association of Global Automakers represents the U.S. operations of international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Global Automakers works with industry leaders, legislators, regulators, and other stakeholders in the United States to create public policies that improve motor vehicle safety, encourage technological innovation and addresses environmental needs. Our goal is to foster an open and competitive automotive marketplace that encourages investment, job growth, and development of vehicles that can enhance Americans' quality of life. Our members' share of sales and production in the United States is nearly 45 percent and growing. For more information, visit www.globalautomakers.org.

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Global Automakers Recommends Approval of the Applications

The Association of Global Automakers recommends that the EPA approve the applications for off-cycle credits from the BMW Group,[2] Ford Motor Company,[3] and Hyundai Motor Group,[4] which are referenced by the Subject FRN (collectively, Applications). Granting the requested credits will encourage further investment in real-world GHG emission reducing technologies and provide greater certainty for manufacturers, as previously noted in comments submitted by Global Automakers and the Alliance of Automotive Manufacturers (Auto Alliance) on a similar set of applications for credits under the off-cycle credit program.[5]

For the most part, the methodologies described by the Applications are consistent with those used by EPA, the magnitude of credits requested is consistent with previously approved applications by other manufacturers, and the magnitude of credits appears to be conservative relative to test data. The exception to this point, regarding test methodologies, is Ford's request regarding high efficiency alternators. Ford proposes a methodology that would scale credits based on the efficiency of the alternator using a 67% VDA as the industry average baseline alternator efficiency for the credit calculation. This would result in alternators with efficiency (as measured using an accepted industry standard procedure) above a baseline value getting credits from 0.2 to 1.9 grams/mile.[6] Global Automakers believes, however, that Ford's proposed test methodology is consistent with the intent of

[2] Dr. Christian Cozzarini, BMW Group to Linc Wehrly, U.S. Environmental Protection Agency. "BMW Request for Greenhouse Gas Credit for Variable Crankcase Suction Valve Technology." January 19, 2017. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0005 (Accessed June 20, 2017).

[3] Ms. Nancy Homeister, Ford Motor Company to Linc Wehrly, U.S. Environmental Protection Agency. "Application for High Efficiency Alternator Off-Cycle GHG Credit." June 21, 2016. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0006 (Accessed June 20, 2017); Todd Fagerman, Ford Motor Company to Linc Wehrly, U.S. Environmental Protection Agency, and James Tamm, U.S. Department of Transportation. "Request for 2010 MY through 2016 MY Greenhouse Gas (GHG) Off-Cycle Credits." February 6, 2017. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0011 (Accessed July 14, 2017); and Todd Fagerman, Ford Motor Company to Linc Wehrly, U.S. Environmental Protection Agency, and James Tamm, U.S. Department of Transportation. "Request for 2017 MY and Beyond Greenhouse Gas (GHG) and Fuel Economy Off-Cycle Credits." February 6, 2017. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0012 (Accessed July 14, 2017).

[4] Steven Sherman, Byungho Lee, Sejun Kim, and Anthony D'Ambrosi, Hyundai Motor Group – Hyundai America Technical Center, Inc. to Linc Wehrly, U.S. Environmental Protection Agency. "Request for GHG credit for Denso SES compressor with variable crankcase suction valve technology." January 23, 2017. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0003 (Accessed June 20, 2017).

[5] Michael Hartrick, Alliance of Automobile Manufacturers, and Julia Rege, Association of Global Automakers, to U.S. Environmental Protection Agency Air and Radiation Docket EPA-HQ-OAR-2016-0503. "Off-Cycle Credits under the Light-duty Vehicle Greenhouse Gas Emissions Program: Application for Alternative Method of Calculation, BMW Group, Ford Motor Co., General Motors Corp., Volkswagen Group of America." September 2, 2016. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2016-0503-0007 (Accessed July 11, 2017).

[6] "Ford recommends the use of 67% VDA as the industry average baseline alternator efficiency for the credit calculation. This credit value is supported by numerous analyses in U.S. Environmental Protection Agency's (EPA) rulemaking documents, by the EU Technical Guidelines for EcoInnovations, and analytical calculations described in the following sections." From "Application for High Efficiency Alternator Off-Cycle GHG Credit." June 21, 2016. Retrieved from https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0189-0006 (Accessed June 20, 2017).

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EPA's regulations and the credit values requested are conservative. It should be noted that EPA has authority to grant alternative test methodologies and credit levels based on performance for pre-menu-credit MYs and also post menu-credit MYs.

For instance, the off-cycle credit value associated with the SAS compressor was previously applied for by several manufacturers, and this credit value was approved by EPA in decisions issued in September 2015 and January 2017.[7] The antecedent applications described in these decision documents were comparable to today's request in that they also requested credit for model years prior to 2014, made use of the same or generally equivalent methodologies as those used by EPA in establishing the predetermined list of credits in the regulations, and resulted in the same credit values as described in the regulations.[8] If EPA were to reject the present Applications, those manufacturers applying for credit could be placed at a competitive disadvantage relative to those which have already had similar credits approved. By approving the present Applications, a level-playing field will be maintained for all automakers.

Therefore, Global Automakers believes that EPA should grant the requested credits based on the methodologies described in the Applications.[9]

Global Automakers Strongly Recommends that EPA Streamline and Standardize the Off-Cycle Credit Application Process

Global Automakers remains concerned that the current process for evaluating applications for off-cycle credit under 40 CFR § 86.1869-12(d) can result in excessive time between completion of a final application and notice for public comment in the Federal Register. Global Automakers notes that in the case of the Applications, six months passed between the receipt of the application from Ford Motor Company and its public notice for comment in the Subject FRN.[10]

Timely processing of applications for off-cycle technology credits is needed to allow manufacturers the critical planning and investment lead-time. Although the present Applications concern obtaining credit

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[7] EPA Office of Transportation and Air Quality Compliance Division. "EPA Decision Document: Off-cycle Credits for Fiat Chrysler Automobiles, Ford Motor Company, and General Motors Corporation." EPA-420-R-15-014, September 2015, and "EPA Decision Document for BMW Group, Ford Motor Company, General Motors Corporation, and Volkswagen of America." EPA-420-R-17-003, January 2017.

[8] *Id.* at 3.

[9] This is not to say that all applications for alternative methodologies under the off-cycle credit program should ultimately be required to follow EPA's methodologies or that all such proposed methodologies should result in credit values consistent with the predetermined list of off-cycle credits described by 40 CFR § 86.1869-12(b). Global Automakers believes that the alternative methodology provisions of 40 CFR § 86.1869-12(d) are intended to provide maximum flexibility for manufacturers to develop methods to determine the on-road benefits of technologies in excess of those observed in standard GHG and fuel economy certification testing.

[10] Ford's application was submitted on January 29, 2017 (*see* note 5, above), but the Subject FRN was not published until June 19, 2017. Conversely, we commend EPA for moving promptly to publish the Subject FRN approximately one week after having received the final application submitted by Volkswagen Group of America.

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for historical actions, the credits in question could, theoretically, make the difference between a manufacturer having sufficient credits to maintain compliance and making additional investments in technology. As importantly, if not more so, in the case where a manufacturer is considering investing in new technology, timely processing of applications would aid the manufacturer in making potentially time-sensitive decisions regarding technology applications on a fully informed basis. Without timely processing, the EPA works against its own stated intent of "provid[ing] an incentive for CO_2 and fuel consumption reducing off-cycle technologies that would otherwise not be developed because they do not offer a significant 2-cycle benefit."[11]

This burden and uncertainty associated with the off-cycle request process may make OEMs hesitate to apply for the off-cycle credits for new innovative technologies. This hesitation results in a negative impact on expanding new innovative technologies into the market and signals that deploying new, innovative technologies into the market is not valued nor can be achieved. Therefore, we would like to suggest that EPA streamline reduplication applications, like the SAS compressor application noted above, in situations where multiple OEMs have submitted petitions for approving the off-cycle technology credit for same technology. For example, the test methodology for one technology, which was applied by one OEM and was approved by EPA through the petition process, can be used to verify the credit value for the same technology by the other OEMs, and then the credit would be approved by EPA without the new petition. This could decrease some burden by skipping the public comment process and review process by EPA. We believe this streamlining could encourage more OEMs to apply for off-cycle technology credits, thus expanding new innovative technology offerings and achieving greater fuel savings in the real world.

In a recent petition for a Direct Final Rule, Global Automakers and the Auto Alliance discuss this and other issues related to off-cycle credits, which if addressed, would provide an improved off-cycle credit approval process.[12] Global Automakers recommends that EPA also consider the concerns and recommendations provided therein. For instance, after approving multiple manufacturers' applications for the same or similar credits for the same technology, it may be appropriate for EPA to update credit values and/or add technologies to the predetermined regulatory list with a defined calculation methodology needed to prove GHG benefits. An additional example, for technologies of common interest to several manufacturers, EPA could enable a third party to expedite review and approval process. Such streamlining would reduce administrative burdens for both EPA and manufacturers and would maximize incentives for manufacturers to seek and incorporate further innovation. In the

[11] EPA Office of Transportation and Air Quality, National Highway Traffic Safety Administration, and California Air Resources Board. "Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025.". EPA-420-D-16-900. July 2016. Page 5-219.

[12] Mitch Bainwol, Alliance of Automobile Manufacturers, and John Bozzella, Association of Global Automakers, to Mark Rosekind, PhD, National Highway Traffic and Safety Administration, and Gina McCarthy, U.S. Environmental Protection Agency. "Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program." June 20, 2016. Retrieved from https://www.epa.gov/aboutepa/petition-direct-final-rule-regard-various-aspects-corporate-average-fuel-economy-program. (Accessed on July 11, 2017).

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interest of facilitating the approval process, Global Automakers would be interested in discussing additional streamlining suggestions with the Agency.

Global Automakers respectfully requests that EPA consider and implement process improvements as soon as possible that could reduce the amount of time between submission of a final application and its subsequent notification in the Federal Register, as well as consider ways to streamline multiple applications for the same technology and adding approved technologies to the pre-approved regulatory list.

Global Automakers Agrees that No Additional Process Is Needed for the Predetermined List of Credit Values and Use of the "5-Cycle" Methodology

Global Automakers agrees that no additional process should be necessary for use of the predetermined list of credit values[13] and use of the "5-cycle" methodology.[14] Decisions made by the agencies that are published in the Federal Register have established credit values for various technologies. Having a reliable source upon which to base planning and calculations allows automakers to plan and invest in fuel saving technologies to reduce GHG emissions.

In the Subject FRN, EPA describes the off-cycle credit program pathways including the predetermined list of credit values and the 5-Cycle methodology. EPA concludes with, "[t]hese first two methodologies were completely defined through notice and comment rulemaking and therefore no additional process is necessary for manufacturers to use these methods."[15] Global Automakers would encourage EPA to continue to use proven methodologies to provide a framework for application of off-cycle credits, which manufacturers can use to plan for the long-term.

EPA Should Reconsider the Application for New and Innovative Air Conditioner Technologies

In the most recent EPA Petition for the "Alternative Method for Calculating Off-cycle Credits under the Light-duty Vehicle Greenhouse Gas Emissions Program," EPA proposed to apply the air conditioner (A/C) efficiency credit cap to the SAS compressor's credit value approved under the off-cycle technology credit approval process. EPA's reasons for this proposal are that this technology is an improvement to variable-displacement A/C compressors and is qualified as an A/C efficiency technology.[16] These applications will likely continue under the petition process as credits encourage the introduction of the technologies into market by offsetting the cost increase of the technologies. While we understand the intent of EPA's point of view, if the A/C efficiency credit cap is applied to these technologies, deployment of these GHG-saving technologies may decrease.

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[13] 40 CFR § 86.1869-12(b).
[14] 40 CFR § 86.1869-12(c).
[15] 82 FR. at 27819.
[16] EPA-HQ-OAR-2017-0189.

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Global Automakers believes many new innovative A/C efficiency technologies will continue to be developed by manufacturers both now and in the future. Credit applications for these A/C-related technologies under the off-cycle credit program is warranted and should be separate from the credits allotted under the GHG and CAFE programs' A/C efficiency credits.[17] Global Automakers encourages EPA to carefully reconsider the proposed implementation of the A/C efficiency credit cap in conjunction with the off-cycle credit opportunities available for new and innovative A/C technologies.

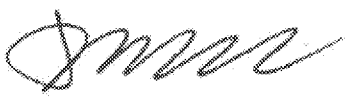
Conclusion

Global Automakers recommends that EPA approve the Applications described by the Subject Notice for the reasons provided above. Granting these requests is consistent with the applicable regulations, the intent of the national program for GHG emissions and CAFE, and the goal of encouraging the rollout of new and innovative technologies that provide real world fuel savings.

Global Automakers also encourages EPA to work with industry to streamline and standardize the application process for alternative methodology off-cycle credits by establishing consistent and uniform procedures for all manufacturers and a prompt response from the Agency.

Thank you for your consideration of our comments. If you have any questions regarding the above comments, please feel free to contact Amandine Muskus at amuskus@globalautomakers.org or (202) 650-5555.

Sincerely,



Julia Rege
Director, Environment & Energy

cc: Byron Bunker, U.S. Environmental Protection Agency
Roberts French, U.S. Environmental Protection Agency
William Charmley, U.S. Environmental Protection Agency
James Tamm, National Highway Traffic Safety Administration
Greg Powell, National Highway Traffic Safety Administration
Mike McCarthy, California Air Resources Board
Annette Hebert, California Air Resources Board

[17] A/C-related technology, however, should not be double counted under both the A/C and off-cycle credits programs.

Message

From: Barbara Kiss [barbara.kiss@gm.com]
Sent: 12/5/2016 8:01:29 PM
To: Charmley, William [charmley.william@epa.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]
CC: Patrick J. McCarroll [patrick.j.mccarroll@gm.com]
Subject: CBI from December 1, 2016
Attachments: GM Agency Post TAR F2F slides CBI 01Dec16.pdf

CONTAINS CONFIDENTIAL BUSINESS INFORMATION

Bill/Jim,

Attached is the confidential slide deck that we (Barbara Kiss, Matt Rudnick and Larry Laws) went through with you (on December 1, 2016) in response to the draft Technical Assessment Report. This deck contains GM's confidential compliance outlook. As such, please keep this confidential:

EPA:
GM requests confidential treatment pursuant to 40 C.F.R. Part 2, Subpart B of the attachments which have been marked "CONFIDENTIAL or CONFIDENTIAL BUSINESS INFORMATION" on their cover page. These attachments contain confidential GM business information the disclosure of which could damage GM's competitive position. If in the future EPA is considering the public release of this confidential information in response to a FOIA request or for any other reason, we request that you first contact me to discuss the need to maintain the confidentiality of this information.

NHTSA
GM believes that this information is entitled to confidential treatment on the basis of 5 USC Section 552(b)(4) as incorporated by reference in and modified by 49 USC Section 32910, under 18 USC Section 1905 and under 49 CFR Parts 7 and 512.

Barbara E. Kiss
Director Energy and Environment, Global Public Policy
barbara.kiss@gm.com
313-665-2964

Nothing in this message is intended to constitute an electronic signature unless a specific statement to the contrary is included in this message.

Confidentiality Note: This message is intended only for the person or entity to which it is addressed. It may contain confidential and/or privileged material. Any review, transmission, dissemination or other use, or taking of any action in reliance upon this message by persons or entities other than the intended recipient is prohibited and may be unlawful. If you received this message in error, please contact the sender and delete it from your computer.

Message

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 4/20/2017 6:48:45 PM
To: Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]
CC: Charmley, William [charmley.william@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]
Subject: MTE Coordination with NHTSA

Hello Jim,

I hope this note finds you well.

As a follow-up to the conversation you had with Bill Charmley I wanted to reach out to you begin thinking about regular EPA and NHTSA coordination meetings. It is my understanding that we may not be in a position to start meeting, but hopefully the situation does not preclude us from thinking about what the meetings could look like if and when they begin. In addition, I am sure the content of the meetings could be dictated by future direction we receive. As a start I would recommend that we begin by updated our respective agencies with new work that has been completed since the Draft TAR. From the EPA side this could include:

- Recent cost studies
  - Turbo Downsized engine
  - Diesel
  - CVT
  - HEG2
  - Updated supporting databases
- Benchmarking data
- Progress on our new baseline

I look forward to hearing your thoughts on the subject.

Finally, EPA is happy to set-up the meetings and arrange the conference call and web meeting infrastructure.

Best Regards,

Mike

Michael R. Olechiw
Director - Light-duty Vehicles and Small Engines Center
USEPA/OTAQ/ASD
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olechiw.michael@epa.gov

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 3/27/2017 9:22:44 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: RE: EPA Toyota Presentation for 3/28/2017 *** CONTAINS CBI ***

Personal Matters / Ex. 6

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Monday, March 27, 2017 5:20 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: Re: EPA Toyota Presentation for 3/28/2017 *** CONTAINS CBI ***

Jim

Looking forward to seeing you and your colleagues tomorrow.

Personal Matters / Ex. 6

Thanks
Bill

Sent from my iPhone

On Mar 27, 2017, at 1:36 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:

Hi Mike,

Thanks for the memo and forwarding the EPA assessment and background materials. Deliberative Process / Ex. 5 Deliberative Process / Ex. 5 We don't have any presentation materials and expect mostly to be listening and asking questions. The following people are planning to attend in person.

Loren Smith, OST (non-career)
Steve Wood, NHTSA, Acting Chief Counsel
Ryan Posten (Tentative – Personal Matters / Ex. 6
Jim Tamm
Kevin Green
Tim Mullins
Greg Powell
Vinay Nagabhushana
Seiar Zia
Ryan Hagen
Dan Bogard
Rebecca Schade
Maurice Hicks

I look forward to seeing you and others from EPA tomorrow. Safe travels.

Jim

From: Olechiw, Michael [mailto:olechiw.michael@epa.gov]
Sent: Monday, March 27, 2017 11:03 AM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Cc: Charmley, William <charmley.william@epa.gov>; Bolon, Kevin <Bolon.Kevin@epa.gov>; Barba, Daniel <Barba.Daniel@epa.gov>; Moran, Robin <moran.robin@epa.gov>
Subject: EPA Toyota Presentation for 3/28/2017 *** CONTAINS CBI ***

Hello Jim,

I hope this note finds you well. In preparation for our meeting tomorrow I am sending you our presentation along with a brief description of how the credit grid, included in the presentation, was developed.

This meeting and the included CBI analysis precipitated of the previous 3-agency meetings with Toyota. EPA had been asking for more information on Toyota's plans for improving conventional technologies and in response Toyota provided CBI on several of their high volume vehicles in 2016. Since the CBI submission Toyota has been periodically following up with us to determine when we could have a detailed technical review and provide feedback. As a result we have prepared the attached materials. Given the time alloted, this presentation is only a high level overview and we have offered to meet with Toyota for a longer and deeper technology discussion.

With regard to EPA attendees, there will be six of us in person:

Chris Grundler
Bill Charmley
Robin Moran
Dan Barba
Kevin Bolon
Myself

Could you send us the list of NHTSA/Volpe/DOT staff that is attending?

If you have any questions on materials please let me know.

Best Regards,

Mike

Michael R. Olechiw
Director - Light-duty Vehicles and Small Engines Center
USEPA/OTAQ/ASD
2000 Traverwood Drive
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olechiw.michael@epa.gov

Message

From: Matthew Rudnick [matthew.rudnick@gm.com]
Sent: 6/8/2017 6:30:15 PM
To: Green, Kevin (VOLPE) (Kevin.Green@dot.gov) [Kevin.Green@dot.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]
CC: Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Barbara Kiss [barbara.kiss@gm.com]; David W. Schrumpf [david.w.schrumpf@gm.com]
Subject: GM Volpe Tech Walks - contains CBI
Attachments: GM Volpe Tech Walks CBI 24May17 mailout.pdf

Kevin and Jim,

On behalf of Larry and myself, I wanted to thank you and your staffs for our productive visit to Volpe Center on May 24. As a follow-up to our discussion, please find attached the slide deck that we presented. This is confidential business information per the below regulatory cites. We will talk more soon.

Matt

NHTSA
GM believes that this information is entitled to confidential treatment on the basis of 5 USC Section 552(b)(4) as incorporated by reference in and modified by 49 USC Section 32910, under 18 USC Section 1905 and under 49 CFR Parts 7 and 512.

EPA
GM requests confidential treatment pursuant to 40 C.F.R. Part 2, Subpart B of the attachments which have been marked "CONFIDENTIAL" on their cover page. These attachments contain confidential GM business information the disclosure of which could damage GM's competitive position. If in the future EPA is considering the public release of this confidential information in response to a FOIA request or for any other reason, we request that you first contact me to discuss the need to maintain the confidentiality of this information.

Matthew Rudnick
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GM – Public Policy - Environment and Energy
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GENERAL MOTORS

Nothing in this message is intended to constitute an electronic signature unless a specific statement to the contrary is included in this message.

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Message

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 3/27/2017 3:03:13 PM
To: Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]
CC: Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Moran, Robin [moran.robin@epa.gov]
Subject: EPA Toyota Presentation for 3/28/2017 *** CONTAINS CBI ***
Attachments: Meeting with Toyota 28 3 2017_rev20170327b.pptx; Description of EPA Compliance Grid Analysis_20170324.docx

Hello Jim,

I hope this note finds you well. In preparation for our meeting tomorrow I am sending you our presentation along with a brief description of how the credit grid, included in the presentation, was developed.

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Message

From: james_kliesch@ahm.honda.com [james_kliesch@ahm.honda.com]
Sent: 12/22/2016 9:56:01 PM
To: Charmley, William [charmley.william@epa.gov]; james.tamm@dot.gov; Kevin.Green@dot.gov; michael.mccarthy@arb.ca.gov
CC: Robert_Bienenfeld@ahm.honda.com; Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]
Subject: Honda Nov 2016 Midterm Eval (post-Draft TAR) Presentation - Public Version
Attachments: Honda Nov 2016 Midterm Eval Joint Agency Briefing - Public Version.pdf

Bill, Jim, Kevin, Mike:

As part of the follow-up to our Nov 2016 CAFE/GHG midterm evaluation (post-Draft TAR) briefings, we offered to share digital copies of both public and CBI versions of Honda's presentation. The public version is attached below.

To help facilitate its use in rulemaking efforts, Honda is submitting this public version into Docket No. EPA-HQ-OAR-2015-0827 as requested in EPA Proposed Determination materials. It is our understanding that its inclusion in this docket will also accommodate its use in NHTSA's MY2022-2025 CAFE NPRM.

The CBI version of the presentation, which is too large to email, will be burned to disc and sent via FedEx. CBI and public materials sent to NHTSA will, as requested, be directed to the Chief Counsel's office with supporting declarations.

Please feel free to contact me if you have any questions. On behalf of Honda, thank you again for meeting with us.

Kind Regards,
Jim Kliesch

(See attached file: Honda Nov 2016 Midterm Eval Joint Agency Briefing - Public Version.pdf)

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American Honda Motor Co., Inc.
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2017-2025 Midterm Review Technical Assessment Report

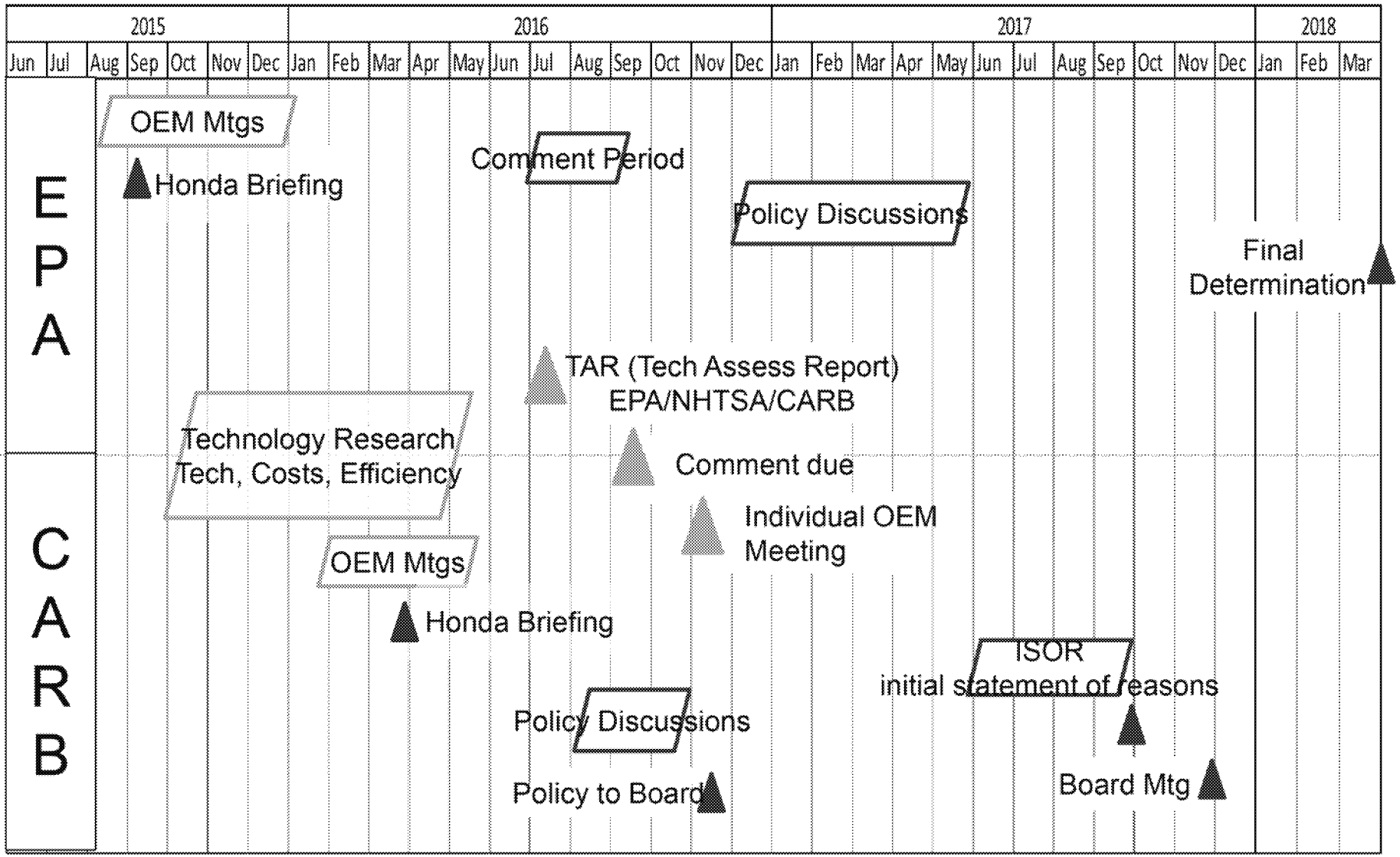
November 9 2016
EPA: Ann Arbor, Michigan

November 10 2016
NHTSA: Washington, D.C.

Agenda Outline

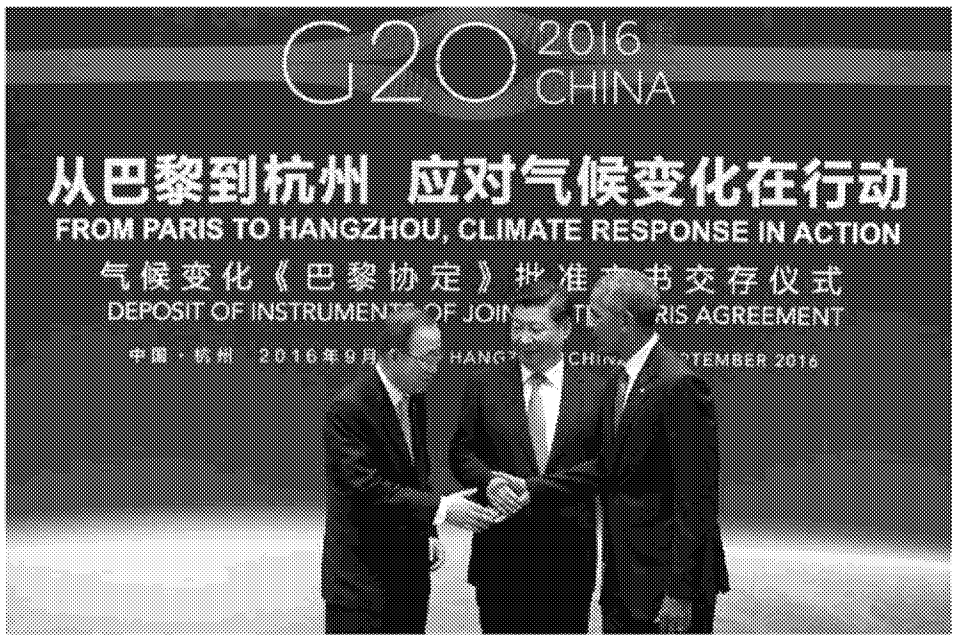
- Overview
- Road Load Analysis
- DTAR Analysis
- Honda's Analysis of EPA's PT Strategy
- Policy Improvements

Midterm Review Steps & Timing



Development after Paris Climate change Agreement

Paris agreement had been ratified



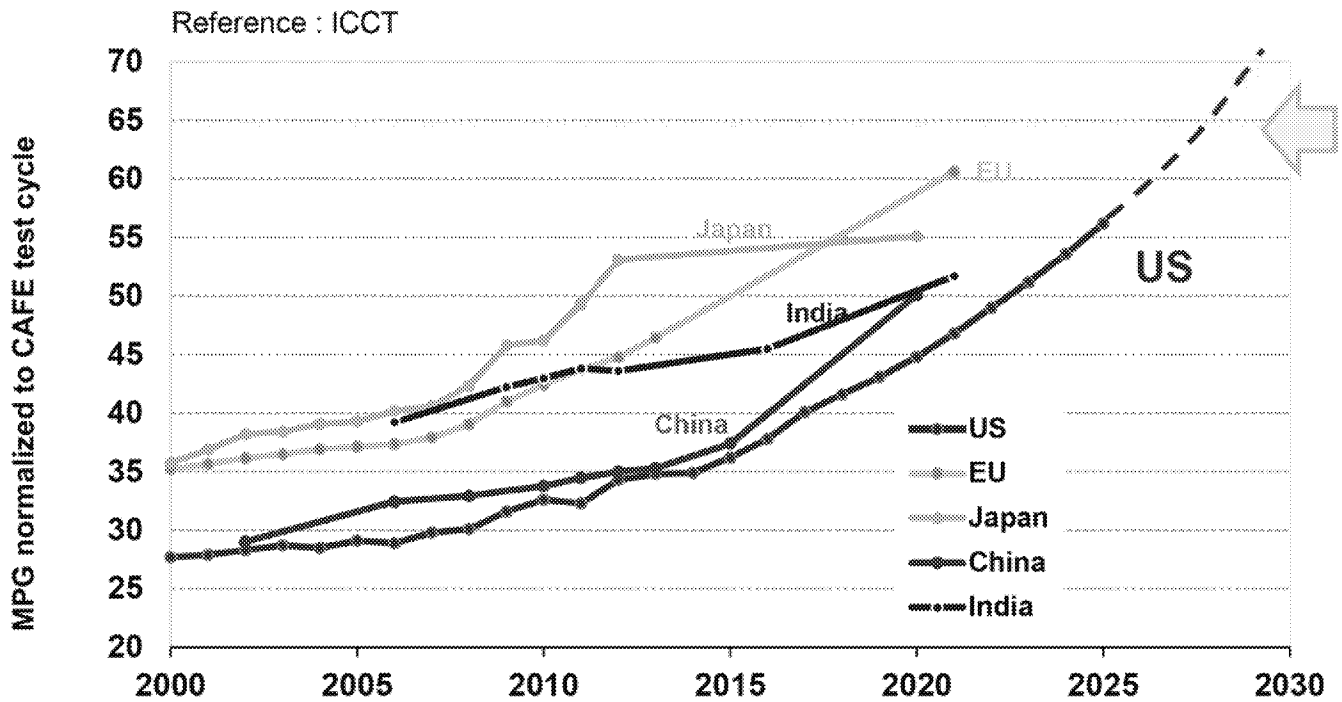
More than 55 countries submitted the agreement to enter into force.
The Paris agreement entered into force on 4 NOV 2016.

According to the Paris agreement, US needs to establish GHG reduction target for 2030.

[REDACTED]

CAFE Regulation Stringency

Tighter CAFE standards will eventually require xEVs.



Electrified vehicles are necessary to comply this high level of CAFE standard

Higher penetration of xEVs will be required to meet standards by 2025 and later.

TAR Summary

Expected 2025 GHG achievement has been updated to 50.8mpge due to gas price and PC/LT fleet balance.

	TAR	FRM(2012)
PC/LT %	52/48	67/33
CO2 g/mile	175	163
MPG	50.8	54.5

Incremental cost for each OEM is similar to FRM(2012)
However, payback period was changed longer due to low gas price.

	TAR(EPA~NHTSA)	FRM(2012)
Incremental cost/vehicle	$894~$1128	$1070
Payback	5~6 yrs	3.2 yrs

<u>Cost for CA ZEV</u>
included in the baseline/reference

Required cost and technology in 2025

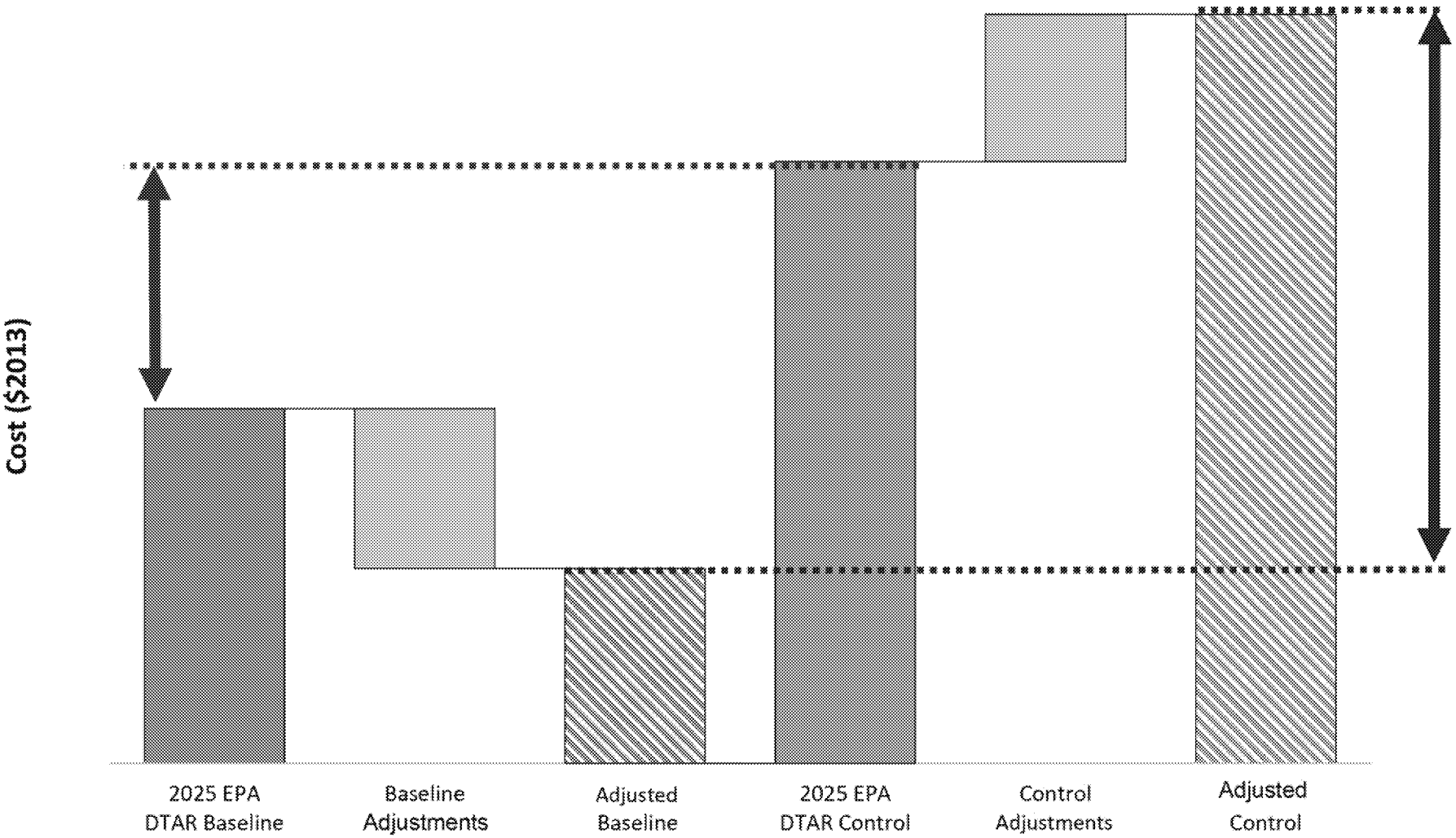
OEMs required "cost" in 2025 (EPA)
"Cost" definition : Control – Reference Cost

OEM	Cost ($)
Fleet	894-1017
Honda	**520**-663
Mazda	525-603
Toyota	694-820
Nissan	734-866
Hyundai	797-946
Ford	890-993
GM	1055-1170
FCA	1245-1371
BMW	1078-1183
VW	1284-1458

Technology penetration (Fleet)
Mainstream = efficient ICE technology
Hybridization = small help (<3%)

	GHG
Turbocharged and downsized gasoline engines	33%
Higher compression ratio, naturally aspirated gasoline engines	44%
8 speed and other advanced transmissions[2]	90%
Mass reduction	7%
Stop-start	20%
Mild Hybrid	18%
Full Hybrid	<3%
Plug-in hybrid electric vehicle[3]	<2%
Electric vehicle[3]	<3%

Overview - EPA compared to Honda

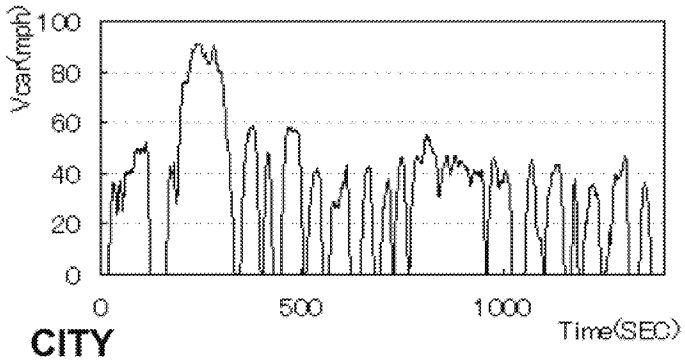


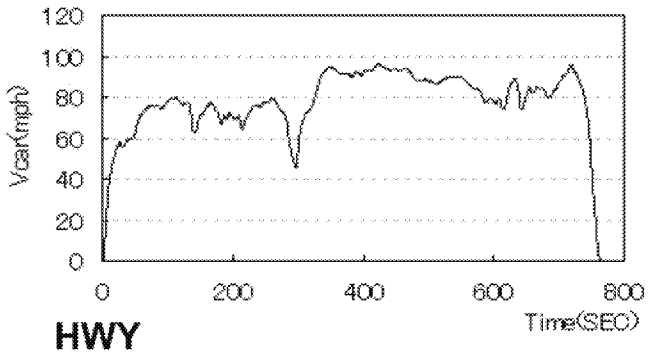
Road Load Analysis

Driving Mode Energy Index (Honda original)

Definition : The driving energy is "accumulated energy" to drive FTP mode and Hwy mode.
This can be calculated by vehicle speed pattern and body spec (regardless of powertrain)
The driving energy is a good index to understand powertrain's efficiency.

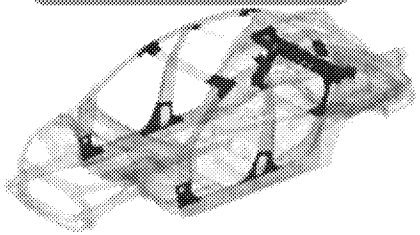
Fuel Energy (Fuel consumption) X **(η) Efficiency** = **Driving Energy**



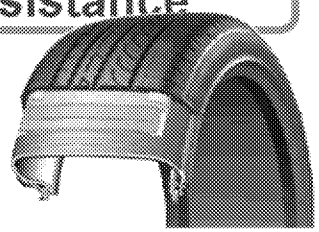


Vehicle Workload (Driving Energy)

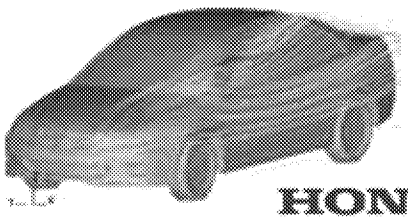
- **Weight**



- **Rolling resistance**



- **Aerodynamic**



HONDA

Lightweighting – Market Current Status

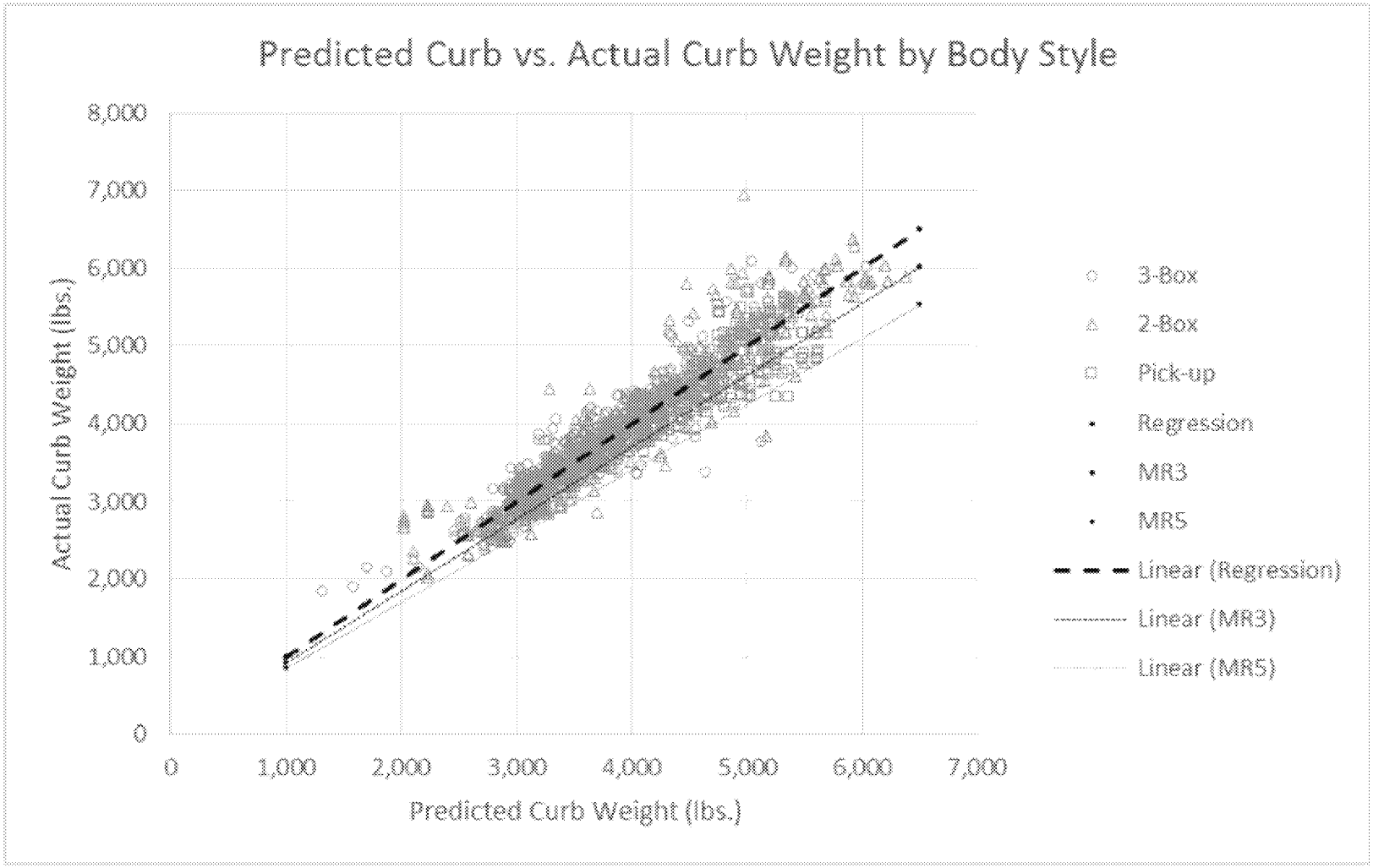
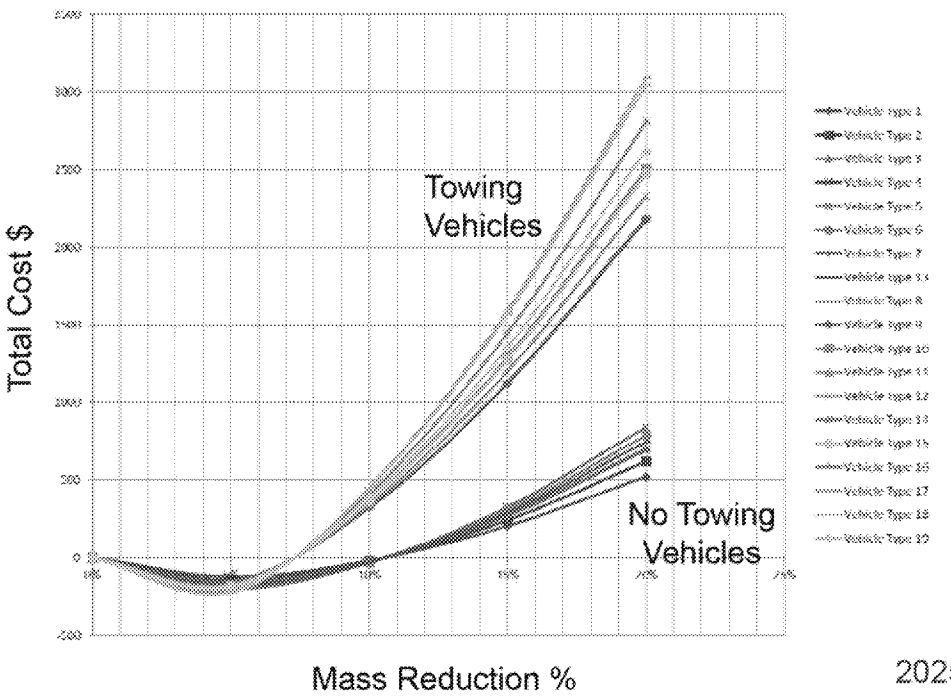


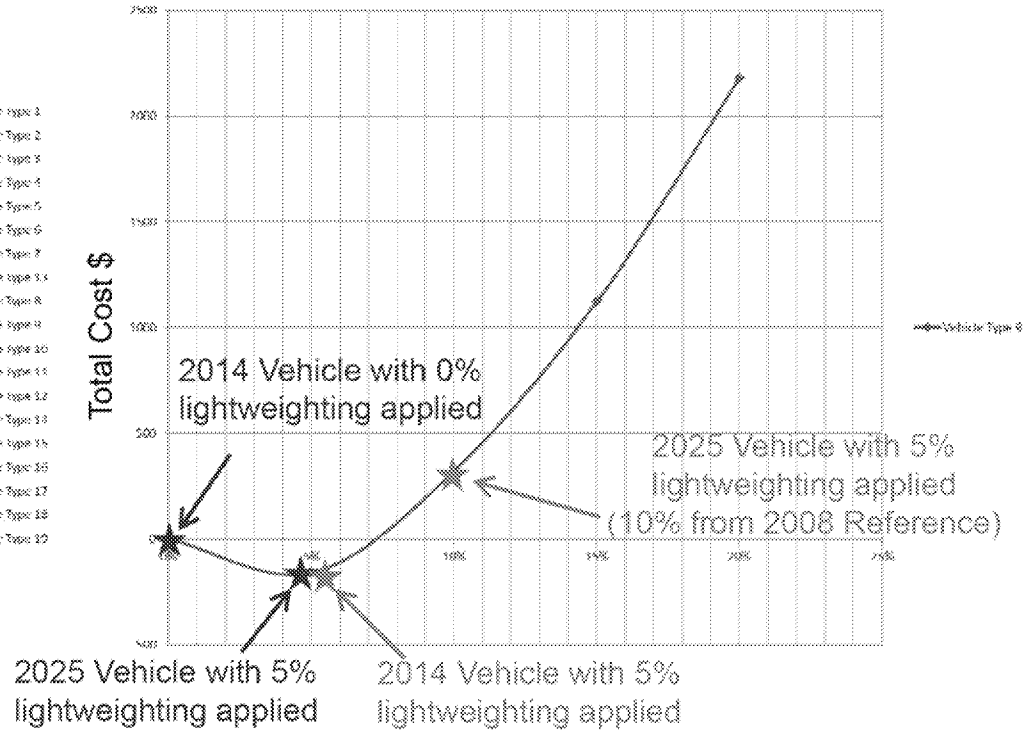
Figure 4.5 Mass Reduction Regression Residual Plot by Body Style

The Draft-TAR recognizes that there are varying levels of Mass Reduction in the Current Fleet for 2015MY

Lightweighting – Cost Impact of Starting Points



The Draft-TAR has established Cost Curves for mass reduction.

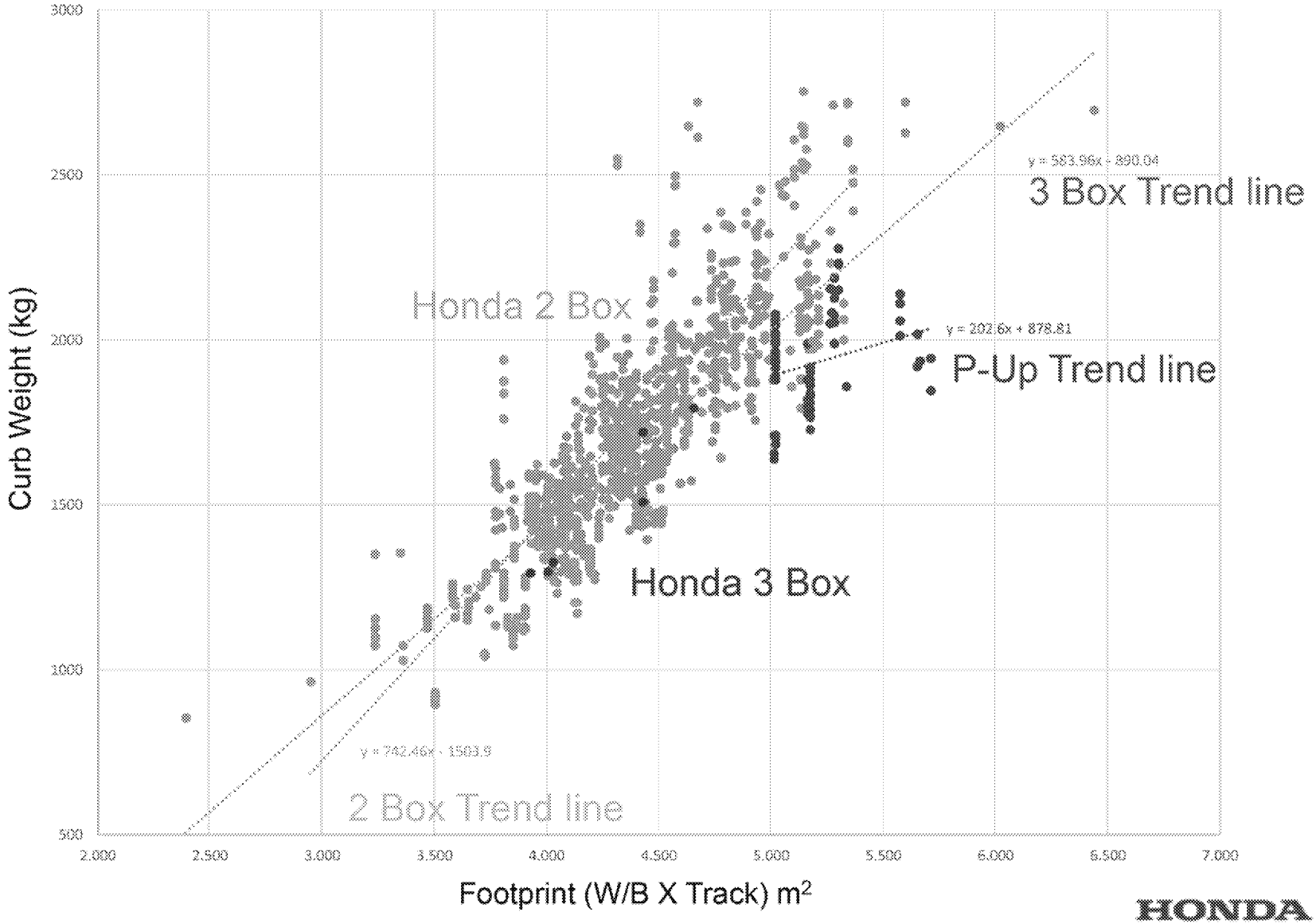


2014 Lightweight % affects starting point along the Cost Curve.

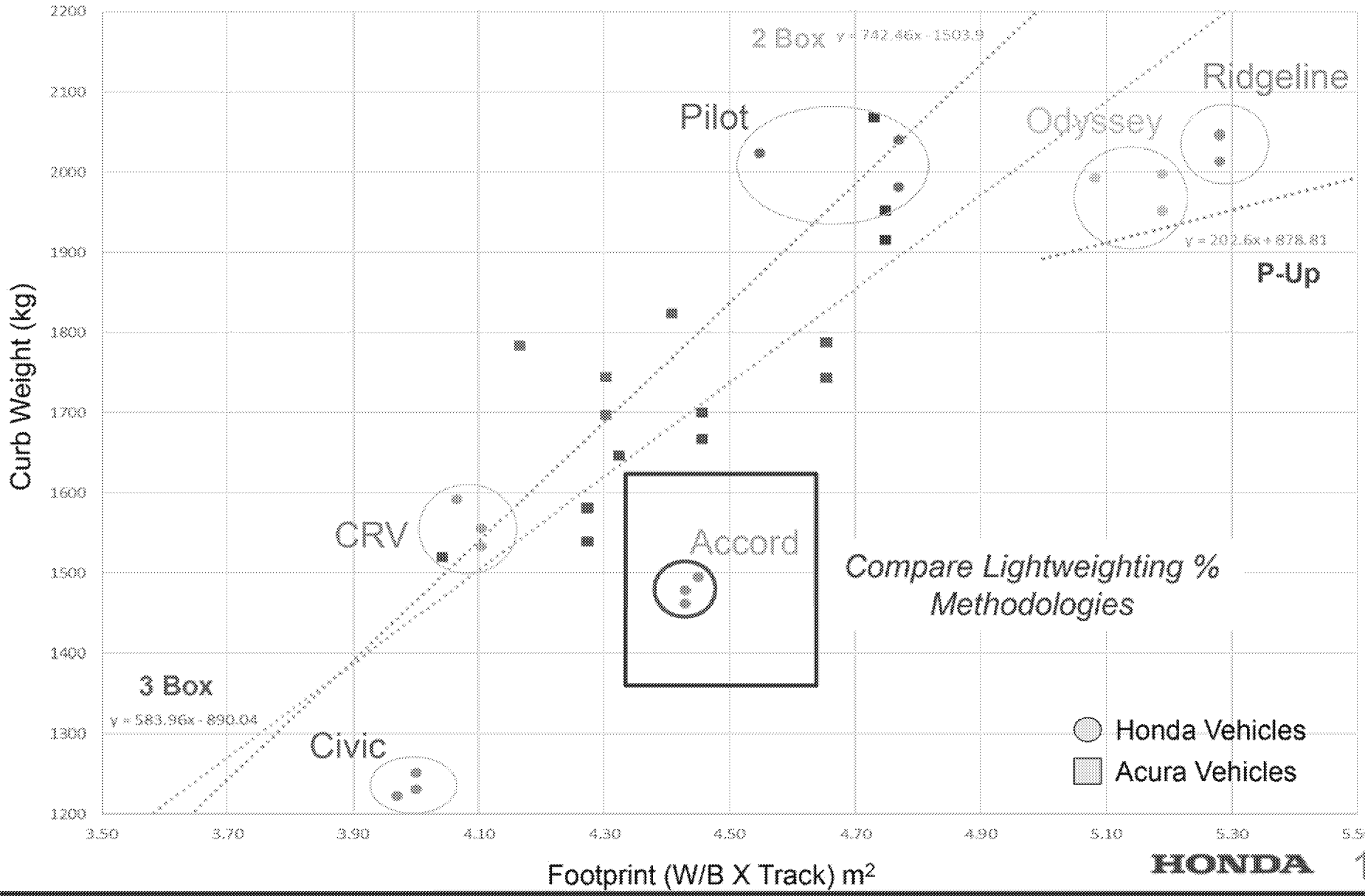
Starting point affects cost for achieving 2025 MR%.

Lightweighting–Industry Standard for LW Analysis

CY 2015 US MARKET (CURB WT v. FOOTPRINT)



Lightweighting % Methodology (D-TAR v. Honda)



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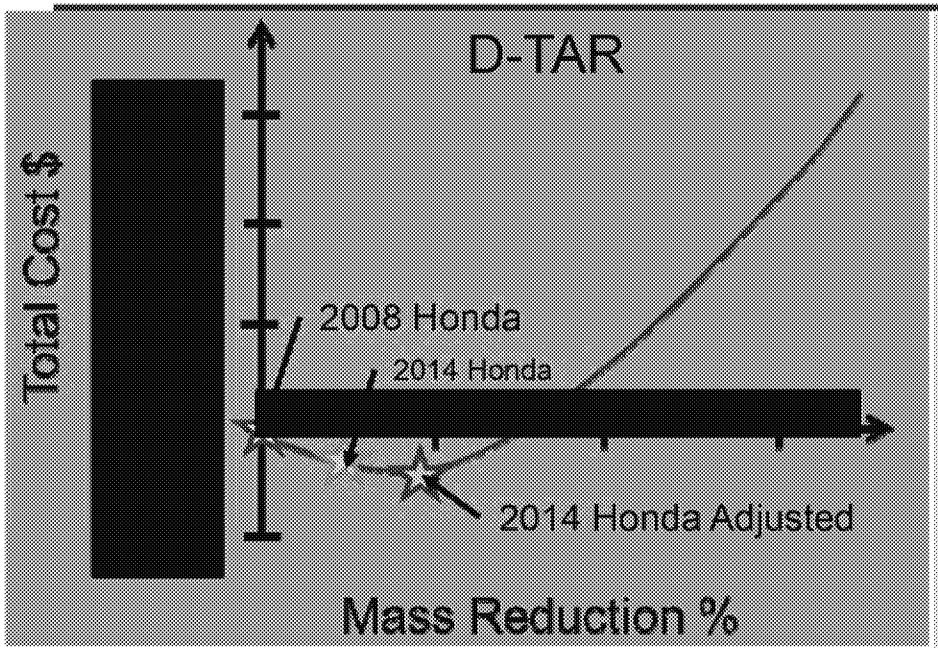
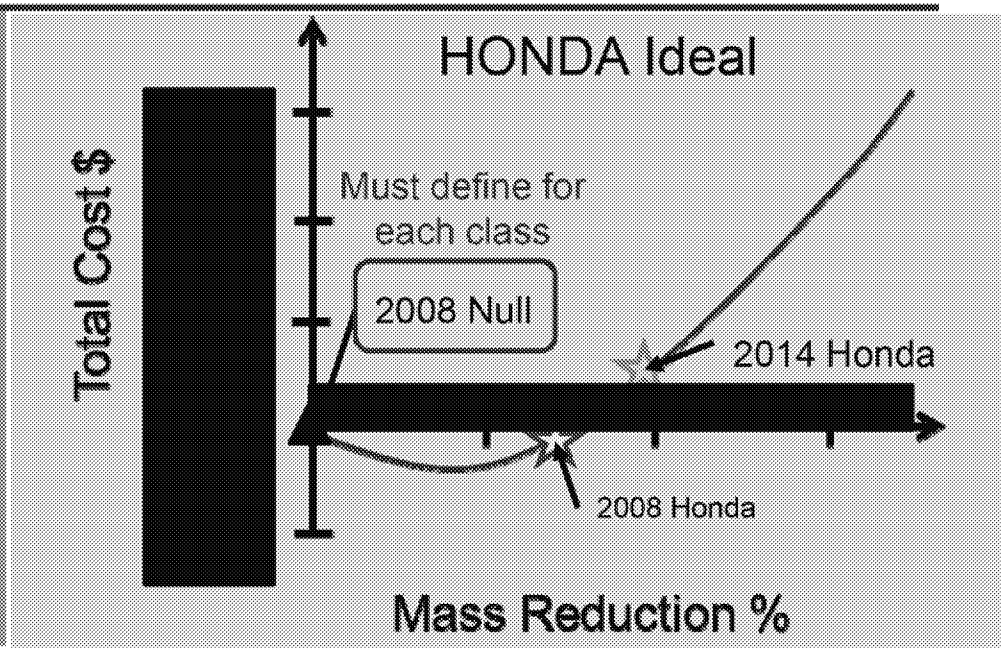
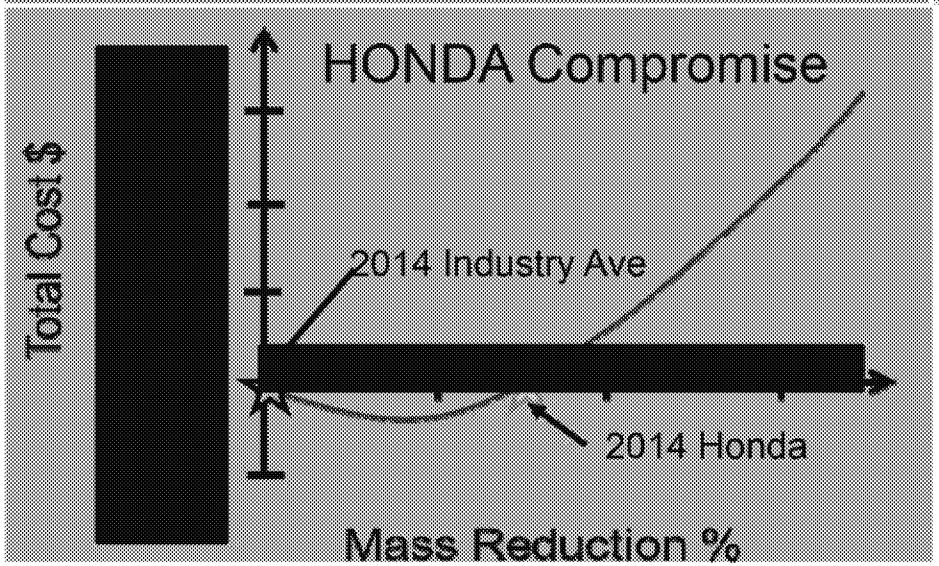
Lightweighting – Starting Point

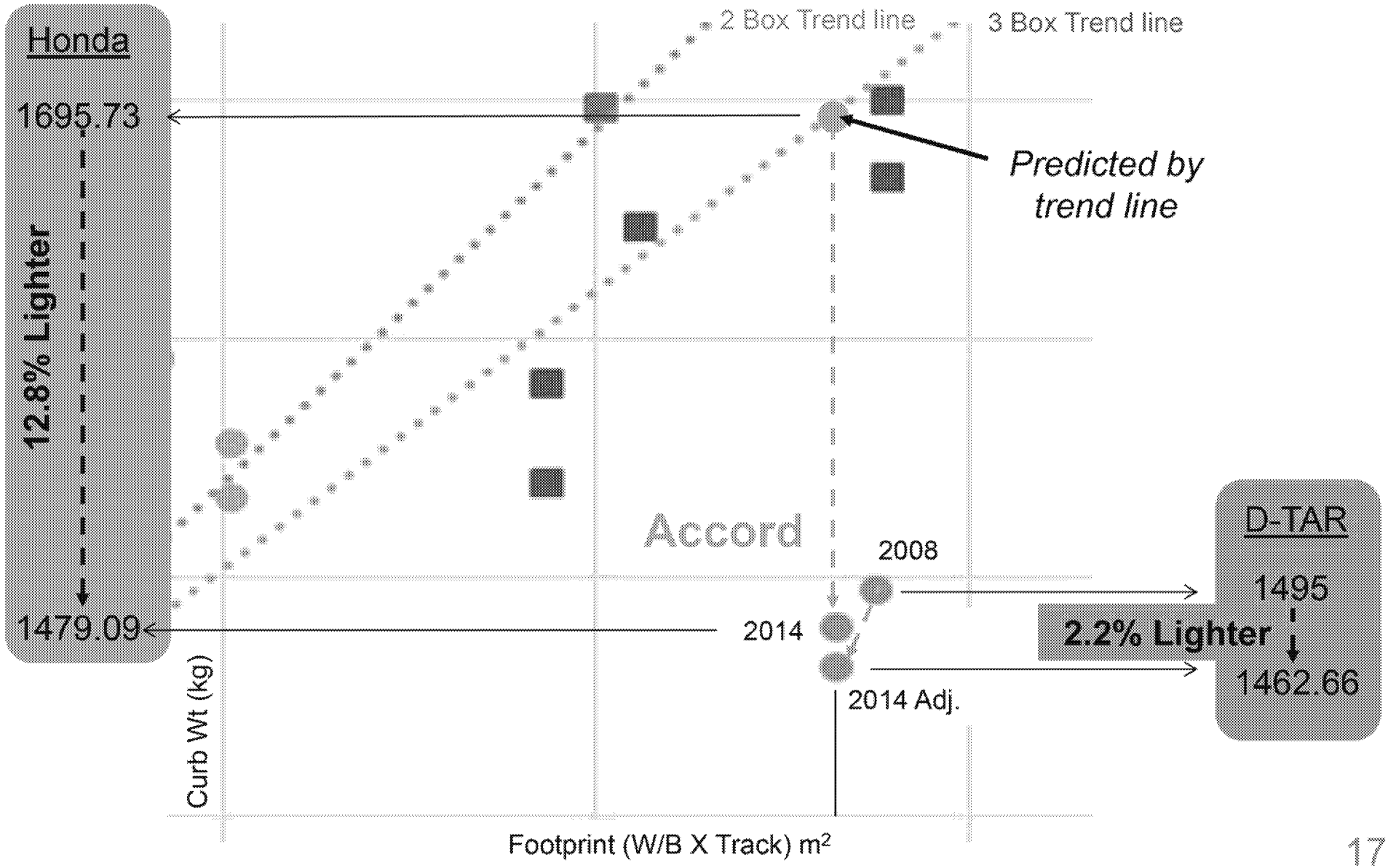






	Cost (Start Point)	Weight Reduction %
D-TAR	Null	Honda 2008 → Honda 2014 Adjusted
Honda Ideal	Null	Null → Honda 2014
Honda Compromise	Null	Industry Ave 2014 → Honda 2014

Lightweighting % Methodology (D-TAR v. Honda)



HONDA

Lightweighting % Methodology Comparison

HONDA

			W.B. (in)	FR track (in)	Ft Print (m^2)	Curb Wt (kg)	Wt Down %	Vehicle Spec
Civic	2008	3 Box	104.3	59	3.970	1222.73		DX AT
	2014		105.1	59	4.001	1251.82		LX AT
	Adjusted	Ft Print Δ	0.03	2.99	4.001	1230.10	-0.6%	D-Tar Method
		Safety Credit		18.73	Predicted	1446.13	13.4%	Honda Method
Accord	2008	3 Box	110.2	62.6	4.451	1495.00		LX AT
	2014		109.3	62.8	4.428	1479.09		LX AT
	Adjusted	Ft Print Δ	-0.02	-2.30	4.428	1462.66	2.2%	D-Tar Method
		Safety Credit		18.73	Predicted	1695.97	12.8%	Honda Method
CRV	2008	2 Box	103.1	61.1	4.064	1591.36		LX AT AWD
	2014		103.1	61.7	4.104	1556.36		LX AT AWD
	Adjusted	Ft Print Δ	0.04	4.05	4.104	1533.59	3.6%	D-Tar Method
		Safety Credit		18.73	Predicted	1543.18	-0.9%	Honda Method
Odyssey	2008	2 Box	118.1	66.7	5.082	1993.18		LX
	2014		118.1	68.1	5.189	1998.18		LX
	Adjusted	Ft Print Δ	0.11	12.30	5.189	1952.28	2.1%	D-Tar Method
		Safety Credit		33.6	Predicted	2139.99	6.6%	Honda Method
Pilot	2008	2 Box	106.3	66.3	4.547	2024.09		LX AT AWD
	2014		109.2	67.7	4.770	2040.45		LX AT AWD
	Adjusted	Ft Print Δ	0.22	25.67	4.770	1981.18	2.1%	D-Tar Method
		Safety Credit		33.6	Predicted	2037.31	-0.2%	Honda Method
Ridgeline	2008		122	67.1	5.281	2045.45		RT AWD
	2014		122	67.1	5.281	2047.27		
	Adjusted	Ft Print Δ	0.00	0.00	5.281	2013.67	1.6%	D-Tar Method
	Predicted	Safety Credit		18.73	Predicted	1948.82	-5.1%	Honda Method
Crosstour	2008	2 Box				0.00		
	2014		110.1	64.9	4.610	1683.18		EX L4 AT
	Adjusted	Ft Print Δ			4.610	1182.16		D-Tar Method
					Predicted	1918.83	12.3%	Honda Method
CRZ	2008	2 Box				0.00		
	2014		95.9	59.6	3.688	1210.45		BASE AT HEV
	Adjusted	Ft Print Δ			3.688	857.13		D-Tar Method
	Predicted				Predicted	1233.92	-1.9%	Honda Method

*Curb weight values are for lowest trim with automatic transmission. Data is shown for example only.

ACURA

			W.B. (in)	FR track (in)	Ft Print (m^2)	Curb Wt (kg)	Wt Down %	Vehicle Spec
ILX	2008	3 Box				0.00		
	2014		105.1	59.4	4.028	1343.18		BASE L4 AT
	Adjusted	Ft Print Δ			4.028	929.08		D-Tar Method
	Predicted				Predicted	1461.97	8.1%	Honda Method
TL	2008	3 Box	107.9	62.1	4.323	1646.82		BASE V6 AT
	2014		109.3	63.2	4.457	1700.45		BASE V6 AT
	Adjusted	Ft Print Δ	0.13	13.81	4.457	1667.91	-1.3%	D-Tar Method
	Predicted	Safety Credit		18.73	Predicted	1712.44	0.7%	Honda Method
TSX	2008	3 Box	105.1	59.6	4.041	1520.45		BASE L4 AT
	2014		106.5	62.2	4.274	1581.36		BASE L4 AT
	Adjusted	Ft Print Δ	0.23	22.82	4.274	1539.81	-1.3%	D-Tar Method
	Predicted	Safety Credit		18.73	Predicted	1605.65	1.5%	Honda Method
RLX	2008	3 Box	110.2	62	4.408	1824.55		BASE V6 AT AWD
	2014		112.2	64.3	4.654	1787.73		BASE V6 AT
	Adjusted	Ft Print Δ	0.25	25.47	4.654	1743.53	4.4%	D-Tar Method
	Predicted	Safety Credit		18.73	Predicted	1827.99	2.2%	Honda Method
RDX	2008	2 Box	104.3	61.9	4.165	1783.64		BASE L4 AT AWD
	2014		105.7	63.1	4.303	1744.55		BASE V6 AT AWD
	Adjusted	Ft Print Δ	0.14	13.97	4.303	1696.98	4.9%	D-Tar Method
	Predicted	Safety Credit		33.6	Predicted	1690.91	-3.2%	Honda Method
MDX	2008	2 Box	108.3	67.7	4.730	2067.27		BASE V6 AT AWD
	2014		111	66.3	4.748	1951.82		BASE V6 AT AWD
	Adjusted	Ft Print Δ	0.02	2.04	4.748	1916.18	7.3%	D-Tar Method
	Predicted	Safety Credit		33.6	Predicted	2021.25	3.4%	Honda Method

Honda method yields lightweighting % much different for the method proposed in the D-TAR. This will affect costs required to achieve the 2025 CAFE targets.

Lightweighting – Platform Effect

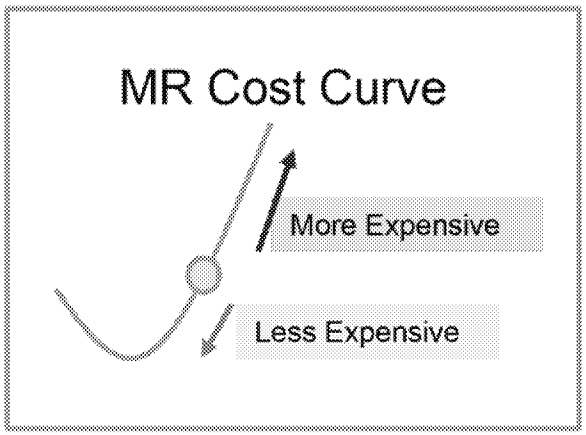
Manufacturer	Model Name	Drive	EPA Baseline WR 2014	EPA control WR 2025	EPA NET WR by model	HONDA NET WR by platform
HONDA	Accord Hybrid	HEV	0%	10%	10%	4.0%
HONDA	Accord Hybrid	HEV	0%	10%	10%	4.0%
HONDA	Accord Plug In	REV	0%	10%	10%	4.0%
HONDA	Accord Plug In	REV	0%	10%	10%	4.0%
HONDA	Accord Sedan	ICE	0%	10%	10%	4.0%
HONDA	Accord Sedan	ICE	0%	2%	2%	4.0%
HONDA	Accord Sedan	ICE	0%	2%	2%	4.0%
HONDA	Accord Sedan	ICE	0%	0%	0%	4.0%
HONDA	Accord Sedan	ICE	0%	0%	0%	4.0%
HONDA	Accord Sedan Sport	ICE	0%	5%	5%	4.0%
HONDA	Accord Sedan Sport	ICE	0%	5%	5%	4.0%
HONDA	Accord Sedan Sport	ICE	0%	3%	3%	4.0%
HONDA	Accord Sedan Sport	ICE	0%	3%	3%	4.0%

Mass Reduction applied on model by model basis

All models on the same platform will have the same amount of lightweighting applied, based on sales Weighting (like NHTSA)

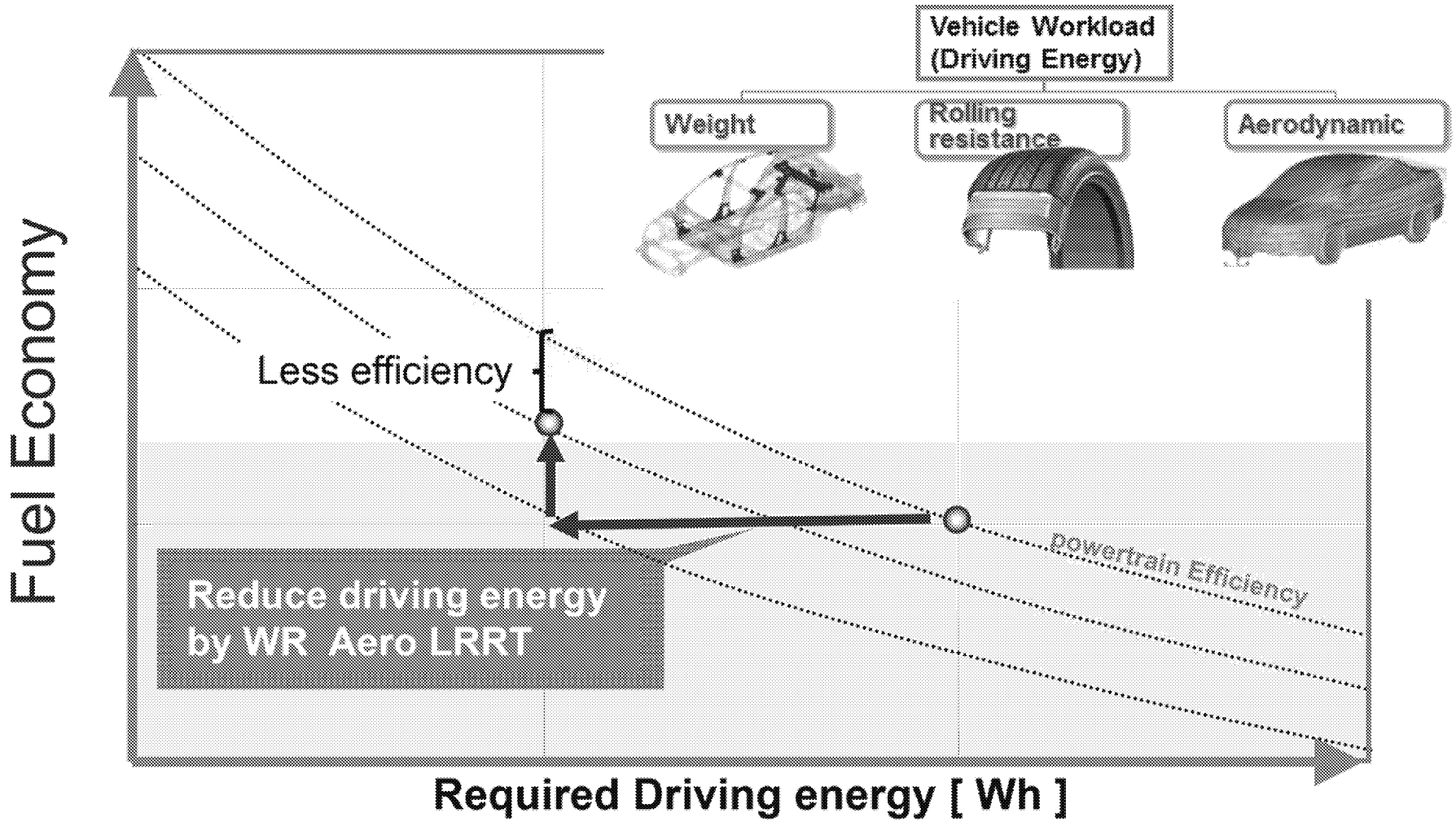
Lightweighting – Impact of Honda Adjustments

	Baseline		Control	
Model	***EPA***	***Honda vs. Ind.***	***EPA Model***	***Honda PF Adj.***
Accord Sedan	0.0%	12.0%	10.0%	16.0%
Civic Sedan	0.0%	12.0%	0.0%	12.0%
Crosstour 2WD	0.0%	6.5%	5.0%	11.0%
Crosstour 4WD	0.0%	6.5%	10.0%	11.0%
CR-V 2WD	3.0%	2.0%	10.0%	8.0%
CR-Z	0.0%	2.0%	0.0%	2.0%
ILX	6.0%	10.0%	6.0%	10.0%
RLX	6.0%	2.0%	10.0%	6.0%
TL 2WD	1.0%	1.0%	10.0%	5.0%
TL 4WD	1.0%	1.0%	10.0%	5.0%
TSX	3.0%	12.0%	8.0%	16.0%
TSX wagon	3.0%	12.0%	10.0%	16.0%
CR-V 4WD	3.0%	2.0%	10.0%	8.0%
Odyssey	3.0%	13.0%	5.0%	15.0%
Ridgeline	0.0%	0.0%	5.0%	4.0%



[REDACTED]

FE Improvement by saving driving energy



In the case of reduced driving energy, some PT efficiency is lost

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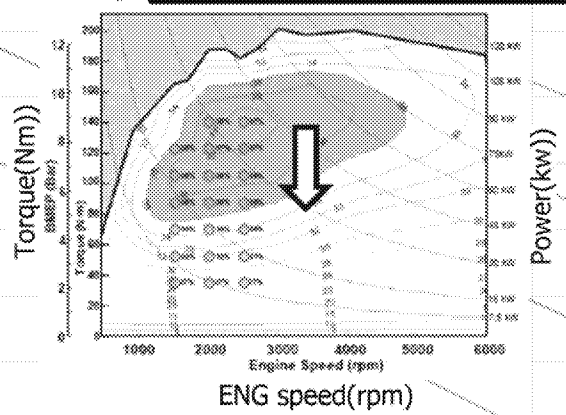
FE Improvement By Saving Driving Energy

[redacted]



In real vehicles, PT efficiency drops [redacted]% with each [redacted]% reduction in driving energy. The reason is that the operating point moves out from the best efficiency area.

[redacted]

[redacted]

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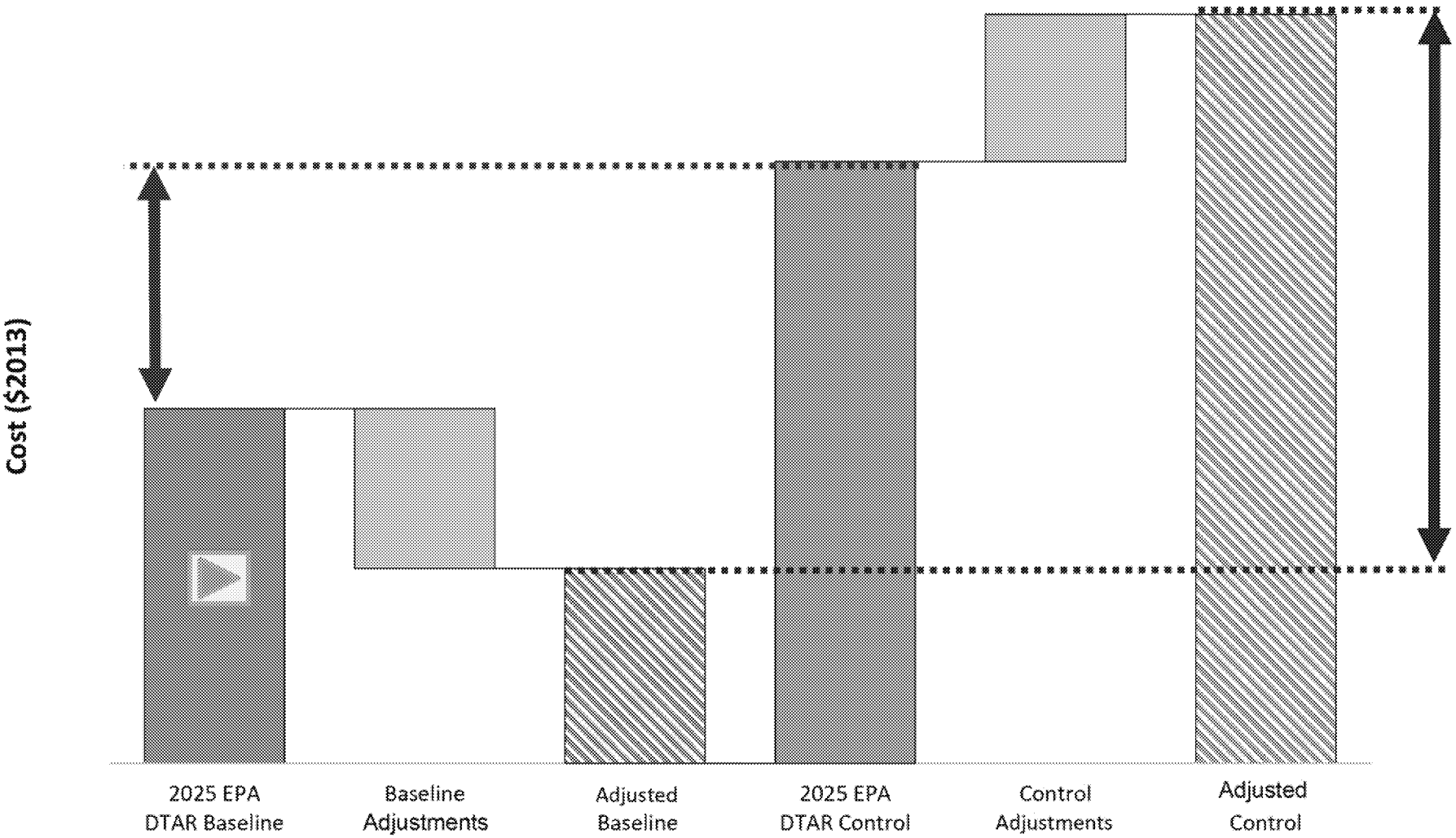
Road Load Reduction - Summary

- Lightweighting:
  - EPA only compares Honda to Honda to establish Baseline.
  - Honda compares Honda to Industry Average in 2014
  - This has the following impacts:
    - Baseline cost up
    - Control cost up
    - No impact to CO2
- Low Rolling Resistance Tire
  - Many Honda Models apply LRRT1
  - This has the following impacts:
    - Baseline cost up
    - 2025 Control CO2 achievement is [redacted] g/mi less
- Road Load Efficiency Loss
  - We cannot optimize BSFC for every application (Same ICE applied to different models)
  - [redacted]% loss in PT Efficiency for each [redacted]% of road load energy reduction, even in the best case (CVT)

DTAR Analysis
(Cost and CO2 Impact)

Overview - EPA compared to Honda



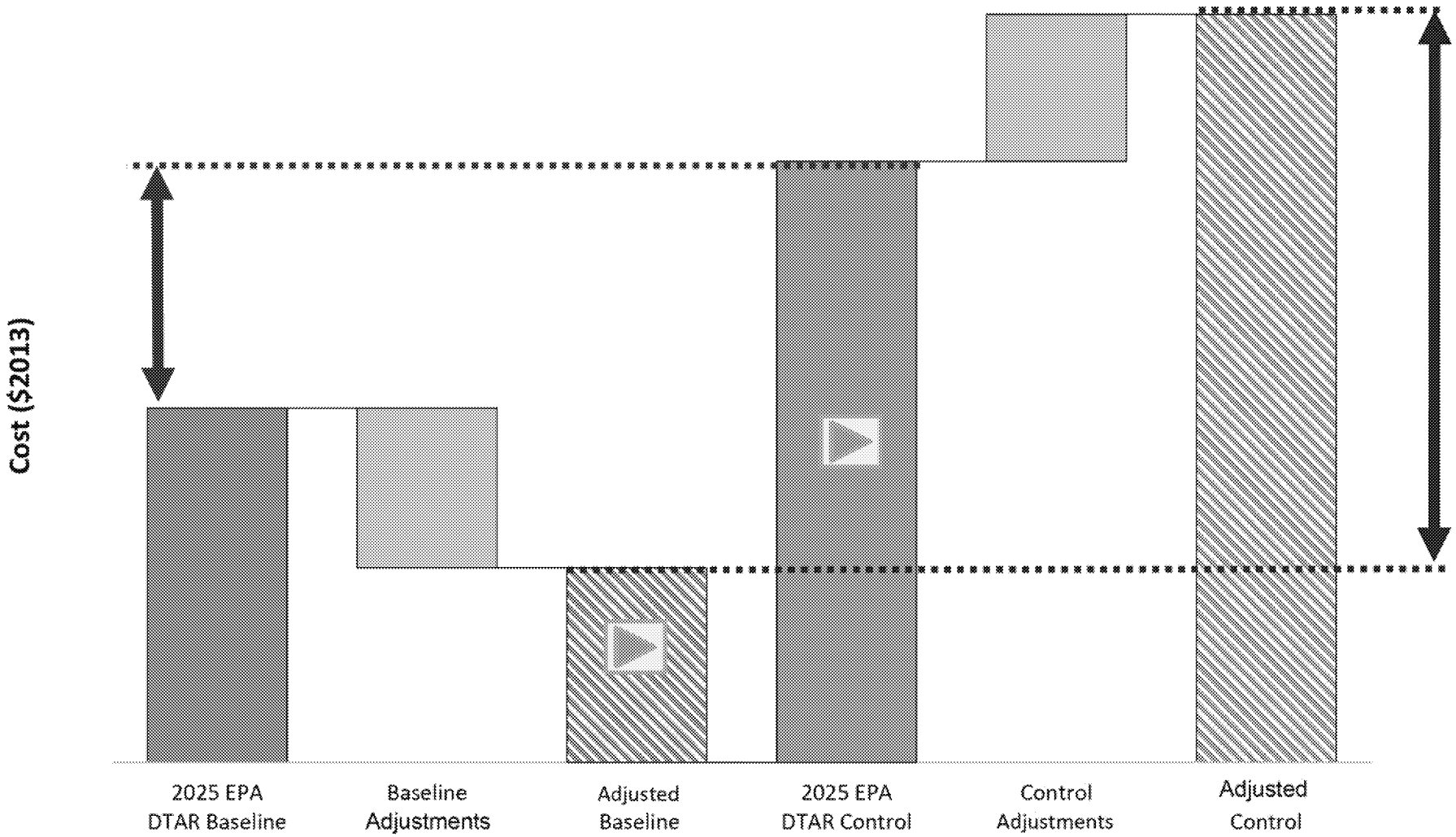
[REDACTED]

Detailed Corrections to 2025 Baseline Case

BASELINE CORRECTIONS

- Compact non-premium sales ($▼)
  - Civic HEV/ Insight
  - Civic HF
  - Civic CNG
- VVT for SOHC-V6 in baseline ($▼)
- No SAX for Ridgeline ($▼)
- Adjusted starting point for RRC ($▲)
- Adjusted starting point for WR ($▲)

Overview - EPA compared to Honda



[REDACTED]

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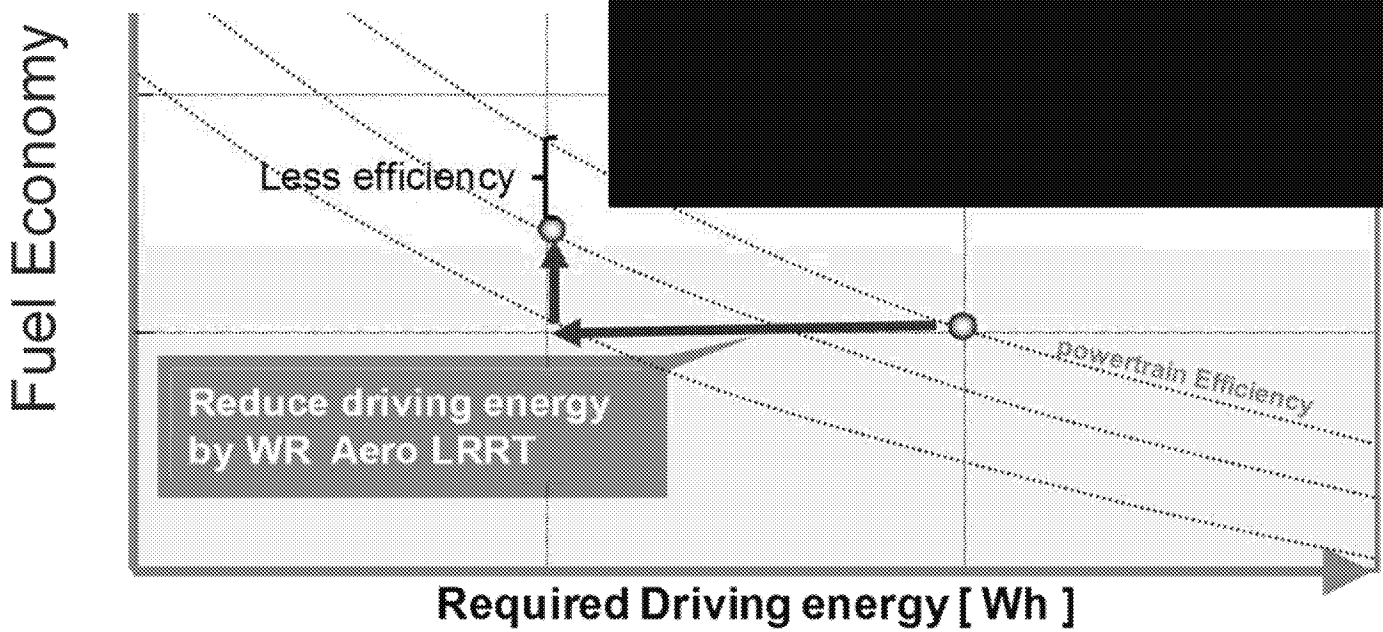
Comparing Efficiencies: Honda vs OMEGA

Honda is higher than OMEGA



[redacted]

OMEGA is higher than Honda

[redacted]

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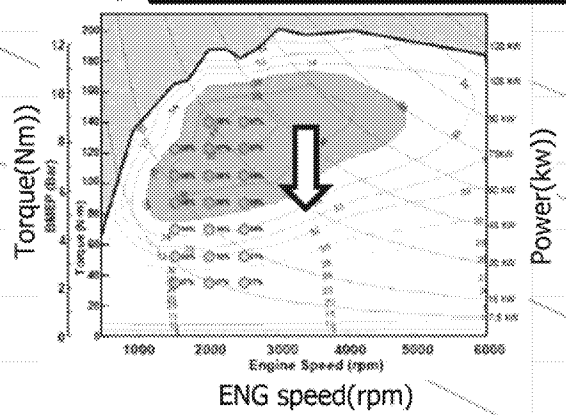
FE Improvement By Saving Driving Energy

[redacted]

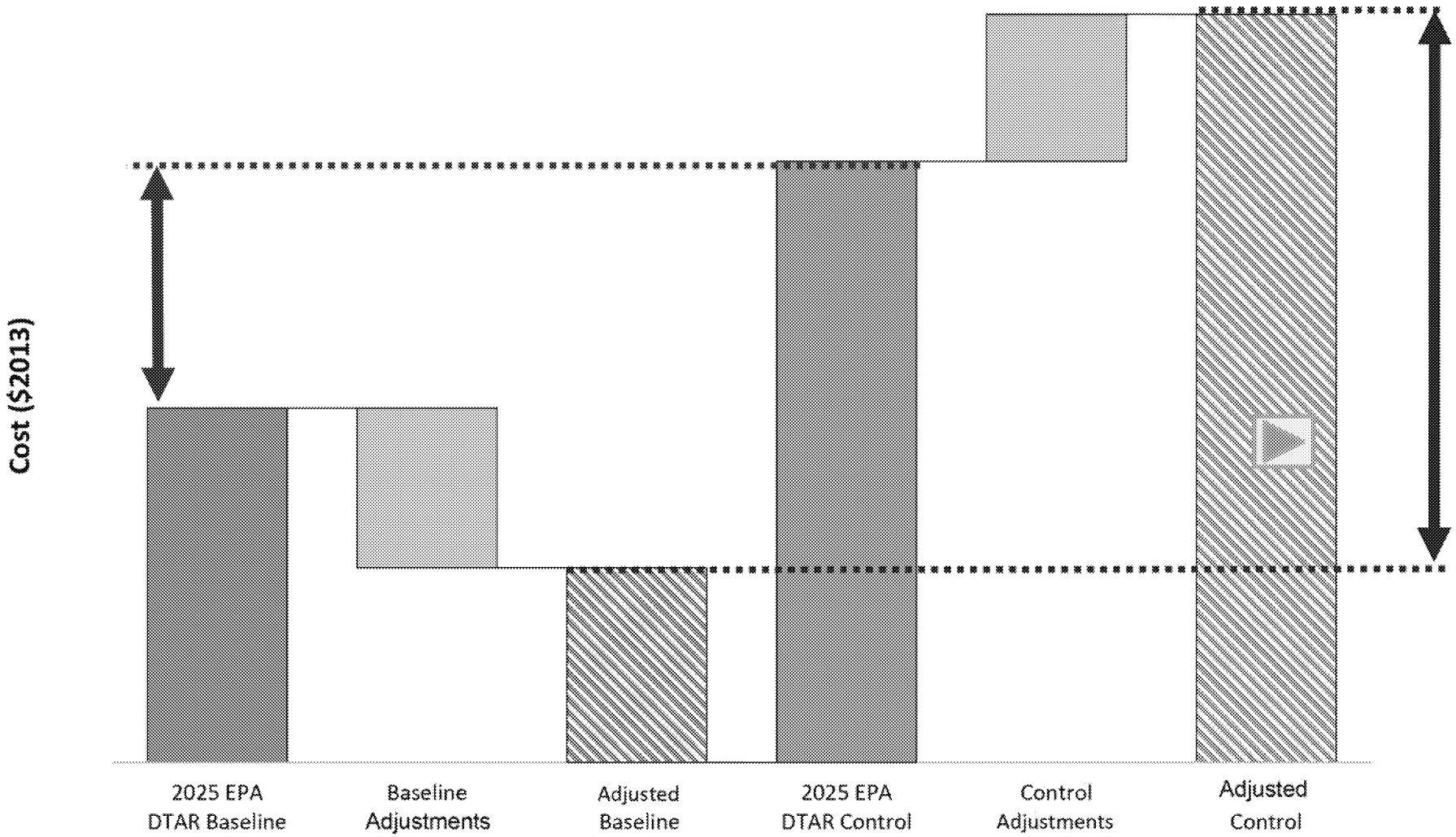


In real vehicles, PT efficiency drops [redacted]% with each [redacted]% reduction in driving energy. The reason is that the operating point moves out from the best efficiency area.

[redacted]

[redacted]

Overview - EPA compared to Honda



PT Strategy Difference TAR and Honda

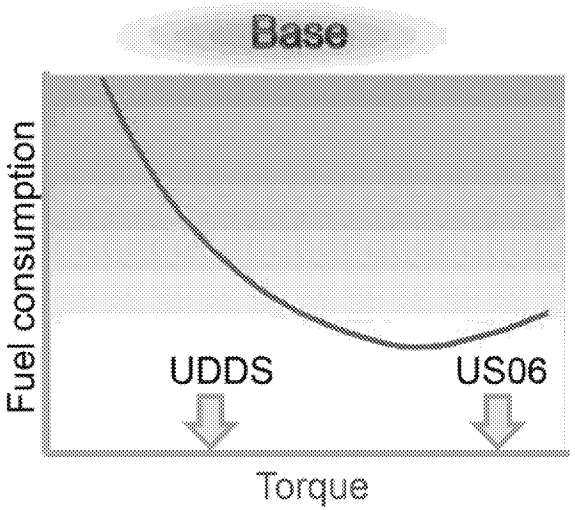
Detail Honda tech penetration by TAR

Control case 2025	HONDA		
	PC+LT	PC	LT
WR tech	5.7%	4.2%	7.4%
WR Net	5.7%	4.1%	7.4%
TDS18	32.1%	11.5%	55.7%
TDS24	0.0%	0.0%	0.0%
TRX11	6.3%	11.8%	0.0%
TRX12	0.0%	0.0%	0.0%
TRX21	79.0%	69.4%	89.9%
TRX22	3.7%	0.0%	8.0%
Deac	50.6%	57.9%	42.2%
VVLT	13.4%	25.1%	0.0%
VVT	96.1%	94.5%	97.9%
CEGR	33.1%	39.7%	25.7%
Strong HEV	6.4%	12.0%	0.0%
EV	1.8%	2.6%	1.0%
PHEV	2.1%	3.0%	1.1%
ATK1	3.4%	6.5%	0.0%
ATK2	32.6%	38.6%	25.7%
Miller	0.0%	0.0%	0.0%
StartStop	0.0%	0.0%	0.0%
Mild HEV	0.0%	0.0%	0.0%
DSL	0.0%	0.0%	0.0%

Acronyms description

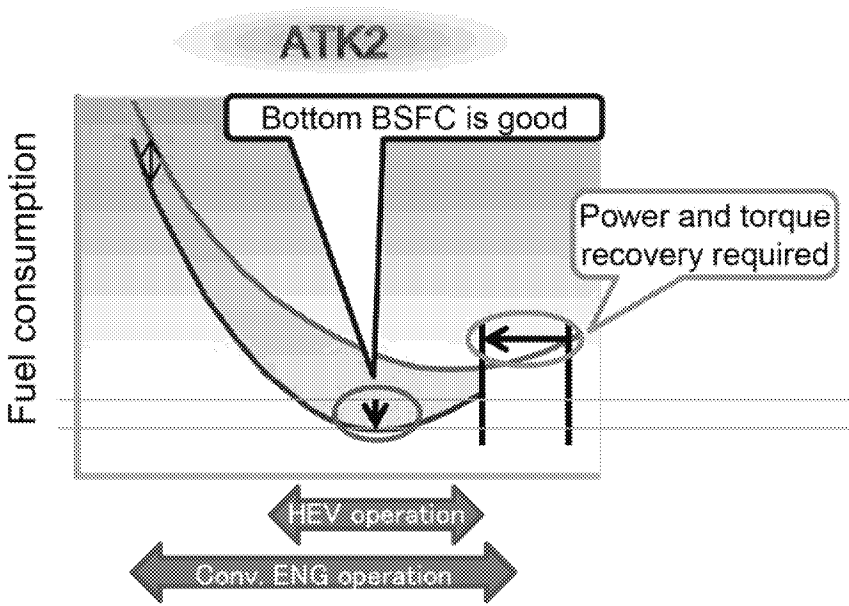
WR Tech	Weight reduction technology applied
WR Net	Weight reduction net (includes added weight from batteries on electrified vehicles)
TDS18	Turbocharged and downsized engine - 18 bar BMEP
TDS24	Turbocharged and downsized engine- 24 bar BMEP
TRX11	Transmission level 1 (i.e., 6 speed auto, 6 speed DCT or CVT today)
TRX12	Transmission level 1 (i.e., TRX11 with efficiency improvements)
TRX21	Transmission level 2 (i.e., TRX11 with a wider gear ratio spread)
TRX22	Transmission level 2 (i.e., TRX21 with efficiency improvements)
Deac	Cylinder deactivation
VVLT	Variable valve lift
VVT	Variable valve timing
CEGR	Cooled Exhaust Gas Recirculation
Strong HEV	Strong hybrid
EV	Full battery electric vehicle
PHEV	Plug-in hybrid electric vehicle)
ATK1	Atkinson cycle engine used in Full Hybrid & REEV
ATK2	Atkinson cycle engine used in naturally aspirated, non-hybrid engines
Miller	Miller cycle, or turbocharged ATK2
Stop-Start	Stop-start, but without also being hybridized
Mild Hybrid	Mild hybrid 48 Volt
DSL	Diesel

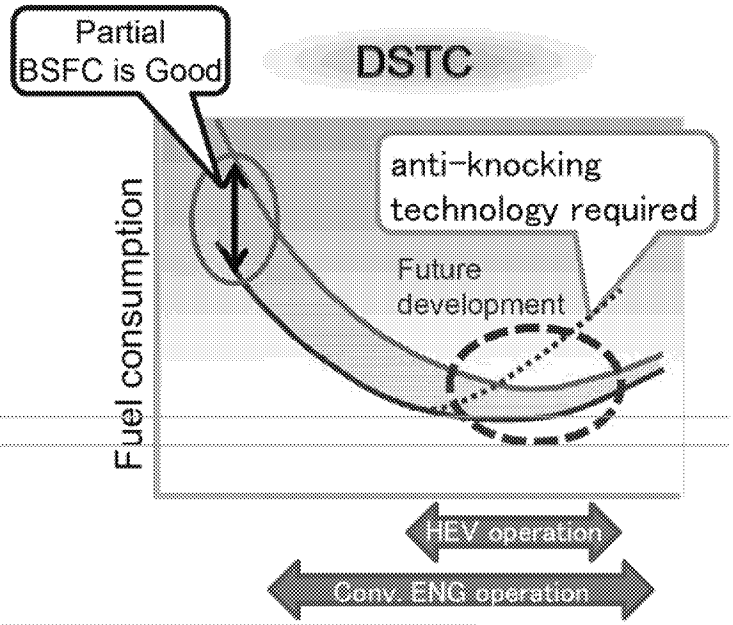
Honda's thought Pros/Cons of ATK and DSTC



[ATK]
Pros : Bottom BSFC
Cons: Less power and torque => need larger ENG displacement

[DSTC]
Pros: Low partial BSFC
Cons: Worse BSFC at high torque without anti-knock technology



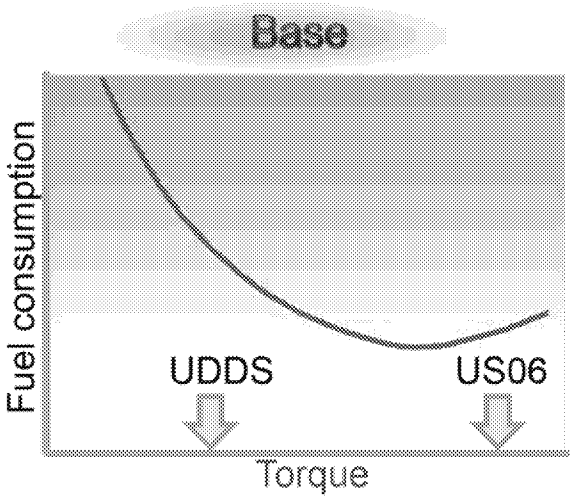


ATK is well matched to HEV, DSTC is matched to non-HEV.

[REDACTED]

[REDACTED]

Honda's thought Pros/Cons of ATK and DSTC



[ATK]
Pros : Bottom BSFC
Cons: Less power and torque => need larger ENG displacement

[DSTC]
Pros: Low partial BSFC
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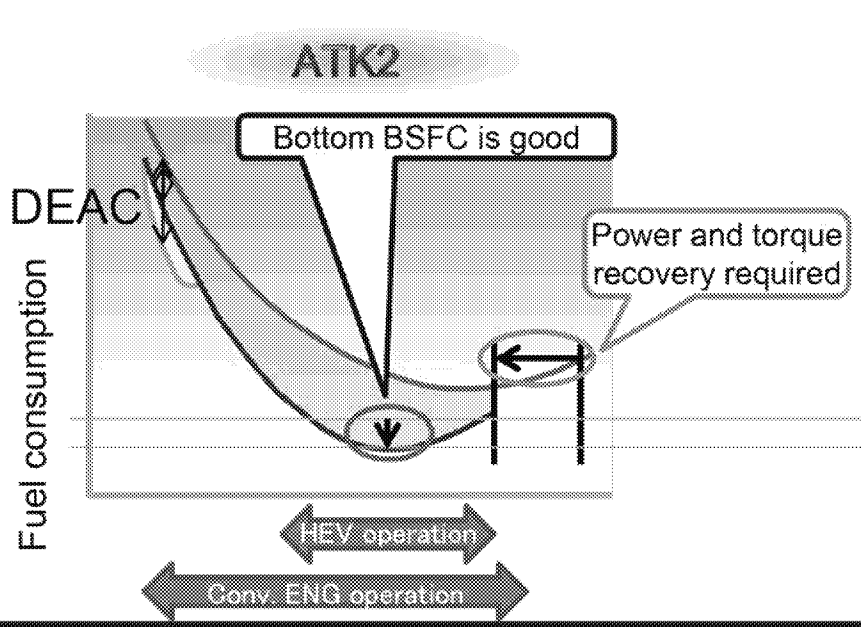

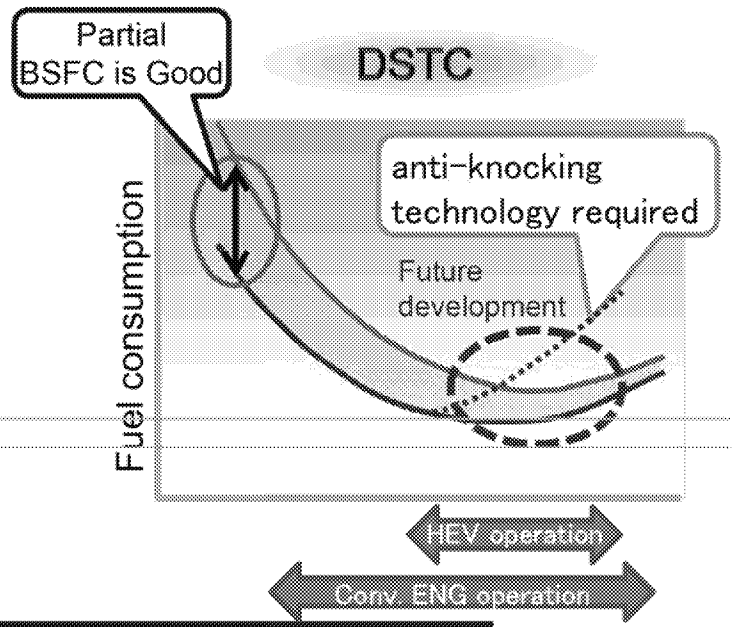

ATK is well matched to HEV , DSTC is matched to non-HEV.

HONDA 39

[REDACTED]

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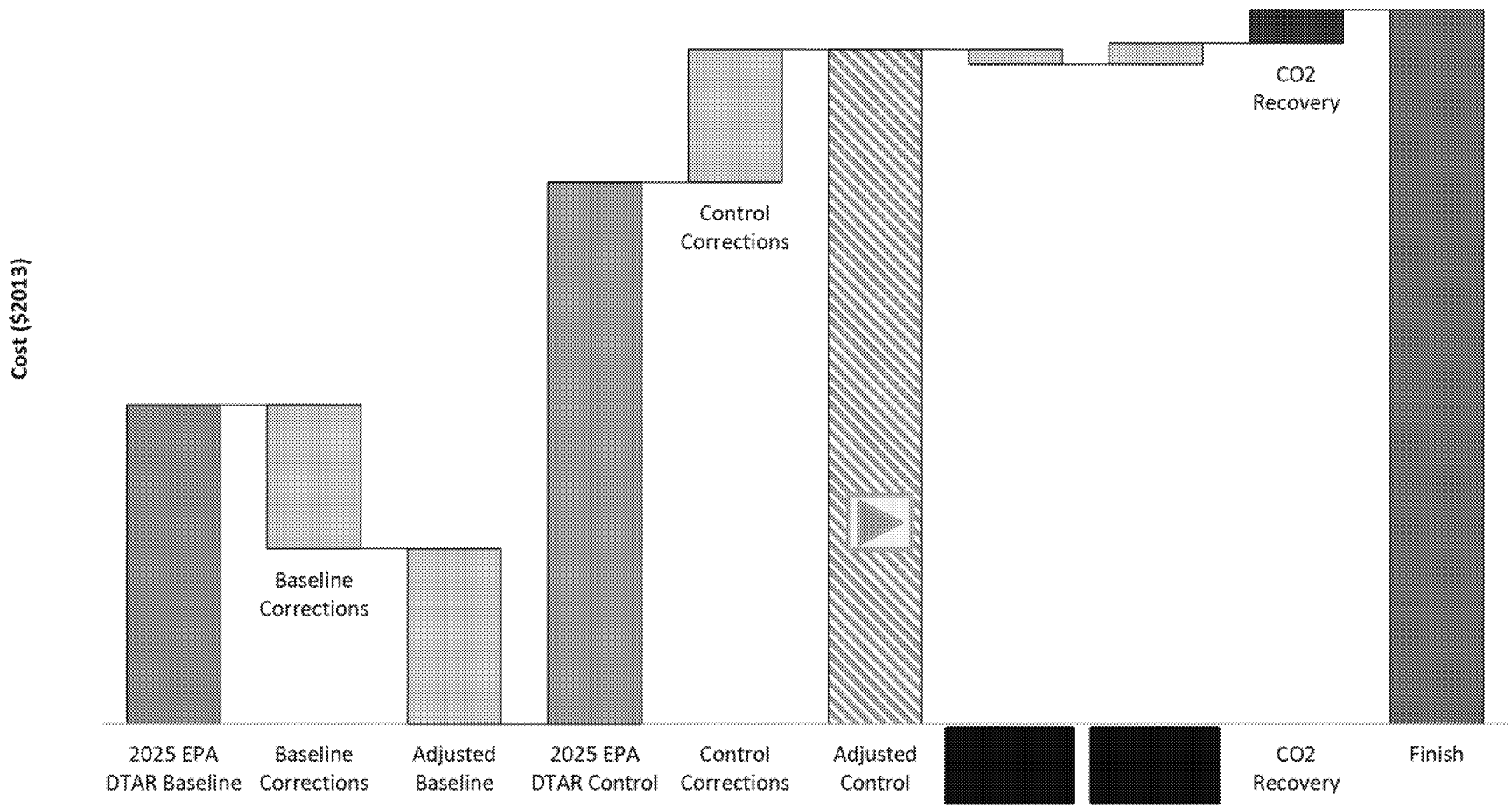
Control Case: Honda's Technology Approach



[REDACTED]

Policy Improvements

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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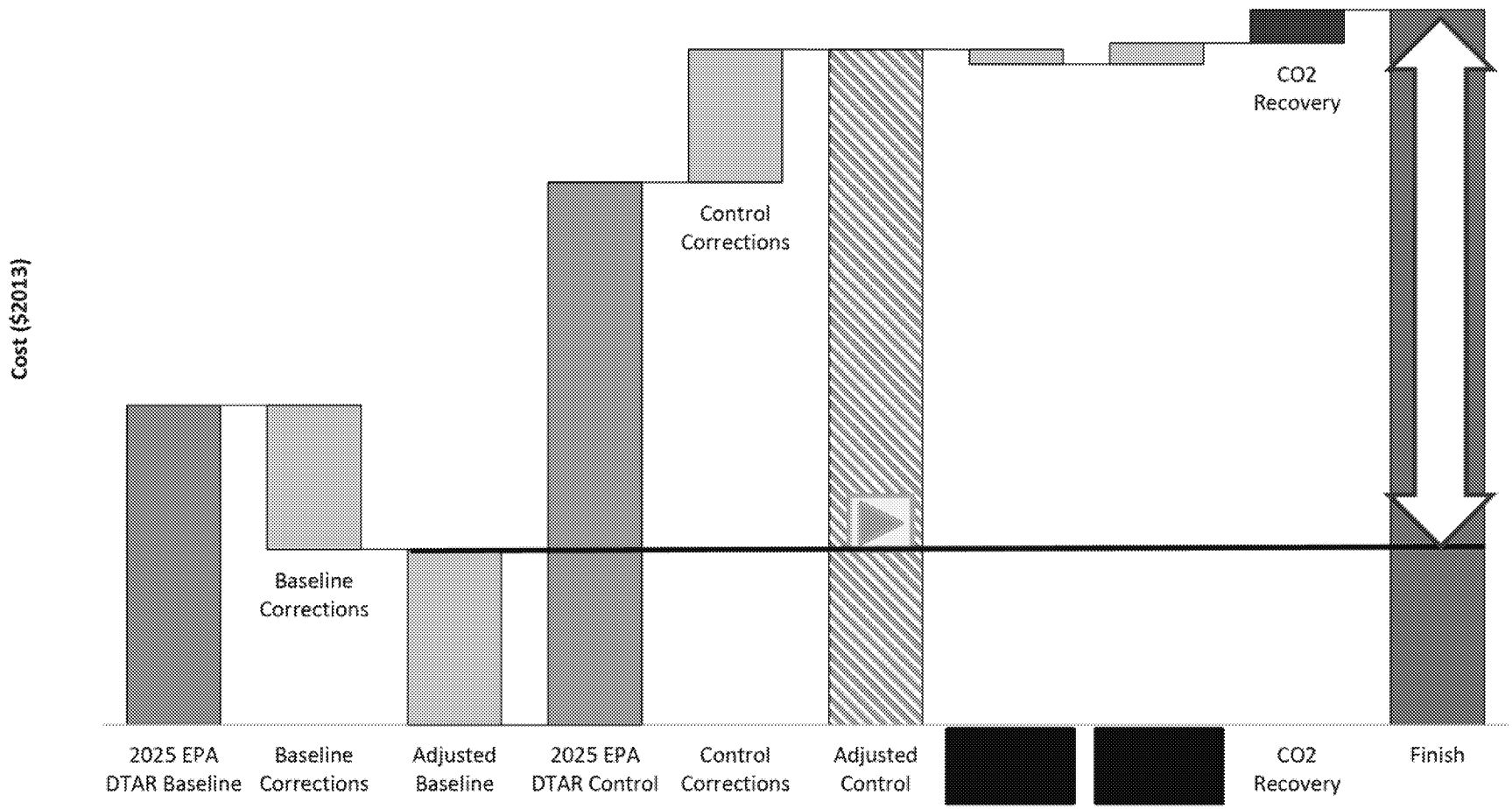
Control Case: Honda's Technology Approach



EPA Total is $900 for Honda to improve from Baseline to Control

Honda's estimate is that our costs are approximately [redacted]

HONDA 61

[REDACTED]

Conclusion

- Honda believes the targets for 2025 are correct, and consistent with long-term environmental goals

- It is important to note that compliance costs are **more than double** the amount estimated by the agencies
  - Technology required to comply is significantly underestimated
  - The marketing challenges are very significant

- Policy improvements Honda (and other OEMs) has identified can reduce compliance costs significantly while remaining true to the overarching program goals
  - Advancing technology development
  - Increasing overlap with ZEV

Message

From: Katz, Ken (NHTSA) [Ken.Katz@dot.gov]
Sent: 11/21/2016 1:11:42 PM
To: Wysor, Tad [wysor.tad@epa.gov]; Tamm, James (NHTSA) [james.tamm@dot.gov]
CC: Russell.Krupen@dot.gov [russell.krupen@dot.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]
Subject: RE: Draft Scoping Notice for 2022-2025 CAFE EIS

Hi Bill and Tad,

Thanks for your comments. We received them and are addressing them.

Have a Happy Thanksgiving!

Ken (also, on behalf of Russell)

From: Wysor, Tad [mailto:wysor.tad@epa.gov]
Sent: Friday, November 18, 2016 4:03 PM
To: Tamm, James (NHTSA)
Cc: Krupen, Russell (NHTSA); Katz, Ken (NHTSA); Charmley, William; Olechiw, Michael; Moran, Robin
Subject: RE: Draft Scoping Notice for 2022-2025 CAFE EIS
Importance: High

Jim, Bill asked me to add these 2 additional requests for the Scoping Notice, based the review from our colleagues in EPA's climate change office (OAP):

Deliberative Process / Ex. 5

Thank you.

--Tad Wysor 734 214 4332

From: Charmley, William
Sent: Friday, November 18, 2016 3:17 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Moran, Robin <moran.robin@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>

Cc: Russell.Krupen@dot.gov; Katz, Ken (NHTSA) <Ken.Katz@dot.gov>
Subject: RE: Draft Scoping Notice for 2022-2025 CAFE EIS

Dear Jim -

Thank you for providing us with the opportunity to review and provide input on the draft EIS Scoping Notice.

Deliberative Process / Ex. 5

We are checking with our colleagues in the Office of Atmospheric Programs here within EPA, and if we have any comments on the climate change analysis discussion we will get those to you ASAP. If we have no more comments, we'll let you know that as well.

Best regards,
Bill

-----Original Message-----
From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Monday, November 14, 2016 4:00 PM
To: Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Moran, Robin <moran.robin@epa.gov>
Cc: Russell.Krupen@dot.gov; Katz, Ken (NHTSA) <Ken.Katz@dot.gov>
Subject: Draft Scoping Notice for 2022-2025 CAFE EIS

Hi Bill, Mike and Robin,

Please see the attached draft scoping notice for the MYs 2022-2025 CAFE EIS. The text parallels recent scoping notices. We welcome EPA review and request your feedback by COB Friday, November 18. Please cc: Russell Krupen and Ken Katz on your response.

Thanks in advance for your feedback.

Jim

Message

From: John Freiler [john@ttmanet.org]
Sent: 6/1/2017 5:38:25 PM
To: marc.megel@swri.org; Cullen, Angela [cullen.angela@epa.gov]; Charmley, William [charmley.william@epa.gov]; Brian Routhier [brian.routhier@dot.gov]; Caitlin Rayman [Caitlin.Rayman@dot.gov]; Chris Grigorian (cgrigorian@foley.com) [CGrigorian@foley.com]; Moulis, Charles [moulis.charles@epa.gov]; Colin Holthaus [colin.holthaus@natm.com]; Collin Mooney [collinm@cvsa.org]; Coralie.Cooper@dot.gov; David Hines [david.hines@dot.gov]; Don Moore [don.moore@atminc.on.ca]; Dornan, Laura (EC) [laura.dornan@canada.ca]; Ed Strocko [Ed.Strocko@dot.gov]; Fortes, Leandro (EC) [leandro.fortes@canada.ca]; Frank Borris [frank.borris@dot.gov]; James Tamm [james.tamm@dot.gov]; Jeremy Harrower [jharrower@atminc.on.ca]; Brakora, Jessica [Brakora.Jessica@epa.gov]; Bachman, Joseph [Bachman.Joseph@epa.gov]; John Berg [john.berg@dot.gov]; Johnson, Dennis [Johnson.Dennis@epa.gov]; Kyle Bowker [kyle.bowker@dot.gov]; Larry Minor [Larry.minor@dot.gov]; Luke Loy [luke.loy@dot.gov]; Mario Demers [mario.demers@tc.gc.ca]; Markus Price [markus.price@dot.gov]; Spears, Matthew [spears.matthew@epa.gov]; Mike Cole [mcole@nhtsa.dot.gov]; Mike Huntley [Michael.huntley@dot.gov]; Nicolas Courville [nicolas.courville@tc.gc.ca]; Pam Trusdale [pam.trusdale@natm.com]; Patrick Hallan [Patrick.Hallan@dot.gov]; Robert Braswell [rbraswel@trucking.org]; Russel Rieger [riegerr@sympatico.ca]; Waltzer, Sam [Waltzer.Sam@epa.gov]; Shashi Kuppa [shashi.kuppa@dot.gov]; Steele, Lauren [steele.lauren@epa.gov]; Thomas Reinhart [thomas.reinhart@swri.org]; Tony Greszler [agreszler@gmail.com]; Trudeau, Pierre (EC) [pierre.trudeau@canada.ca]; Wade, Marilyn D. [marilyn.wade@swri.org]; William Schaefer [williams@cvsa.org]; Wysor, Tad [wysor.tad@epa.gov]
CC: Carrie Renuart [carrie@ttmanet.org]; Jeff Sims [Jeff@ttmanet.org]
Subject: Re: TTMA's Joint Industry/Government Meeting - August 2

Sorry about the confusion: the meeting is actually on Wednesday, August 2nd as shown in the subject line.

Corrected e-mail follows:

Good Afternoon Ladies & Gentlemen,

The Truck Trailer Manufacturers Association would like to invite you to attend our annual Joint Industry/Government Meeting in Alexandria, VA, at the Embassy Suites Hotel. The meeting will begin at 8:00 am on Wednesday, August 2nd and run into the afternoon. We plan to serve some breakfast items for our early arrivals and a box lunch. As usual, there is no charge to attend this meeting, but we do request that you RSVP so we can prepare the space and provide chairs & materials for everyone.

We value the relationship we have established with professionals outside our organization and hope to both ask and answer questions on issues of the day. Currently, our agenda is open; let me know if you have an issue to suggest and I'll add it to the agenda.

The hotel is directly across the street from the King Street Metro station. If you need a room, you can book one in TTMA's room block at our negotiated rate of $174 per night here. The room block closes on July 7th.

Meeting particulars:

Location:

Embassy Suites Hotel - Old Town

1900 Diagonal Road

Alexandria, Virginia, 22314

TEL: 1-703-684-5900

Date & Time:

August 2nd, 2017 8:00 am – 3:00 pm

Room:

Salon A

Please let me know if you have any questions and if you can attend.

John Freiler - Engineering Manager

Truck Trailer Manufacturers Association
7001 Heritage Village Plaza
Suite 220
Gainesville, VA 20155-3094

703-549-3010 - Phone

On Thu, Jun 1, 2017 at 1:14 PM, John Freiler <john@ttmanet.org> wrote:

Good Afternoon Ladies & Gentlemen,

The Truck Trailer Manufacturers Association would like to invite you to attend our annual Joint Industry/Government Meeting in Alexandria, VA, at the Embassy Suites Hotel. The meeting will begin at 8:00 am on Thursday, July 28th and run into the afternoon. We plan to serve some breakfast items for our early arrivals and a box lunch. As usual, there is no charge to attend this meeting, but we do request that you RSVP so we can prepare the space and provide chairs & materials for everyone.

We value the relationship we have established with professionals outside our organization and hope to both ask and answer questions on issues of the day. Currently, our agenda is open; let me know if you have an issue to suggest and I'll add it to the agenda.

The hotel is directly across the street from the King Street Metro station. If you need a room, you can book one in TTMA's room block at our negotiated rate of $174 per night here. The room block closes on July 7th.

Meeting particulars:

Location:

Embassy Suites Hotel - Old Town

1900 Diagonal Road

Alexandria, Virginia, 22314

TEL: 1-703-684-5900

Date & Time:

July 28, 2016 8:00 am – 3:00 pm

Room:

Salon A

Please let me know if you have any questions and if you can attend.

John Freiler - Engineering Manager

Truck Trailer Manufacturers Association
7001 Heritage Village Plaza
Suite 220
Gainesville, VA 20155-3094

703-549-3010 - Phone

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 4/13/2017 1:17:09 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: RE: HD Phase 2

3:30 works for me. I'll pencil it in.

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Thursday, April 13, 2017 9:02 AM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: RE: HD Phase 2

Jim,

I am open between 3:30 and 5pm. If you have an open time in that window let me know, and we will go with that time.

Thanks
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Wednesday, April 12, 2017 5:54 PM
To: Charmley, William <charmley.william@epa.gov>
Subject: RE: HD Phase 2

Bill,
Tomorrow would work. Would you be available around 1:00 or later?
Jim

Sent with Good (www.good.com)

From: Charmley, William <charmley.william@epa.gov>
Sent: Wednesday, April 12, 2017 11:18:17 AM
To: Tamm, James (NHTSA)
Subject: HD Phase 2

Jim,

I left you a voice-mail on your desk number this morning regarding the heavy-duty Phase 2 program.

Do you have time on either Thursday or Friday of this week for a short discussion – maybe 15 minutes?

Thanks
Bill

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 11/18/2016 8:17:55 PM
To: Charmley, William [charmley.william@epa.gov]
Subject: Automatic reply: Draft Scoping Notice for 2022-2025 CAFE EIS

I am out of the office and will return on Tuesday, November 29. If you need immediate response, please contact

November 17, 18 and 28: Greg Powell (gregory.powell@dot.gov)
November 21 and 22: Seiar Zia (seiar.zia@dot.gov)
November 23 and 25: Vinay Nagabhushana (vina.nagabhushana@dot.gov)

Message

From: Chris Nevers [CNevers@autoalliance.org]
Sent: 1/11/2017 4:58:24 PM
To: McCabe, Janet [McCabe.Janet@epa.gov]
CC: grundler.chris@epa.gov; Charmley, William [charmley.william@epa.gov]; james.tamm@dot.gov
Subject: Hearing Request
Attachments: MTE Hearing Request Alliance 1-11-17.pdf

Dear Acting Administrator McCabe,

Please see the attached request for a hearing on EPA's Proposed Determination Regarding MY 2022-2025 Motor Vehicle Greenhouse Gas Standards. Let me know if you or your staff have any questions.

Best Regards,
Chris Nevers
Vice President, Energy and Environment
Alliance of Automobile Manufacturers
248-794-5002

AUTO ALLIANCE
DRIVING INNOVATION

January 11, 2017

Janet McCabe
Acting Assistant Director
Office of Air and Radiation
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, N.W.
Mail Code: 6101A
Washington, DC 20460

Submitted electronically to www.reguations.gov; Docket ID No. EPA-HQ-OAR-2015-0827

Subject: Request for Hearing on EPA's Proposed Determination Regarding MY 2022-2025 Motor Vehicle Greenhouse Gas Standards

Dear Ms. McCabe:

The Alliance of Automobile Manufacturers[1] (Alliance) requests a hearing on EPA's Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation, published at 81 FR 87927 (December 6, 2016).

Section 307of the CAA sets forth requirements applicable to administrative proceedings and judicial review in connection with actions taken by EPA pursuant to the CAA. Pursuant to Section 307(d), whenever EPA engages in "the promulgation or revision of regulations under section 7521 of this title[2] [CAA § 202], the Administrator "shall give interested persons an opportunity for the oral presentation of data, views, or arguments, in addition to an opportunity to make written submissions." 42 U.S.C § 7607(d)(5). The CAA further directs the Administrator to keep transcripts of oral presentations made at the hearing, and to keep the record of the proceeding open for thirty days after the hearing "to provide an opportunity for

[1] Alliance members are BMW Group, FCA US, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, and Volvo Cars of North America. For additional information, go to http://www.autoalliance.org
[2] See CAA 307(d)(1)(K), 42 U.S.C § 7607(d)(1)(K).

submission of rebuttal and supplementary information." *Id.* In accordance with these provisions, the Alliance hereby requests an opportunity for the oral presentation of data and information in connection with the Proposed Determination.

EPA has asserted that its proceedings in connection with the Midterm Evaluation amount to an "adjudication." Even assuming this is the case, it is an adjudication regarding future standards of general applicability to the automobile industry, and a hearing on the Proposed Determination would help to inform EPA's decision-making process with respect to any Final Determination. We therefore request a hearing on the Proposed Determination regardless of the nature of the proceeding.

The Alliance stands ready to participate in such a hearing at the time and place of the Administrator's choosing.

Thank you for your attention to this request.

Yours truly,

Chris Nevers
Vice President, Energy and Environment

Cc: Chris Grundler, EPA
Bill Charmley, EPA
James Tamm, NHTSA

Message

From: Amandine Muskus [amuskus@globalautomakers.org]
Sent: 6/27/2017 12:55:47 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]
CC: Michael Hartrick (MHartrick@autoalliance.org) [MHartrick@autoalliance.org]; Julia Rege [JRege@globalautomakers.org]; Nevers, Chris (Alliance) [cnevers@autoalliance.org]; (Kevin.Green@dot.gov) [Kevin.Green@dot.gov]; Helfand, Gloria [helfand.gloria@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Kargul, John [kargul.john@epa.gov]; warren.bogard@dot.gov; Charmley, William [charmley.william@epa.gov]; james.tamm (james.tamm@dot.gov) [james.tamm@dot.gov]; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]
Subject: EPA and Global and Alliance
Attachments: 2017-06-22 FINAL Industry Presentation to EPA.pdf

Hi Mike,

Thank you for this list. Please find a copy of our presentation from last week. Please let us know if you need additional information.

Best,
Amandine Muskus
Manager, Environment & Energy
Association of Global Automakers, Inc. (Global Automakers)
1050 K Street, NW, Suite 650
Washington, DC 20001
202.650.5547 (direct)
202.650.5555 (main)
amuskus@globalautomakers.org

GlobalAutomakers

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From: Olechiw, Michael [mailto:olechiw.michael@epa.gov]
Sent: Monday, June 26, 2017 6:21 PM
To: Michael Hartrick (MHartrick@autoalliance.org) <MHartrick@autoalliance.org>; Amandine Muskus <amuskus@globalautomakers.org>
Cc: Moran, Robin <moran.robin@epa.gov>
Subject: Attendees at last week's meeting between EPA and Global and Alliance

Mike and Amandine,

Thank you both for all of your efforts in organizing last week's meeting. I hope that both organizations found the meeting to be beneficial.

I have attached the sign-in sheet. Please confirm the list of attendees for your respective associations at your earliest convenience.

Finally, when can we expect to receive your presentation? Please let me know.

Best Regards,

Mike

Michael R. Olechiw
Director - Light-duty Vehicles and Small Engines Center
USEPA/OTAQ/ASD
2000 Traverwood Drive
Ann Arbor MI 48105
Tel: +1-734-214-4297
Mobile: +1-734-546-8079
Fax: +1-734-214-4050
olechiw.michael@epa.gov

Midterm Evaluation Discussion

Industry - EPA

June 22, 2017

GlobalAutomakers

AUTO ALLIANCE
DRIVING INNOVATION®

Agenda

- Introduction
- Recent Compliance Trends
- Technical Modeling
- Customer Acceptance
- Economic Considerations
- Technical and Process Questions

Background

- Automakers support reducing fuel consumption and greenhouse gas emissions
- A robust, technically accurate NHTSA rulemaking and EPA midterm evaluation is critical
- Automakers have significant concerns with technical outputs from EPA thus far
- We support a transparent and technically accurate modeling process

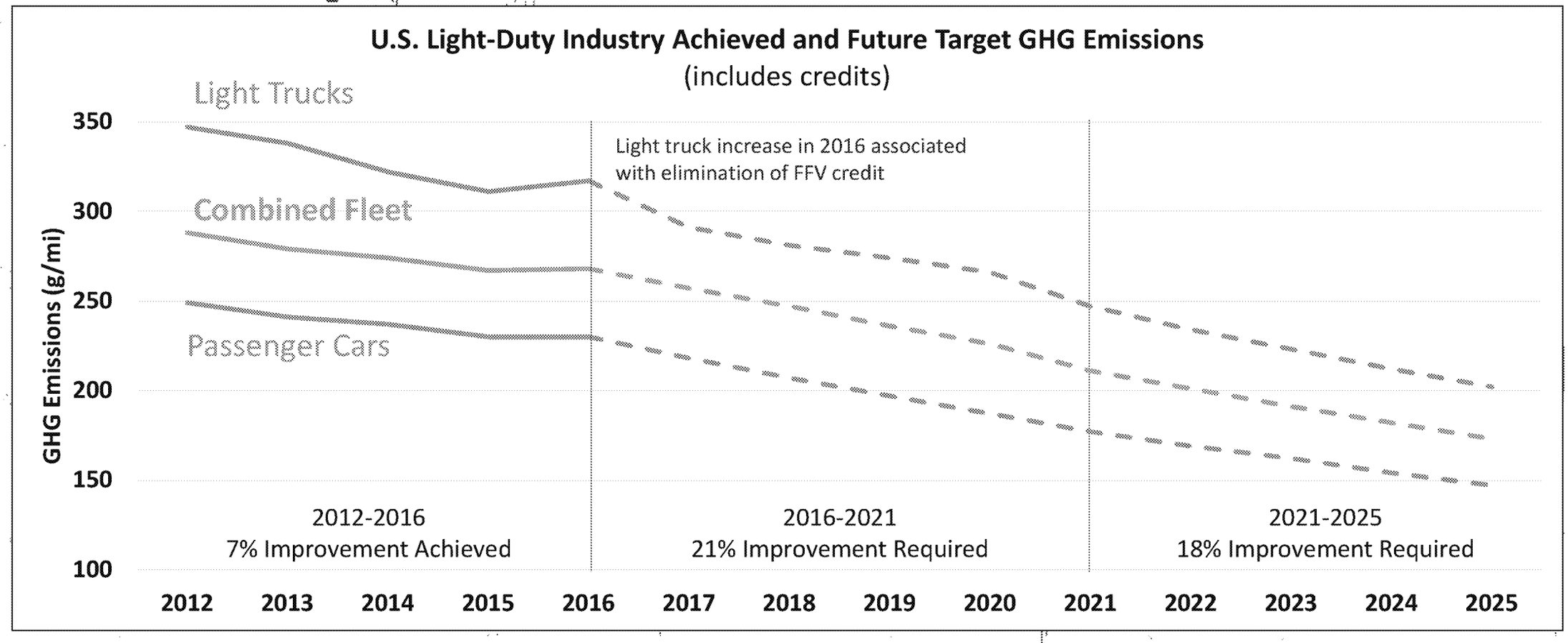
Process Moving Forward?

- **Interagency communication**
- **Staff engagement with auto manufacturers to understand and adequately respond to concerns**
  - Most efficient to have joint communications to resolve differences
- **Transparency in processes and assumptions**
- **Adequate time to assess technical inputs and outputs as specifically applied for the MTE**

Recent Manufacturer Efforts

- **Focused on NHTSA modeling**
  - Iterative meetings to more fully inform a 2016 model year technology baseline assessment
  - In-depth technical meetings with industry experts
  - Briefing from Novation Analytics regarding displacement-based transforms of full vehicle simulation data to compliance models
- **Evaluation of 2016+ compliance and technology trends**
  - Recent compliance trends as standards continue to ramp up
  - Continuing gap between non-electrified vehicles and future compliance targets
- **Assessment of EPA modeling work which informed the proposed and final determinations**
  - Continued efforts to understand the source of significant differences
  - Additional study by Novation Analytics subject of July 13 briefing to EPA

Light-Duty GHG Progress and Future Requirements

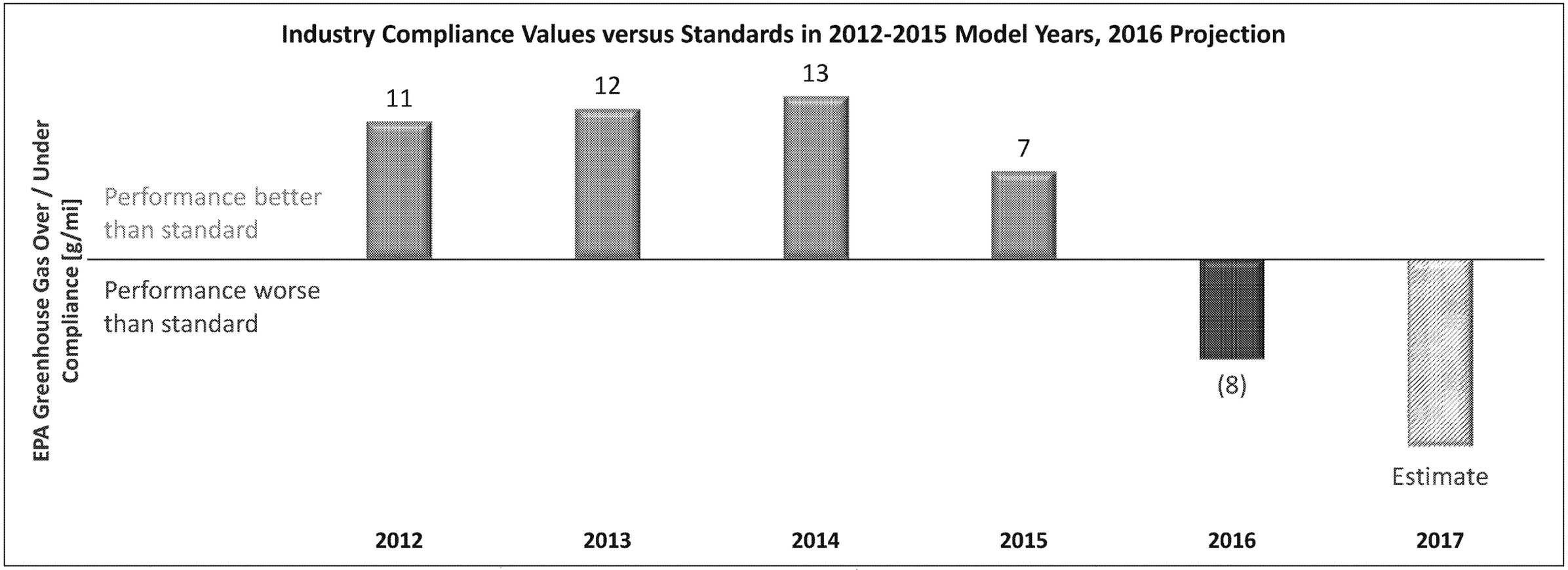


Significant challenges lie ahead

Sources

- 2012-2015: "Greenhouse Gas Emission Standards for Light-Duty Vehicles: Manufacturer Performance Report for the 2015 Model Year." U.S. Environmental Protection Agency. EPA-420-R-16-014, November 2016. 56.
- 2016: "MY 2016 Baseline Study." Novation Analytics. December 20, 2016. 31.
- 2017-2025: U.S. Environmental Protection Agency OMEGA v1.4.56 runs for the Proposed Determination. November, 2016.

GHG Compliance Trend

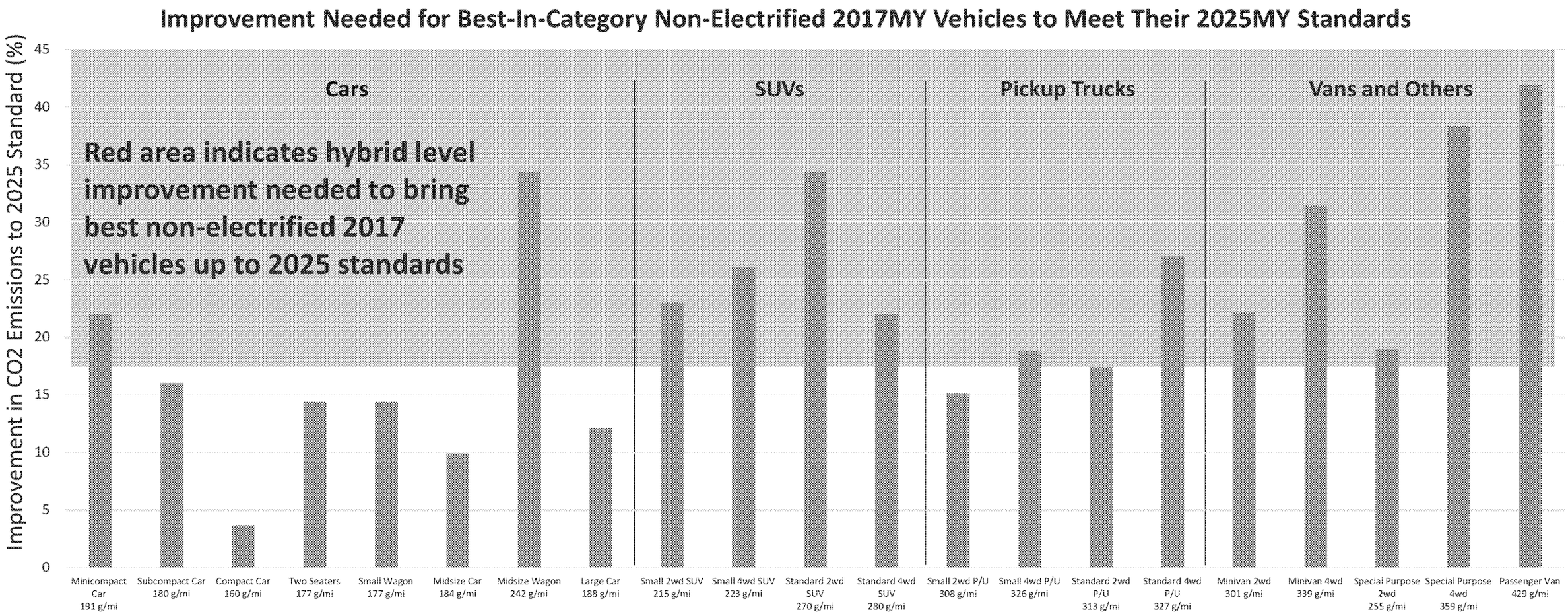


Industry is no longer "meeting the standards more quickly than required" and is falling behind

Sources:

- 2012-2015: "Greenhouse Gas Emission Standards for Light-Duty Vehicles: Manufacturer Performance Report for the 2015 Model Year." U.S. Environmental Protection Agency. EPA-420-R-16-014, November 2016. iii.
- 2016: "MY 2016 Baseline Study." Novation Analytics. December 20, 2016. 31. Calculation.
- 2017: Estimate based on "Projected Fuel Economy Performance Report." National Highway Traffic Safety Administration. February 2017. Estimate removes ~0.5 mpg FFV credit from reported CAFE performance.

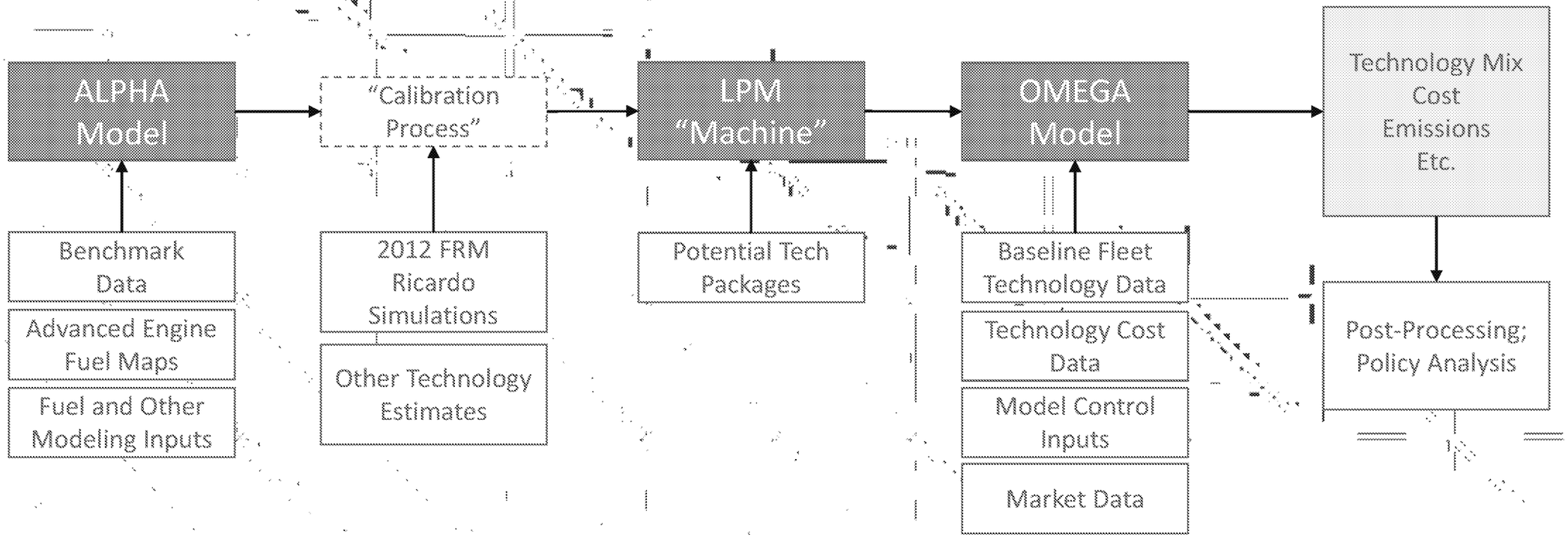
Improvement Needed to Meet 2025MY Standards



Sources: www.fueleconomy.gov; strong hybrid range from U.S. EPA Technical Support Document to the Nov. 2016 Proposed Determination

Current data on best non-electrified vehicles highlights manufacturer concerns on EPA technical outputs

Manufacturers' Understanding of Process



- **Many inputs to LPM, not just ALPHA model?**
- **Unclear "calibration process"**
- **LPM "machine" requires special knowledge to operate**
- **Many concerns with all three models used to inform previous determination**

ALPHA Model

- **Recent EPA SAE papers describe improvements in ALPHA not used for the January determination**
  - Development of transient operation correction factors (increase in modeled fuel consumption)
  - Additional work on Atkinson engine modeling

- **Additional work could improve ALPHA model accuracy further**
  - Inclusion of hybrid systems including 48V mild hybrids
  - Validation of transient operation estimates across vehicle technologies and classes
  - Cold start penalties: Advanced emission system changes to bag 3; less exhaust heat availability
  - Regulation-driven requirements: Regular grade octane fuel, emission test weight bins
  - Performance neutrality metrics
  - Refinement of cylinder deactivation assessments
  - Validation of GT Power model using recently introduced Atkinson engines
  - Modeling of emissions and emission control system impacts

Lumped Parameter Model

- Documentation of step through from ALPHA to Lumped Parameter Modeling
  - Has this been updated?
  - If no, is there a timeline for updating?
- Is there additional information beyond the 18% of 2025 technology packages in control case were traceable back to ALPHA simulations?
- Unclear if change to road load and power to weight ratio fully addresses concerns regarding lack of displacement basis to modeling results

Manufacturers are seeking greater clarity on data and processes used for calibration of the lumped parameter model

OMEGA Model Discussion Points

- **Model generally optimizes technology package selection in a manner not executable by manufacturers**
  - Explosion of single vehicle / powertrain variants into multiple new variants
  - Implicit assumption of infinite engine displacement availability
  - "Improved" models at zero or negative cost
- **No consideration of product timing implications to cost**
- **Cost traceability**
  - FEV teardown analysis costs based on specific assumptions of volume and time in market – OMEGA outputs may violate these constraints without subsequent impact on cost

OMEGA generally yields results that are over-optimized in comparison to an executable plan
Need model outputs to be reviewed for feasibility and practicability before use in policy analysis

Consideration of Customer Acceptance

- **Draft TAR, Proposed / Final Determinations:**
  - Minimal consideration of gap between regulatory mandates and consumer desires
  - Affordability issues minimized by only looking at ~~pieces~~ of the regulatory burden over limited time
  - Favored 3rd party analysis over that provided by manufacturers

- **Need more than "customers like fuel economy"**
  - How do customers prioritize and value fuel economy in the actual purchase decision?
  - How much are customers willing to pay for additional fuel economy technologies?

- **Need to evaluate overall impact on vehicle affordability**
  - Total cost increases expected from baseline year associated with GHG regulations
  - Additional costs imposed by related regulations approved by EPA
  - In the context of changing credit markets

Considerations of Economic Impacts

- **Previous EPA analysis provided generic estimates and argued that long-term fuel savings would generate positive economic outcomes**
  - What are the next steps in expanding these estimates based on new data?
- **How are economic impacts of stranded capital and changes to supply of parts demands being accounted for in the model?**
  - Sharing of technology is not freely open from one manufacturer to another, how is this accounted for in the modeling?
- **3rd party studies of employment gains from efficiency technologies are limited**
  - Fail to consider job creation associated with increasing sales absent efficiency regulation
  - Fail to consider whether similar investments in other types of technology would have created equivalent jobs

Economics of development cycles have not been fully accounted for/documented in the modeling

Process Going Forward?

- How does EPA plan on coordinating MTE analysis with the NHTSA CAFE rulemaking modeling?
- Does EPA plan on making any wholesale changes to the modeling approach or will it be similar to the previously used approach?
- What adjustments does EPA plan on making based on recent meetings with manufacturers?
- What additional input is needed to understand our concerns?
- What other ongoing work is EPA engaged in?
- What does EPA see as next steps?
- How is the EPA planning on working to keep California at the table to continue One National Program?

Message

From: Hengst, Benjamin [Hengst.Benjamin@epa.gov]
Sent: 12/20/2016 6:55:35 PM
To: McCabe, Janet [McCabe.Janet@epa.gov]; Shoshana Lew [shoshana.lew@dot.gov]; Dan G. Utech [Dan_G._Utech@who.eop.gov]; Jason S. EOP/WHO Miller [Jason_S_Miller@who.eop.gov]; Paul Hemmersbaugh (NHTSA) [paul.hemmersbaugh@dot.gov]; James Tamm [james.tamm@dot.gov]
CC: Charmley, William [charmley.william@epa.gov]; Distefano, Nichole [DiStefano.Nichole@epa.gov]; Grundler, Christopher [grundler.christopher@epa.gov]
Subject: Fwd: Draft Response to Petitions for Harmonization and Civil Penalties
Attachments: Alliance Global petition on credits -- grant of petition -- 20 Dec 2016 (inc OTAQ comments).docx; ATT00001.htm; civil penalty adjustment response to Alliance Global PFR -- 20 Dec 16 pa (inc OTAQ-CD comments).docx; ATT00002.htm

Hi all,

Attached are EPA's edits to the documents Paul circulated. These have been shared with NHTSA staff already, but we wanted to send as an FYI. Thanks, Ben

From: Charmley, William
Sent: Tuesday, December 20, 2016 7:34 AM
To: Jim Tamm <james.tamm@dot.gov>; Rebecca Yoon <rebecca.yoon@dot.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Silverman, Steven <silverman.steven@epa.gov>
Subject: Fwd: Draft Response to Petition for Harmonization and Civil Penalties

Dear Jim and Rebecca

Our plan on Ann Arbor is to send you all comments by noon today on these documents that Jim and Paul Hemmersbaugh sent yesterday.

Personal Matters / Ex. 6 between Robin, Mike and Tad we should be available if there are any questions on the comments EPA provides.

Thanks

Bill

Sent from my iPhone

Begin forwarded message:

From: "Hemmersbaugh, Paul (NHTSA)" <paul.hemmersbaugh@dot.gov>
Date: December 19, 2016 at 4:29:13 PM EST
To: "Tamm, James (NHTSA)" <james.tamm@dot.gov>, 'Janet McCabe' <mccabe.janet@epa.gov>, 'Chris Grundler' <Grundler.christopher@epa.gov>, 'Ben Hengst' <Hengst.benjamin@epa.gov>, "charmley.william@epa.gov" <charmley.william@epa.gov>, "Utech, Dan G. EOP/WHO" <Dan_G._Utech@who.eop.gov>, "Miller, Jason S. EOP/WHO" <Jason_S_Miller@who.eop.gov>
Cc: "Lew, Shoshana (OST)" <shoshana.lew@dot.gov>
Subject: Draft Response to Petition for Harmonization and Civil Penalties Deliberative Process / Ex. 5

All,

Attached are the draft grant of the civil penalties deferral and the revised partial grant of the Petition for rulemaking regarding credits (harmonization). Dan and Jason, it looks like you may not have been on the prior distribution that Jim sent out. If so, sorry. Revisions to the harmonization/credits petition from today's earlier version are indicated in track changes. If you have comments or edits on either of the two documents, please let us know at your earliest opportunity. Thanks, Paul.

PAUL HEMMERSBAUGH

NHTSA CHIEF COUNSEL

PAUL.HEMMERSBAUGH@DOT.GOV

202/ 366-2830 (O)

(202) 420-1531 (C)

From: Tamm, James (NHTSA)
Sent: Monday, December 19, 2016 1:35 PM
To: 'Janet McCabe'; 'Chris Grundler'; 'Ben Hengst'; charmley.william@epa.gov

Cc: Lew, Shoshana (OST); Hemmersbaugh, Paul (NHTSA)
Subject: Draft Response to Petition for Harmonization and Civil Penalties

As follow-up to the meeting earlier today, please see the attached draft documents. Note the attached grant of petition for credits does not yet include the added text that was discussed in the meeting. An updated draft with that text will be sent soon.

Thanks.

Jim

<Alliance Global petition on credits -- grant of petition -- 19 Dec 2016 + outreach + harmonization.docx>

<civil penalty adjustment response to Alliance Global PFR -- 19 Dec 16 pah post OMB.docx>

Message

From: Wysor, Tad [wysor.tad@epa.gov]
Sent: 12/20/2016 4:13:43 PM
To: Jim Tamm [james.tamm@dot.gov]; Rebecca Yoon [rebecca.yoon@dot.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Silverman, Steven [silverman.steven@epa.gov]; Charmley, William [charmley.william@epa.gov]
Subject: RE: Draft Response to Petitions for Harmonization and Civil Penalties
Attachments: Alliance Global petition on credits -- grant of petition -- 20 Dec 2016 (inc OTAQ comments).docx; civil penalty adjustment response to Alliance Global PFR -- 20 Dec 16 pa (inc OTAQ-CD comments).docx

Importance: High

Jim and Rebecca...Please find attached our collective OTAQ/OGC comments on the NHTSA notices on the harmonization petition and civil penalties petition. I have incorporated comments on the harmonization petition action from Robin, Steve Silverman; Bill Charmley has also seen these.

Also, on the civil penalties notice, I included two suggestions from our Compliance Division staff. (Others in CD may have more input, in which case I've encouraged them to pass them to me ASAP, hopefully around noon.)

Keep me in the loop in any questions about our comments. And, again, thanks for the opportunity.

Tad Wysor 734 214 4332

From: Charmley, William
Sent: Tuesday, December 20, 2016 7:34 AM
To: Jim Tamm <james.tamm@dot.gov>; Rebecca Yoon <rebecca.yoon@dot.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Silverman, Steven <silverman.steven@epa.gov>
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Thanks
Bill

Sent from my iPhone

Begin forwarded message:

> **From:** "Hemmersbaugh, Paul (NHTSA)" <paul.hemmersbaugh@dot.gov>
> **Date:** December 19, 2016 at 4:29:13 PM EST
> **To:** "Tamm, James (NHTSA)" <james.tamm@dot.gov>, 'Janet McCabe' <mccabe.janet@epa.gov>, 'Chris Grundler' <Grundler.christopher@epa.gov>, 'Ben Hengst' <Hengst.benjamin@epa.gov>, "charmley.william@epa.gov" <charmley.william@epa.gov>, "Utech, Dan G. EOP/WHO" <Dan_G._Utech@who.eop.gov>, "Miller, Jason S. EOP/WHO" <Jason_S_Miller@who.eop.gov>
> **Cc:** "Lew, Shoshana (OST)" <shoshana.lew@dot.gov>

Subject: Draft Response to Petition for Harmonization and Civil Penalties Deliberative Process / Ex. 5

Deliberative Process / Ex. 5

All,

Attached are the draft grant of the civil penalties deferral and the revised partial grant of the Petition for rulemaking regarding credits (harmonization). Dan and Jason, it looks like you may not have been on the prior distribution that Jim sent out. If so, sorry. Revisions to the harmonization/credits petition from today's earlier version are indicated in track changes. If you have comments or edits on either of the two documents, please let us know at your earliest opportunity. Thanks, Paul.

PAUL HEMMERSBAUGH
NHTSA CHIEF COUNSEL
PAUL.HEMMERSBAUGH@DOT.GOV
202/ 366-2830 (O)
(202) 420-1531 (C)

From: Tamm, James (NHTSA)
Sent: Monday, December 19, 2016 1:35 PM
To: 'Janet McCabe'; 'Chris Grundler'; 'Ben Hengst'; charmley.william@epa.gov
Cc: Lew, Shoshana (OST); Hemmersbaugh, Paul (NHTSA)
Subject: Draft Response to Petition for Harmonization and Civil Penalties

As follow-up to the meeting earlier today, please see the attached draft documents. Note the attached grant of petition for credits does not yet include the added text that was discussed in the meeting. An updated draft with that text will be sent soon.
Thanks.
Jim

<Alliance Global petition on credits -- grant of petition -- 19 Dec 2016 + outreach + harmonization.docx>

<civil penalty adjustment response to Alliance Global PFR -- 19 Dec 16 pah post OMB.docx>

Message

From: Amandine Muskus [amuskus@globalautomakers.org]
Sent: 6/22/2017 4:02:09 PM
To: Moran, Robin [moran.robin@epa.gov]; Michael Hartrick [mhartrick@autoalliance.org]; Julia Rege [JRege@globalautomakers.org]; Chris Nevers [cnevers@autoalliance.org]; Mike McCarthy [mmccarth@arb.ca.gov]; Mader, Pippin@ARB [pmader@arb.ca.gov]; james tamm [james.tamm@dot.gov]; Kevin Green [kevin.green@dot.gov]
CC: Olechiw, Michael [olechiw.michael@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Charmley, William [charmley.william@epa.gov]
Subject: Re: EPA Material for the 1pm Alliance/Global meeting

Hi Robin,

Personal Matters / Ex. 6 we have it on a jump drive to bring to you, but no internet connection now. I am writing this to you on my phone.

I hope this is ok. Amandine

Obtenez Outlook pour iOS

From: Moran, Robin <moran.robin@epa.gov>
Sent: Thursday, June 22, 2017 11:55:16 AM
To: Michael Hartrick; Julia Rege; Amandine Muskus; Chris Nevers; Mike McCarthy; Mader, Pippin@ARB; james tamm; Kevin Green
Cc: Olechiw, Michael; Bolon, Kevin; Charmley, William
Subject: EPA Material for the 1pm Alliance/Global meeting

Dear Colleagues,

We're looking forward to our discussion at 1pm today. Attached is the material that EPA will plan to share for this meeting.

Mike/Amandine, if you could email around your materials as well, that would be helpful, just in case there are any snags with the webex connection.

Thanks,
Robin

Robin Moran
Senior Policy Advisor
U.S. EPA, Office of Transportation and Air Quality
2000 Traverwood Dr.
Ann Arbor, MI 48105
(734) 214-4781 (phone)
(734) 214-4821 (fax)

Message

From: Hemmersbaugh, Paul (NHTSA) [paul.hemmersbaugh@dot.gov]
Sent: 12/19/2016 9:29:13 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; McCabe, Janet [McCabe.Janet@epa.gov]; Grundler, Christopher [grundler.christopher@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Utech, Dan G. EOP/WHO [Dan_G._Utech@who.eop.gov]; Miller, Jason S. EOP/WHO [Jason_S_Miller@who.eop.gov]
CC: Lew, Shoshana (OST) [shoshana.lew@dot.gov]
Subject: Draft Response to Petition for Harmonization and Civil Penalties [WARNING: DKIM validation failed]
Attachments: Alliance Global petition on credits -- grant of petition -- 19 Dec 2016 + outreach + harmonization.docx; civil penalty adjustment response to Alliance Global PFR -- 19 Dec 16 pah post OMB.docx

Importance: High

All,

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PAUL HEMMERSBAUGH
NHTSA CHIEF COUNSEL
PAUL.HEMMERSBAUGH@DOT.GOV
202/ 366-2830 (O)
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From: Tamm, James (NHTSA)
Sent: Monday, December 19, 2016 1:35 PM
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Thanks.
Jim

Message

From: Tamm, James (NHTSA) [james.tamm@dot.gov]
Sent: 12/19/2016 6:34:45 PM
To: McCabe, Janet [McCabe.Janet@epa.gov]; Grundler, Christopher [grundler.christopher@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]; Charmley, William [charmley.william@epa.gov]
CC: Lew, Shoshana (OST) [shoshana.lew@dot.gov]; Hemmersbaugh, Paul (NHTSA) [paul.hemmersbaugh@dot.gov]
Subject: Draft Response to Petition for Harmonization and Civil Penalties [WARNING: DKIM validation failed]
Attachments: civil penalty adjustment response to Alliance Global PFR -- 19 Dec 16.docx; Alliance Global petition on credits -- grant of petition -- 15 Dec 2016.docx

As follow-up to the meeting earlier today, please see the attached draft documents. Note the attached grant of petition for credits does not yet include the added text that was discussed in the meeting. An updated draft with that text will be sent soon.
Thanks.
Jim

Message

From: Bolon, Kevin [Bolon.Kevin@epa.gov]
Sent: 5/26/2017 8:20:45 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Homeister, Nancy (N.L.) [nhomeist@ford.com]; Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Kargul, John [kargul.john@epa.gov]; Newman, Kevin [newman.kevin@epa.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; McDonald, Joseph [McDonald.Joseph@epa.gov]
CC: Glodich, Jeffrey (J.M.) [jglodich@ford.com]; McCarthy, Mike@ARB [michael.mccarthy@arb.ca.gov]; Moskalik, Andrew [Moskalik.Andrew@epa.gov]; Caffrey, Cheryl [caffrey.cheryl@epa.gov]
Subject: Materials: Meeting with Ford regarding MTE (contains CBI)
Attachments: Meeting with Ford 2017_05_22_Final.pptx

Attached are the materials that EPA presented at the 5/22 Ford meeting in Ann Arbor.
Note that some slides reflect the CBI that Ford provided, and are marked 'CBI'. Please treat the information in those slides as confidential.

Feel free to contact me if you have any questions about the slide content, or the methodology used to create these compliance grids.

Meeting with Ford 2017_05_22_Fin...

Thank you,
Kevin Bolon

Kevin Bolon, Ph.D.
Light Duty Center, Assessment and Standards Division
National Vehicle and Fuel Emissions Laboratory
U.S. EPA, Office of Transportation and Air Quality
734-214-4331 bolon.kevin@epa.gov

-----Original Appointment-----
From: Olechiw, Michael
Sent: Monday, April 10, 2017 11:22 AM
To: Olechiw, Michael; Homeister, Nancy (N.L.); Moran, Robin; Charmley, William; Bolon, Kevin; Barba, Daniel; Sherwood, Todd; Cherry, Jeff; Kargul, John; Newman, Kevin; Jim Tamm (james.tamm@dot.gov); McCarthy, Mike@ARB; McDonald, Joseph
Cc: Glodich, Jeffrey (J.M.); McCarthy, Mike@ARB; Moskalik, Andrew; Caffrey, Cheryl
Subject: Meeting with Ford regarding MTE
When: Monday, May 22, 2017 2:00 PM-4:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: AA-Room-Office-C126-ConfRoom/AA-OTAQ-OFFICE

http://epawebconferencing.acms.com/mte-ford/

Conference call information:

Conference Line/Code / Ex. 6

Agenda:

1. Introductions
2. Update on MTE
3. Technical Exchange
4. Next Steps

Meeting with Ford

TECHNOLOGY EFFECTIVENESS AND COMPLIANCE SCENARIOS

May 22, 2017
Office of Transportation and Air Quality
National Vehicle and Fuel Emissions Laboratory

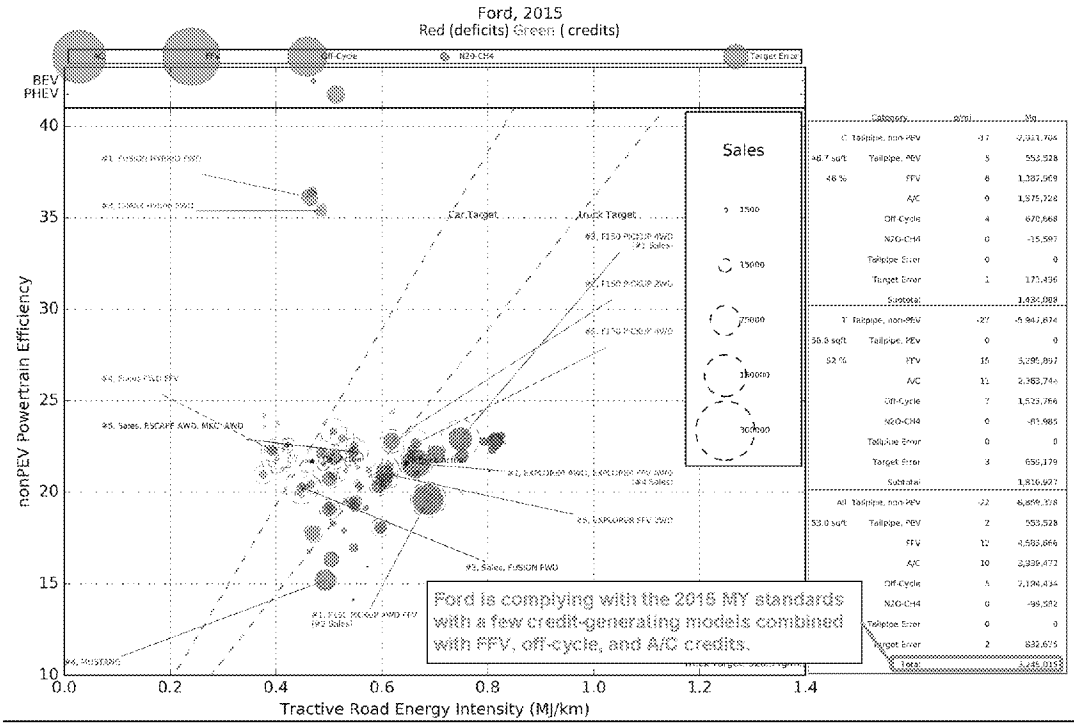
Contains CBI

Recap of Past MTE Meetings with Ford

- **EPA has met previously with Ford during the MTE process to discuss emissions-reducing technologies**
  - Dearborn – September 2015
  - Ann Arbor – November 2015
  - Ann Arbor – December 2015
  - Ann Arbor, web – January 2016
- **EPA extensively reviewed Ford's comments on the Draft Technical Assessment Report and the Proposed Determination**
- **Ford's key messages**
  - Ford anticipates substantially more electrification being required to meet the 2025 MY standards
  - Customers are not willing to pay for the cost of electrification
- **EPA asked Ford to provide more detail regarding conventional technologies – *How far can conventional technologies take you?***
  - Confidential Business Information was provided in the spring of 2016
  - EPA assessed the CBI and used the information (in a blind manner) to inform the Nov 2016 Proposed and Jan 2017 Final Determination

Ford's 2015 MY Compliance Situation

* Based on publicly available data, published in 1) EPA's MY2015 GHG Manufacturer Performance Report and 2) MY2015 Baseline Fleet data in Proposed Determination TSD



	Category	g/mi	Mg
	C Tailpipe, non-PEV	-17	-2,931,704
46.7 sq/t	Tailpipe, PEV	5	552,528
48 %	FFV	8	1,387,969
	A/C	9	1,575,728
	Off-Cycle	4	670,668
	N2O-CH4	0	-15,597
	Tailpipe Error	0	0
	Target Error	1	171,436
	Subtotal		1,434,089
	T Tailpipe, non-PEV	-27	-5,947,674
56.3 sq/t	Tailpipe, PEV	0	0
52 %	FFV	16	3,295,897
	A/C	11	2,363,744
	Off-Cycle	7	1,523,766
	N2O-CH4	0	-81,985
	Tailpipe Error	0	0
	Target Error	3	656,179
	Subtotal		1,816,927
	All Tailpipe, non-PEV	-22	-8,879,378
53.0 sq/t	Tailpipe, PEV	2	553,528
	FFV	12	4,683,866
	A/C	10	3,939,472
	Off-Cycle	5	2,194,434
	N2O-CH4	0	-96,582
	Tailpipe Error	0	0
	Target Error	2	832,675
	Total		3,250,015

Technology Walks – Approach Used for 5 Vehicle Case Studies

Overview

- EPA modeled 2-cycle GHG emissions in ALPHA for 5 High Volume Vehicles (Fiesta, Fusion, Escape AWD, Explorer AWD, and F150 4x4)

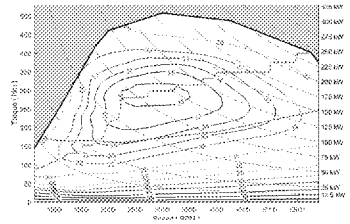
Non-CBI approach using only public domain data for current technology engines and near-future transmissions*1

- start with MY2015 actual Ford vehicles (from test car list)
- add OEM-published engine maps + Stop-start, sized for performance neutrality
  - Normally aspirated: Toyota TNGA 2.5L, 40% BTE *2
  - Turbocharged: Honda 1.5L GDI *3
- add Transmission improvements
  - Current 8-speed (TRX21, based on 2nd generation ZF)
  - Efficiency improvements (TRX22)
- add Accessory improvements (25% reduction in alternator load)
- add 3 levels of Load Reduction (Low LR, Mid LR, High LR)

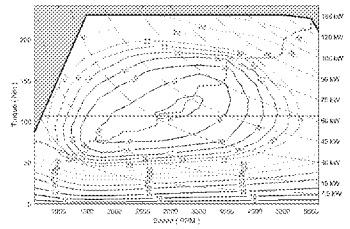
CBI approach using Ford-provided data

- start with MY2015 actual Ford vehicles (from test car list)
- add Ford-projected 2025 road load improvements
- add Engine map and transmission selected to match Ford-projected GHG values
- With and without Ford-projected power and performance changes

2015 Ford 2.7L EcoBoost map (BTE)*4



Honda 1.5L Turbo Map (BTE)*4



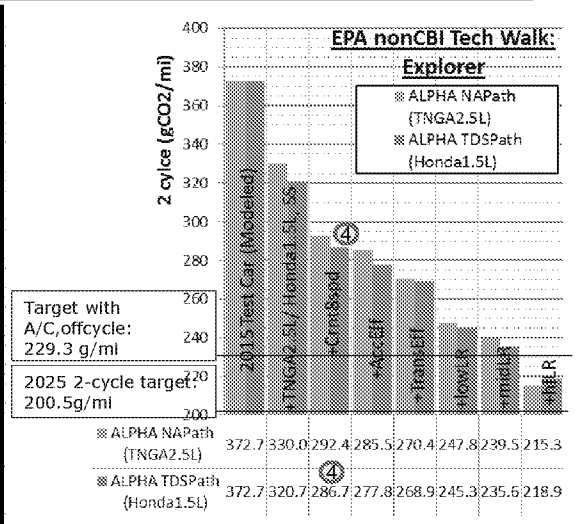
*1 non-CBI approach shown here is described further in Section 2.1 of EPA's Response to Comments Document for the January 2017 Final Determination (pp. 21-24.)
*2 Eiji Murase and Rio Shimizu, "Innovative Gasoline Combustion Concepts for Toyota New Global Architecture," 25th Aachen Colloquium Automobile and Engine Technology 2016.
*3 Wada, Y., Nakano, K., Mochizuki, K., and Hata, R., "Development of a New 1.5L I4 Turbocharged Gasoline Direct Injection Engine," SAE Technical Paper 2016-01-1020, 2016, doi:10.4271/2016-01-1020. (supplemented with data publicly available during the 2016 SAE World Congress).
*4 See Appendix slides 21-26 for higher resolution engine maps

Summary of EPA Technology Walk for Ford Explorer AWD: CBI Walk and non-CBI Walk

CBI

[redacted]

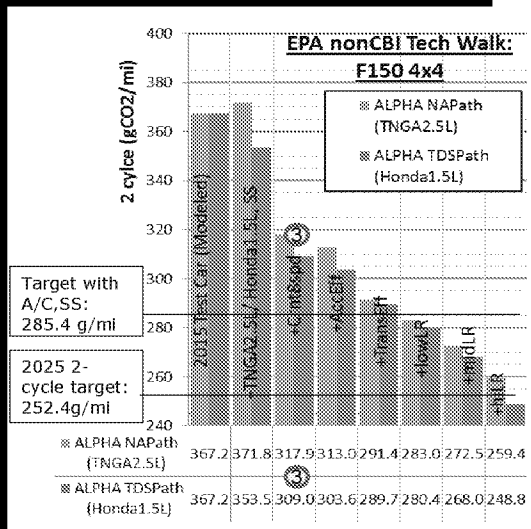
[redacted]



Summary of EPA Technology Walks for Ford F150 4x4: CBI Walk and non-CBI Walk

CBI

[redacted]



Technology Walks – Summary of Results

CBI

[redacted]

EPA's non CBI projections:

1. powertrain efficiencies of **27~29%**
2. load reductions resulting in **4~10%** tractive energy reduction (for 'Low LR' case); **10~14%** ('Mid LR'); **13~19%** ('High LR');
3. **performance neutral** within ±5%
4. A/C credits 18.8 g/mi (car), 24.4 g/mi (truck)
5. 2 cycle + credits values **below footprint targets** for Fiesta, Fusion, EscapeAWD and F150. Explorer and EscapeFWD values **approach footprint targets** (for 'Mid LR' and 'High LR' cases)

			Specifications						ALPHA Modeling Results								MY2025 Standards			
									3 Performance (0-60 accel, sec)		1 Powertrain Efficiency		Tractive Road Energy Intensity (MJ/km)		2 Cycle GHG Emissions (g CO2/mi)		SS off-cycle	AC	2 cycle + credits
			FP	ETW	Road Load Coefficients			HP									Target	credits	credits	vs. Target
			(sq ft)	(lbs)	A (lbs)	(lbs/mph)	(lbs/mph2)		Value	Decrease	Value	Increase	Value	Decrease	Value	Decrease	(g/mi)	(g/mi)	(g/mi)	(g/mi)
Fiesta	2015 Test Car		40.8	2875	22.880	0.25500	0.019160	119.8	9.6	-	21.4%	-	399.5	-	220.4	-		-	-	-
																		4		
	EPA	Low LR		2625	20.927	0.25500	0.017244	112	8.9	7%	29.4%	37%	367.9	8%	147.7	33%	130.5	2.5	18.8	14.1
	nonCBI	Mid LR		2625	19.316	0.25500	0.015328	110	9.0	6%	29.2%	36%	348.2	13%	140.8	36%	130.5	2.5	18.8	11.0
		High LR		2375	17.691	0.25500	0.015328	101	8.9	7%	29.1%	36%	329.6	17%	133.3	39%	130.5	2.5	18.8	18.5
Fusion	2015 Test Car		49.0	3750	18.880	0.30750	0.015990	169	8.9	-	21.9%	-	415.4	-	224.0	-	-	-	-	-
	EPA	Low LR		3375	17.068	0.30750	0.015990	147.6	8.6	3%	29.1%	33%	391.4	6%	158.6	29%	156.5	2.5	18.8	19.2
	nonCBI	Mid LR		3375	15.659	0.30750	0.014213	147.6	8.5	4%	28.8%	32%	374.2	10%	153.1	32%	156.5	2.5	18.8	24.7
		High LR		3000	14.227	0.30750	0.014213	133	8.5	4%	29.1%	33%	351.4	15%	142.2	37%	156.5	2.5	18.8	35.6
Escape FWD	2015 Test Car		45.6	3875	21.790	0.41240	0.023450	237	7.4	-	21.1%	-	499.9	-	280.0	-	-	-	-	-
	EPA	Low LR		3500	19.355	0.41240	0.021105	212.6	6.9	7%	27.6%	31%	456.9	9%	194.8	30%	145.5	2.5	18.8	[redacted]
	nonCBI	Mid LR		3500	17.461	0.41240	0.018760	207.3	6.9	6%	27.5%	30%	433.5	13%	186.1	34%	145.5	2.5	18.8	[redacted]
		High LR		3125	15.538	0.41240	0.018760	186.5	7.0	6%	27.7%	32%	408.8	18%	173.7	38%	145.5	2.5	18.8	[redacted]
Escape AWD	2015 Test Car		45.6	4000	25.100	0.42490	0.023360	172.9	9.5	-	22.8%	-	519.7	-	268.8	-	-	-	-	-
	EPA	Low LR		3625	20.303	0.42490	0.021024	148	9.3	2%	29.9%	31%	467.4	10%	184.4	31%	175.7	4.4	24.4	20.1
	nonCBI	Mid LR		3625	18.816	0.42490	0.018688	148	9.3	2%	29.7%	30%	445.6	14%	176.9	34%	175.7	4.4	24.4	27.6
		High LR		3250	17.021	0.42490	0.018688	136.9	9.0	5%	30.0%	32%	420.7	19%	165.4	38%	175.7	4.4	24.4	39.1
Explorer AWD	2015 Test Car		52.5	5000	36.190	0.84250	0.022530	290.1	7.6	-	21.1%	-	665.9	-	372.7	-	-	-	-	-
	[redacted]																			
	EPA	Low LR	52.5	4500	27.238	0.84250	0.022530	235.5	7.8	-3%	29.4%	40%	611.6	8%	245.3	34%	200.5	4.4	24.4	[redacted]
	nonCBI	Mid LR	52.5	4500	24.463	0.84250	0.020027	235.5	7.8	-3%	29.2%	39%	583.6	12%	235.6	37%	200.5	4.4	24.4	[redacted]
		High LR	52.5	4000	21.112	0.84250	0.020027	210.1	7.7	-1%	29.5%	40%	548.3	18%	218.9	41%	200.5	4.4	24.4	10.4
F150 AWD	2015 Test Car		68.1	5250	31.040	0.35380	0.036860	365.2	6.7	-	22.1%	-	687.6	-	367.2	-	-	-	-	-
	[redacted]																			
	EPA	Low LR	68.1	5250	31.040	0.35380	0.033174	334.3	6.6	1%	27.8%	26%	661.5	4%	280.4	24%	256.3	4.4	24.4	[redacted]
	nonCBI	Mid LR	68.1	5250	27.905	0.35380	0.029488	330.4	6.7	1%	27.5%	24%	624.3	9%	268.0	27%	256.3	4.4	24.4	[redacted]
		High LR	68.1	4750	25.755	0.35380	0.029488	307.1	6.6	1%	28.2%	28%	595.2	13%	248.8	32%	256.3	4.4	24.4	[redacted]

Compliance Grid Analysis

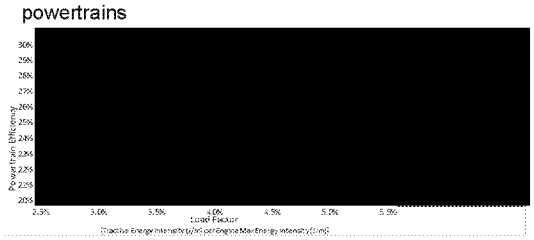
CBI

- EPA conducted a simple Excel-based analysis for the purpose of investigating Ford's technology projections
- Limited to only existing conventional technologies, without cost-minimizing pathway (OMEGA does that)
- Vehicle GHG performance (g/mi) estimated from CBI and non-CBI tech walks
  - Assumptions for powertrain, performance, load reduction, off-cycle and A/C credits from Ford CBI and non-CBI sources
  - non-PEV emissions = (Tractive Energy Intensity * CO2 Density of fuel) / Powertrain Efficiency

Powertrain Improvement Assumptions

[redacted]

- nonCBI grid: Efficiency curve based on conservative representation of current and nearly-available powertrains



Off-cycle and A/C credit Assumptions

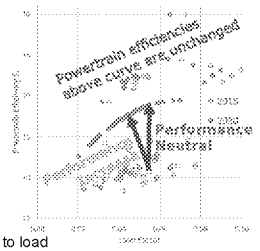
[redacted]

- non-CBI: 18.8 g/mi (car) and 24.4 g/mi (truck) + stop-start credits applied to all non PEVs

Performance Assumptions

[redacted]

- non-CBI: Performance neutral, using constant Load Factor to determine powertrain efficiency

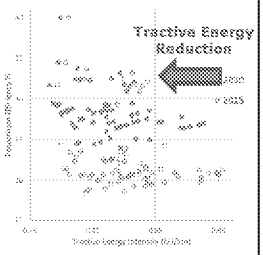


* i.e. 10% increase in power proportional to load

Load Reduction Assumptions

[redacted]

- non-CBI grid: Tractive energy reductions of 8% (car), 4% (truck), similar to 'Low LR' tech walk step



Ford Compliance Grid Analysis – Based on Ford CBI

CBI

(CBI: MY2025 Projections of technology, performance, off-cycle and A/C credits)

1. MY2015 Baseline + IHS mix projections

increasing stringency | constant stringency

(Tg CO2)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Truck	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
All	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Compliance Status	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

MY2025	MY2015 to MY2025		
nonPEV PTEfficiency	Tractive Energy	2cycle GHG	PEV share
%	% ↓	% ↓	% ↑
21.6%	0.0%	0.0%	-0.7%
21.7%	0.0%	0.0%	0.0%
21.6%	0.0%	0.0%	-0.3%

[redacted]

At End of Model Year: Credits, Deficits — After credit Carry Forward and Carry Back: Compliant, Non compliant

Ford Compliance Grid Analysis – EPA's Non-CBI Assessment
(Published engine maps with EPA trans improvements, performance, A/C credits)

increasing stringency | constant stringency

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	MY2025 nonPEV PTEfficiency	Δ MY2015 to MY2025 Tractive Energy	2cycle GHG	PEV share
																	%	% ↓	% ↓	% ↑
1. MY2015 Baseline + IHS mix projections	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.6%	0.0%	0.0%	-0.7%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.7%	0.0%	0.0%	0.0%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.6%	0.0%	0.0%	-0.3%
	Compliance Status																			
2. + A/C Credits • Car: 18.8 g/mi • Truck: 24.4 g/mi	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.6%	0.0%	0.0%	-0.7%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.7%	0.0%	0.0%	0.0%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.6%	0.0%	0.0%	-0.3%
	Compliance Status																			
3. + Good current powertrains w/ SS • TNGA/HondaTDS efficiency on all nonPEVs • Accessory and 8speed trans improvements • w/ SS off-cycle credits. Car/Truck: 2.5/4.4 g/mi	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.5%	0.0%	23.5%	-0.7%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.3%	0.0%	20.7%	0.0%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.6%	0.0%	21.7%	-0.3%
	Compliance Status																			
4. + Load Reduction • Tractive Energy reduction with aero/mass/tire • 4% (Truck), 8% (Car)	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.5%	8.0%	25.6%	-0.7%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.3%	4.0%	23.5%	0.0%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.6%	5.6%	26.0%	-0.3%
	Compliance Status																			

gap ↕ **Multiple options to fill compliance gap**

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	MY2025 nonPEV PTEfficiency	Δ MY2015 to MY2025 Tractive Energy	2cycle GHG	PEV share
Option 1: Off cycle + 5.0% PEV increase • 8 g/mile (Car/Truck) off-cycle credits • MY2015 PEV share = 0.9% → 5.9% in 2025 • 50/50 PHEV(50 mile CD range)/BEV	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.5%	8.0%	25.6%	6.1%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.3%	4.0%	23.5%	3.8%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.6%	5.6%	26.0%	5.0%
	Compliance Status																			
Option 2: Perf + Off cycle + LR + 3.8% PEV increase • 5% increase in power-to-weight • 8 g/mile (Car/Truck) off-cycle credits • Load Reduction 6% (Truck), 10% (Car) • MY2015 PEV share = 0.9% → 4.7% in 2025 • 50/50 PHEV(50 mile CD range)/BEV	Car (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.6%	10.0%	30.4%	4.5%
	Truck (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.0%	6.0%	24.6%	2.5%
	All (Tg CO2)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.3%	7.6%	26.7%	3.8%
	Compliance Status																			

At End of Model Year: Credits | Deficits — After credit Carry Forward and Carry Back: Compliant | Non-compliant

Technical Conclusions

CBI

- **Tech Walks:** Main differences between EPA and Ford assumptions for vehicle improvements in MY2025:

[redacted]

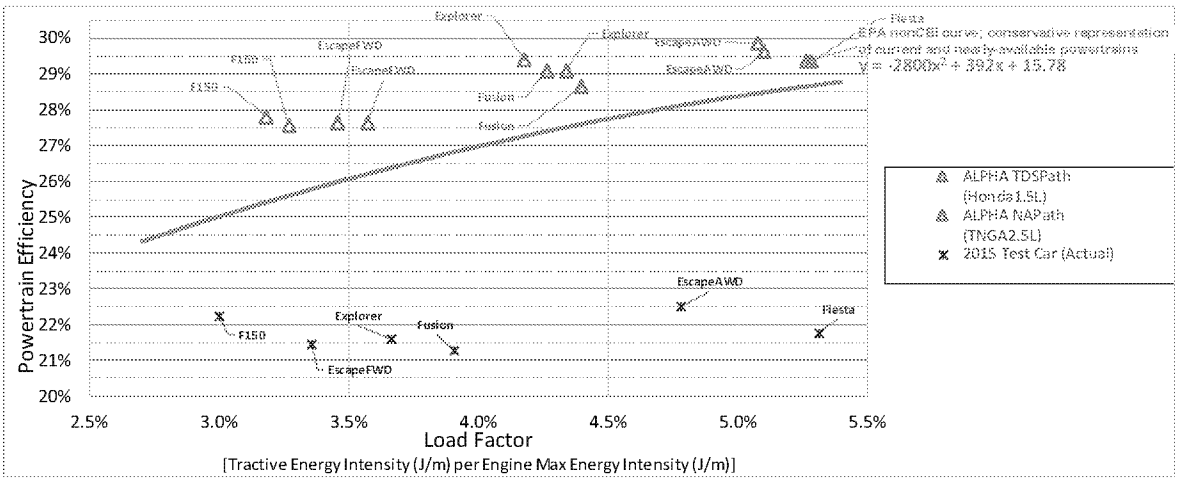
- **Compliance Grid based on Ford CBI** (see slide 9)

[redacted]

- **Compliance Grid based on EPA non-CBI** (see slide 10)
  - Compliance gap can be reduced significantly using only existing (and very near-term) conventional technologies and performance neutrality
  - Remaining compliance gap of approximately 2 years could be filled with:
    - Minimal electrification, combined with some combination of
    - Moderate off-cycle credits or additional load reduction, even with some performance improvement

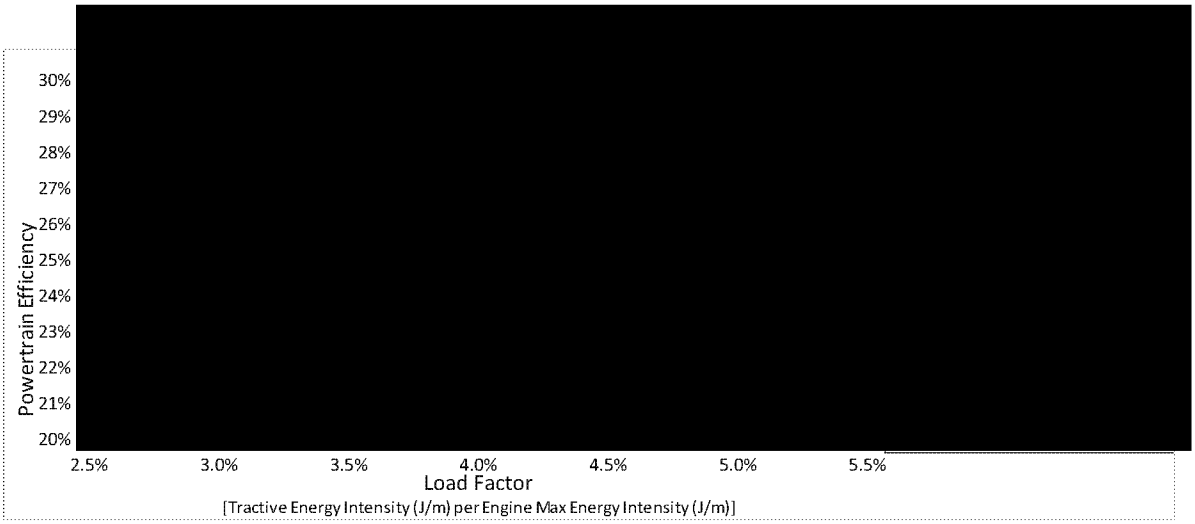
Appendix

Compliance Grid Analysis: Fit of Powertrain Efficiency Curves (1/2)

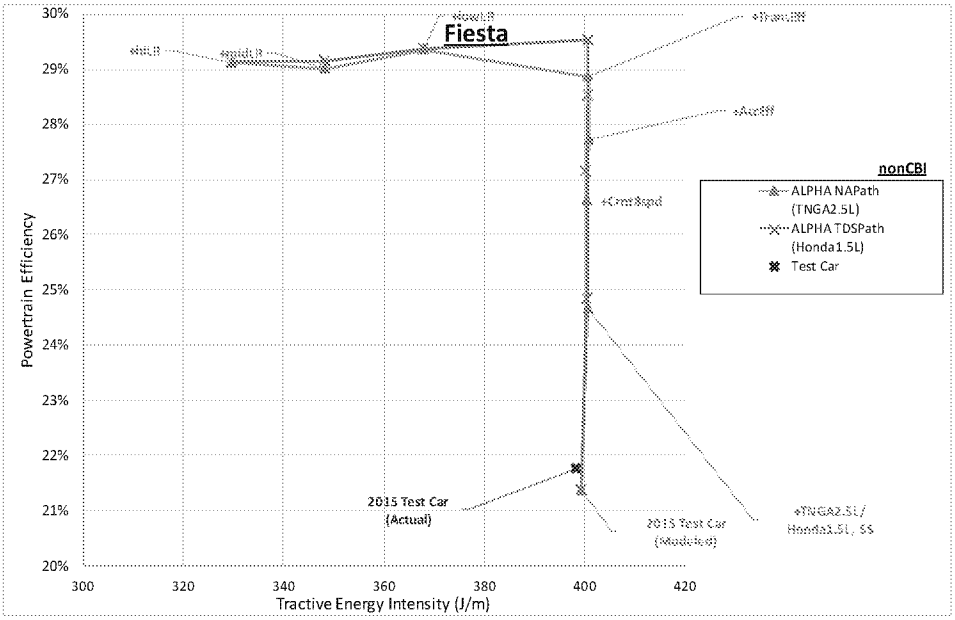


Compliance Grid Analysis: Fit of Powertrain Efficiency Curves (2/2)

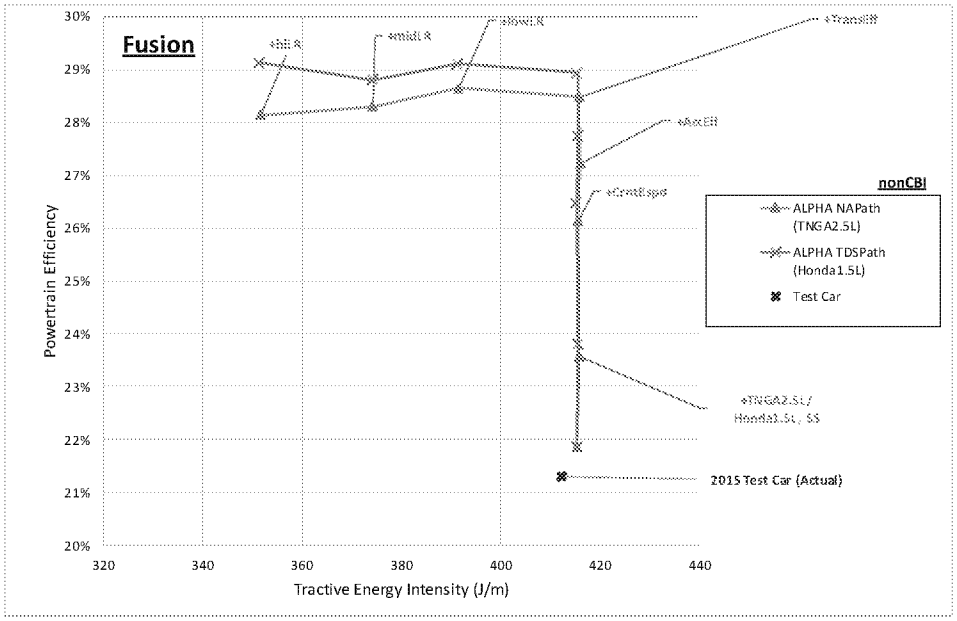
CBI



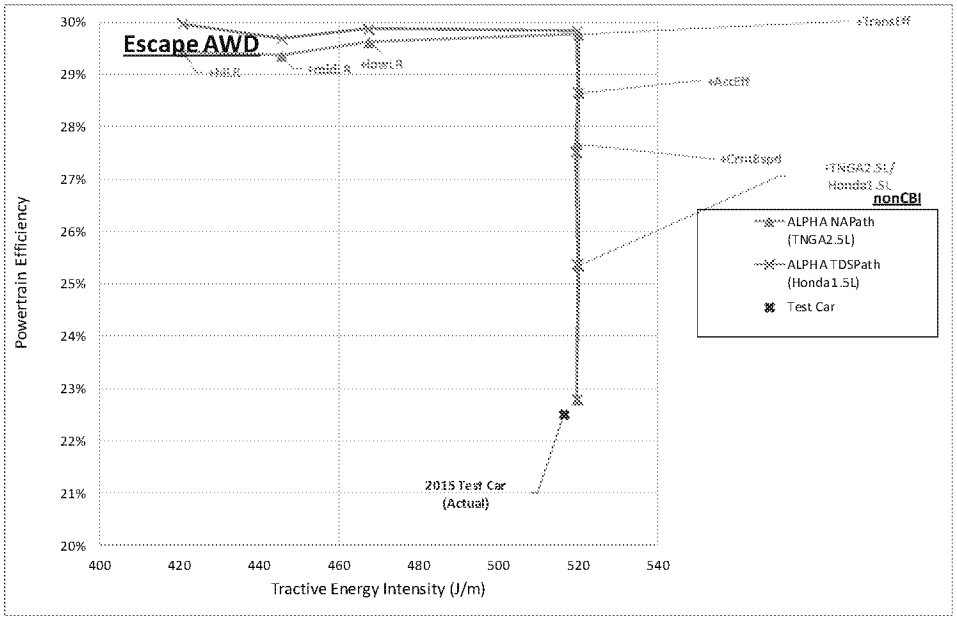
EPA Technology Walks for Ford Fiesta: non-CBI Walk



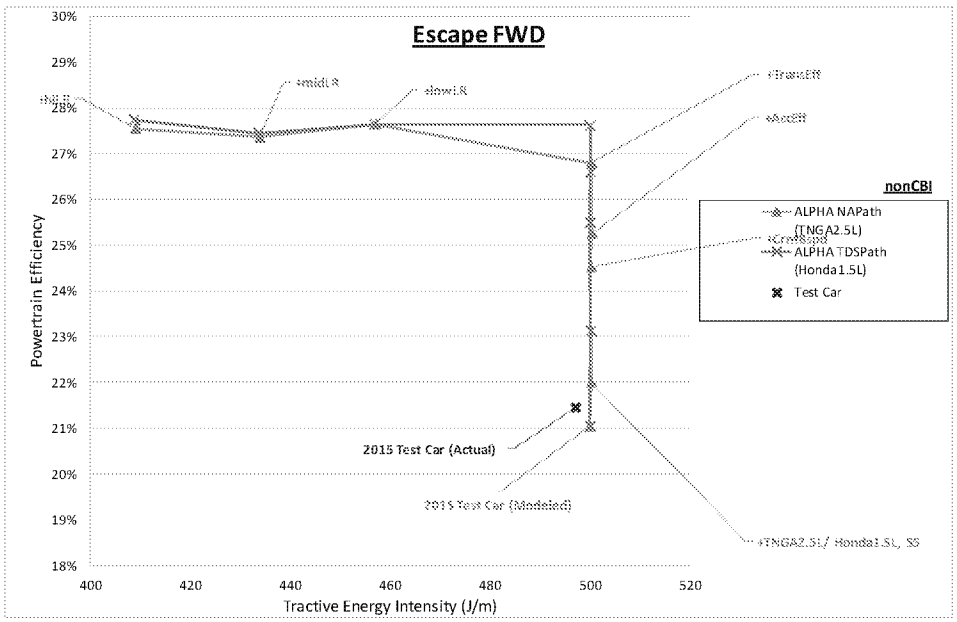
EPA Technology Walks for Ford Fusion: non-CBI Walk



EPA Technology Walks for Ford Escape AWD: non-CBI Walk



EPA Technology Walks for Ford Escape FWD: non-CBI Walk



EPA Technology Walks for Ford Explorer AWD: CBI and non-CBI Walk

CBI

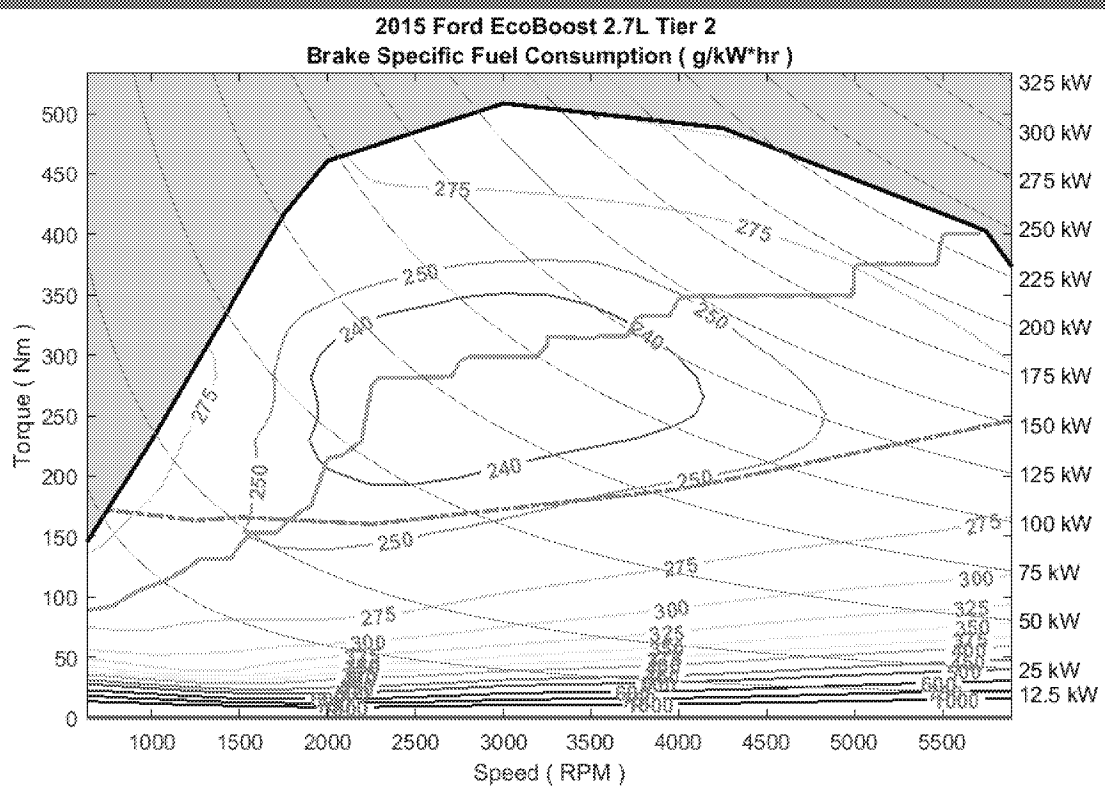
[redacted]

EPA Technology Walks for Ford F150 4x4: CBI and non-CBI Walk

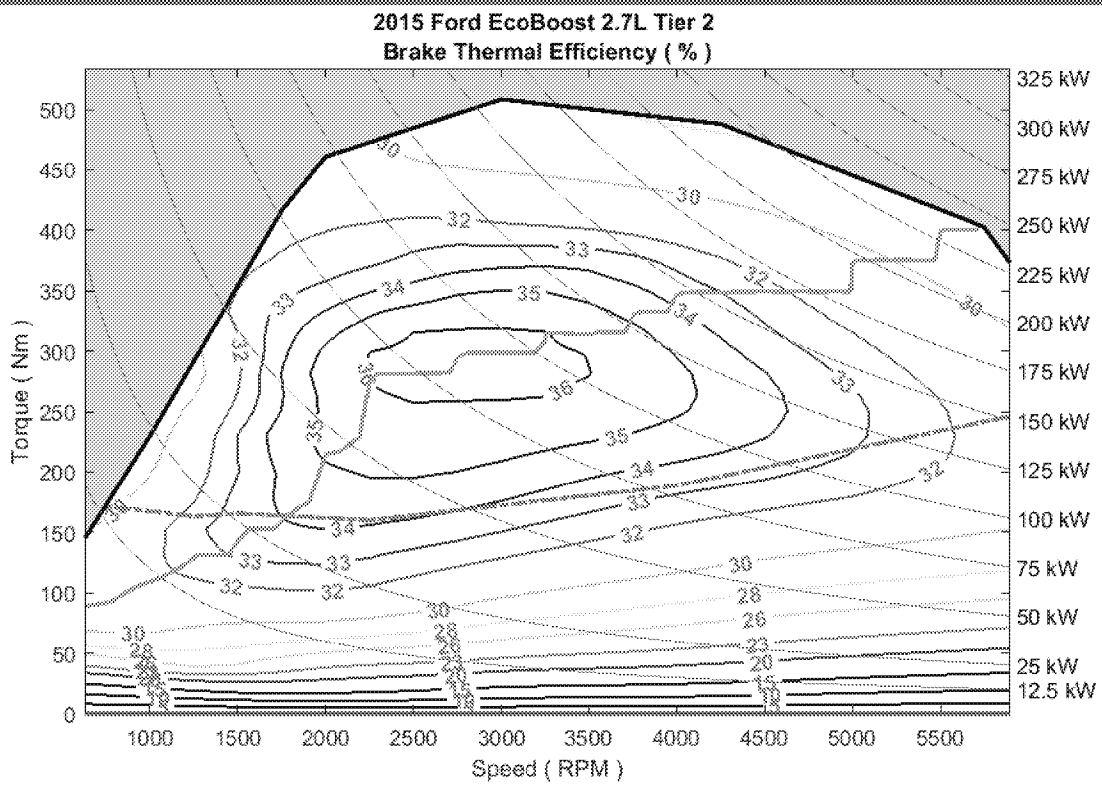
CBI

[redacted]

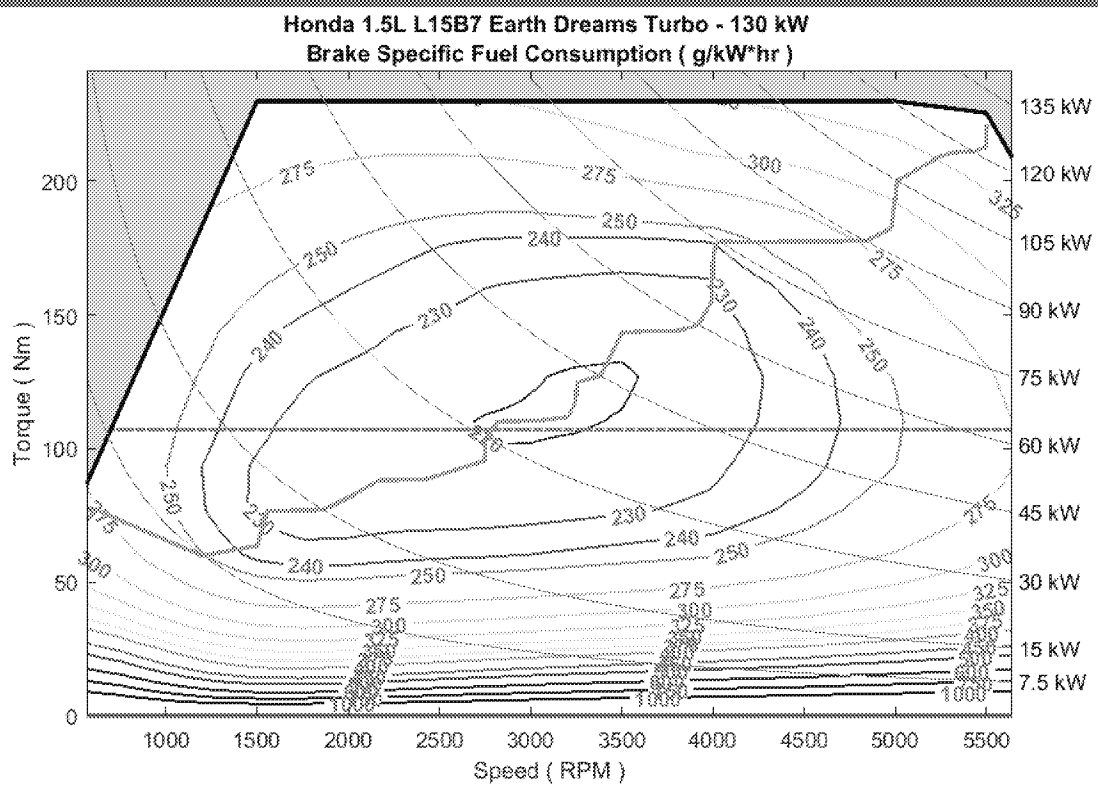
2015 Ford EcoBoost 2.7L Engine Map - BSFC



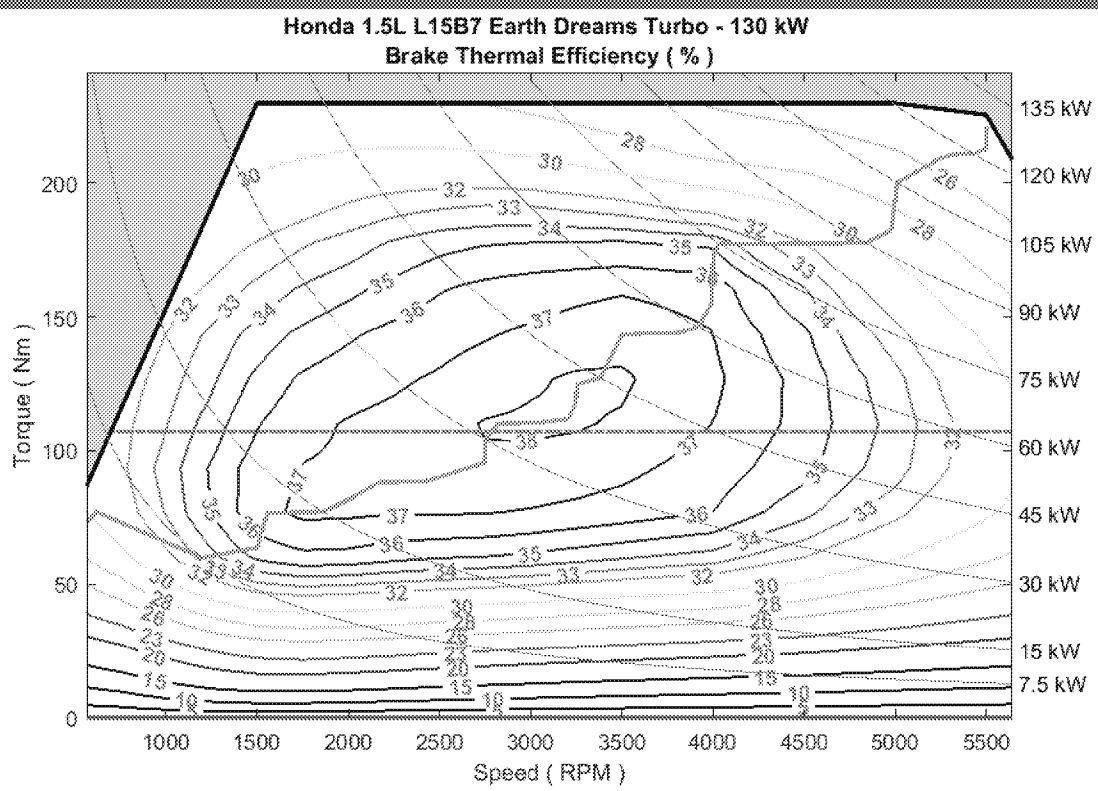
2015 Ford EcoBoost 2.7L Engine Map - BTE



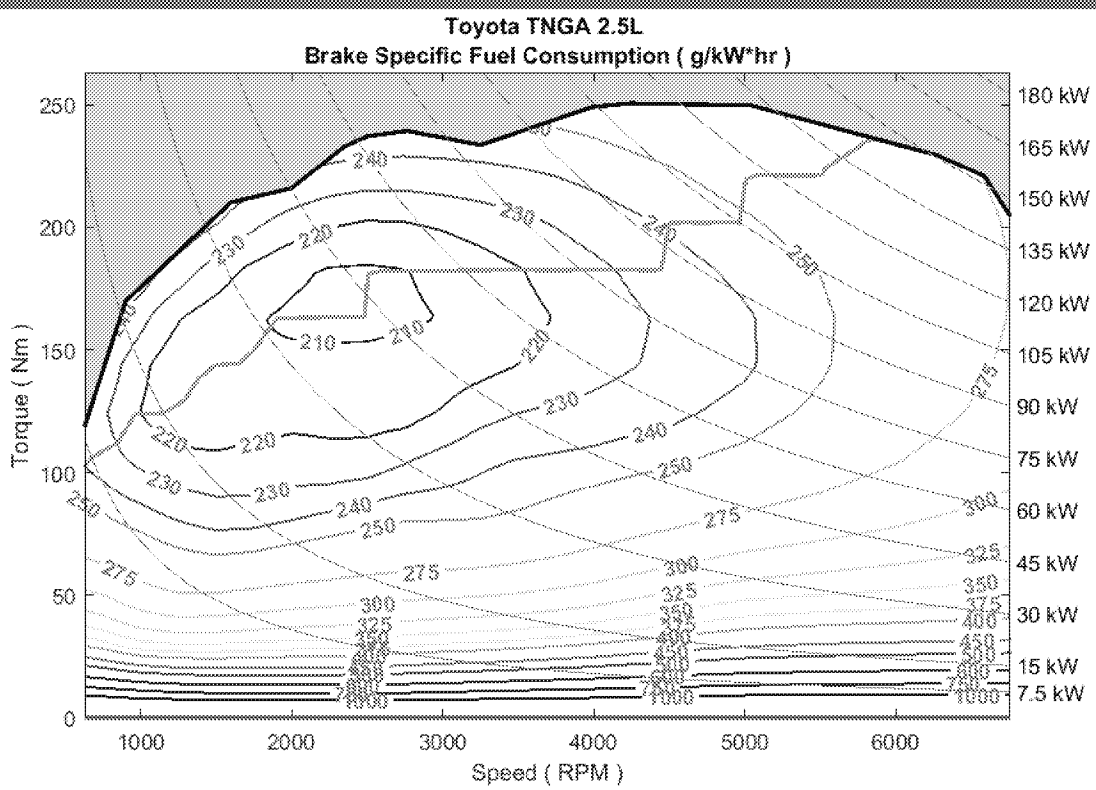
Honda TDS 1.5L Engine Map - BSFC



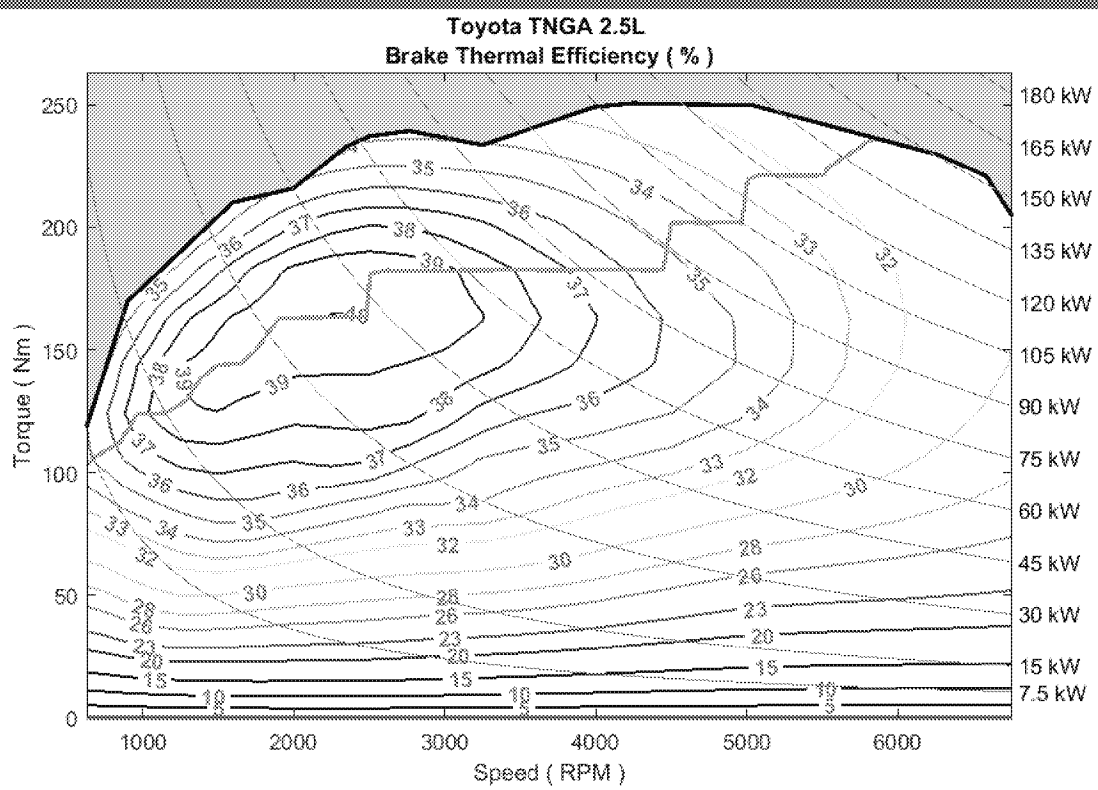
Honda TDS 1.5L Engine Map - BTE



Toyota TNGA 2.5L Engine Map - BSFC



Toyota TNGA 2.5L Engine Map - BTE



Message

From: Spears, Matthew [spears.matthew@epa.gov]
Sent: 1/7/2017 4:06:35 PM
To: Charmley, William [charmley.william@epa.gov]; Orlin, David [Orlin.David@epa.gov]; Moulis, Charles [moulis.charles@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Mitchell, George [Mitchell.George@epa.gov]; Cullen, Angela [cullen.angela@epa.gov]; Brakora, Jessica [Brakora.Jessica@epa.gov]; Ryan Hagen [ryan.hagen@dot.gov]; James Tamm [james.tamm@dot.gov]
Subject: Another petition for reconsideration of HD Phase 2: RMA (tire manufacturers), next steps?
Attachments: RMA Petition of Phase 2 Rule as Filed_12.23.16.pdf; ATT00001.htm

Hi all (& Happy New Year Jim & Ryan),

Please see RMA's note below.

Some of us EPA engineers on the Phase 2 team are agreeable to having another informal technical call with RMA, as they seem to suggest below. But before we respond, would Ryan Hagen (NCC) and David Orlin (EPA-OGC) please advise us on whether or not their petition changes how we should engage with RMA at this time? I wouldn't want to run afoul of any legal process that their petition might've triggered.

Deliberative Process / Ex. 5

Anyway, any advice on next steps for engaging with RMA would be much appreciated.

Regards,

Matthew Spears
Center Director, Heavy-Duty Diesel Standards
U.S. Environmental Protection Agency
2000 Traverwood Dr.
Ann Arbor, MI 48105
spears.matthew@epa.gov
w. 734-214-4921
m. 734-276-7079

Begin forwarded message:

> **From:** "Jesse Levine" <JLevine@rma.org>
> **To:** "Spears, Matthew" <spears.matthew@epa.gov>, "Cullen, Angela" <cullen.angela@epa.gov>, "ryan.hagen@dot.gov" <ryan.hagen@dot.gov>

Cc: "Tracey Norberg" <TNorberg@rma.org>
Subject: RMA Petition for Reconsideration of Phase 2 Rule

Matt, Angela, and Ryan,

As you may know, on December 23rd, RMA filed a petition for reconsideration requesting that EPA and NHTSA reconsider several aspects of the Phase 2 rule. It would be great if we could schedule a call next week to discuss potential solutions to the issues raised in RMA's petition.

Next Tuesday late afternoon (1/10), Wednesday late afternoon (1/11), or Friday afternoon (1/13) works well for us. We look forward to speaking with you.

Best,
Jesse

Jesse Levine
Manager, Regulatory Affairs
Rubber Manufacturers Association

1400 K Street, NW, Suite 900
Washington, DC 20005
jlevine@rma.org
(o) (202) 682-4866

RUBBER
manufacturers
association

1400 K Street, NW • Washington, DC 20005 • tel (202) 682-4800 • fax (202) 682-4854 • www.rma.org

December 23, 2016

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DEC 23 2016
EPA DOCKET CENTER

The Honorable Gina McCarthy
Administrator
Air and Radiation Docket and Information Center
U.S. Environmental Protection Agency
Mail code: 28221T
1200 Pennsylvania Ave. NW.
Washington, DC 20460

The Honorable Mark Rosekind, Ph.D.
Docket Management Facility, M-30
U.S. Department of Transportation
West Building, Ground Floor, Rm. W12-140
1200 New Jersey Avenue SE.,
Washington, DC 20590

Dear Administrator McCarthy and Administrator Rosekind:

RE: Petition for Reconsideration and Amendment of Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, Final Rule, 81 Fed. Reg. 73478 (October 25, 2016), RIN 2060–AS16; RIN 2127–AL52 (Docket Numbers EPA–HQ–OAR–2014–0827 and NHTSA–2014–0132; FRL–9927–21–OAR)

I. Introduction

The Rubber Manufacturers Association ("RMA")[1] petitions the Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) to reconsider the above-captioned final rule. As companies that manufacture tires for use on new medium and heavy-duty vehicles, RMA members have a direct interest in this rulemaking. Overall, RMA supports the goals of this rulemaking and appreciates the opportunity to partner with other stakeholders in contributing to better fuel economy and GHG emission reductions. RMA also appreciates several changes to the rule, addressing issues raised in RMA comments on the proposed rule and notice of data availability, such as the changes incorporating tire-pressure monitoring systems ("TPMS") into the greenhouse gas emission model ("GEM") and basing EPA's recall authority on the plain language of the Clean Air Act. But, RMA believes that on several other issues such as, lab alignment, standards for non-box and non-aero box trailers, SAE J1025 and J2452, and speed limited tires, the agencies should reconsider their approach.

[1] RMA represents the tire companies manufacturing tires in the United States. RMA's membership includes: Bridgestone Americas; Continental Tire the Americas, LLC; Cooper Tire & Rubber Company; Kumho Tire U.S.A., Inc.; Michelin North America, Inc.; Pirelli Tire North America, Inc.; Sumitomo Rubber North America, Inc.; The Goodyear Tire & Rubber Company; Toyo Tire Holdings of Americas Inc. and Yokohama Tire Corporation.

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DEC 28 2016
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II. The Agencies Should Establish a Reference Laboratory

In the proposed rule, the agencies proposed to continue to allow use of either STL or Smithers in testing based on their conclusion that lab-to-lab variability is "very small" and "would not significantly affect RRc values." 80 Fed. Reg. 40243. Also, in the preamble discussion for the final rule, the agencies mistakenly noted that they *"did not receive any comments on the issue."* 81 Fed. Reg. 73625. Emphasis added. But, as the agencies noted in the response to comment document, RMA submitted extensive comments and data advocating for the establishment of an alignment machine and challenging the Agencies' assertion that lab-to-lab variability is very small. RMA Comments on Proposed Rule at 2-9 (Oct. 1, 2015). For example, RMA provided test data showing that while the labs are correlated, they do not produce the same results, as some tires perform better at one lab, while others perform better at the other.

While the agencies, in the response to comment document, seemed to acknowledge potential compliance concerns, noting that tire manufacturers may select trailer tire rolling resistance level (TRRL) values identical to the measured rolling resistance or any higher value, RMA members may still feel compelled to correlate to both labs to avoid any potential compliance issue. Response to Comment Document at 1820. Additionally, at section 1037.520(c)(2), the regulation requires that rolling resistance test results not be "biased low," but the agencies do not define or explain what that means. Even small differences in test results can be very meaningful to a tire company, particularly in business, auditing, or compliance contexts. It would be helpful for the agencies to establish a reference machine to address this issue.

III. The Agencies Should Reconsider the Rolling Resistance Limit Values for Non-Box and Non-Aero Box Trailers

In the proposed rule, the agencies proposed to set rolling resistance limit values for non-aero and non-box trailer tires at 6.0 for 2017, 5.1 for 2018-2021, and 4.7 for 2024-2027. In the final rule, the agencies split out the standards for non-box trailers and for non-aero box vans. The final rule raised the limit values for non-box trailers from 5.1 to 6.0 for 2018-2020 and from 4.7 to 5.1 for 2024+. However, the non-aero box standards were unchanged from the proposed values of 5.1 for 2018-2020 and 4.7 for 2021+. In the discussion about non-box trailers, the agencies noted that while they agree with RMA and Michelin comments that "the baseline tires for non-box trailers should have a higher rolling resistance" than what was proposed, the agencies asserted that they "did not receive any that included C_{RR} data." 81 Fed. Reg. 73652. This appears to be an oversight by the agencies as this issue does seem to be addressed in the response to comment document.

In RMA's comments, RMA recommended the following limit values for non-aero and non-box trailer tires: 7.0 in 2018, 6.5 in 2021, 6.1 in 2024, and 5.8 in 2027. RMA based these recommended values on rolling resistance data collected on a range of tires used for non-aero vans and non-box trailers, which were included in RMA's comments. See RMA Comments on Proposed Rule at 21-25 (Oct.

2015); RMA Comments on NODA p. 3-4 (Apr. 2016). RMA also noted that the application of low rolling resistance tires to non-box and non-aero trailers may present conflicts in ultimate service and application. For example, trailers used on variable terrain often demand deeper tread depths and sidewall scuffing resistance such that typical highway-type low rolling resistance tire may not provide optimal service performance. In addition to potential performance issues, RMA members may not have enough lead time to meet these standards for non-box trailers and non-aero box vans. It would be helpful for the agencies to raise the rolling resistance limit values to align them with rolling resistance values that can be feasibly met in the future.

IV. The Agencies Should Reconsider Incorporating the SAE J1025 Standard

While RMA appreciates the agencies' attempt to clear up confusion regarding use of the terms "static loaded radius" and "loaded radius," the SAE J1025 standard for revolutions per mile is problematic. 81 Fed. Reg. 74076. In RMA's comments on the proposed rule, RMA noted that truck tire revolutions per mile can be measured using SAE 1025-2012, but RMA also highlighted that this test method could cause variations among similar tires depending on load and pressure, tread wear, tread geometry, driving and braking torque, and type and condition (wet, dry) of the pavement. RMA Comments on Proposed Rule at 30. The implications here are that vehicle manufacturers may ask RMA members to conduct additional testing based on a standard that has historically been based on engineering practices. RMA members are aware of only one facility that conducts this SAE J1025 testing and RMA is concerned that there may be limited capacity as well as a significant financial burden associated with such testing.

RMA advocates that the agencies allow tire manufacturers to rely on engineering practices to develop an estimate for static loaded radius and revolutions per mile. For example, the Tire and Rim Association has published "Guidelines for Static Loaded Radius (SLR_R) for Radial Truck-Bus Tires." In addition, The European Tyre and Rim Technical Organization (ETRTO) published a calculation for Theoretical Rolling Circumference. Tire manufacturers commonly use such engineering estimates. Tire companies also use other similar, equivalent formulas. RMA is interested in discussing with the agencies ways to incorporate accepted engineering practices that would provide the agencies with information essentially equivalent to results from J1025 testing.

V. The Agencies Should Reconsider Incorporating the SAE J2452 Standard

The agencies essentially created a modified version of the SAE J2452 coast down tire rolling resistance test for use with truck tires that is likely not technically valid and is outside the scope of the original SAE J2452 standard. 81 Fed. Reg. 73626, 73676, 74085. Beyond the agencies' generic discussion about coast down test procedure improvements, the agencies never discussed the specific possibility of relying on the J2452 standard in the proposed rule or in the notice of data availability. RMA members are concerned that they were not provided notice of the agencies consideration of the J2452 standard. The issue here is that the agencies have taken a test for passenger tires and applied it to truck tires,

changing loads and pressures, but not the warm-up time or adjusting the coast down profile to match that of truck tires.

It is not appropriate to apply a test method designed for light duty vehicles and apply it to medium and heavy duty vehicles or their components without evaluating the method's application to other vehicles, considering adaptations and validating the method. Given these issues, RMA members are concerned about the reliability and accuracy of such testing and therefore RMA recommends that this test be removed from the final rule. RMA is interested in discussing with the agencies alternative ways to provide the agencies with information essentially equivalent to results from J2452 testing.

VI. The Agencies Should Reconsider Removing the Exemption for 55-mph Speed Rated Tires

In the proposed rule, the agencies proposed to discontinue the criterion for exemption based solely on use of tires with maximum speed rating at or below 55 mph. 80 Fed. Reg. 40295. RMA commented that these tires typically are designed to achieve tire performances such as high load carrying capacity and durability that are specific to the vehicles on which they are installed, which often are used in off-road applications. RMA also noted that a tire that is appropriate for use on a vehicle used for off-road applications would not see a meaningful fuel consumption benefit due to the use of low rolling resistance tires as its typical drive cycle is at low speeds on aggressive terrain. Also, a speed restricted tire would not be suitable for use on a vehicle that does not specify these tires.

While acknowledging RMA's comments, the agencies ultimately were not persuaded that it would be detrimental for a vehicle to drive above 55 mph with speed-limited tires. The agencies' incorrectly assumed that vehicles that have the potential to travel at high speeds over 55 mph may be fitted with 55-mph speed rated tires that could later be removed. This assumption is mistaken because 55-mph speed rated tires are only installed on vehicles that do not have the capacity to safely travel at speeds over 55 mph.

As the Federal Motor Carrier Safety Administration noted in its recently issued final rule Parts and Accessories Necessary for Safe Operation, vehicles should be equipped with tires that have the proper speed rating for the vehicle's intended use because operating a vehicle at speeds that exceed the specified tire speed rating could create a potential safety issue. 81 Fed. Reg. 47728. Moreover, FMCSA adopted language in 49 CFR § 393.75 prohibiting the use of speed-restricted tires labeled for 55 mph or less, in accordance with S6.5(e) of FMVSS No. 119, on vehicles that operate at speeds that exceed the rated limit of the tires. Id. Therefore, the concern that this type of tire could be installed on a vehicle that could exceed such speed limits is not founded because speed restricted tires would not perform appropriately with and are prohibited on vehicles that exceed such limits.

VII. The Agencies Should Consider Directing Consumers to RMA Member Websites for Information on Rolling Resistance

In the proposed rule, the agencies proposed to determine that tire rolling resistance measurements would not be considered confidential business information. Ultimately, the agencies chose not to pursue a public database through this rulemaking. As RMA commented, RMA members consider rolling resistance test data to be confidential business information and while RMA appreciates the interest EPA expresses in educating vehicle operators about rolling resistance, releasing this data would not contribute to that goal. Instead, RMA recommended that the agencies consider an alternate approach, which RMA affirms again, that directing consumers to RMA member website fuel economy calculators would be valuable as these websites are good sources of information for tire replacements and comparisons.

VIII. The Agencies Should Ensure that Tire-Pressure Monitoring Systems for Trailers Provide a Visual Telltale to the Driver While the Vehicle Is in Motion

In the proposed rule, the agencies did not include a greenhouse gas emission model (GEM) reduction value for tire pressure monitoring systems (TPMSs). 80 Fed. Reg. 40187, 40218. But, the agencies requested comment on this approach and sought data from those in support of a GEM reduction value. In comments, RMA expressed support for a GEM credit for TPMS similar to the credit proposed for automatic tire inflation systems (ATIS). RMA also cited to a NHTSA study on the effectiveness of FMVSS 138, which mandates that TPMS be installed as original equipment in all passenger cars, multipurpose passenger vehicles and trucks and buses with a gross vehicle weight rating (GVWR) of 10,000 pounds or less and manufactured on or after September 1, 2007. In the NHTSA study, the agency found that the presence of TPMS led to a 55.6 percent reduction in the likelihood that a vehicle would have one tire that is significantly underinflated (25 percent or greater) and that TPMS saves $511 million in fuel costs across the vehicle fleet. RMA Comments at 25-28.

In the final rule, the agencies adopted provisions allowing manufacturers of tractors, trailers, and vocational vehicle chassis to input a percent decrease in overall fuel consumption and CO_2 emissions into GEM if the vehicle includes either an ATIS or a tire pressure monitoring system. 81 Fed. Reg. 73545, 73592-93. The agencies noted that they found the comments submitted, including those from RMA to be persuasive. The RMA commends the agency for adding tire pressure monitoring systems in the Phase 2 GEM. The use of these systems will provide a substantial improvement in vehicle efficiency as well as improve tire performance and extend tire life through more frequent and proper maintenance.

RMA, however, recommends that the agencies ensure that TPMS visual telltales for trailers are provided to the driver while the vehicle is in use. The final rule states that heavy duty trailers must use TPMSs "as specified in S4.3 and S4.4 of 49 CFR 571.138," citing to FMVSS 138, a TPMS standard for passenger vehicles, trucks and buses. 49 CFR Section 535.5(e)(2)(ii)(A). FMVSS 138 S4.3 and S4.4 requires that the low pressure warning telltale be mounted inside the occupant compartment, in front of and in clear view of the driver, and illuminated when the ignition locking system is on, whether or not the engine is running.

EPA-HQ-OAR-2019-003231

The issue here is that, unlike passenger or vocational vehicles, trailers make up part of a unit and due to the design of the vehicle manufacturers may seek to utilize TPMS at the tire not visible to the driver while driving. RMA cautions against such systems as they may not provide an adequate warning of pressure loss and could eliminate the benefits of the system. Instead, as required under FMVSS 138, RMA recommends that any tire pressure monitoring system use low pressure warning and malfunction telltales in clear view of the driver while the vehicle is in operation, such as communication/telematics within the cab or by additional telltale visual warnings.

IX. The Agencies Should Provide Relief for Adjustable Spread Axle Trailers

In the response to comment document, the agencies noted that because trailers with large spread axles are more susceptible to scrubbing, trailers with axle spreads greater than 120 inches are exempted from the rule. Response to Comments at 1035. But, the regulatory exemption states that "in the case of adjustable axle spacing, this refers to the closest possible axle positioning," meaning that if it is possible to narrow the axle gap to under 120 inches, the exclusion would not apply. 40 C.F.R. § 1037.5(h)(3). This regulatory exemption does not appear to have been raised by the agencies in the proposed rule or notice of data availability.

While RMA appreciates the agencies providing some relief for spread axle trailers, the agencies should expand the exemption to more broadly cover trailers with adjustable axles, which make up the great majority of spread axle trailers. As the agencies acknowledged, scrubbing is an issue for spread axle trailers, but the relief provided does not completely address the issue. RMA looks forward to discussing potential solutions with the agencies.

X. Conclusion

RMA appreciates the opportunity to submit this petition and looks forward to working with the agencies on potential changes to the regulation.

Sincerely,

Tracey J. Norberg
Senior Vice President & General Counsel
Rubber Manufacturers Association

ED_002375_00000111-00006

Message

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 5/18/2017 6:40:43 PM
To: McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Jim Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Homeister, Nancy (N.L.) [nhomeist@ford.com]
Subject: Meeting with Ford on Monday, May 22nd

Mike and Jim,

I apologize for the late notice, but I have now confirmed that a tentative meeting that EPA had scheduled with Ford will actually take place on Monday, May 22nd. I will send you both an invitation and a call-in number.

Best Regards,

Mike

Michael R. Olechiw
Director - Light-duty Vehicles and Small Engines Center
USEPA/OTAQ/ASD
2000 Traverwood Drive
Ann Arbor MI 48105
Tel: 734-214-4297
Mobile: 734-546-8079
Fax: 734-214-4050
olechiw.michael@epa.gov

Message

From: Erika Nielsen [enielsen@borgwarner.com]
Sent: 9/25/2017 6:51:47 PM
To: Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]; Kargul, John [kargul.john@epa.gov]; Cherry, Jeff [Cherry.Jeff@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Fernandez, Antonio [fernandez.antonio@epa.gov]; Lieske, Christopher [lieske.christopher@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; McDonald, Joseph [McDonald.Joseph@epa.gov]; Bohac, Stani [bohac.stani@epa.gov]; Safoutin, Mike [safoutin.mike@epa.gov]; Jim Tamm [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Mikkelsen, Brandon [Mikkelsen.Brandon@epa.gov]
CC: Pak, Gloria@ARB [Gloria.Pak@arb.ca.gov]; Mader, Pippin@ARB [pippin.mader@arb.ca.gov]; Shobna Sahni [ssahni@arb.ca.gov]
Subject: RE: Meeting with Borg-Warner re MTE and Off-cycle Program
Attachments: BW_'17 Ride n Drive Meeting Invite_9.21.17-V2.pdf

All,

Please note the location change to our Tech Center address:

BorgWarner
3800 Automation Ave.
Auburn Hills, MI 48326

Invite includes directions and instructions for parking.

Erika Nielsen
Director, Global Government Affairs

BorgWarner
Tel: +1-248-754-0422
Cell: +1 248-877-7346
enielsen@borgwarner.com

-----Original Appointment-----
From: Olechiw, Michael [mailto:olechiw.michael@epa.gov]
Sent: Monday, September 25, 2017 2:09 PM
To: Moran, Robin; Charmley, William; Bolon, Kevin; Barba, Daniel; Kargul, John; Cherry, Jeff; Sherwood, Todd; Fernandez, Antonio; Lieske, Christopher; Wysor, Tad; McDonald, Joseph; Bohac, Stani; Safoutin, Mike; Nielsen, Erika (PTC); Jim Tamm; McCarthy, Mike@ARB; Mikkelsen, Brandon
Cc: Pak, Gloria@ARB; Mader, Pippin@ARB; Shobna Sahni
Subject: Meeting with Borg-Warner re MTE and Off-cycle Program
When: Tuesday, September 26, 2017 2:00 PM-5:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: Borg Warner Facility - Auburn Hills, MI

BorgWarner

3850 Hamlin Road (Note: address change to 3800 Automation Ave. our Tech Center) Auburn Hills, MI 48326

Tel: +1-248-754-0422
Cell: +1 248-877-7346
enielsen@borgwarner.com

Meeting extended 1 hour to allow for facility tour.

BorgWarner Propulsions Systems Stakeholders Meeting and Ride-n-Drive – September 26,2017

Please forward the invite attached as you see fit to various the agency contacts you would like to attend.

Webcast Link
(See link below as some computers could have issues using link from the PDF)

ATTENDEE INFORMATION

PARTICIPANTS WILL USE THIS LINK TO REGISTER AND JOIN THE LIVE EVENT. THIS LINK BECOMES THE ARCHIVE (RECORDING LINK) AFTER THE EVENT.
This link gives participants access to the live and/or archived event.

https://engage.vevent.com/rt/borgwarner~092617

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Please disable your pop-up blockers in order to view the content in its entirety.

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Toll-Free Attendee Dial In: 833-812-9297
Conference ID: 86574701

Please test your connection prior to joining to ensure a successful user experience.

Connection Test: Click Here

For system requirements, visit our FAQ

Message

From: Helfand, Gloria [helfand.gloria@epa.gov]
Sent: 5/16/2017 11:57:01 AM
To: Charmley, William [charmley.william@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [Huang.Hsing-Hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Lie, Sharyn [Lie.Sharyn@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green [Kevin.Green@dot.gov]; Ryan Keefe (ryan.keefe@dot.gov) [ryan.keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]; Hoyer, Marion [hoyer.marion@epa.gov]; Burch, Julia [Burch.Julia@epa.gov]
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6)
Attachments: US Economy-Wide Impacts of 2012-16 LDV Rule FinalV2.pptx

Here's a proposed agenda:

1. 9 AM: Introductions, opening comments (about 10 minutes)
2. Carley & Graham presentation (75-90 minutes)
3. EPA presentation on IGEM analysis (about 10-15 minutes) (see attached, and above)
4. Open discussion (5-25 minutes)
5. Tour of the National Vehicles and Fuels Emissions Laboratory, where vehicle and fuels research and testing are done (~11 AM)

The attached slides describe the economy-wide modeling that EPA conducted for the MY 2012-16 rule.

Gloria Helfand, Ph.D.
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4688

-----Original Appointment-----
From: Charmley, William
Sent: Friday, March 31, 2017 9:49 AM
To: Charmley, William; Helfand, Gloria; Hengst, Benjamin
Cc: Moran, Robin; Olechiw, Michael; Yanca, Catherine; Alson, Jeff; Bolon, Kevin; Huang, Hsing-Hsiang; Shelby, Michael; Lie, Sharyn; Sargeant, Kathryn; Davidson, Ken; Wysor, Tad; Sherwood, Todd; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green; Ryan Keefe (ryan.keefe@dot.gov); McCarthy, Mike@ARB; Chen, Belinda@ARB; Simon, Karl; Dickinson, David; Burke, Susan; Snapp, Lisa; Jackman, Dana; Hoyer, Marion; Burch, Julia
Subject: Meeting with John Graham Conference Line/Code / Ex. 6
When: Wednesday, May 17, 2017 9:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: C126

U.S. ECONOMY-WIDE IMPACTS OF LIGHT-DUTY VEHICLE GHG STANDARDS

1

5/15/2017

ECONOMY-WIDE MODELING OF THE LIGHT-DUTY VEHICLE GHG STANDARDS

- In 2010, EPA undertook an analysis of the economy-wide impacts of the 2012-2016 light duty vehicle standards as an exploratory exercise
  - See Memorandum to Docket, "Economy-Wide Impacts of Proposed Greenhouse Gas Tailpipe Standards," March 4th, 2010 (Docket EPA–HQ–OAR–2009–0472)
- We used the Intertemporal General Equilibrium Model (IGEM) developed by Drs. Dale Jorgenson, Peter Wilcoxen, Richard Goettle, Mun Ho and Daniel Slesnick
- Received little public comment on the analysis
- We also have conducted internal staff analyses of the 2017-2025 light duty vehicle standards with IGEM and the pattern of results are similar

IGEM STRUCTURE

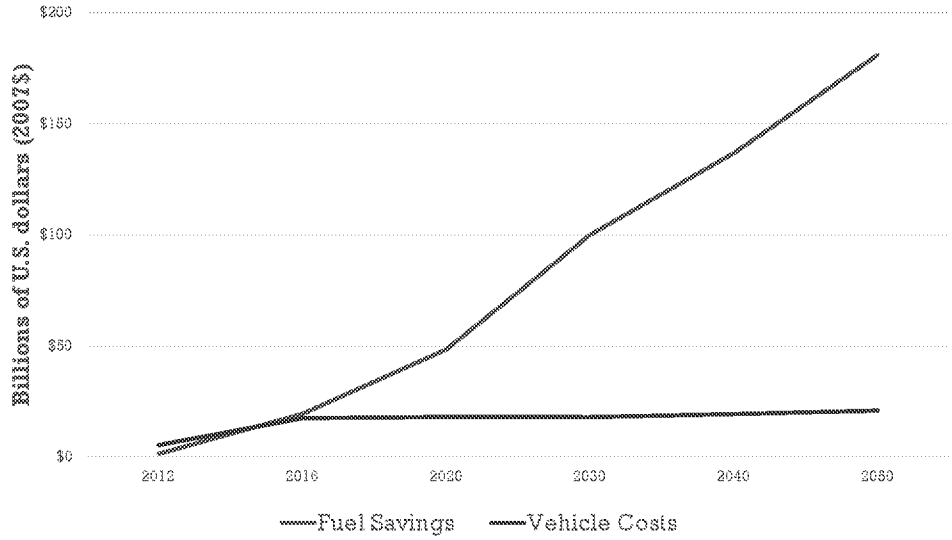
- IGEM is a computable general equilibrium (CGE) model
- The parameters of the equations in IGEM are estimated econometrically from historical data spanning over more than 40 years (1960 to the mid-2000 decade)
- IGEM's industries/commodities generally match the 2 digit sectors in the National Income and Product Accounts/Standard Industrial Classification (SIC)
- Production in IGEM is disaggregated into 35 industries (energy (e.g., petroleum refining, etc.) and 30 non-energy (e.g., chemical, wholesale/retail trade, etc.)
- More on IGEM: http://www.igem.insightworks.com/

4 MODEL INPUTS

VEHICLE/FUEL MARKET INPUTS
USED IN THE 2010 ANALYSIS OF MY2012-2016 STANDARDS

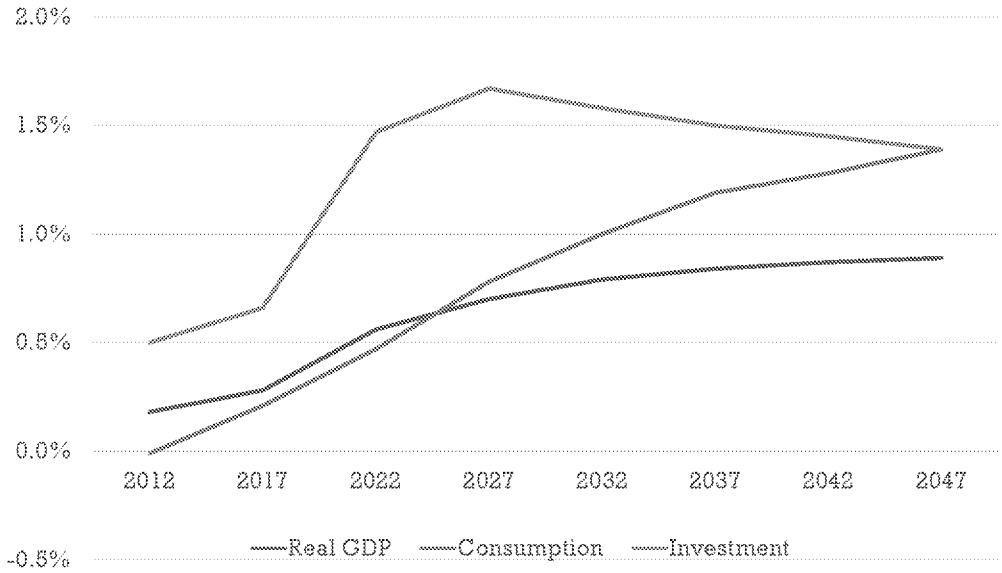
- IGEM's Base Case calibrated to AEO 2009 Reference Case
- To model the economy-wide impacts of the rule, the following inputs were provided to IGEM:
  - annual vehicle costs from the rule
  - annual fuel savings (pre-tax)
  - world oil price impacts from the rule (from: ORNL)
- Vehicle costs/fuel savings were calculated using EPA's OMEGA model
  - Passenger cars/light duty trucks are ~50% of the motor vehicles sector in IGEM

ANNUAL FUEL SAVINGS & VEHICLE COSTS FROM 2012-2016 STANDARDS



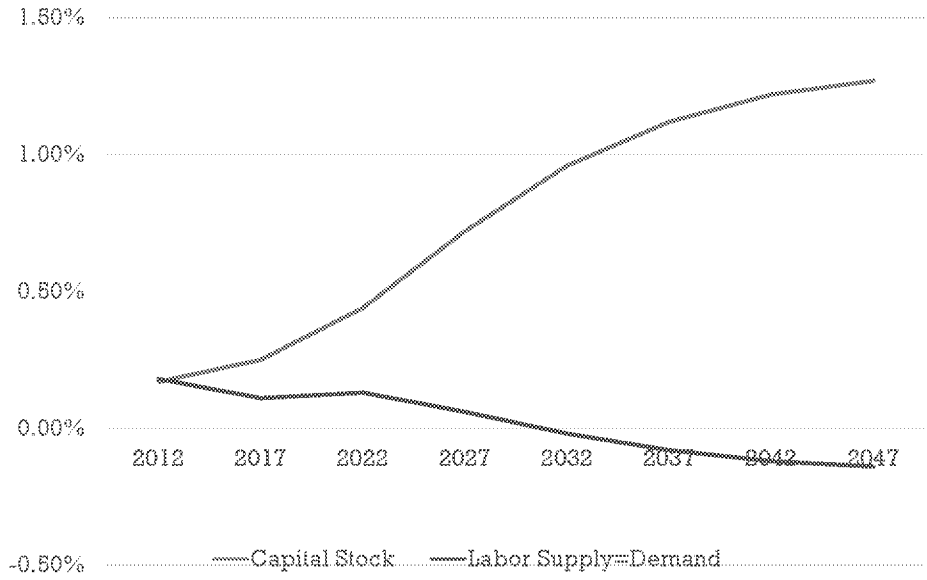
7 RESULTS

IMPACTS OF 2012-2016 STANDARDS ON U.S. GDP/CONSUMPTION/INVESTMENT



U.S. CAPITAL/LABOR SUPPLY IMPACTS OF 2012-2016 STANDARDS

(% CHANGES IN CONSTANT DOLLAR UNITS)



WHY DOES CONSUMPTION INCREASE?

- Firms pass on their reduced expenditures on fuel in lower prices for goods/services
  - With lower prices for goods/services, workers see an increase in their real wages and, therefore, increases in income/consumption
  - Higher real wages causes workers initially to supply more labor (through the 2020's time frame), but eventually increases in productivity/larger capital stock allow workers to take more leisure
  - More savings/capital accumulation/productivity growth causes real output of the economy to increase further, resulting in further increases in income/consumption

WHY DOES CONSUMPTION INCREASE?

- Consumers shift their spending from fuel/related energy intensive goods toward more spending on everything else consumers buy (i.e., food, clothing, health services, etc.)
  - Industries that benefit from increases spending have higher average levels of productivity growth than fuel supply/related industries
  - Combination of more production from industries with higher levels of productivity, and price-induced technical change, results in higher productivity growth across the whole economy, further increasing output which increases income/consumption

WHY DOES INVESTMENT INCREASE?

- Demand Side
  - Lower prices/cost savings result in an increase in income/consumer spending, which boosts demand from the stronger economy
  - With more spending, firms respond by increasing investment
- Supply Side
  - Savings from reduced expenditures on fuel to households/firms using light-duty vehicles (i.e., construction firms, agro-businesses, etc.) improve the profitability of firms throughout the economy resulting in increased investment
  - As the economy's capital stock, labor supply/productivity increase, lower input costs further boosts firm's profitability, resulting in further investment
  - Investment increases remain significant after mid-2020s when vehicle costs from the rule stabilize through time but fuel savings continue to trend upwards

QUESTIONS?

Message

From: Julia Rege [JRege@globalautomakers.org]
Sent: 5/15/2017 11:54:30 PM
To: Grundler, Christopher [grundler.christopher@epa.gov]; Charmley, William [charmley.william@epa.gov]; Bunker, Byron [bunker.byron@epa.gov]; 'James Tamm (james.tamm@dot.gov)' [james.tamm@dot.gov]; Doa, Maria [Doa.Maria@epa.gov]
CC: Amandine Muskus [amuskus@globalautomakers.org]; Charles Haake [chaake@globalautomakers.org]
Subject: Submission on EPA's Evaluation of Existing Regulations
Attachments: 2017-05-15 Global Automakers Smarter Regulation Comments to EPA.PDF

All,

Attached please find a copy of Global Automakers' comments on EPA's Evaluation of Existing Regulations submitted this evening to the docket. We approached this from the point of view of looking to streamline existing regulations and creating more efficient processes while preserving environmental benefits. Per the cover letter, copies will also be shared with the California Air Resources Board, who is identified as a necessary partner in seeing through many of these proposed vehicles certification and test procedure related items.

We would be pleased to discuss these further with you at any time.

Best, Julia

Julia Rege
Director, Environment & Energy
Association of Global Automakers, Inc. (Global Automakers)
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Maserati • McLaren • Nissan • Subaru • Suzuki • Toyota

May 15, 2017

Sarah Rees
Director, Office of Regulatory Policy and Management, Office of Policy
1200 Pennsylvania Avenue NW
Mail Code 1803A
Washington, DC 20460

ATTN: Docket ID No. EPA-HQ-OA-2017-0190

To: Ms. Rees

The Association of Global Automakers, Inc.[1] (Global Automakers) appreciates the opportunity to submit comments in response to the U.S. Environmental Protection Agency's (EPA) Federal Register Notice, "Evaluation of Existing Regulations" [82 FR 17793, April 13, 2017]. Global Automakers is approaching this effort as an opportunity to identify ways to assess smarter, more efficient ways to implement existing regulations through streamlining and reduced regulatory costs. More importantly, Global Automakers is offering a list of items that will reduce resources associated with existing regulations **without compromising environmental benefits**.

Global Automakers and our members have consistently supported the long-term goals of environmental improvements and development of advanced, innovative technology. Regulatory certainty and fair competition are needed to support these goals.

Global Automakers has evaluated the breadth of EPA regulations that impact the automobile sector, looking for opportunities that significantly reduce costs to industry – estimated to have the potential to save $150-200 million annually across the industry – while at the same time preserving environmental benefits.

[1] The Association of Global Automakers represents the U.S. operations of international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Global Automakers' companies have invested $47 billion in U.S.-based production facilities, have a combined domestic production capacity of 4.5 million vehicles, and directly employ more than 92,000 Americans. Global Automakers works with industry leaders, legislators, regulators, and other stakeholders in the United States to create public policies that improve motor vehicle safety, encourage technological innovation and addresses environmental needs. Our goal is to foster an open and competitive automotive marketplace that encourages investment, job growth, and development of vehicles that can enhance Americans' quality of life. For more information, visit www.globalautomakers.org.

Association of Global Automakers, Inc. 1050 K Street, NW, Suite 650 • Washington, DC 20001 TEL 202.650.5555 GLOBALAUTOMAKERS.ORG

GlobalAutomakers

Thank you for the consideration of our comments. Global Automakers would be pleased to discuss these comments further at any time.

Sincerely,

Julia M. Rege
Director of Environment & Energy
(202) 650-5555
jrege@globalautomakers.org

CC: Chris Grundler, EPA-OTAQ
Bill Charmley, EPA-OTAQ
Byron Bunker, EPA-OTAQ
Maria Doa, EPA-OCSPP
Jim Tamm, NHTSA
Mary Nichols, California Air Resources Board
Alberto Ayala, California Air Resources Board

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COMMENTS SUBMITTED BY
THE ASSOCIATION OF GLOBAL AUTOMAKERS, INC.
ON THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S
"EVALUATION OF EXISTING REGULATIONS"

DOCKET NO. EPA-HQ-OA-2017-0190

The Association of Global Automakers, Inc. (Global Automakers) hereby submits these comments in response to the U.S. Environmental Protection Agency's (EPA) Federal Register Notice, "Evaluation of Existing Regulations." [82 FR 17793, April 13, 2017]. EPA issued this request in acknowledgment of Presidential Executive Order 13771, "Reducing Regulation and Controlling Regulatory Costs," released on January 30, 2017 and Presidential Executive Order 13777, "Enforcing the Regulatory Reform Agenda," released February 24, 2017.

In the spirit of the Federal Register notice, Global Automakers is presenting opportunities that will streamline regulatory requirements impacting the automotive sector while at the same time maintaining the environmental benefits the Agency seeks to preserve. More generally, we support efforts that will reduce duplicative requirements, provide certainty for industry, and maximize flexibility and harmonization. Having a stable regulatory environment with prudent and sensible rules is crucial to good business practice and will help ensure consumer choice and affordability. In a rapidly changing technology landscape, increased innovation can render old regulations obsolete, counterproductive, or inefficient.

At the same time, it is imperative that the idea of smarter regulations not be conflated with the idea of an agency operating with fewer resources. The agency's ability to provide oversight, and to ensure that all companies are adhering to the same set of rules, is paramount to fair competition. It is important that we maintain a fair and competitive market in which all participants can maximize investments in the research and development of innovative technologies, create jobs, and continue their efforts to protect the environment.

The items we identify below will reduce costs and burden on industry—and in some cases on EPA as well—without impacting environmental protection, vehicle safety, or a competitive marketplace. Global Automakers notes, however, that many of these cost savings cannot be fully realized without incorporation by the California Air Resources Board (ARB) as well. There may be even more opportunity for streamlining and cost reduction if EPA and ARB were to work together to adopt best practices and reduce duplication and inconsistencies in regulatory requirements and test procedures. Finally, while we have carefully considered our recommendations, Global Automakers believes these comments are only a starting point to a larger process and discussion. Further discussion between

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industry and the agency will help ensure a consistent and correlated approach is necessary – many of these programs are interrelated and rely on information from each other.

Based on estimates provided by our member companies, Global Automakers approximates that the measures identified below could save on the order of $150-200 million annually for the industry as a whole; these estimated savings may vary, and Global Automakers provides costs per measure below where information was available. Our comments do not include the midterm review of greenhouse emissions standards for light-duty vehicles or the petition for greater harmonization between the greenhouse gas (GHG) and Corporate Average Fuel Economy (CAFE) programs. For both issues, we are engaged with the agency on a parallel pathway.

Global Automakers' comments on streamlining existing regulations, reducing regulatory costs, and promoting innovation and investment in a competitive and strong automotive sector are provided in three categories: light-duty vehicle certification and test procedures, fuel economy labeling, and other EPA regulations. These comments, as follow, are applicable to the Office of Air and Radiation, Office of Chemical Safety and Pollution Prevention, Office of Atmospheric Programs, and Small Business Administration.

1. Light-Duty Vehicle Certification and Test Procedures

The resources spent on vehicle certification and compliance testing are a major source of cost to both the automotive industry and EPA. The cost of the facilities to test vehicles and the time spent administering tests adds complexity to an already cumbersome regulatory process. Global Automakers and its members recommend several measures as candidates for streamlining and simplification but whose overall modification would not reduce environmental benefit. These measures include:

- Air Conditioner Efficiency Credits via AC17 Tests
- Cold Temperature Testing
- Elimination of Manufacturer's Confirmatory Test
- Reduce the Need for Routine Particulate Matter Testing
- Reduce or Eliminate N_2O Testing Procedures
- Simplification of Evaporative Emissions Testing
- In-Use Verification Program Streamlining
- Eliminate Fuel Change Requirement in the IUVP Test Vehicle Before and After the Preconditioning Drive
- Relaxation of Test Facility Requirement
- The Verify System Reporting
- No Longer Require Full Applications for Certification for Carryover or Minor Changes to Vehicles
- Optional Relaxation of the Grouping Requirement

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- Other Areas for Consideration in Certification and Test Procedures

Additionally, Global Automakers believes that a strong agency laboratory equipped with sufficient certification-testing resources is fundamental to maintaining a level playing field upon which automakers can equitably compete. It is important for EPA to provide oversight, and to ensure that all companies are adhering to the same set of rules.

Air Conditioner Efficiency Credits via AC17 Tests

EPA currently requires manufacturers to perform a time and resource-intensive test, called the AC17, to substantiate emissions improvements associated with more efficient motor vehicle air conditioner (A/C) systems. The AC17, overall, continues to be problematic, because it is lengthy to perform and requires a special test chamber to conduct. Further, this test is unduly burdensome for many manufacturers that lack the facilities and resources to conduct testing, in particular for small-volume manufacturers, which are therefore at a disadvantage compared to larger companies to earn A/C-related efficiency credits.

Since its inception, automakers have raised concerns about the AC17 test and have worked with EPA, and with the SAE, for many years to develop and implement the test. Yet, the agency has persisted in supporting use of AC17 to earn air conditioner efficiency credits. Global Automakers believes this entire test sequence would benefit from a thorough evaluation to see if there are alternative methods available that would achieve the same goal – to substantiate credit values – in a far less burdensome and costly manner. Global Automakers and its members would like an opportunity to work with the agency to consider ways to reduce burden associated with this test. While we have some ideas – such as going back to a table-type menu, minimizing the number of test vehicles, or reducing the number of tests – there may be better alternatives to make this test easier to perform that should be collaboratively explored.

Nonetheless, if this larger undertaking is not possible, Global Automakers believes that several smaller but still significant improvements can be made to the AC17 test, including streamlining the test procedure and providing clear guidance in the off-cycle credit program for requesting A/C technology-related credits.

For example, one helpful modification to the AC17 test procedure would be an allowance for a longer time between the A/C on and A/C off portions of the test. AC17 testing currently requires the test to be repeated (A/C off conditions) within 10 to 15 minutes after emissions sampling has concluded for A/C on conditions. This creates significant burden, as a single test takes over four hours to complete (in comparison, it takes only about one hour to perform general emissions and fuel economy testing on the FTP and highway test cycles) and must be run in a specialized environmental testing chamber. Since both sections of the test require a pre-conditioning UDDS test cycle and a soak period, results are expected to be the same regardless of the time between the two portions of the test. In other words, the pre-test requirements simulate the same types of conditions the agency would otherwise hope to

achieve by having a short time period in-between tests. This provision provides no additional benefit and no notable impact on the test results, yet creates a significant burden on test facilities and staffing resources. Global Automakers recommends that EPA amend the test procedure and allow up to one day (or even longer) to pass between the A/C on and A/C off portions of the AC17 test.

An even more significant reduction in testing costs and resources could be achieved by changing the criteria for test-to-test variability. The regulations allow up to 5.0 and 7.2 g/mile for passenger cars and light trucks, respectively, but capturing a 0.1 g/mile difference between tests is not realistic given test-to-test variation. More consideration should be given on how to discern small differences between tests (test variability). It is very unlikely that a true comparison of a more efficient to less efficient A/C system can take place that adequately quantifies A/C system differences due to test-to-test variation. Further, identifying a vehicle which does not incorporate the credit-generating technologies for comparison to a more efficient A/C system is not realistic, due to the additive effects of other powertrain technologies also adopted on the comparison vehicles.

Finally, Global Automakers requests that EPA create a clear process for A/C efficiency technologies, including consideration in the off-cycle credit program. This clarification will help automakers consider additional technological improvements and provide a clear pathway to ensure those improvements are accounted for. Having a clear process that encourages automakers to install innovative fuel-efficient technologies will result in greater real world emissions improvements. Further, as noted below with respect to the off-cycle credit process in general, once technologies are approved for off-cycle credits, these accepted technologies and/or methodologies should be added to a menu for future use by any manufacturer.

Cold Temperature Testing

Cold temperature testing is required to demonstrate compliance with cold temperature carbon monoxide (CO) standards as well as the standards for cold temperature non-methane hydrocarbons (NMHC). It requires a special facility and equipment that can produce, maintain, and be durable in cold temperatures.

There is no longer much of an ambient cold temperature CO attainment issue, and the cold CO standards have not been updated commensurate with the pace of technology. Hence, the standards are relatively easy to meet, and it seems the cost of cold testing may not be warranted for every single test group. In contrast, the cold NMHC requirement was added more recently as an air toxics provision, and likely raises more of a compliance issue than cold CO. This may require that cold FTP testing be performed regardless. Thus, while total elimination of cold testing may not be justified, some degree of streamlining should be possible.

As discussed under the 5-cycle labeling issue, cold test data is needed for the 5-cycle computation. If it is not run for actual cold CO or NMHC compliance purposes, then it would

be needed for input to the fuel economy label process. But under our recommendation for streamlining of the fuel economy label program (below), cold testing could be greatly reduced. Our recommendation includes dropping the litmus test which would require cold testing of all emissions data vehicles (EDVs), but we do recommend that EPA continue to acquire some level of full 5-cycle results to allow for periodic updating of the derived 5-cycle equation.

Thus, we recommend that cold testing be minimized via a similar requirement that was adopted in the Tier 3 standards for particulate matter (PM) testing. For PM testing, only 25% of all "durability" groups are required to be tested each year. A similar reduction approach could be applied for cold temperature testing along with liberal carryover criteria that could be applied to certain technologies that have been demonstrated to be reliably compliant with cold temperature standards.

Elimination of Manufacturer's Confirmatory Test

The benefits associated with manufacturer-performed confirmatory testing have greatly diminished over the years. Automakers' confirmatory testing is essentially a double check of certification tests already performed by the automakers. The value of this testing is negligible.

Global Automakers recommends that EPA eliminate manufacturer confirmatory testing. Elimination of manufacturer's confirmatory test **represents almost $1.5 million per year in testing in savings.**

Reduce the Need for Routine Particulate Matter Testing

Historically gasoline engines were exempted from particulate matter (PM) testing, because their PM emissions were inherently lower than the standards, which were based on diesel engines. While gasoline engines were still held accountable for meeting PM standards, EPA provided an option to provide a statement of compliance, based on good engineering judgement, that gasoline vehicles would meet the PM standards for the full useful life of the vehicle.

With the development of EPA's Tier 3 regulations (and California's corresponding LEVIII regulations), EPA tightened the PM standard and added additional requirements to test gasoline engines for PM. The test procedure for PM, however, is cumbersome and lengthy and is subject to a high level of testing variability. As a result, this testing is costly to perform and often has to be repeated.

EPA has recognized PM testing burdens to some degree, and it had adopted a provision to reduce it somewhat. The Tier 3 regulations only require PM testing in certification for only about 25% of "durability groups." See 86.1829-15(d)(1). However, even with this reduction, additional reductions are warranted given the expense and difficulty associated with PM testing.

Therefore, Global Automakers recommends that EPA develop criteria to eliminate PM testing on certain technologies, like low-emitting non-GDI gasoline engines, that have been determined to be continually below the PM standards. The exempted test groups meeting such criteria

would be certified upon receiving a compliance certification based on a good engineering judgement and manufacturer development testing. This amendment would greatly streamline the certification process, reduce testing burden, and therefore reduce associated testing costs as well.

To be clear, Global Automakers is not proposing that the agency delete the PM compliance requirement from the regulation. PM emissions have recognized associated health impacts, and Global Automakers agrees that compliance with the PM standards should continue to be checked through surveillance testing, In-Use Verification Program, and/or other audit processes. This would ensure that environmental objectives are maintained, while reducing automakers' testing burden. By reducing the certification requirements to test PM emissions for certain technologies, Global Automakers estimates that more than **$2 million per year per manufacturer could be saved**; these savings also include estimates for reduced laboratory equipment requirements, as addressed below.

It is also important to note that PM emissions is another area where California has related test requirements. As a result, it is critical that EPA and California align to reduce this test burden; otherwise, any action EPA takes will not result in a real cost or test burden reduction.

Reduce or Eliminate N_2O Testing Procedures

Although EPA has included nitrous oxide (N_2O) standards as part of the overall GHG light-duty vehicle program, the reality is that the main reductions in GHG-related emissions from mobile sources will be from reductions in carbon dioxide (CO_2). These reductions will come from the mandated improvements in vehicle fuel economy associated with the NHTSA CAFE program and the EPA GHG emissions reduction program. Mobile source emissions of N_2O and CH_4, are inherently low, with N_2O emissions largely being a byproduct of nitrogen oxides (NO_x) emission controls.

Over the years, manufacturers have worked with EPA to address concerns with available technology to test for N_2O. Manufacturers have also raised concerns with test-to-test variability and the cost of such technologies. At one point in time, EPA did agree to delay the test requirements as a result. These concerns, however, have not been addressed, and testing remains a significant burden with little to no benefit to the environment or impact on meeting the GHG standards.

Therefore, Global Automakers strongly recommends reducing the need for N_2O testing, or eliminating these test requirements in their entirety. It should be sufficient to allow manufacturers to attest to compliance with the N_2O capped standards based upon good engineering judgement, development testing, and correlation to NOx emissions. EPA could, however, maintain the option to request testing to be performed for new technologies, only, which could have unknown impacts on N_2O emissions.

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The **elimination or significant reduction of these testing requirements for N_2O may exceed $600,000 per year in savings per manufacturer.**

Simplification of Evaporative Emissions Testing

Testing for evaporative emissions is conducted through several different time-consuming and costly test procedures, including two different types of diurnal testing, onboard refueling, bleed emissions, etc. In 2005, EPA recognized the significant hardships associated with evaporative emission test and finalized a rule to allow several important streamlining aspects. See 70 FR 72917, December 8, 2005. In this rule, EPA noted:

> The enhanced evaporative test procedure is important for measuring evaporative emissions from vehicles under numerous drive and park conditions, and the ORVR test is important for measuring refueling emissions from vehicles. In some cases, similar parameters are tested by these test procedures. The two-diurnal and three-diurnal test sequences both test canister capacity, permeation control, and canister purge capacity. The three-diurnal test sequence also tests hot drive vapor generation (running loss) and high temperature vapor generation. The ORVR test procedure tests canister capacity and canister purge capacity, in addition to refueling vapor generation and fill pipe losses…performing all four test procedures requires a minimum of 12 days…EPA believes it is appropriate to streamline the evaporative test procedure to reduce testing burden and to reduce overlapping procedures without affecting the level of stringency.

These provisions did what was intended, and helped to reduce duplication and testing burden, but since this 2005 streamlining effort, the regulations have been revised by the Tier 3 rulemaking (and California's LEVIII rule), and additional tests have been added.

Taken as a whole, it is not clear that all of these tests continue to provide individual value. They would likely benefit from a more complete review of opportunities to streamline the testing. The result of a new, revised, and more streamlined set of evaporative emissions tests would benefit both the agency and manufacturers. Thus, Global Automakers recommends that EPA, along with ARB and industry, work together to develop a robust and holistic evaporative emission test procedure.

For instance, both the 3-day test and 2-day diurnal breathing loss test are required for evaporative emission testing. It has been allowed, however, that either one of them is generally sufficient to show compliance, with the default test case being the 3-day test with running loss. The 3-day test is the longer, more resource-intensive test to perform, and does not necessarily have an added benefit over that of the 2-day test, particularly at the super low standards adopted in EPA's Tier 3 regulations (as well as California's LEVIII regulations). Therefore, Global Automakers requests that EPA work with industry, and ARB, to develop a single test that is less

burdensome, reduces unnecessary testing (like running loss), and ensures control of evaporative emissions.[1]

Further, the bleed emissions test, originally developed by ARB and later adopted by EPA, may no longer provide any incremental benefit. This test replaced another evaporative emission test, the rig test, and EPA agreed to harmonize with ARB's procedure. The purpose of the rig test is to assure control of vapor "bleeds" from the canister. While it may be appropriate to consider eliminating this test, it should be part of the broader evaluation of the suite of evaporative emissions-related tests and thus considered as part of a simplified, holistic and streamlined evaporative emission test procedure. In the interim, allowing the bleed emission test to be replaced by a manufacturer statement of compliance based on good engineering judgment should be sufficient and would provide significant relief. Further harmonization with California will be necessary if a statement of compliance is allowed.

Streamlining this process represents a **potential savings of $160,000 per model year per manufacturer.** This estimate includes potential savings associated with the elimination of the evaporation bleed emissions requirements noted below.

Finally, the onboard refueling vapor recovery (ORVR) standard requires the vehicle to be designed to prevent excessive displacement of vapor from a vehicle tank to escape to the atmosphere as the tank is being filled during refueling. The ORVR test procedure simulates the refueling operation in a sealed chamber (or SHED) designed to capture and measure any vapor that might escape during the fill operation. That escaped vapor may not exceed the number of grams allowed over a controlled fill of a specified amount of new fuel pumped into a tank having a specified starting fuel level. Given that manufacturers have been running the full test for 15 or more years, existing testing has resulted in substantial demonstration of the system designs. Hence, it should be possible for manufacturers to base future demonstrations on use of prior data on combinations of previously-proven filler interfaces and canister/tank size relationships.

In addition, the ORVR test requires a special test facility that is not common among manufacturer test facilities. As a result, in addition to paying for the test, additional costs are incurred through transportation fees to and from the facility. Furthermore, while the ORVR test sequence is similar to the evaporative emissions test sequence, EPA requires that both sequences be performed separately.

Having a single testing procedure would help streamline a cumbersome, duplicative process, while reducing test burden. If necessary, automakers could provide a statement of compliance in place of the EPA certification test. The requirement to run the full test procedure could be retained for cases where totally new, and hence unproven, changes have been made that fall

[1] It is also important to note that California has long been the proponent of a 3-day evaporative emission test with running loss. As a result, it is necessary that EPA and California align to reduce this test burden, otherwise, any action EPA takes will not result in a real cost or test burden reduction.

outside the range of what has been previously proven. In any case, manufacturers would still be subject to complying with the standard under the full test procedure should EPA perform confirmatory testing either during certification or on in-use vehicles.

Benefits of the elimination of this test would be contingent on ARB's elimination of its testing requirements. Elimination of this test could represent **a savings of $1.2 million per model year.**

Coordination with the California Air Resources Board on this topic is highly recommended to ensure the full benefits of an elimination could be achieved.

In-Use Verification Program Streamlining

In a rulemaking finalized in the 1999-2000 timeframe (referred to as CAP2000), EPA streamlined how emission deterioration should be projected for vehicles when operated over their useful lives. Previously the procedures involved driving a prototype "whole vehicle" on a track or on a mileage-accumulation dynamometer over the full number of useful-life miles (i.e. 100,000 miles and up to 150,000 miles under the latest Tier 3 standards). Given this had to be accomplished before the start of production, compromises had to be built into the procedure to allow accumulation of 100,000 or more miles on an accelerated basis. The procedure was costly and yet failed to exercise the vehicle under realistic on-road conditions. EPA replaced this "whole vehicle" driving procedure with a procedure that allowed a manufacturer a fair degree of flexibility to develop its own durability testing procedure based on component "bench aging" techniques. In exchange for this flexibility, manufacturers were required to perform testing on consumer-owned vehicles to verify the credibility of their bench testing procedures. This program was called the in-use verification program (IUVP). Consumer-owned vehicles had to be tested for every certified test group at two points in their useful lives. The first set of tests was required at low mileage (nominally at one year after the end of production) and then again at high mileage (nominally after the four-year point).

While at the beginning, every test group had to be tested every year – even for "carryover" years where the product had not been changed – the regulations authorized EPA to consider reducing test burdens over time as manufacturer durability procedures were demonstrated to be effective and when good in-use performance had been demonstrated.

IUVP testing has been ongoing for about 15 years, and nearly all manufacturers have demonstrated good durability performance. This presents an opportunity for significant streamlining or elimination from the program in order to reduce testing requirements and volumes. This effort has actually been the subject of discussion with EPA for many years, but previous efforts with EPA to identify and implement streamlining measures have not resulted in any notable reductions to the testing requirements and volumes, despite strong support and justification for doing so.

There are a variety of aspects of IUVP that EPA should address, all of which have good reasons to be streamlined and will have little overall impact on the data collected by EPA. These

suggested amendments will have little to no impact on real world emissions. They will, however, have a significant impact on reducing unnecessary cost and burden. The aspects of IUVP that should be streamlined include:

1. Eliminating high altitude testing. High altitude testing is extremely costly, because it requires special test facilities, which are limited in availability and must be shared by all automakers for both certification testing and IUVP. The limited facilities available to conduct this testing often leads to delays and increased testing prices. Further, for smaller automakers that build much of their fleet abroad, they are limited to two testing sites in Europe, which creates additional competitive disadvantages for these smaller automakers. Even with certain "work arounds" that allow testing in facilities that can simulate high altitude conditions, the facilities are limited, overbooked, and costly to use. High altitude testing for IUVP also provides little to no environmental benefit at this time. Finally, high altitude IUVP testing has an extremely high pass rate for testing, which helps to justify the elimination of this test requirement.
2. Reducing testing requirements and volumes. An overall reduction in test requirements and volumes would result in a significant reduction in costs. The current IUVP requirements specify percentages of vehicles that must be procured for testing (which could be greatly reduced), as well as requirements for testing on several test cycles, including FTP, Highway, and US06 testing requirements.
3. Eliminating or significantly reducing low-mileage testing and reducing high-mileage testing by not testing carryover groups.
4. Redefine the high-mileage testing requirements for years and mileage. The current requirements for high-mileage testing require vehicles to meet the criteria of four years and 50,000 miles. These two criteria taken together make it very difficult for manufacturers to identify and procure vehicles for this category of testing. While EPA does provide additional flexibility to expand procurement areas and occasionally procure vehicles slightly outside the mileage requirements, manufacturers must seek advance EPA approval. EPA should evaluate the number of requests they receive regarding procuring high-mileage vehicles and consider changing the criteria if it appears manufacturers have to frequently request additional flexibility.
5. Consider shortening the record retention period. EPA currently requires that manufacturers retain records for eight-years. Record retention requires secure facilities and adequate storage space for the eight years. Therefore, Global Automakers suggests that the agency should consider a shorter retention time should be used.

The cost savings resulting from implementing these four items could produce per-manufacturer cost reductions of **$120,000 per model per year to up to more than $1.2 million per year for larger manufacturers**. It is important to note that the California Air Resources Board also has requirements for IUVP that are similar to EPA's. So even if EPA implements

these more streamlined testing procedures, if California does not fully align with the federal modifications, the reductions in testing and costs will not be fully achieved. Under EPA Tier 3 and California LEVIII regulations, it is expected that most test groups will be certified as 50-state tests groups (i.e. meeting both EPA and California requirements), and therefore would be subject to the test requirements of both EPA and California testing, in this case IUVP. Therefore, Global Automakers recommends that EPA and ARB work together to streamline IUVP requirements.

Eliminate Fuel Change Requirement in the IUVP Test Vehicle After the Preconditioning Drive Cycle

The emission test sequence begins with a prep test being run on the same cycle that will then undergo official testing. This allows the vehicle to adapt to the laboratory conditions of the official test to be run. The fuel is then drained and replaced with fresh fuel filled to the specified fill level of the test. Then the vehicle is parked for six to 36 hours in a controlled temperature environment to allow the vehicle and fuel to all reach a stable condition. This is all done to ensure that the official test is done under an exact highly controlled and repeatable test condition. Global Automakers requests that this step – to change the fuel after the preparation drive cycle - be eliminated for the IUVP tailpipe emissions test sequence. The fuel change requirement adds an additional set of steps to the test procedure that requires additional labor burdens in the testing procedure. The resulting test results do not merit the use of this additional fuel change and should be eliminated. To be clear, Global Automakers is only requesting this change for IUVP and suggests it be maintained for "official" certification and recall tests (whether run by EPA of the manufacturers).

Relaxation of Test Facility Requirement

EPA's Tier 3 regulations added new test procedure requirements, including dramatically increasing testing accuracy. Part 1066.245 forces automakers to update most of the testing facilities. As a result, older dynamometers do not comply with the new test procedures, and these old dynamometers must be replaced. The replacement cost of new equipment can be extremely high, and in some cases may be entirely unnecessary. It also takes a significant amount of time to procure new equipment and install it.

There are some test facility requirements newly introduced at the timing of Tier 3 regulations in 40 CFR Part 86.1065 and Part 1066 that avoid carry-over of current test facility specification (e.g. 1066.245: Response time verification (for chassis dynamometer). These should be eliminated, or at a minimum, EPA should extend the required deadline for incorporation of these elements.

A one-time upgrade of one automakers' facilities requires **more than $7 Million**.

The Verify System Reporting

Certification burdens were decreased with the CAP2000 program, but much of the savings came from giving manufacturers more control over routine decision making, reducing the number of emissions data vehicles required, and allowing revised durability procedures based upon bench testing. While manufacturers were given more autonomy as it relates to certification testing, the revised approach did not radically decrease what is required to be reported to the Verify System. A significant amount of data is required to be submitted to EPA to certify vehicles. Thus, there is an opportunity to reduce another area of certification burden by streamlining and lessening reporting requirements.

For instance, the Excel report of CAFE/GHG is no longer necessary, except for credit information, because the Verify System can calculate CAFE and carbon related exhaust emissions (CREE) values. Therefore, except for the credit information, EPA is duplicating reporting requirements by requiring this Excel report, with no added benefit. Further, Global Automakers supports integration of the calculation and values of credits, such as those earned under the CAFE and GHG programs for off-cycle technologies, into the Verify System. By adding this data submission into Verify, the system can then automatically compute the end data. This incorporation would reduce the potential for human-related errors from transcribing Excel reports into the Verify System and simplify the EPA's work in computing compliance with the CAFE and GHG standards.

Further, the contents of ARB E-Cert system are almost identical to those of the Verify System, so manufacturers' burdens could be further decreased by combining the two systems – California's E-Cert and EPA's Verify System – into a single, shared, and harmonized database that both ARB and EPA use.

These suggested streamlining efforts would reduce unnecessary duplication of efforts.

No Longer Require Full Applications for Certification for Carryover or Minor Changes to Vehicles

Global Automakers recommends that EPA no longer require a new full application for certification each model year when the vehicle is carryover and/or only has minor changes. Even if there are minor changes that require new test data for the carryover model, such changes could be reported through an update notification as opposed to a full application. In other words, the emission certification system can be streamlined to adopt a "self-certification"-like system for carryover models.

The current requirements for vehicles include a minimum of three tests for model-year exhaust emission compliance: a regular model-year exhaust emission certification application, an in-use emission test submitted by a manufacturer, and a surveillance test conducted by EPA. For purposes of carryover models, Global Automakers recommends a self-certification-like system (such as the one NHTSA allows for vehicle safety certification) that would not require a regular

model-year exhaust emission certification application. For example, NHTSA accepts manufacturers' self-certification and verifies its performance through a compliance test after sales. Since emission performance will still be inspected through IUVP and EPA surveillance testing, there is adequate assurances to check the performance of carryover models and hold manufacturers accountable for the vehicle's performance.

Optional Relaxation of the Grouping Requirement

Global Automakers recommends that EPA consider additional flexibility for the current emission data vehicle (EDV) grouping requirement. This flexibility would allow manufacturers to reduce the number of EDV groups (tailpipe and evaporation), should they choose. An example would be to eliminate the specified limits for canisters. Under the current system, identical evaporation systems with only a difference in canisters result in different EDV groups. This is unnecessarily restrictive and does not provide any environmental benefit. Test groups should be separated based on performance, not on specification difference. **Savings could exceed $2 million per year.**

Other Areas for Consideration in Certification and Test Procedures

These items are based on Global Automakers' initial review of opportunities to streamline existing certification and test procedure burdens, but they may not represent the full possibilities available to EPA and the automotive industry. Additional discussion between EPA and the industry could help identify other areas that would benefit from further clarification, guidance, or streamlining that could result in greater reductions in cost and burden. For example, while EPA allows for automakers to use a simulation for road load values, in some instances, EPA has not approved use of the simulation. It is possible that manufacturers could use additional guidance to help clarify EPA's criteria and decision-making process to help ensure manufacturers will be able to use this intended cost-saving flexibility. Global Automakers recommends that EPA and industry work together to further identify streamlining opportunities.

2. Fuel Economy Labeling

There are two topics covered in this section:

- Simplification of the Fuel Economy Labeling Program
- Expanded Use of Analytically Derived Fuel Economy (ADFE)

Simplification of the Fuel Economy Labeling Program

It has long been recognized that the original city test (i.e., FTP) and highway test significantly overstate fuel economy compared to real world driving. While the original FTP and highway

test results are locked into the Corporate Average Fuel Economy (CAFE) program by statute, EPA has the authority to provide adjusted fuel economy results for fuel economy labeling purposes to try to better estimate real world fuel economy that the "average" driver might expect to experience. EPA has been using "adjusted" fuel economy results for labeling since the mid-1980's.

EPA adopted new label adjustment procedures that became fully effective with MY 2011. It involves a two-step process. A complex equation was developed that utilizes fuel economy data inputs from five different driving cycles. These five cycles have been in place for several years for emission certification purposes, but were not previously used for estimating fuel economy. These are resource-intensive laboratory vehicle testing cycles. They include the Federal Test Procedure (FTP), highway, US06, SC03 and cold FTP test cycles. The fuel economy computed using the data collected by these five test is referred to as "5-cycle" fuel economy. The first step in the process involves computing this 5-cycle fuel economy based upon testing that is generally done on an emission data vehicle (EDV) for emissions compliance purposes. Additional fuel economy data vehicles (FEDVs) must be tested to obtain the minimum required data needed to generate a fuel economy label. It would be extremely burdensome if every one of these FEDVs needed to also be tested on all five cycles. EPA provided a second step in the process to minimize such extra testing.

A second simpler regression equation was developed that only needed input from just the FTP and highway test. These tests would be run regardless of the labeling program for CAFE compliance purposes. This equation, referred to as the "derived 5-cycle equation," attempts to predict the same results as the more cumbersome true 5-cycle computations. Due to its simplicity, it represents a cruder approximation of the data but works well on average. The derived 5-cycle results are then compared to the full 5-cycle results. This comparison process is referred to as the "litmus test." If the "derived" results compare within an established acceptable limit boundary to the full 5-cycle results for the EDV (within 4% for FTP and within 5% for highway) the litmus test is considered "passed." If passed, all remaining FEDVs from the same test group as the EDV may then use the simpler derived 5-cycle equation. This means all fuel economy values used for labeling purposes from that test group could be computed only from the FTP and highway test inputs, significantly saving time and resources associated with 5-cycle testing.

If the litmus test is "failed," all FEDVs from that test group must undergo testing on all five cycles to fulfill the minimum data requirement to support a label computation, and the full 5-cycle fuel economy is then used to generate labels.

The availability of the option to use the simpler derived 5-cycle fuel economy greatly reduces the amount of testing that that is needed for labeling. In EPA's rulemaking, it predicted that on the order of 75% of all test groups would be expected to pass the litmus test. Actual experience has shown that even a higher pass rate has occurred. It appears that somewhere in

the range of as low as 5% to perhaps a high of 15% of test groups (this can vary with model year, vehicle technology, and manufacturer) fail the litmus test and hence are subject to increased testing.

Despite of the burden reductions built into this ability to use only the "derived 5-cycle" equation, additional benefits can be achieved via further simplification of this program.

EPA has a goal of presenting "label values [that] are the best 'real world' estimates for consumers," and EPA should continue to strive for values as close as possible to real world fuel economy.[2] This goal can be achieved, however, through other means that reduce reliance on large amounts of laboratory tests of light-duty vehicles.

Global Automakers requests that EPA simplify the fuel economy label test procedures to rely even more on the "derived 5-cycle equation." A potential method to make this changeover would be reducing FEDVs and increasing the cap on analytically derived fuel economy (ADFEs) above the current 20% threshold.

Based on EPA's and industry's extensive vehicle testing, the derived 5-cycle equation should be periodically updated to maintain the correlation between the historical 5-cycle data and current vehicles. While no additional 5-cycle testing would be performed on FEDVs, full 5-cycle data would continue to be generated from emissions certification testing of the EDV on all 5-cycles. This amendment would allow for elimination of the litmus test and reduce testing burdens associated with all 5-cycles tested FEDVs. There are several reasons to consider this item as a candidate for streamlining, including:

- A high percentage of test groups routinely qualify for use of the derived 5-cycle equation anyway.
- If the empirical equation is subject to periodic updates, it should provide a reasonable "fit" for all vehicles.
- Cost savings would be incurred from both reductions in record reporting requirements and extra testing needed to complete the litmus test. Note that while in theory the only 5-cycle data needed for the litmus test would come from emission certification testing of the EDV, there are circumstances where additional testing becomes necessary. Even greater cost savings could be incurred by eliminating the full 5-cycle test on those FEDVs needed to satisfy minimum data needs for labels from test groups that fail the litmus test.
- Competitive inequities would be removed. Under current policy, a vehicle that just passes the allowable litmus tolerance (4% for city and 5% for highway) can continue to use "average results" from the derived 5-cycle equation. On the other hand, a similar

[2] EPA, Office of Transportation and Air Quality. *Questions and Answers: Fuel Economy Labeling*. EPA-420-F-14-015 at p. 1. (April 2014).

vehicle that just barely falls outside the tolerance must base its label on full 5-cycle testing. While the two example vehicles might only differ from each other in 5-cycle fuel economy by a very small percentage, the one that just passes the litmus test gets to use the nearly 4% higher derived 5-cycle result while the one that just fails must use the full 5-cycle result that could be four or more percent lower.

- Testing on the 5-cycle tests requires special and expensive facilities (especially for the SC03 and cold temperature tests on FEDVs), which could be reduced. Instead, this testing would only occur on vehicles needed for certification. For vehicle manufacturers that are smaller or newer to the market with fewer resources, these 5-cycle tests present a real economic hurdle to bringing new and innovative vehicles to market, and initially such vehicle could fall within the failed litmus realm.

Expanded Use of Analytically Derived Fuel Economy (ADFE)

The provisions of 40 CFR 600.006-89(e) allow EPA to accept analytical expressions to generate fuel economy data. EPA has historically implemented the use of such ADFE computations via guidance letter. Prior guidance limited use of ADFE results to a maximum of 10% of the number of sub-configurations required for a manufacturer's CAFE value. In 2004, EPA raised the maximum allowance to 20% via guidance letter.[3]

EPA historically has been concerned about excessive use of ADFE values as this could unduly increase computed CAFE levels. One reason was because manufacturers could pick and choose what works best for them. If a computed ADFE value produces a favorable value, a manufacturer could use it, but if the ADFE value is undesirably low, the manufacturer could then choose to go through the expense of actually testing the vehicle to achieve a better result. Additionally, EPA was concerned that manufacturers would maximize the use of ADFE computations when they could be based upon what EPA called a "sweet" test result (i.e., a test that by luck of the draw in test variability came out high). The impact of this value could be magnified if this vehicle then served as the basis for computing ADFE results for other vehicles. Hence, EPA applied the limit on maximum use of ADFE values.

But EPA's guidance letters applied other protections to minimize such a high bias from potential "sweet" fuel economy tests. Such measures should be sufficient to maintain credible fuel economy computations without limiting ADFE use to only 20%.

By streamlining the procedure and implementing an increase in maximum allowed ADFEs, there is potential to **reduce costs between $500,000 and $2.5M per model**. Variation in these estimates depends on the number of FEDVs that would need to be tested. High volume models, for example, might have between two and eight FEDVs, while low volume models might have between one and three FEDVs. Consequently, reducing the number of fuel economy test

[3] US Environmental Protection Agency. *Updated Analytically Derived Fuel Economy (ADFE) Policy for 2005 MY and Later (CCD-04-06 LDV/LDT).* March 11, 2004.

vehicles would allow for an immediate reduction in fixed costs to the automotive industry, as well as the agency.

3. Additional Regulations for Streamlining Consideration

There are four topics covered in this section:

- Important Considerations for Small-Volume Manufacturers
- Stakeholder Engagement in Chemicals Regulations
- GHG Reporting Requirements for Subpart QQ
- Improve Off-Cycle Credit Program Process

Important Considerations for Small-Volume Manufacturers

Global Automakers represents the U.S. operations of international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Of our member companies, twelve are automobile manufacturers ranging in size, resources, investment, and sales, including some small, specialized brands. As we noted above, Global Automakers supports a fair and competitive market that encourages innovation and green technology. Some smaller companies, therefore, may need additional consideration in the regulatory process to ensure they can continue to compete against larger companies with more resources, while also working toward the same environmental goals.

Global Automakers is recommending that as part of this effort to reduce regulatory burden, EPA should consider flexibilities for small-volume manufacturers (SVMs). These flexibilities will reduce costs, allowing these SVMs to instead invest in research and development to advanced cleaner and more efficient vehicles. The following are some concepts on how EPA can reduce regulatory burdens without compromising environmental improvements for SVMs:

- Additional Lead Time: In general, when implementing new emissions requirements, EPA should consider providing additional lead-time for SVMs, on a case-by-case basis. In some cases, a separate implementation date may be appropriate and in others, simply implementing effective dates for SVMs that start at the end of any large volume manufacturers' phase-in requirements. The reason for this is that SVMs have fewer models – sometimes only one or two engine families – and limited product offerings compared to large volume manufacturers. As a result, a percent phase-in for requirements inadvertently results in them having to meet the requirements faster and earlier than large-volume manufacturers. Global Automakers recommends that EPA issue additional lead-time for SVMs to help reduce costs and smooth the transition to new requirements.

- Certainty for Alternative Standards: In recent years, EPA has implemented alternative standards for SVMs in certain scenarios. This flexibility should help SVMs comply with the intent of regulations – to reduce emissions year-over-year – but account for the specific challenges that SVMs face, including, but not limited to, leaner resources and small, specialized product lines. SVMs must submit requests for alternative standards in a timely manner, with adequate lead time before the standards would be implemented.

  In concept, alternative standards should help SVMs as they plan for cleaner, greener technologies to meet the regulations and provide a clear and consistent path forward for technology investment. There have been, however, issues with the process for approving alternative standards, which have resulted in delays in approval. EPA needs to ensure adequate resources to make sure that all manufacturers' requests are dealt with in a timely and efficient manner. SVMs, as well as other companies, should not be unduly penalized by delays in agency decision-making. Any delay in approval reduces (or eliminates) necessary lead time. These unnecessary delays in the approval process create regulatory uncertainty, drive up costs, are overly restrictive, and most importantly divert resources from developing cleaner and more efficient technologies.

- Deterioration Factors: There are two areas where EPA could help support industry, and in particular SVMs, related to the generation and application of deterioration factors (DFs).

  First, EPA allows for the use of industry-assigned deterioration factors (ADFs) based on industry data. The last time ADFs were updated was approximately three years ago, and so the ADFs are likely outdated by now. It would be beneficial for EPA to consider a more regular process for updating the ADFs. This process will help keep ADFs updated and relevant, and assist manufacturers in determining if it is appropriate to apply ADFs.

  Second, as noted above, the evaporative emissions standards and associated test procedures would benefit from an EPA-industry process to review and revise the program to reduce duplication and costs. One area that was not addressed above was the evaporative emission durability program. This program was developed to provide additional flexibility to automakers in developing DFs for evaporative emission control systems, but this process remains overly costly and extremely difficult for SVMs. There is no clear industry DF available, and it would be helpful to provide general DFs, particularly for SVMs, whose systems may remain largely unchanged year after year. Global Automakers recommends that EPA evaluate options to reduce burden for SVMs in this area, but also ensures compliance, and provide clarity on what is required for SVMs.

- Streamlined Reporting Requirements: Similar to our comments to streamline and revise reporting requirements above, evaluating opportunities to simplify SVM reporting

requirements, as appropriate, would help to reduce time and resources necessary for reporting.

These recommendations can provide important flexibility to help SVMs to continue investment in greener technologies and remain competitive with larger manufacturers. They can help free up resource for the SVMs, but EPA as well. Just as importantly, these flexibilities will have a "de minimis" effect on environmental improvements; in some cases, they may result in a slight delay in environmental improvements, but ultimately ensure greater success for SVMs in ultimately meeting any requirements and therefore provide greater certainty that such environmental improvements will be made.

Stakeholder Engagement in Chemicals Regulations

EPA has begun work on regulating the first ten priority chemicals under the Frank R. Lautenberg Chemical Safety for the 21st Century Act of 2016, which amended the existing Toxic Substances Control Act (TSCA). The regulation of these chemicals will have significant impacts not only on those companies that manufacture the chemicals, but also (and sometimes more directly) on chemical users, including auto manufacturers, suppliers, and importers of articles that may contain the regulated chemical.

While consultation with stakeholders can be a cumbersome process that can add cost and time at the beginning of a rulemaking, it is critical to have all stakeholders engaged in the regulatory process to ensure fully-informed and fact-based regulations. Resources invested at the beginning and throughout the regulatory process will result in a valuable return on investment that will be reflected in smarter, more efficient and effective environmental regulation.

For example, chemical users are critical stakeholders that have not always been invited to participate in the process of evaluating candidate chemicals, their uses, and the availability of viable substitutes. Chemical users can have valuable information that should be considered at the outset of any regulatory process. Finding suitable substitutes once a chemical is marked for elimination adds additional cost to manufacturing of products that can then be passed to American consumers. To allow for the lead-time for users to change product plans and make updates to their manufacturing processes, it is important to engage with the entire supply chain as early in the rulemaking process as possible.

GHG Reporting Requirements for Subpart QQ

On November 9, 2010, EPA issued a rule for the mandatory reporting of greenhouse gases (GHGs) from large sources of fluorinated GHGs such as hydrofluorocarbons (HFCs), nitrogen trifluoride (NF3), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). This rulemaking includes reporting for imports and exports of pre-charged equipment or closed-cell foams containing fluorinated GHGs (Subpart QQ). Global Automakers recommends that EPA eliminate reporting under Subpart QQ, since there is no environmental benefit incurred with this reporting.

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Under this rule, EPA estimates the total cost of reporting for the private sector will be approximately $7.6 million for the 1st year and $7.2 million in subsequent years.[4] This is a significant cost for reporting. Global Automakers does not know what portion of these reporting costs are attributed to Subpart QQ, but nonetheless, any effort to reduce reporting such as Subpart QQ will help reduce these overall costs.

Improve Off-Cycle Credit Program Process

Our member companies remain committed to investing in technology that provides real environmental benefits while meeting consumers' needs, and we have consistently requested greater alignment in the One National Program for emissions and fuel economy to reduce unnecessary costs and regulatory burdens that provide no incremental environmental benefit. Global Automakers, with the Alliance of Automobile Manufacturers, submitted a petition for rulemaking to EPA and the National Highway Traffic Safety Administration on June 20, 2016.[5] This petition is incorporated by reference in these comments.

Global Automakers is, however, including additional discussion about a more general improvement to the GHG off-cycle credit program, which was included in our June 2016 petition. It is a critical component of the overall One National Program, and with the right implementation, this program can help launch innovative fuel-saving technologies.

Automakers and suppliers are bringing new and innovative technologies to the market year-over-year. These technologies have the potential to provide real-world environmental benefits that were not considered in previous rulemakings. In this rapidly changing technological landscape, it is important to continually evaluate innovations that provide real benefit and to give credit for these. Thus, Global Automakers recommends that EPA evaluate ways to encourage this innovation and avoid arbitrary barriers to real world fuel economy improvements.

First and foremost, Global Automakers requests that EPA, along with NHTSA, establish more guidance for the alternative method for GHG off-cycle credit generation. Providing clear and consistent running rules on tested technologies that provide real GHG reduction promotes the use of various methods to reduce pollutants at a reasonable cost. Greater guidance from the EPA about acceptable procedures, reputable data sets, how to capture driver behavior, etc. will incentivize automakers to use this channel, resulting in the application of more CO_2-reducing technologies coming to market sooner. This would allow for a lower cost of technology penetration and the potential for increased environmental benefits.

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[4] https://www.epa.gov/sites/production/files/2015-07/documents/qqfactsheet.pdf.

[5] Association of Global Automakers and The Alliance of Automobile Manufacturers. *Joint Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program.* https://www.epa.gov/sites/production/files/2016-09/documents/petition_to_epa_from_auto_alliance_and_global_automakers.pdf. (June 20, 2016).

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Guidance will help to create a more streamlined process to apply for and obtain off-cycle credits. Streamlining the process would reduce the current onerous test programs and, more importantly, address the low confidence among manufacturers of EPA acceptance of off-cycle credit applications. Taken together, these concerns have acted as barriers to manufacturers that wish to apply for off-cycle credits, and as a result, have directly slowed the rollout of innovative fuel-saving technologies. In contrast, improving the process will build confidence in the procedure for obtain credit approval, and thereby provide real environmental benefits and reduce costs associated with the implementation of newer technology.

In addition to providing guidance and streamlining the process, Global Automakers requests that EPA allow automakers to reference previously accepted applications especially in areas of:

- Defining off-cycle testing and procedures
- Demonstrating "real-world" ambient conditions, road type, geography, etc.
- List of accepted assumptions (i.e. city weighting)
- Capturing driver behavior / usage

EPA should seek to make improvements that support such innovative growth and should expedite this activity. This activity could lead to more cost-effective approaches to reducing emissions and at the same provide additional environmental benefits in the real world.

In summary, Global Automakers believes that Executive Orders 13771 and 13777 provide an important opportunity to reassess regulations to date and assess smarter, more efficient ways to implement such regulations. Global Automakers is evaluating the breadth of EPA regulations that impact the automobile sector and looking for opportunities that significantly reduce costs to industry – estimated to have the potential to save $150-200 million annually across the industry – while at the same time preserving environmental benefits.

Thank you for the consideration of our comments.

Message

From: Chris Nevers [CNevers@autoalliance.org]
Sent: 5/15/2017 8:23:38 PM
To: Bunker, Byron [bunker.byron@epa.gov]; Charmley, William [charmley.william@epa.gov]; Ayala, Alberto@ARB [Alberto.Ayala@arb.ca.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; james.tamm@dot.gov
CC: Wehrly, Linc [wehrly.linc@epa.gov]; Machiele, Paul [machiele.paul@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yoon, Rebecca (NHTSA) [rebecca.yoon@dot.gov]; Cullen, Angela [cullen.angela@epa.gov]
Subject: Regulatory Reform Comments
Attachments: Alliance of Automobile Manufacturers Comments to EPA OAR on Regulatory Burdens.pdf

Good Afternoon,

Please see the attached Alliance comments submitted to Docket ID #EPA-HQ-OA-2017-0190 in response to EPA's memo requesting information pursuant to the President's Executive Order 13777. We look forward to working with EPA and other agencies to address regulatory burden while not sacrificing environmental progress.

Contact me if you have any questions.

Best Regards,
Chris Nevers
Vice President, Energy and Environment
Alliance of Automobile Manufacturers
248 794 5002

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May 15, 2017

Samantha K. Dravis
Regulatory Reform Officer and Associate Administrator
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U.S. Environmental Protection Agency
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On behalf of the Alliance of Automobile Manufacturers and approximately 7 million U.S. workers who earn a living from building, selling and servicing cars and trucks, we appreciate this opportunity to provide the EPA with recommendations on ways to reduce regulatory burdens affecting vehicle development, manufacturing, and sales in the U.S.

Without question, industry and government need to cooperatively work together to identify and remove regulatory burdens that add inefficiencies while not meaningfully altering past environmental achievements or future progress desired by all.

This submission is specifically in response to EPA's efforts to gather information pursuant to President Trump's Executive Order 13777 identifying opportunities to reduce regulatory burdens. However, the Auto Alliance continues to work with federal agencies and departments on other regulatory matters, including:

- An accurate and informed Mid Term Evaluation to assess customer acceptance of vehicles needed to comply with the Model Year 2022-2025 light-duty vehicle efficiency standards.
- Harmonization opportunities that must be addressed to fulfill the promise of One National Program for regulatory compliance. In short, these changes need to be made to reduce or eliminate the existing disparities between EPA and NHTSA regulatory programs in a separate rulemaking in advance of the 2022-2025MY rulemaking by NHTSA.[1]
- Better evaluation of fuel and vehicle improvement opportunities, understanding that the fuel and the vehicle act as an integrated system to reduce emissions.

Attached is the list of opportunities directly responsive to the Executive Order and identifying opportunities that warrant consideration by the EPA. Each issue includes a brief explanation and CFR citation (when possible).

In addition to the recommendations contained in this letter, we believe that EPA and California Air Resources Board (CARB) officials should continue working together to streamline regulatory testing and

[1] Letter from Mitch Bainwol and John Bozzella to Administrator McCarthy and Administrator Rosekind Re: Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and Greenhouse Gas Program, June 20, 2016.

reporting requirements while effectively maintaining environmental outcomes. In the past, such efforts have proven successful. For example, in 1996, the EPA, CARB, and the automobile industry signed a Compliance Assurance Program 2000 or "CAP2000" Statement of Principles that called for improvements to emissions control performance of light-duty vehicles while reducing overall compliance burdens. This resulted in broad regulatory streamlining which touched nearly every aspect of compliance. Efficiencies were achieved by shifting the agency's regulatory emphasis from the pre-production to the post-production environment where the proof of compliance is validated. A regulatory lookback such as CAP 2000 should be conducted periodically to address inefficiencies.

Thank you for the opportunity to provide comments. The Alliance looks forward to working with the EPA task force on implementing the specific recommendations in this letter and to offering additional suggestions for streamlining regulations while effectively maintaining environmental and safety outcomes.

Sincerely,

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Light-Duty Issues

1.1 Issue: Regulatory changes required to implement Tier 3 E10 test fuel for FE and CAFE are incomplete.

1.2 Issue: Duplicative testing is required on E0 and E10 test fuels for Tier 3 emissions certification.

1.3 Issue: Certification durability requirements are unnecessarily burdensome.

1.4 Issue: Manufacturers should not be held responsible for upstream power plant emissions.

1.5 Issue: Off-cycle credit approval process is overly burdensome.

1.6 Issue: 5-cycle fuel economy labeling is overly complicated.

1.7 Issue: Jointly developed air conditioning efficiency test (AC17) lacks the fidelity to effectively measure AC technology improvements.

1.8 Issue: Fleet NMOG+NOx calculation is incorrect.

1.9 Issue: Fuel economy testing and calculations for vehicles equipped with Select-Shift and/or Multimode transmissions is overly burdensome.

1.10 Issue: Guidance for manual (and manually shifted automatic) transmission shift schedules and Shift Indicator Light (SIL) burdens OEMS with unnecessary vehicle surveys.

1.11 Issue: SC03 testing is overly burdensome.

1.12 Issue: In-Use Verification Program (IUVP) testing is overly burdensome.

1.13 Issue: CO_2 fleet average credit trading regulations have unnecessary restrictions.

1.14 Issue: Unnecessary restrictions on the evaporative emission fleet average, NMOG+NOx tailpipe emission fleet averages, and early Tier 3 credits, credit life and trading regulations.

1.15 Issue: Reporting imported/exported fluorinated GHG mass is unnecessary for low GWP refrigerants.

1.16 Issue: Constraining truck technology crediting method is misaligned with environmental goals.

1.17 Issue: Accelerated HFC-134a ban restricts manufacturers' ability to choose the most cost effective compliance plan for their fleet.

1.18 Issue: HFO-1234yf mandate starting in 2026MY on exports is an incentive to foreign manufacturing.

1.19 Issue: Lack of FFV usage factor creates regulatory uncertainty.

1.20 Issue: Vehicle and engine manufacturers must submit unnecessary website performance reports.

1.21 Issue: Pre-model year reports are an unnecessary burden.

1.22 Issue: Individual vehicle thermal control cap drives unnecessary vehicle level reporting.

1.23 Issue: Advanced technology volume multiplier does not function as intended and needs to be corrected.

1.24 Issue: Lack of public transparency and timely EPA review and decision on petitions and State authorization requests.

1.25 Issue: Undefined reporting requirements for new rules create a regulatory burden on manufacturers.

1.26 Issue: Unnecessary running change requests should be eliminated.

1.27 Issue: Excessive Manufacturer Confirmatory Test (MCT) is burdensome.

1.28 Issue: Certification Application submission for carry-over models is overly burdensome.

1.29 Issue: Analytically Derived Fuel Economy (ADFE) is arbitrarily limited to 20% of tests in CAFE/GHG increasing OEM test burden.

1.30 Issue: Testing, reporting, and tracking requirements for N_2O and CH_4 are overly burdensome.

Market Fuels Issues

2.1 Issue: Marketplace fuels need to be better aligned to enable beneficial new vehicle technologies.

2.2 Issue: Higher octane rated gasoline for the U.S. market is necessary to enable high compression ratio engine efficiency gains.

2.3 Issue: Outdated 1 psi Reid Vapor Pressure (RVP) waiver for E10 gasoline needs to be eliminated.

2.4 Issue: Need to protect consumer access to market fuels required or recommended by the OEM.

2.5 Issue: Fuel detergents used with high ethanol blend gasoline (>51%) retail/commercial fuels cause significant clogging problems at service stations.

Heavy-Duty Issues

3.1. Issue: Certification durability requirements are unnecessarily burdensome. (similar to light-duty issue)

3.2. Issue: In-Use Verification Program (IUVP) testing is overly burdensome. (similar to light-duty issue)

3.3. Issue: Vocational CO_2 requirement is redundant in the HD GHG Phase 2 program.

3.4. Issue: Testing 10% of sub-configurations for Class 2B & 3 cab complete vehicles drives a disproportionate amount of testing compared to other vehicle segments.

3.5. Issue: Undefined reporting requirements for new rules create a regulatory burden on manufacturers. (similar to light-duty issue)

3.6. Issue: EPA and NHTSA do not recognize AC improvements in heavy duty segment, but do in light-duty segment.

3.7. Issue: EPA and NHTSA do not recognize off-cycle improvements in the heavy-duty segment, but do in the light-duty segment.

3.8. Issue: Constraining truck technology crediting method is misaligned with environmental goals. (similar to light-duty issue)

3.9. Issue: Pass-by noise requirement for trucks >10k lbs. GVWR are outdated.

3.10. Issue: Unnecessary restrictions on the CO_2 fleet average credit trading regulations. (similar to light-duty issue)

3.11. Issue: Unnecessary restrictions on the evaporative emission fleet average, NMOG+NOx tailpipe emission fleet averages and early Tier 3 credits, credit life and trading regulations. (similar to light-duty issue)

3.12. Issue: Testing, reporting, and tracking requirements for CH_4 and N_2O are overly burdensome. (similar to light-duty issue)

3.13. Issue: Heavy Duty Phase 2 sunset alternate CO_2 compliance mechanism for loose engines is burdensome.

3.14. Issue: Vehicle and engine manufacturers must submit unnecessary website performance reports. (similar to light-duty issue)

3.15. Issue: Pre-model year reports are an unnecessary burden. (similar to light-duty issue)

Remove Duplicative regulatory requirements and Coordinate criteria emission test procedures between EPA and California

General Harmonization Issues

4.1. Issue: Different test fuels between EPA and CARB resulting in excessive burden during product development.

4.2. Issue: Excessive pre-production reviews delay certification approvals.

4.3. Issue: Precertification testing impacts vehicle launch timing.

4.4. Issue: Different electronic reporting systems between agencies add no value.

4.5. Issue: Emission warranty reporting to CARB and emissions defect reporting to EPA is duplicative.

4.6. Issue: Duplicative reporting of manufacturer field fix bulletins is wasteful.

4.7. Issue: EPA/CA VECI labeling requirement is outdated.

Test Procedure Harmonization Issues

5.1. Issue: EPA and CARB certification test procedures for electrified technologies (e.g., charge depleting PHEV, HEV, BEV) are not aligned, resulting in duplicative testing.

5.2. Issue: Substantial development, test, certification, and in-use compliance burdens OEM's on LEV III 1 mg/mile particulate regulations.

5.3. Issue: Evaporative emissions test procedure differences drive unnecessary testing.

Light-Duty Issues

1.1 **Issue:** Regulatory changes required to implement Tier 3 E10 test fuel for FE and CAFE are incomplete.
Background: The regulations finalized in 2013 require the use of E10 test fuel for FE and CAFE by 2020MY, however, the agency has still not issued the regulatory changes that are necessary to enable such testing. This delay has eroded the expected lead-time for this changeover, cast doubt on the feasibility of the 2020MY deadline and has created considerable uncertainty in manufacturers' product development and compliance planning processes.
Agency: EPA
Regulation: 40 CFR 600.117; 40 CFR 600.112
Recommendation: Modify the regulation to allow optional usage of E0 test fuel beyond 2020MY.

1.2 **Issue:** Duplicative testing is required on E0 and E10 test fuels for Tier 3 emissions certification.
Background: Emissions certification under Tier 3 requires the use of E10 fuel. However, to address separate GHG emissions testing, OEMs are also required to test the EDV (Emissions Data Vehicle) on E0 fuel. This burdensome requirement is in place solely to generate trace emission data (methane and nitrous oxide) on E0 at the time of certification, even though this data will be generated in later FEDV (Fuel Economy Data Vehicle) testing.
Agency: EPA
Regulation: 40 CFR 600.113
Recommendation: Repeal the unnecessary requirement for E0 data on EDVs certifying on E10, and allow manufacturer to attest to the CH_4 and N_2O values, or allow the FEDV, which is already testing on E0 fuel, to provide the data in lieu of the EDV.

1.3 **Issue:** Certification durability requirements are unnecessarily burdensome.
Background: For diesel products, instead of allowing a more efficient bench aging process, which is allowed for gasoline products, OEMs are required to run full vehicle durability testing for 150,000 miles. In addition to bench aging, the same general process used for demonstrating gasoline catalyst systems should be allowed for diesel catalyst systems. The cost and time burden are extremely high with these processes. The Alliance has taken steps with EPA to update the current requirements, and now seeks EPA to prioritize completion of this effort. Technology and procedures have evolved over time. Another issue is the current bench aging process where O_2 sensors, for example, have become durable and control systems adaptable to the point that emissions do not vary when using a new or an aged O_2 sensor. Requiring aged O_2 sensors for full useful life testing only adds cost, complexity, and burden to testing procedures. Another area of concern is in establishing battery deterioration factors for PHEVs as it is premature and could discourage this promising technology. However, this deterioration varies considerably from vehicle to vehicle and is not yet well understood. Finally, manufacturers are responsible for emission variations caused by drivers, testing environments, fuels, and myriad other factors. Along with all of the factors that determine a product's performance throughout its useful life, manufacturers should also have the authority to determine their own deterioration factors. This would streamline the certification process and reduce costs.
Agency: EPA, CARB
Regulation: 40 CFR part 86.1823, 86.1829, etc. (multiple), 1065.415, 86.1818-12
Recommendation: Modify the regulations to allow manufacturers greater flexibility in terms of durability demonstrations (the following are examples of requirements that need to be addressed):
1. Allow bench aging of diesel emission systems, as allowed for gasoline products.
2. Eliminate the need for aged O_2 sensors for full useful life testing of gasoline products.

3. Allow greater flexibility in assigning deterioration factors.
4. Allow negative deterioration factors (DF's) for PM, CO_2, N_2O, CH_4 and all other GHG's and criteria emissions components, as demonstrated by data.
5. EPA should work with auto manufacturers to understand better how real world electric miles are likely to change as PHEVs age, PHEV technology matures, consumers adapt to PHEV technology, and electric vehicle charging infrastructure improves.
6. EPA should more regularly publish assigned DF's for each technology.

1.4 **Issue:** Manufacturers should not be held responsible for upstream power plant emissions.
Background: Plug-in Electric Vehicles (PEVs) after 2021 Model Year and over a defined production volume threshold will be required to include the CO_2 emissions associated with the production of electricity ("upstream emissions") in a PEV's CO_2 compliance value. Upstream emissions are not emitted by vehicles or engines and are not controlled or influenced by automobile manufacturers. Automobile manufacturers should not be held accountable for emissions produced by other sectors and sets a precedent not seen in other regulatory programs. Electric operation of vehicles should remain "zero" emissions for fleet average GHG compliance.
Agency: EPA
Regulation: 40 CFR 600.113-12
Recommendation: Repeal the upstream emissions CO_2 penalty from the vehicle GHG standards.

1.5 **Issue:** Off-cycle credit approval process is overly burdensome.
Background: Case-by-case approvals for off-cycle credit applications is excessively burdensome due to slow agency response and unnecessary testing. The procedures for granting off-cycle GHG credits are not being implemented per the provisions of the regulation and are not functioning to the level necessary for industry for long-term compliance. Without timely processing, EPA works against its stated intent of "provid[ing] an incentive for CO_2 and fuel consumption reducing off-cycle technologies that would otherwise not be developed because they do not offer a significant 2-cycle benefit."
Agency: EPA
Regulation: 40 CFR 86.1869-12(d)
Recommendation: Modify the current process for evaluating off-cycle applications, which can result in excessive time between completion of a final application and its notice for public comment in the Federal Register. If one manufacturer has already demonstrated the benefit of a technology to EPA, allow following manufacturers to use the same benefit for that technology without repeating the entire testing and application process. We recommend that EPA also consider the concerns and recommendations provided in the June 20 2016 Alliance and Global Automakers Petition to NHTSA on harmonization. Finally, we request that the list of pre-defined and pre-approved off cycle credits be updated and expanded to include additional technologies such as high efficiency alternators, air conditioner compressors with variable crankcase suction valve technology, transmission bypass valves, and other technologies identified by the industry in their submissions to recent EPA and NHTSA rulemakings. Also, the fleet credit cap needs to be removed as it restricts the application of fuel saving technologies.

1.6 **Issue**: 5-cycle fuel economy labeling is overly complicated.
Background: The requirement to use 5-cycle testing to generate fuel economy labels is complicated and unnecessary.
Agency: EPA
Regulation: 40 CFR 600.114-12, 40 CFR 600.115-11

Recommendation: Repeal the requirement to use 5-cycle testing to generate fuel economy labels. Since the derived 5-cycle fuel economy labels have good agreement with the 5-cycle fuel economy labels as reported in guidance letter CD-15-15, 5-cycle testing for the label is not necessary. At a minimum, the 5-cycle fuel economy label testing should be made optional, at the manufacturer's discretion, and the litmus requirement eliminated.

1.7 **Issue:** Jointly developed air conditioning efficiency test (AC17) lacks the fidelity to measure effectively AC technology improvements.
Background: EPA and industry jointly developed the AC17 test. Unfortunately, in many cases, multiple AC17 tests must be performed to demonstrate a statistically significant result and it still does not fully capture the effectiveness of the A/C technologies. The test procedure is also longer and more complicated than most emission tests. As such, the AC17 represents an unnecessary test requirement and an excessive testing burden. EPA has already developed a simple lookup table, which eliminates the need to perform the AC17 test.
Agency: EPA
Regulation: 40 CFR 86.1868-12(f), 40 CFR 1066.845
Recommendation: Modify the regulation to allow manufacturers to continue to use EPA's MAC efficiency credit look-up table.

1.8 **Issue:** Fleet NMOG+NOx calculation is incorrect.
Background: EPA Tier 3 final rule calculates a manufacturer's NMOG+NOx fleet average without credit for HEV sales i.e., credit for zero tailpipe emissions in charge-depleting (eVMT) mode. The CARB LEV III regulation provides NMOG+NOx emission credits for HEVs by using a HEV Contribution Factor whereas Tier 3 does not. Similarly, LEV II provided NMOG emission credit for HEVs (Title 13, CCR, Section 1961 (b)(1)(B)) and Tier 2 provided NOx emission credit for HEVs. In Tier 2, the numerator in the NOx fleet average equation may be adjusted downward by the product of the number of HEVs from each NOx emission bin multiplied by a HEV NOx contribution factor (Section 86.1860-04 (f)(4)). Based on EPA's Tier 2 NOx fleet average adjustment and its policy to harmonize Tier 3 with LEV III, there was an oversight in Tier 3 by not including NMOG+NOx emission credits for HEVs in the eVMT mode (i.e., HEV Contribution Factor). This same issue also applies to the Tier 3 NMOG+NOx fleet average for the Class 2b and Class 3 vehicles.
Agency: EPA
Regulation: 40 86.1811-17, 86.1816-18, and 86.1860-17.
Recommendation: Modify the Tier 3 final rule to correct the oversight that resulted in the omission of HEV credits for light-duty vehicles and class 2b/3 trucks.

1.9 **Issue:** Fuel economy testing and calculations for vehicles equipped with Select-Shift and/or Multimode transmissions is overly burdensome.
Agency: EPA
Regulation: CISD-09-19
Recommendation: Modify guidance so that all vehicles are tested in the default mode at key-on. Test in best and worst latched modes if there are no default modes at key-on. Remove predominant mode dependency on ETW/power ratios and whether access to Select-Shift controls requires removing your hand from the steering wheel. Continue to allow surveys to establish predominant mode or to establish the two most prevalent modes.

1.10 **Issue:** Guidance for manual (and manually shifted automatic) transmission shift schedules and Shift Indicator Light (SIL) burdens OEMS with unnecessary vehicle surveys.

Agency: EPA
Regulation: Advisory Circular 72A and CISD-09-19
Recommendation: Modify/update existing default shift schedule guidance (last updated in 1984) with one based on power and road load, which can be used for both manual and manually shifted automatic transmissions. Modify/update guidance to eliminate shift survey/shift schedule dependency on presence of SIL.

1.11 Issue: SC03 testing is overly burdensome.
Background: Given the extensive AECD provisions already in place, this test can be replaced by an attestation in the certification application using good engineering judgment. The current emissions compliance regulations already encompass the absence of an SC03 test (i.e., use two FTPs).
Agency: EPA, CARB
Regulation: 40 CFR 86.160-00, 40 CFR 1066.835, 13CCR
Recommendation: Modify the regulation to remove the mandate to run a separate SC03 test for pre-sale certification for related calculations and compliance with standards (i.e., allow option of two FTPs in the SFTP composite equation).

1.12 Issue: In-Use Verification Program (IUVP) testing is overly burdensome.
Background: There is no need to test in certain conditions because the intrinsic abilities and redundancies built into modern vehicle emission computers sense and adjust for varying operating conditions. One example is testing at altitude. The verification provided by actual testing at high altitude conditions is no longer necessary to provide assurance of performance at high altitude. Similarly, other steps in the process of obtaining data and test vehicles for the in-use verification program can be streamlined and yet achieve the same assurance of in-use emission performance.
Agency: EPA, CARB
Regulation: 40 CFR 86.1845 & 86.1846
Recommendation: Repeal duplicative, impractical, and unnecessary requirements for in-use verification program (IUVP) testing. The following requirements are examples of requirements that are extremely burdensome while providing little environmental benefit and should be reviewed for deletion. We look forward to working with the agencies to reduce the burdens from discrete requirements.

1. Reduce altitude exhaust IUVP requirements.
2. Reduce refueling requirement (ORVR) for IUVP. For example, only test at high mileage.
3. Modify high mileage requirement to allow testing vehicles with >75% of all reply mileages if none of the replies meet the target mileage (75-100% of useful life).
4. Reduce or eliminate low mileage IUVP testing. Reduce quantity of IUVP tests for both high mileage and low mileage tests. For example, complete required testing for first model year (both low and high mileage). However, only require one test for subsequent years for c/o test group – if no exceedances.

1.13 Issue: CO_2 fleet average credit trading regulations have unnecessary restrictions.
Background: EPA has inconsistent regulations that needlessly limit and impede the logical trading of CO_2 credits between vehicle types, manufactures and fleets. The agency stopped following the regulatory language in 40 CFR 86.1865-12(k)(4), (5) & (7) in 2012MY without formal guidance including public comment. The consequence is the diversion of capital and resources to comply with EPA CO_2 trading rules.
Agency: EPA

Regulation: 40 CFR 86.1865-12(k)(4), (5) & (7), 40 CFR 1037–710 40 CFR 1037.715 40 CFR 1037.730 40 CFR 1037.74 (et al)
Recommendation: Modify the regulations as follows:
GHG credits generated in 40 CFR 86-1865-12(k)(4), (5), & (7) should never expire and should be freely traded across all fleets (light-duty, medium-duty, heavy duty) in a uniform currency (aka tons of CO_2).

1.14 Issue: Unnecessary restrictions on the evaporative emission fleet average, NMOG+NOx tailpipe emission fleet averages, and early Tier 3 credits, credit life and trading regulations.
Agency: EPA, CARB
Regulation: 40 CFR 86.1861-17, 40 CFR 1037.745, 40 CFR 86.1811-17(b) (10), Title 13 CCR 1961.1(c), Title 13 CCR 1976(G)
Recommendation: Modify the regulations as follows:

1. Allow evaporative emission credits earned in any averaging set to offset debits in any other averaging set in any model year.
2. Allow NMOG+NOx tailpipe emission credits earned in any fleet average (i.e., FTP and SFTP fleet averages for light-duty, medium-duty passenger, medium-duty, Class 2b/3 vehicles) to offset debits in any model year for the specific fleet average (i.e., light-duty FTP, light-duty SFTP, and medium-duty FTP).
3. Remove the cap on early Tier 3 credits.
4. All credits should retain full value and never expire.

1.15 Issue: Reporting imported/exported fluorinated GHG mass is unnecessary for low GWP refrigerants.
Background: Given that HFO-1234yf has a Global Warming Potential of 4 and its use in mobile air conditioning is mandated starting with 2021MY, it is unreasonable to continually require automobile manufacturers to submit this annual report. Reporting requirements should end when manufacturers no longer use high GWP refrigerants.
Agency: EPA
Regulation: 40 CFR 98.430-98.438
Recommendation: Modify 40 CFR subpart QQ, thus eliminating the requirement to report import/export of low GWP refrigerants.

1.16 Issue: Constraining truck technology crediting method is misaligned with environmental goals.
Background: EPA allows manufacturers to earn Greenhouse Gas (GHG) credits for applying advance technologies like BISG (Belt Integrated Starter Generator), Strong Hybrid, and other technologies that over perform vehicle's own footprint target by 15 - 20 percent. EPA provided these incentives to encourage the OEMs to apply costly technologies to light-duty pickup trucks. Although these technologies are similar for full size light-duty pickup trucks, other light-duty trucks, and heavy-duty trucks, the credits are only allowed on light-duty pickup trucks. The regulation also has a fleet volume requirement that must be achieved to earn the credits. Since the credits are earned on a "per vehicle so equipped" basis, the volume threshold only discourages the application of technology as a manufacturer cannot be confident of sales volumes of technology that customers do not demand.
Agency: EPA
Regulation:
40 CFR 86.1870–12 CO_2 credits for qualifying full-size pickup trucks
40 CFR 600.510-12 Calculation of average fuel economy and average CREE

Recommendation: Modify the light-duty and heavy-duty vehicle regulations to include Full Size Pickup Truck credits for all light-duty trucks and all heavy-duty vehicles based on the menu tables so that credits can be earned with certainty, and without any fleet volume requirements, for both EPA and NHTSA space starting MY2017 for light-duty trucks and MY2014 for heavy-duty vehicles.

1.17 Issue: Accelerated HFC-134a ban restricts manufacturers' ability to choose the most cost effective compliance plan for their fleet.
Background: The use of HFO-1234yf refrigerant is mandated on US light-duty vehicles starting in 2021MY, while the original premise was that HFO-1234yf would be an optional compliance method through 2025MY. When EPA delisted the HFC-134a refrigerant for light-duty automotive applications in 2015, they implemented the refrigerant ban in the middle of the GHG program.
Agency: EPA
Regulation: 40 CFR Part 82 Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program; Final Rule
Recommendation: Modify the SNAP delisting of HFC-134a Refrigerant Rule, delaying the HFC-134a refrigerant ban for US light-duty vehicles until MY2026, providing manufacturers' flexibility and aligning it with the greenhouse gas rule.

1.18 Issue: HFO-1234yf mandate starting in 2026MY on exports is an incentive to foreign manufacturing.
Background: When EPA delisted the HFC-134a refrigerant for light-duty automotive application in 2015, they also banned this refrigerant for export to other countries starting in 2026MY. No other country regulates emissions, fuel economy or refrigerant in other countries. There are many reasons not to implement expensive technologies in other markets including, but not limited to, cost of vehicles, infrastructure of new materials, training of employees, service equipment, etc. EPA's action forces manufacturers to add cost and complexity to vehicles produced for export, which could jeopardize US jobs since other countries will not have the same requirements. EPA should let other countries regulate themselves, based on their needs and infrastructure.
Agency: EPA
Regulation: 40 CFR Part 82 Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program; Final Rule
Recommendation: Modify the SNAP delisting of HFC-134a Refrigerant Rule to remove the HFC-134a ban starting in 2026MY for export market vehicles produced in the US.

1.19 Issue: Lack of FFV usage factor creates regulatory uncertainty.
Background: EPA is responsible for defining the F-factor via guidance. Long-term guidance with adequate lead-time is necessary for manufacturers to properly plan for FFVs in their fleet.
Agency: EPA
Regulation: 40 CFR 86.1818-12 & 40 CFR 86.600.510-12 & 40 CFR 600.113-12
Recommendation: Modify the regulations as follows:
EPA Administrator to generate long term F-factor guidance to fulfill 40 CFR 600-510-12(c)(2)(iv)(B)(v) and reduce regulatory uncertainty.

1.20 Issue: Vehicle and engine manufacturers must submit unnecessary website performance reports.
Background: Manufacturers operate web sites to make service information available to the public. Regulations require that these web sites maintain levels of performance and that manufacturers submit web site performance reports as to their compliance to these requirements. Manufacturers have been submitting these reports annually since 2004.
Agency: CARB, EPA

Regulation: Title 13 CCR §1969(f)(6), 40 CFR 86.096-38(g) (18) and 40 CFR 86.010(f) (18), 40 CFR 86.010-38(18)
Recommendation: Modify the regulations so annual website performance reports are no longer required when the vehicle or engine manufacturer service information website has been performing within the requirements of the regulation for some specific number of years (e.g., 5 years). In the event that there is evidence that a manufacturer's website stops performing within the requirements, reinstate the annual website performance reports for that manufacturer.

1.21 Issue: Pre-model year reports are an unnecessary burden.
Agency: EPA
Regulation: 40 CFR 600.514-12(LD), 86.1819-14(HD), 86.1869-12(off cycle)
Recommendation: Repeal the pre-model year reporting requirements. Allow manufacturers to attest to compliance and demonstrate at year-end.

1.22 Issue: Individual vehicle thermal control cap drives unnecessary vehicle-level reporting.
Background: EPA has imposed a per vehicle cap on the thermal control technologies described in 40 CFR 86-1869-12(b)(viii). This action in turn has imposed a huge regulatory VIN-by-VIN bookkeeping burden on manufacturer and agency staff.
Agency: EPA
Regulation: 40 CFR 86-1869-12(b)(viii) Thermal control technologies. The maximum credit allowed for thermal control technologies is limited to 3.0 g/mi for passenger automobiles and to 4.3 g/mi for light trucks.
Recommendation: Modify the regulation by issuing guidance that states 40 CFR 86-169-12(b)(viii) is a fleet level requirement.

1.23 Issue: Advanced technology volume multiplier does not function as intended and should be corrected.
Background: The GHG program offers advanced technology multipliers to incentivize the production of advanced technology vehicles. These multipliers increase the volume of battery electric, plug-in hybrid electric, fuel cell, or CNG fueled vehicles in the fleet CREE average performance calculation. However, since these multipliers do not apply to the fleet target calculation, it is possible that some manufacturers will not earn the full credit intended for their advance technology vehicles.
Agency: EPA
Regulation: 40 CFR 86.1866-12
Regulation: Modify the regulation language so the advanced vehicle technology multiplier is applied uniformly to all production volumes, appearing in the target and CREE average equations so that the incentive functions as intended.

1.24 Issue: Lack of public transparency and timely EPA review and decision on petitions and State authorization requests.
Background: Regulated parties are deprived of process certainty and lead time (e.g. off-cycle credit petitions) to comply with possible regulations or modify product plans while awaiting EPA decisions. There is no specific time requirement for EPA to respond to petitions and State authorization requests or for EPA to make publicly available requests in a timely manner.
Agency: EPA
Recommendation: EPA should publish all outstanding petitions and authorization requests on a quarterly basis. EPA should issue public responses to all petitions and authorization requests in a timely manner depending on the topic, and provide an EPA point of contact.

1.25 Issue: Undefined reporting requirements for new rules create a regulatory burden on manufacturers.
Background: Regulations have been issued without establishing VERIFY reporting requirements (VERIFY is EPA's compliance information reporting system). Without defined requirements, manufacturers submit their compliance reports with inconsistent formats. This results in a regulatory burden as EPA staff require explanations of spreadsheet submissions that are unique to each manufacturer.
Agency: EPA
Regulation: 40 CFR 86-, 40 CFR 600, 40 CFR 1066
Recommendation: Modify the regulatory process so that new regulations are not promulgated until EPA defines the reporting requirements, reporting format, and develops the VERIFY system to accept the required data.

1.26 Issue: Unnecessary running change requests should be eliminated.
Background: If a design change is for a non-functional component and has no emission impact (e.g., supplier change for evaporative hose or bolt), eliminate reporting requirements prior to production start.
Agency: EPA
Regulation: 40CFR S86.1842-01
Recommendation: Modify regulations to allow submission of only applicable part numbers at the Certification Application Part 2 submission.

1.27 Issue: Excessive Manufacturer Confirmatory Test (MCT) is burdensome.
Agency: EPA
Guidance Letter CD-15-22
Recommendation: Modify regulations to provide an option to forgo MCT for fuel economy based on good engineering judgement, should there exist supporting justification (i.e. 4K Fuel Economy results match expectation based on development or other cert test results) in doing so. Most MCTs fall within +/- 3% criteria from 4K result, which means this is a redundant test according to EPA guidance.

1.28 Issue: Certification Application submission for carry-over models is overly burdensome.
Agency: EPA
Regulation: 40CFR S86.1844-01
Recommendation: Modify regulations to allow OEMs to streamline applications for carry over models. For example, Part 1 cover page would contain test models and standards and test information, referring to original application. OEMs would only submit necessary information (e.g. part number, actual sales) at the Part2 submission timing.

1.29 Issue: Analytically Derived Fuel Economy (ADFE) is arbitrarily limited to 20% of tests in CAFE/GHG increasing OEM test burden.
Background: Usage of ADFE is limited to 20%.
Agency: EPA
Regulation: 40 CFR S600.006(e), CCD-04-06
Recommendation: Modify the regulation. EPA should reduce the testing burden by increasing the ADFE usage limit beyond 20%.

1.30 Issue: Testing, reporting, and tracking requirements for N_2O and CH_4 are overly burdensome.
Background: EPA's Manufacturer Performance Report continues to show that CH_4 and N_2O are only minor contributors to light-duty GHG. EPA should reduce complexity by not requiring manufacturers to measure trace amounts of CH_4 and N_2O. The measurement of N_2O is burdensome as the technologies used to measure are still evolving.
Agency: EPA
Regulation: 40 CFR 86.1818-12 & 40 CFR 86.600.510-12 & 40 CFR 600.113-12; 40 CFR 600.112
Recommendation: Modify the regulations as follows:

1. Eliminate CH_4 and N_2O from 40 CFR 600.113-12 CREE equations.
2. If elimination of CH_4 and N_2O is impossible, adjust CH_4 & N_2O downward by the usage factor in 40 CFR 600-510-12(c) (2)(iv)(B)(v)10-12.
3. Modify regulation and remove CH_4 & N_2O provisions threshold, reporting, tracking requirements.

Market Fuels Issues

2.1 Issue: Marketplace fuels need to be better aligned to enable beneficial new vehicle technologies.
Background: As EPA itself has stressed, achieving long-term reductions in emissions requires that vehicle technologies and fuels are treated as integrated systems, codependent on each other's properties. In order to support more energy efficient and clean vehicle technologies that continue to improve air quality and reduce GHG, concomitant investment to assure compatible fuels is necessary. Any potential new costs to fuel providers are both equitable and warranted, given the huge investments made by automakers to improve fuel economy and implement stringent vehicle emission controls (e.g., including the new Tier 3 Rule standards, among many others). EPA must address requisite fuel properties federally that enable emerging vehicle technology requirements. This will also save state resources.
The following two gasoline properties (2.2 and 2.3) are high priority for OEMS:

2.2 Issue: Higher octane rated gasoline for the U.S. market is necessary to enable high compression ratio engine efficiency gains.
Background:

- In joint 2013 Tier 3 Comments to U.S. EPA[2], the Alliance and Global Automakers supported coordination toward a national, higher RON (Research Octane Number), higher AKI (Anti-knock Index), higher Octane Rated retail gasoline for use in prospective conventional vehicles.
- Higher octane rating properties in gasoline help control the timing and intensity of combustion events in the engine, to avoid knock and damage. With smaller, higher compression ratio powertrains proving more energy efficient, but in need of higher octane for combustion management, it is necessary to adopt compatible market fuel to optimize and enable the new technology.
- Additional technical research has been developed (*e.g.*, the U.S. DOE Co-Optima Program).

[2] 78 Fed. Reg. 29816, May 21, 2013. Docket NO. EPA-HQ-OAR-2011-0135

- It is timely for U.S. EPA to undertake an accelerated process to implement and synchronize market introduction of higher octane fuel that will enable the benefits of advanced technologies and support OEM investment.
- In addition to commercial market fuel specifications, new alternative certification test fuels must be developed.

Regulation: 40 CFR Sec. 1065.701(c), EPA itself agrees it has authority and precedent to regulate national commercial gasoline octane specifications under the Clean Air Act, and the Agency should also clarify approval criteria for alternative certification test fuels.
Agency: U.S. EPA
Recommendation: Implement a fast track process under the aegis of EPA for means to assure higher octane gasoline for the U.S. commercial supply that meets the market/timing needs for new vehicle technology.

2.3 Issue: Outdated 1 psi Reid Vapor Pressure (RVP) waiver for E10 gasoline needs to be eliminated.
Background:

- A cap on summer gasoline RVP for conventional vehicles at 9 psi -- for E0, E10, E15 and higher blends is necessary.
- Federal resolution of national RVP would greatly reduce the burden on states and EPA itself to regulate RVP in SIPs and under state law and simplify compliance.
- Manufacturers have long advocated to eliminate the E10 waiver and 10 psi RVP gasoline/ethanol blends for use in conventional (non FFV) vehicles during the high ozone (summer) season. This means imposing a new cap for summer RVP at 9 psi (notwithstanding any additional 1-psi waiver for E10, i.e., no 10 psi summer fuel).
- Eliminating the waiver would make the RVP for E10 consistent with the existing EPA 9 psi RVP summer limit for E15 and should apply for any future ethanol gasoline blends. This approach provides a "level playing field" across gasoline/ethanol blends and will reduce smog-forming emissions further from vehicle and non-road equipment and storage sources.
- The original purpose for the waiver, to facilitate introduction of E10 gasoline into the U.S. market (in Sec. 211(h)(4) of the Clean Air Act 1990 amendments) has been fulfilled and is now out of date.
- The original extra 1 psi RVP Waiver for E10 was promulgated before 1990 by U.S. EPA, as a <u>temporary</u> waiver to help facilitate use of gasohol (E10) in a time when E0 (zero ethanol) 9 psi summer RVP was the ubiquitous gasoline. Adding the ethanol and the base gasoline together increases the RVP by 1 psi (i.e., 9 psi E0 + 10% ethanol will result in 10 psi RVP E10 fuel). To accommodate this RVP increase, the waiver was allowed for gasohol. The *reason* for the extra 1 psi waiver was to allow the oil industry to sell E0 9psi gasoline and *also* use it (or a blend-stock like it) as the base for adding the 10% ethanol. At the time, the waiver reduced transitional barriers from having to distribute and store different E0 and E10 blend-stocks, given limited capacities. It also saved petroleum refiners the cost of reducing the RVP of the blend-stock for E10 below the 9 psi allowed for E0.
- Today, ~95% of gasoline is now E10, so the prior distribution and storage barrier argument is no longer valid. Today, assuring 9 psi summer RVP for ethanol blends is primarily a cost issue for the oil industry.
- Given the investments automakers have made in emission controls, it is equitable that fuel producers do their part to invest to minimize emissions.

- It is technically and economically feasible for the petroleum industry to make and sell lower RVP blend-stock, as they have long had to do in California, Reformulated Gasoline areas, and States disallowing the extra 1 psi RVP E10 waiver.

Regulation: CAA Sec. 211(h)(4) and implementing U.S. EPA Regulations
Agency: EPA, and/or via Congressional Amendment
Recommendation: Modify the regulation, as recommended in Alliance[3] and Renewable Fuels Association[4] White Paper Petitions from December 2015, to eliminate 10 psi RVP gasoline/blends in summer months for non FFV gasoline.

2.4 **Issue:** Need to protect consumer access to market fuels required or recommended by manufacturers in vehicle owner's manuals.
Background: EPA policy should assure consumers' ability to follow vehicle manufacturers' fuel requirements and recommendations for both new and legacy vehicles, per their owner's manuals. There should be free market dynamics for sales of new and legacy fuels. A corollary for this would be for EPA to require language on Retail Fuel Dispensers that would direct consumers to check their owner's manuals for correct fuel usage to help prevent mis-fueling for vehicles and other equipment. The Alliance has consistently supported fueling labels, for E15 and Biodiesel (>B5). Likewise, State and local governments should not be able to ban availability of market fuels specified in owner's manuals (or mandate a single choice of fuel).

- For example, current Minnesota law requires sale of ONLY B10 (and for 2018 and later ONLY B20) biodiesel (FAME) blends as diesel fuel in the summer months (Minnesota Statute 239.77)
- The Alliance and a number of other industries oppose single fuel mandates that disallow consumers access to the fuels recommended for their vehicles.
- Manufacturers also noted that most current light-duty diesel vehicles in the US are made to use no greater than B5 (5%) biodiesel blends.
- It is different to offer incentives to add or substitute an alternative fuel, versus a mandate *requiring* jurisdiction-wide sale of only one particular type of fuel, especially when that mandate may contradict the vehicle owner's manual instructions.

Agency: US EPA
Regulation: General federal fuel quality authority
Recommendation: Ensure free access for choice of fuels for consumers.

2.5 **Issue:** Fuel detergents used with high ethanol blend gasoline (>51%) retail/commercial fuels cause significant clogging problems at service stations.
Background: Manufacturers are supportive of adequate fuel detergency to promote clean engines and optimal combustion, but some additives are not soluble in high concentrations of ethanol (51%-83%). When the wrong additive is used, a thick tar-like substance will settle on the bottom of tanks at service stations, clogging filtration systems and pumps.
Agency: EPA
Regulation: 40 CFR 80.155 - Interim detergent program controls and prohibitions
Recommendation: Remove detergency requirement for the gasoline portion of fuel when blended as >51-85% Ethanol by volume (i.e., certain Flex Fuels, like those formerly called E85)

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[3] Letter from Valerie Ughetta Director, Alliance Automobile Fuels to Chris Grundler and Paul Machiele, U.S. EPA Re: Support for EPA Action to Cap Reid Vapor Pressure (RVP) of Summer Gasoline, December 7, 2015.
[4] Letter from Bob Dinneen, President & CEO, Renewable Fuels Associations to Christopher Grundler, U.S. EPA Re: Request for EPA Action to Reduce RVP Cap of Summer Conventional Gasoline, December 8. 2015.

Heavy-Duty Issues

3.1. Issue: Certification durability requirements are unnecessarily burdensome. (similar to light-duty issue)
Background: Technology and procedures have evolved over time. O_2 sensors, for example, have become so durable and control systems so adaptable that emissions do not vary when using a new or an aged O_2 sensor. Requiring aged O_2 sensors for full useful life testing only adds cost, complexity, and burden to testing procedures. In addition, manufacturers, with approval from EPA, have been successfully bench aging gasoline catalyst systems for years. The process saves time and money for manufacturers and should be available for use with diesel catalyst systems as well. Finally, manufacturers are responsible for emission variations caused by drivers, testing environments, fuels, and myriad other factors. Along with all of those factors that determine a product's performance throughout its useful life, OEMs should also have the authority to determine their own deterioration factors. This would streamline the certification process and reduce costs.
Agency: EPA, CARB
Regulation: 40 CFR part 86.1823, 86.1829, etc. (multiple)
Recommendation: Modify the regulations to allow OEM's greater flexibility in terms of durability demonstrations (the following are examples of requirements that must be addressed)

1. Allow bench aging of diesel emission systems, as allowed for gasoline products.
2. Eliminate the need for aged O_2 sensors for full useful life testing of gasoline products.
3. Allow OEMs to assign their own deterioration factors (DF's) for PM, CO_2, N_2O, CH_4 and all other GHG's and criteria emissions components, as demonstrated by data.
4. Allow negative deterioration factors (DF's) for PM, CO_2, N_2O, CH_4 and all other GHG's and criteria emissions components, as demonstrated by data.
5. EPA should more regularly publish assigned DF's for each technology.

3.2. Issue: In-Use Verification Program (IUVP) testing is overly burdensome. (similar to light-duty issue)
Background: There is no need to test in certain conditions because of the intrinsic abilities and redundancies built into modern vehicle emission computers for sensing and adjusting varying operating conditions. One example being changes in altitude. The verification provided by actual testing at high altitude conditions is no longer necessary to provide assurance of performance at high altitude. Similarly, other steps in the process of obtaining data and test vehicles for the in-use verification program can be streamlined and yet achieve the same assurance of in-use emission performance.
Agency: EPA, CARB
Regulation: 40 CFR 1845 & 1846
Recommendation: Repeal duplicative, impractical, and unnecessary requirements for in-use verification program (IUVP) testing. The following requirements are examples of requirements that are extremely burdensome while providing little environmental benefit and should be reviewed for deletion:

1. Repeal altitude exhaust IUVP requirements.
2. Repeal refueling requirement (ORVR) for IUVP.

3. Modify high mileage requirement to allow testing vehicles with >75% of all reply mileages if none of the replies meet the target mileage (75-100% of useful life).
4. Reduce quantity of high mileage IUVP tests.
5. Reduce or repeal low mileage IUVP testing.
6. Repeal GHG requirements within IUVP testing.
7. Repeal HD MST OBD requirements for low volume manufacturers.
8. Repeal charge depleting testing on hybrid electric vehicles.

3.3. Issue: Vocational CO_2 requirement is redundant in the HD GHG Phase 2 program.
Background: There is a CO_2 standard for the engine only certification test and another one in the GEM2 (Engine MAP) emissions model reporting.
Agency: EPA, NHTSA
Regulation: 40 CFR 1037, 49 CFR 535
Recommendation: Remove redundancy of measuring the engine twice.

3.4. Issue: Testing 10% of sub-configurations for Class 2B & 3 cab complete vehicles drives a disproportionate amount of testing compared to other vehicle segments.
Background: There are very high numbers of Class 2B & 3 sub-configurations but, compared to light-duty vehicles, the sales volumes for Class 2B and 3 vehicles are generally very low. This leads to an unusually high-test burden (>5 times the testing compared to light-duty trucks on a sales normalized basis) for a relatively small fraction of vehicles sold by any manufacturer. The testing requirements for Class 2B & 3 vehicles should be reasonably proportionate to their total volume.
Agency: EPA
Regulation: 40 CFR 86.1819-14(d)(9)(i)
Recommendation: Repeal the additional provisions in 40 CFR 86.1819-14(d)(9)(i).

3.5. Issue: Undefined reporting requirements for new rules create a regulatory burden on manufacturers. (similar to light-duty issue)
Background: Regulations have been issued without establishing VERIFY reporting requirements (VERIFY is EPA's compliance information reporting system). Without defined requirements, manufacturers submit their compliance reports with inconsistent formats. This results in a regulatory burden as EPA staff require explanations of spreadsheet submissions that are unique to each manufacturer
Agency: EPA
Regulation: 40 CFR 86, 40 CFR 1036, 40 CFR 1037, 40 CFR 1065, 40 CFR 1066
Recommendation: Modify the regulatory process so that new regulations are not promulgated until EPA defines the reporting requirements, reporting format, and develops the VERIFY system to accept the required data.

3.6. Issue: EPA and NHTSA do not recognize AC improvements in heavy-duty segment, but do in light-duty segment.
Background: EPA and NHTSA both recognize the benefits of AC technologies that reduce GHGs and fuel consumption. Since the benefits of these technologies are not measured in the certification process, they are applied as credits. Although the benefits are as appropriate for heavy-duty as they are for light-duty vehicles, neither EPA nor NHTSA allow credits for AC technologies. Manufacturers believe these credits should be harmonized between the light-duty and heavy-duty programs.
Agency: EPA and NHTSA
Regulation:

40CFR 86.1867-12 CO_2 credits for reducing leakage of air conditioning refrigerant
40CFR 86.1868-12 CO_2 credits for improving the efficiency of air conditioning systems
40 CFR 600.510-12 Calculation of average fuel economy and average CREE
49 CFR 535.6

Recommendation: Modify (harmonize with light-duty) EPA's and NHTSA's heavy-duty vehicle regulations to include A/C credits using a list of pre-approved default credits, from start of program.

3.7. Issue: EPA and NHTSA do not recognize off-cycle improvements in the heavy-duty segment, but do in the light-duty segment.

Background: As with AC credits described above, EPA and NHTSA recognize the benefits of off-cycle technologies but do not offer credits for heavy-duty vehicles. (Off-cycle means the benefits are not fully measured in the certification test cycle.) These credits should be harmonized between the light-duty and heavy-duty programs.

Agency: EPA and NHTSA

Regulation:

40 CFR 86.1869-12 CO_2 credits for off-cycle CO_2-reducing technologies
40 CFR 600.510-12 Calculation of average fuel economy and average CREE
49 CFR 535.6

Recommendation: Modify (harmonize with light-duty) EPA and NHTSA heavy-duty vehicle regulations to include credits for CO_2 reducing off-cycle technologies using a list of pre-approved default credits, from start of program.

3.8. Issue: Constraining truck technology crediting method is misaligned with environmental goals. (similar to light-duty issue)

Background: EPA allows manufacturers to earn Greenhouse Gas (GHG) credits for applying advance technologies like BISG (Belt Integrated Starter Generator), Strong Hybrid, and other technologies that over perform a vehicle's footprint target by 15 - 20 percent. EPA provided these incentives to encourage the manufacturers to apply costly technologies to light-duty pickup trucks. Although these technologies are similar for full size light-duty pickup trucks, other light-duty trucks, and heavy-duty trucks, the credits only are allowed on light-duty pickup trucks. The regulation also has a fleet volume requirement that must be achieved to earn the credits. Since the credits are earned on a "per vehicle so equipped" basis, the volume threshold only discourages the application of technology as a manufacturer cannot be confident of sales volumes of technology that customers do not demand.

Agency: EPA

Regulation:

40 CFR 86.1870–12 CO2 credits for qualifying full-size pickup trucks
40 CFR 600.510-12 Calculation of average fuel economy and average CREE

Recommendation: Modify the light-duty and heavy-duty vehicle regulations to include Full Size Pickup Truck credits for all light-duty trucks and all heavy-duty vehicles based on the menu tables so that credits can be earned with certainty, and without any fleet volume requirements, for both EPA and NHTSA space starting MY2017 for light-duty trucks and MY2014 for heavy-duty vehicles.

3.9. Issue: Pass-by noise requirement for trucks >10k lbs. GVWR are outdated.

Background: It is believed that these regulations have not been updated since the Reagan administration. At issue is that the CFR does not accurately comprehend the modern state of

drivetrains in this vehicle class. A complicating factor is that state and municipal governments look to EPA for expertise and regulatory leadership to avoid a patchwork of local standards.
Agency: EPA
Regulation: 40 CFR Part 205 Subpart B
Recommendation: Modify and update vehicle pass-by noise requirements for trucks >10,000 lbs. GVWR. We suggest development of an industry-working group to pursue regulatory modernization.

3.10. **Issue:** Unnecessary restrictions on the CO_2 fleet average credit trading regulations. (similar to light-duty issue)
Background: EPA has inconsistent regulations that needlessly limit and impede the logical trading of CO_2 credits between vehicle types, manufactures and fleets. The agency stopped following the regulatory language in 40 CFR 86.1865-12(k)(4), (5) & (7) in 2012MY without formal guidance including public comment. The consequence is the diversion of capital and resources to comply with arbitrary EPA CO_2 trading rules.
Agency: EPA
Regulation: 40 CFR 86.1865-12(k)(4), (5) & (7), 40 CFR 1037–710 40 CFR 1037.715 40 CFR 1037.730 40 CFR 1037.74 (et al)
Recommendation: Modify the regulations as follows

1. GHG credits generated in 40 CFR 86-1865-12(k)(4), (5), & (7) should never expire and should be freely traded across all fleets (light-duty, medium-duty, heavy-duty) in a uniform currency (aka tons of CO_2).
2. The agency should not restrict trading between vehicles, manufacturers, fleets, and the on-cycle gap.

3.11. **Issue:** Unnecessary restrictions on the evaporative emission fleet average, NMOG+NOx tailpipe emission fleet averages and early Tier 3 credits, credit life and trading regulations. (similar to light-duty issue)
Agency: EPA, CARB
Regulation: 40 CFR 86.1861-17, 40 CFR 1037.745
Recommendation: Modify the regulations as follows:
Allow evaporative emission credits earned in any averaging set to offset debits in any other averaging set in any model year.
Allow NMOG+NOx tailpipe emission credits earned in any fleet average (i.e., FTP and SFTP fleet averages for light-duty, medium-duty passenger, medium-duty, Class 2b/3 vehicles) to offset debits in any model year for the specific fleet average (i.e., light-duty FTP, light-duty SFTP, and medium-duty FTP).
Remove the cap on early Tier 3 credits.
All credits should retain full value and never expire.

3.12. **Issue:** Testing, reporting, and tracking requirements for CH_4 and N_2O are overly burdensome. (similar to light-duty issue)
Background: EPA's Manufacturer Performance Report continues to show that CH_4 and N_2O are only minor contributors to GHG. EPA should reduce complexity by not requiring manufacturers to measure trace amounts of CH_4 and N_2O. The measurement of N_2O is burdensome and the technologies used to measure are still evolving.
Agency: EPA
Regulation: 40 CFR 1036.108 (2), (3), (4) & 1036.108 (c)

Recommendation: Modify regulation and remove CH_4 & N_2O provisions threshold, reporting, tracking requirements. If this option is not feasible, allow credit generation and ABT for N_2O and CH_4 over compliance.

3.13. **Issue:** Heavy Duty Phase 2 sunset alternate CO_2 compliance mechanism for loose engines is burdensome.
Agency: EPA
Regulation: 40 CFR 86.1819-14(k)(8) - sunset, 40 CFR 1037.150(m)
Recommendation: Repeal the phase out statements implemented in the Heavy Duty Phase 2 regulations and maintain the original quantities allowed by the Heavy Duty Phase 1 regulations.

3.14. **Issue:** Vehicle and engine manufacturers must submit unnecessary website performance reports. (similar to light-duty issue)
Background: Manufacturers operate web sites to make service information available to the public. Regulations require that these web sites maintain minimum levels of performance and that manufacturers submit web site performance reports as to their compliance to these requirements. Manufacturers have been submitting these reports annually since 2004.
Agency: CARB, EPA
Regulation: Title 13 CCR §1969(f)(6), 40 CFR 86.096-38(g) (18), 40 CFR 86.1808-01(f) (18), 40 CFR 86.010–38(18)
Recommendation: Modify the regulations so annual website performance reports are no longer required when the vehicle or engine manufacturer service information website has been performing within the requirements of the regulation for some specific number of years (e.g., 5 years). In the event that there is evidence that a manufacturer's website stops performing within the requirements, reinstate the annual website performance reports for that manufacturer.

3.15. **Issue:** Pre-model year reports are an unnecessary burden. (similar to light-duty issue)
Agency: EPA
Regulation: 40 CFR 600.514-12(LD), 86.1819-14(HD), 86.1869-12(off cycle)
Recommendation: Repeal the pre-model year reporting requirements. Allow manufacturers to attest to compliance and demonstrate at year end.

Remove Duplicative regulatory requirements and Coordinate criteria emission test procedures between EPA and California

The following is a specific list of regulatory items that would benefit from such a harmonization:

General Harmonization Issues

4.1. **Issue:** Different test fuels between EPA and CARB results in excessive burden during product development.
Background:
Agency: EPA, CARB
Regulation: 40 CFR 1065.530-535 13 CCR
Recommendation: Modify regulations to harmonize on single national cert test fuels

4.2. **Issue:** Excessive pre-production reviews delay certification approvals.

Background: EPA and CARB administer several historic regulations, which currently focus on pre-production checking/approvals as opposed to post-production auditing/enforcement. In fact, pre-production considerations currently extend beyond the established regulatory space also to consider additional documentation, rounds of questions with reviews, and in certain instances unregulated steady state emission testing. Thus, manufacturers can no longer accurately anticipate how long certification reviews will take and many manufacturers have experienced delayed market introductions, which come at significant cost.
Agency: EPA / CARB
Regulation: 40 CFR part 86
Recommendation: Modify the regulation to allow qualified OEM's to truly self-certify.
PREFERRED: Consider a Rest of World (ROW) self-certification environment for the combined US market, which would allow US regulators to focus their efforts downstream in the production environment.
ALTERNATIVE: Consider a reciprocal approval environment where a single approval from either CARB or EPA (would be accepted by the other) and allow a manufacturer to proceed to market in a timelier manner.

4.3. Issue: Precertification testing impacts vehicle launch timing.
Background: Modify the focus of EPA and CARB from pre-production testing to the post-production environment.
Agency: EPA / CARB
Regulation: EPA CD-15-24 (LDV)
Recommendation: Modify guidance to shift current testing from a pre-production exercise to a post-production investigation. The agency could better use pre-production testing as an internal evaluation tool to help direct and focus in-use compliance testing within the laboratory environment. As with self-certification recommended above, it is a shift from highly burdensome pre-production oversight (that has caused production delays today) to post-production audit and evaluation. Additionally, EPA should provide some clarification of the general modes of operation and judgement criteria used for emissions conformity when testing is conducted under this off-mode testing.

4.4. Issue: Different electronic reporting systems between agencies add no value.
Agency: EPA, CARB
Regulation: 40 CFR 86.150-98 thru 157.98, 40 CFR 86.1, 13 CCR 1961, 1962, 1971, 1976 and 2144-2146
Recommendation: Modify the rules to require all data submissions to be harmonized and submitted via the VERIFY system. If necessary, set up a separate module for CARB.

4.5. Issue: Emission warranty reporting to CARB and emissions defect reporting to EPA is duplicative.
Agency: EPA, CARB
Regulation: 40 CFR 85.1901-1909, 13 CCR § 2141-2149
Recommendation: Modify the regulation to simplify and harmonize emissions/defect reporting. CARB EWIR @ 1% and EPA EDIR reporting based on 25 or more defects serves the same function of early detection of emission defects. Therefore, eliminate the duplicative reports on the same issue that arise due to the different and overlapping reporting criteria.
EDIR and EWIR should be combined into one reporting format and use one set of standardized criteria (i.e. 1%) warranty claim threshold).

4.6. Issue: Duplicative reporting of manufacturer field fix bulletins is wasteful.
Agencies: EPA, CARB
Regulation: EPA guidance in MSAPC Advisory Circular No. 2B, dated March 17, 1975 entitled "Field Fixes Related to Emission Control-Related Components."
Recommendation: Repeal the field fix reporting as it is covered effectively with defect reporting.

4.7. Issue: EPA/CA VECI labeling requirement is outdated.
Agency: EPA, CARB
Regulation: 40 CFR 86.1807, 40 CFR 1037.135, 13 CCR 1965
Recommendation: Modify the regulation and remove the requirement to apply the VECI label to the vehicle. Implement a simplified label that declares the vehicle is certified and includes a QR code. Make VECI data available via database/web app instead. Consider modification of other labels to QR code/web access format that only have value pre-sale, or limited/no consumer interest.

Test Procedure Harmonization Issues

5.1. Issue: EPA and CARB certification test procedures for electrified technologies (e.g., charge depleting PHEV, HEV, BEV) are not aligned, resulting in duplicative testing.
Agency: EPA, CARB
Regulation: 40 CFR 86, 40 CFR 600, 13 CCR § 1962
Recommendation: Modify the rule so that the only test procedure is SAE J1711. Two test procedures for HEV's and PHEV's – one for CA, and one federal - is an unnecessary burden.

5.2. Issue: Substantial development, test, certification, and in-use compliance burdens OEM's on LEV III 1 mg/mile particulate regulations.
Background: As manufacturers start to phase into the California LEV III 1 mg/mile particulate matter standards in 2025MY, lack of test-to-test accuracy and repeatability between government and industry labs remain as concerns. These concerns exist because the ultra-low 1 mg/mile standard was not well coordinated with the development of measurement equipment and test cycles. EPA was aware of this concern and saw the inability to measure low levels as a reason for why it did not promulgate 1mg for Tier 3.
Agency: EPA, CARB
Regulation: 40 CFR 1066.605
Recommendation: Modify the regulations with EPA guidance that allows OEM's to repeat/average tests if 1 mg/mile emission test results are questionable. PM measurement variation at the 1 mg/mi level, and even 3 mg/mi level, still is not well understood and could significantly impact results. Research continues to identify issues and propose measurement improvements. In the interim, EPA should allow some testing flexibility to mitigate this risk, perhaps with a measurement allowance and/or allowing multiple tests for the averaging of data.

5.3. Issue: Evaporative emissions test procedure differences drive unnecessary testing.
Agency: EPA, CARB
Regulation: 40 CFR 86, 13 CCR § 1976
Recommendation: Modify the regulations as follows:

1. Harmonize CARB and EPA test procedures including SHED temperature profile and test fuel. Having different SHED temperature profiles and test fuels creates excessive testing and laboratory resource burden during product development.

2. Eliminate the measurement of criteria emissions during evaporative/ORVR FTP tests. Eliminate complication of measuring for FTP tailpipe emissions on evaporative and refueling tests. It is burdensome, complicates FE Litmus calculations, and requires evaporative vehicles to include aged engine after-treatment components when the goal for the test is focused on evaporative performance.
3. Delete CARB requirement to do methanol/ethanol retention checks on the evaporative and ORVR SHEDS (CARB only). Recommend that CARB align with EPA guideline, which indicates, "The methanol retention check must be performed only upon initial installation and after major maintenance, consistent with good engineering judgment." EPA recognizes that the propane retention test is sufficient to ensure integrity of the enclosure (SHED) for measurement of evaporative emissions.
4. Delete the requirement to account for the alcohol (ethanol) component for E10 evaporative and ORVR SHEDs testing. Use of specialized and costly gas analyzer (Innova photo acoustic analyzer) to measure small differences in evaporative, running loss and ORVR emissions is burdensome and unnecessary. The evap., running loss and ORVR test can be streamlined by eliminating this requirement.
5. Delete the requirement to ORVR test T3/LEV3 flex-fueled vehicles on legacy splash blended Tier 2 fuel with 10% ethanol added (creates a unique 10 psi ORVR fuel versus EPA T3 9 psi). There is no basis for requiring FFVs to test on a different ORVR test fuel vs. non-FFVs. The worst-case ethanol blend test fuel for ORVR vapor generation is E10 (applicable to FFV and non-FFV); therefore, both FFV and non-FFV should test with the same 9 psi RVP E10 test fuel.
6. Delete altitude requirements in general. High Altitude accounts for a small fraction of in use customer usage. EPA allows a less stringent high altitude evaporative standard and adjustments to FTTP (fuel tank temperature profile) for 3-day high altitude testing in order to ensure that high altitude is not a worst-case condition. ORVR is not an issue at high altitude due to use of lower RVP test fuel at high altitude. EPA has indicated that high altitude conditions should not drive the evaporative hardware/calibration. EPA should streamline the certification process by eliminating the high altitude evaporative requirements.
7. Delete the canister bleed test (BETP) requirement. The BETP test requirement is complicated and burdensome to execute because the test is performed on discrete vehicle components, not on the whole vehicle. The test is redundant because the 2-day whole vehicle evaporative test already includes canister bleed emissions in the result. EPA and CARB should streamline the certification process by eliminating this redundant requirement.
8. Delete the leak test requirement (especially for IUVP). OBD-II leak detection already captures any in use customer vehicle evaporative system leaks; therefore, this test is unnecessary. EPA should eliminate this test for both certification (attestation) and IUVP (data submission).
9. 3-day evaporative test procedure simplification:
    a. Delete entirely, or
    b. Delete the requirement to measure run loss emissions, fuel tank temperatures and PID control heat during the run loss test (run an ambient run loss). ORVR drives canister sizing for U.S. programs (not 3-day Evap.); therefore, it is unnecessary to require compliance with 3-day Evap. In addition, FTTP is not required because fuel temperatures in the tank must be maintained at appropriate levels to prevent fuel vapor smell (customer dissatisfaction) and to ensure proper vehicle drivability in hot conditions. Furthermore, an alternative method, which specifies that a

manufacturer attest to compliance with an upper fuel temperature limitation, would allow EPA and CARB to eliminate 3-day/FTTP without concerns about excessive fuel temperatures under high temperature conditions.

Message

From: Helfand, Gloria [helfand.gloria@epa.gov]
Sent: 5/15/2017 5:46:06 PM
To: Charmley, William [charmley.william@epa.gov]; Hengst, Benjamin [Hengst.Benjamin@epa.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [Huang.Hsing-Hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Lie, Sharyn [Lie.Sharyn@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green [Kevin.Green@dot.gov]; Ryan Keefe (ryan.keefe@dot.gov) [ryan.keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]; Hoyer, Marion [hoyer.marion@epa.gov]; Burch, Julia [Burch.Julia@epa.gov]
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6
Attachments: Macroeconomic analysis CAFE_Graham and Carley_EPA_A2_Final.pptx

I'm attaching the slides that Sanya Carley just sent me.

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-----Original Appointment-----
From: Charmley, William
Sent: Friday, March 31, 2017 9:49 AM
To: Charmley, William; Helfand, Gloria; Hengst, Benjamin
Cc: Moran, Robin; Olechiw, Michael; Yanca, Catherine; Alson, Jeff; Bolon, Kevin; Huang, Hsing-Hsiang; Shelby, Michael; Lie, Sharyn; Sargeant, Kathryn; Davidson, Ken; Wysor, Tad; Sherwood, Todd; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green; Ryan Keefe (ryan.keefe@dot.gov); McCarthy, Mike@ARB; Chen, Belinda@ARB; Simon, Karl; Dickinson, David; Burke, Susan; Snapp, Lisa; Jackman, Dana; Hoyer, Marion; Burch, Julia
Subject: Meeting with John Graham Conference Line/Code / Ex. 6
When: Wednesday, May 17, 2017 9:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: C126

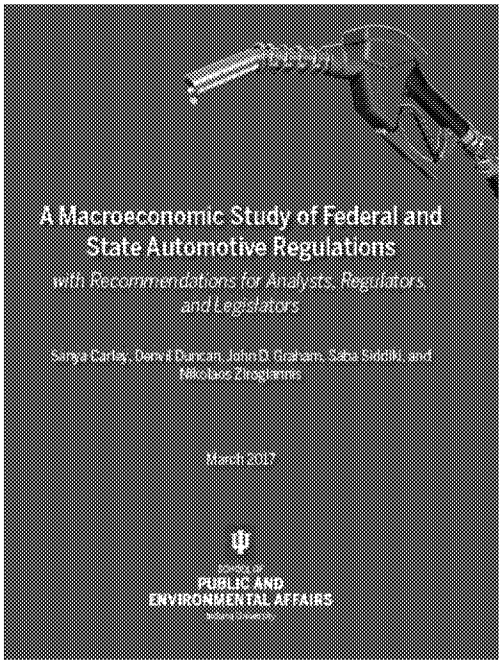
A Macroeconomic Study of Federal and State Automotive Regulations

Sanya Carley, Ph.D.
Associate Professor

John D. Graham, Ph.D.
Dean and Professor

Coauthors: Denvil Duncan, Saba Siddiki, Nikos Zirogiannis

SCHOOL OF PUBLIC AND ENVIRONMENTAL AFFAIRS
INDIANA UNIVERSITY



Advisory Panel

Dr. Joseph Aldy
Associate Professor Public Policy, Harvard University; former White House Special Assistant to the President for Energy and Environment

Gurminder Bedi
Former Vice President of Ford Motor Company

Dr. Rob Carey
Director of the Regional Dynamics and Economic Modeling Laboratory, Clemson University

Dr. Carolyn Fischer
Senior Fellow, Resources for the Future

Dr. Heather MacLean
Professor of Civil Engineering, University of Toronto

Dr. Edward Montgomery
Dean, McCourt School of Public Policy, Georgetown University; former Executive Director of the White House Council on Auto Communities and Workers

Consultants

Alan Jenn
Postdoctoral Fellow, University of California at Davis

Wally Wade
Member of the National Academy of Engineering

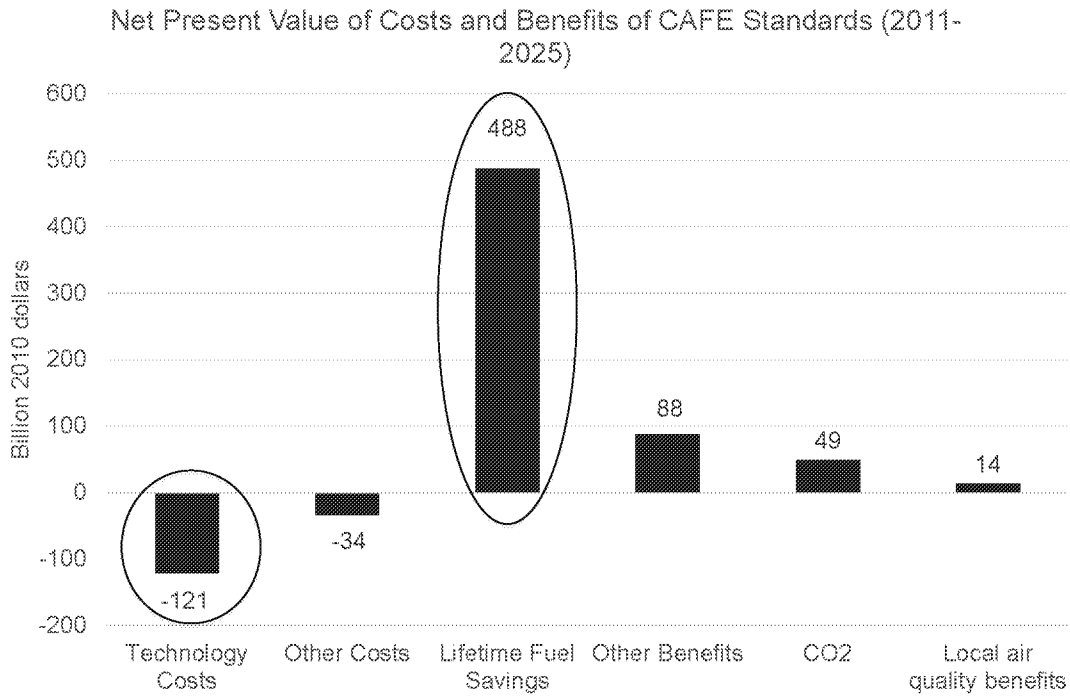
Project funded by the Alliance of Automobile Manufacturers

The authors are fully and independently responsible for the design, execution, and findings of the study

Presentation Outline

1. 2012 versus 2016 Perspectives
2. Macroeconomic Modeling
3. Impacts on New Vehicle Sales
4. Policy Recommendations

2012 VS. 2016 PERSPECTIVES

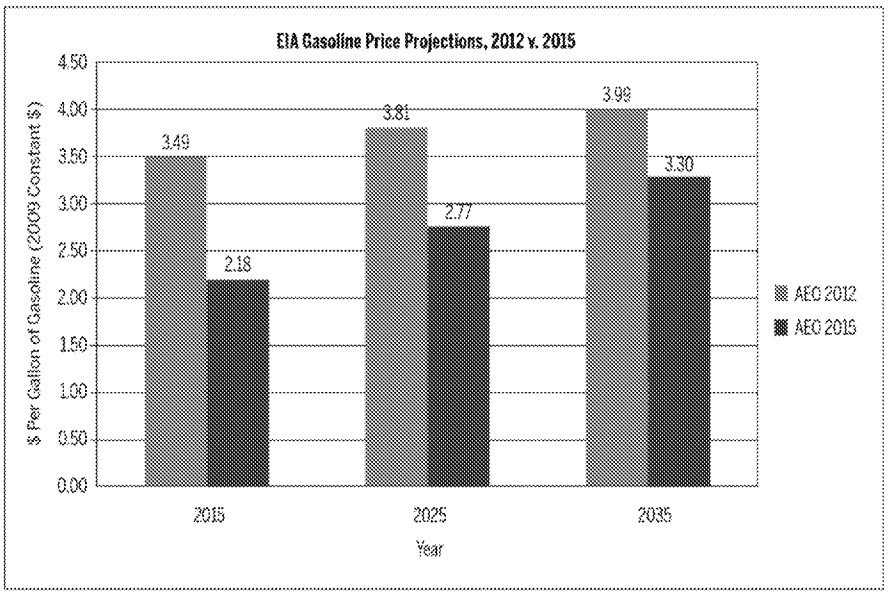


Source: NHTSA RIA (2012), Table 13, p. 49

Unexpected Changes in Global Oil Market between 2012-2016

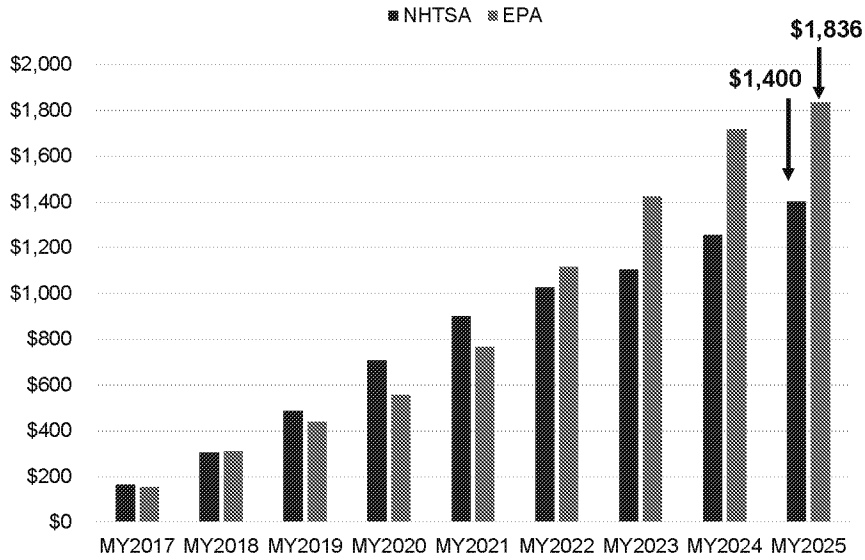
- Slowdown in global demand for oil (especially China)
- “Shale revolution” of oil and gas production in North America

Gas Price Projections



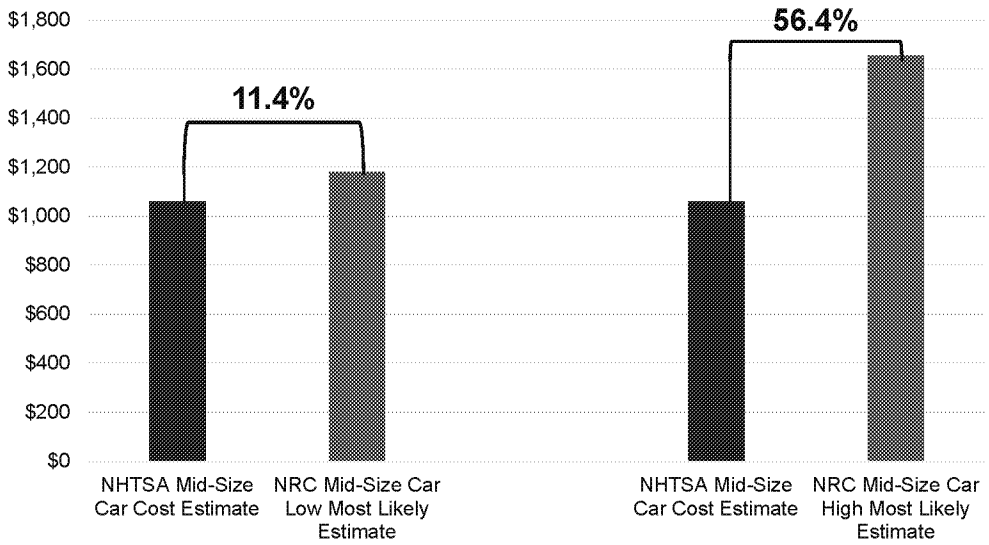
Source: EIA. (2012). Annual energy outlook 2012 with projections to 2035.; EIA. (2015). Annual energy outlook 2015 with projections to 2040.

Price premium for the average Light-Duty Vehicle due to the CAFE/GHG standards



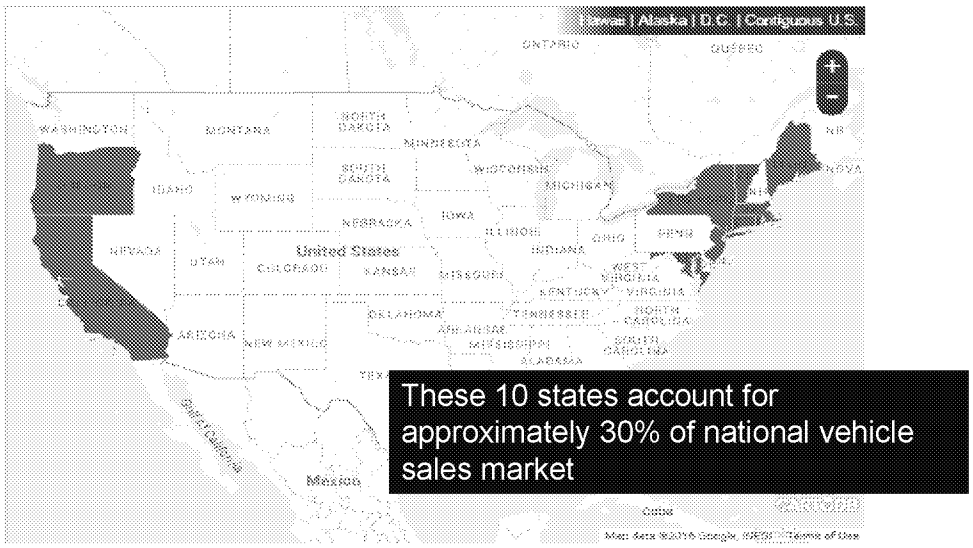
Source of EPA figures: Federal Register, Table I-24, page 62665
Source of NHTSA figures: Federal Register, Table I-15, pages 62659-62660

Incremental Cost of Producing a Mid-Size Car: NRC Low Most Likely and High Most Likely Estimates, MY 2025



Source of data: NRC (2015)

Zero Emissions Vehicle (ZEV) States



Source of image: *http://www.c2es.org/us-states-regions/policy-maps/zev-program*

Electric Vehicle Sales

2016 Electric Vehicle Sales	2025 Electric Vehicle Sales (To meet a 15.4% target in 30% of U.S. Auto Market)
159,139	785,400

Assumption about 15.4% requirement: CARB, 2012

Payback Period Analysis for a consumer investing a **$10,000** premium in a fuel efficient vehicle (PEV)

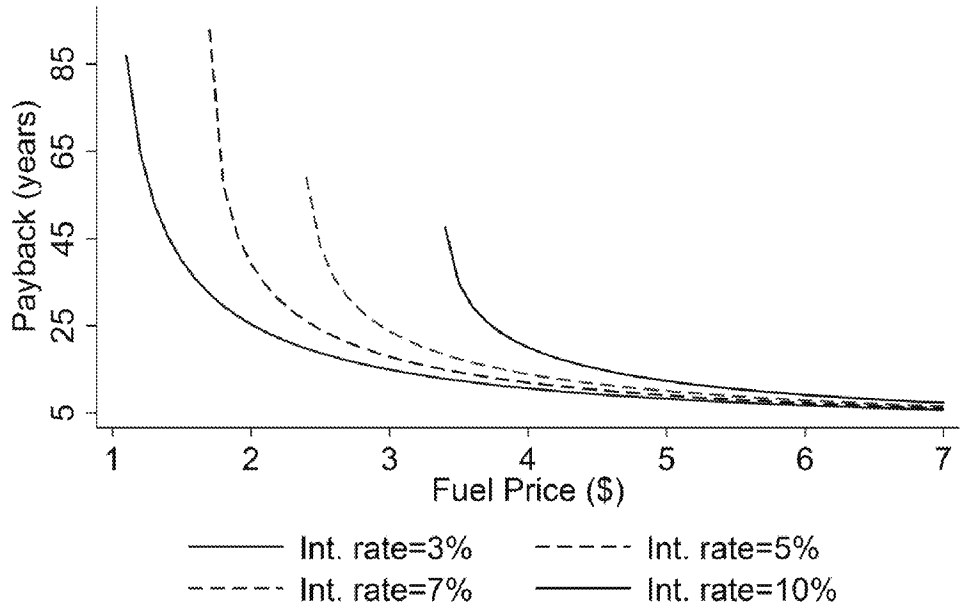


Figure I.4, p. 152

Price Premium per Vehicle to Comply with the ZEV (in constant 2010$)

	MY 2025
ZEV Premium (TAR)	$440
ZEV Premium (DOE)	$407

We assume that the incremental cost of the ZEV will be spread across all cars and trucks, and across all states

Estimates based on Table 7.8, p. 77. Details on how these numbers are derived are in Appendix V and Section 7.3.

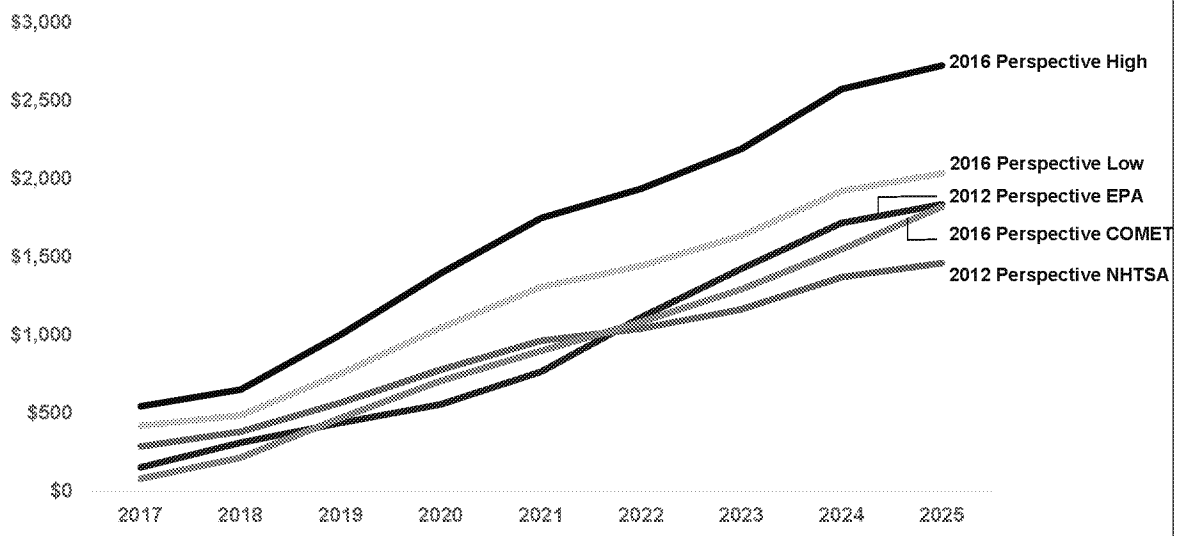
Cost Optimization Modeling for Efficiency Technologies (COMET)

- Recreated EPA's OMEGA with both a GHG and a ZEV constraint
- Model accounts for each manufacturer separately
- Model is run using EPA 2012 data (OMEGA 1.4.1) and EPA TAR 2016 data (OMEGA 1.4.56)
- Hundreds of technologies and combinations thereof

2012 vs. 2016 Perspectives

	2012 Perspectives	2016 Perspectives
Gas Price	EIA, 2012 ($3.84 per gallon in 2025)	EIA, 2016 ($2.74 per gallon in 2025)
Price Premium	Original assumptions from regulatory impact assessments (NHTSA 2012; EPA 2012)	1) Apply NRC price adjustments to NHTSA 2012 data 2) Build a new model to replicate OMEGA but that also accounts for ZEV
Assumptions about ZEV included	No	Yes

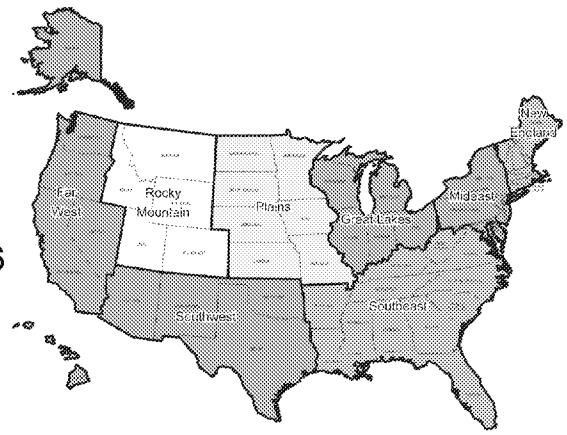
Vehicle Price Premiums, all Five Datasets



MACROECONOMIC MODELING

Model

- REMI PI+ 2.0.2: input-output, computable general equilibrium, econometric, and economic geography modeling components
- 160-industry-sector, 9-region
- Baseline: Standards freeze at 2016 (CAFE/GHG) and 2017 (ZEV)
- Analysis: 2017-2035
- Indicators: Employment, GDP, Personal Disposable Income



Source of Map: U.S. BEA, http://united-states.reaproject.org/

Regulatory Mechanisms

1. Price Premium on Vehicle Consumers (Individuals, Government, Industry)
2. Auto Industry Innovation in the auto supply chain
3. Gas Savings for all Vehicle Consumers (Individuals, Government, Industry)

- The scope does not include environmental or security impacts

Price Premium

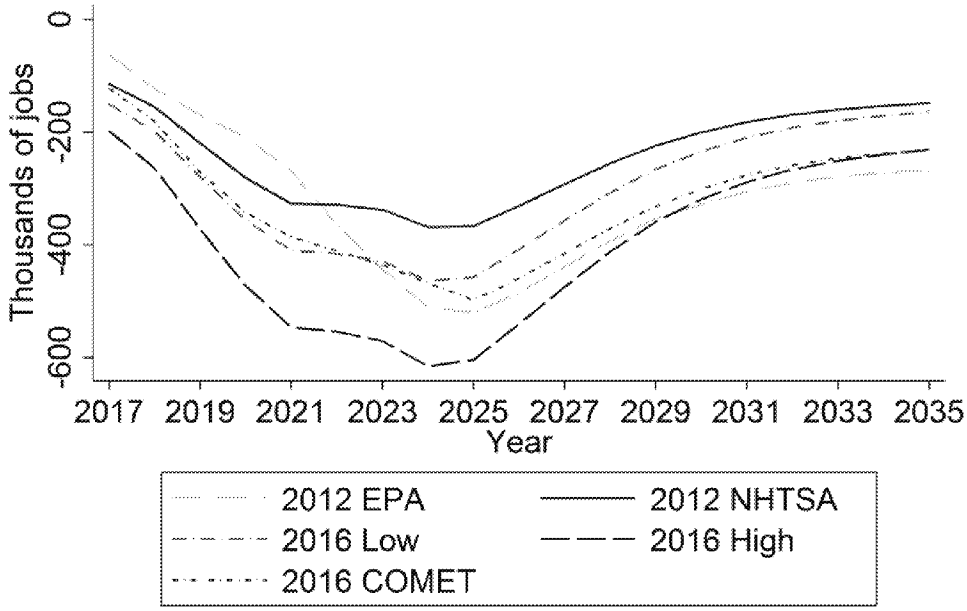


Figure 8.3, p. 92

Auto Industry Innovation

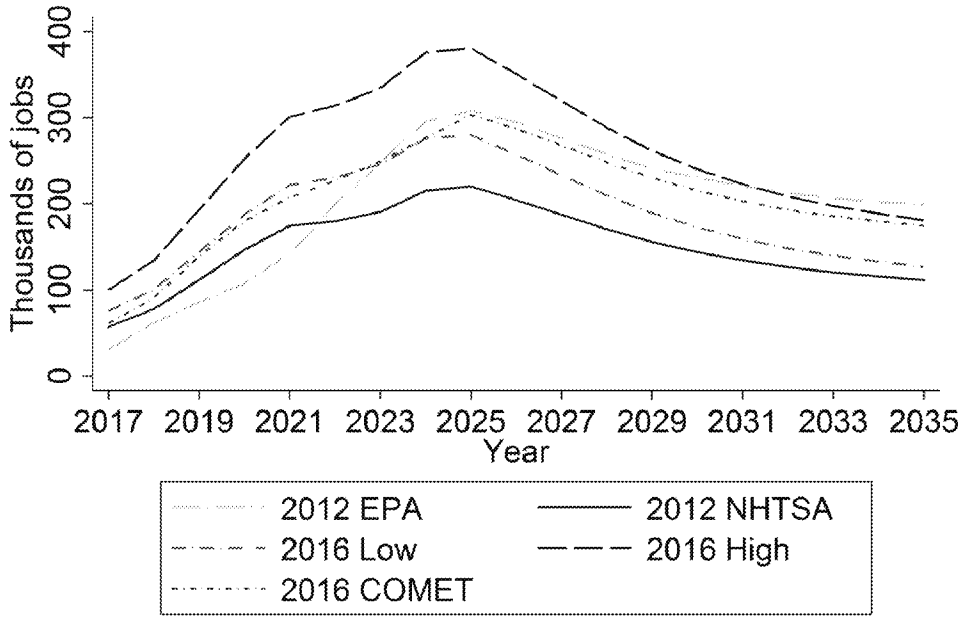


Figure 8.7, p. 95

Gas Savings (by Calendar Year)

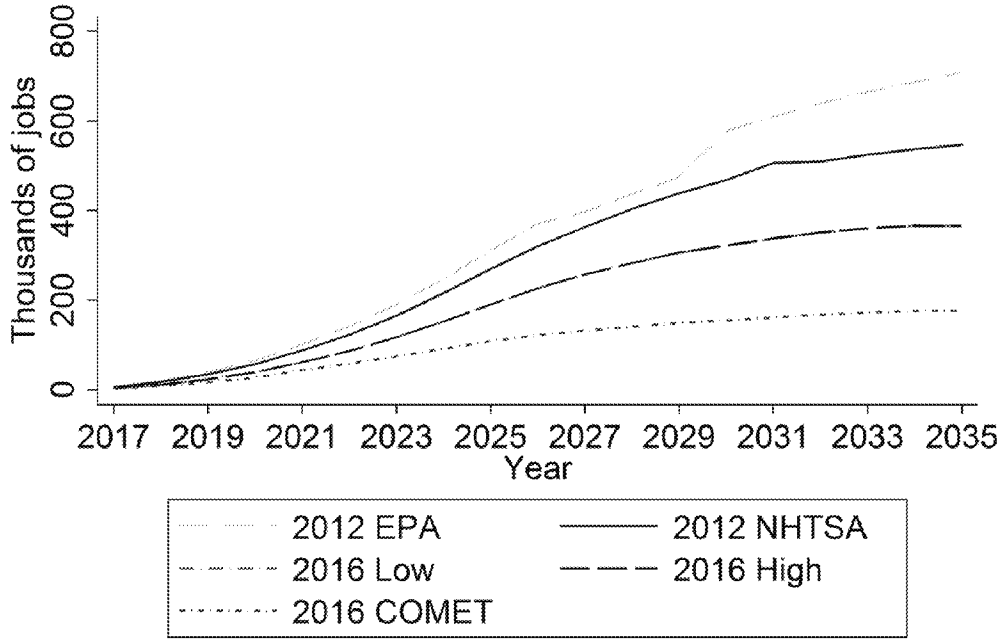


Figure 8.12, p. 99

Combined Effects

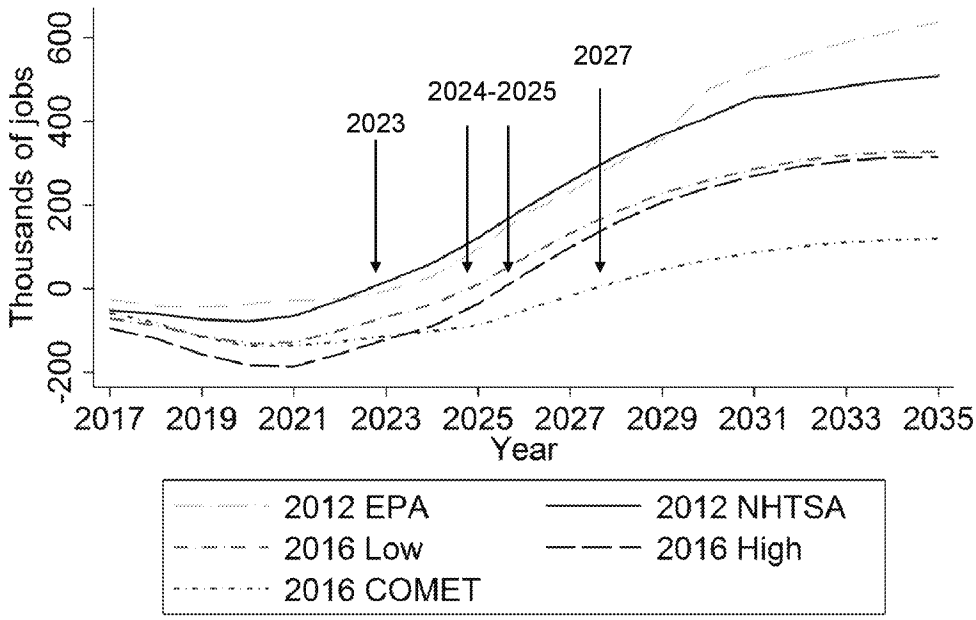


Figure 8.16, p. 101

Market Share of Passenger Cars vs. Light Trucks in COMET 2016 Perspective

	2009	2010	2011	2012	2013	2014	2015	2016
Passenger Cars	52%	49%	48%	50%	49%	47%	43%	40%*
Light Trucks	48%	51%	52%	50%	51%	53%	57%	60%*

Table 5.1, p. 59

Accounting for these changes delays the macroeconomic benefits

Source of data: Ward's Auto. (2016). U.S. vehicle sales by vehicle type and source, 1931-2015; * = preliminary

Table 8.1. Macroeconomic Modeling Results, Cumulative 2017-2025 and 2017-2035		
Dataset and Indicator	**2017-2025**	**2017-2035**
EPA 2012 Perspective		
GDP	-27.2	332.6
PDI	-2.8	334.6
NHTSA 2012 Perspective		
GDP	-30.3	290.3
PDI	-6.6	285.8
2016 COMET Perspective		
GDP	-92.6	-52.1
PDI	-45.1	22.7
2016 Low Perspective		
GDP	-75.8	120.5
PDI	-33.7	158.2
2016 High Perspective		
GDP	-111.9	67.4
PDI	-52.3	135.5

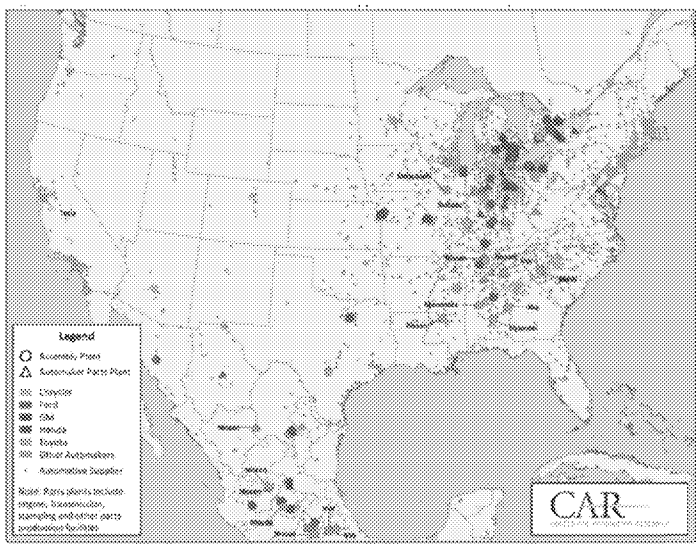
Note: GDP and PDI in billions of dollars.

Table 8.1, p. 105

Cumulative GDP and PDI

Cumulative values:
$Year_1 + Year_2 + Year_3 + \ldots + Year_n$

Could ZEV Have Implications for the Geographic Distribution of U.S. Manufacturing?



Source of image: Center for Automotive Research

Regional Combined Effects

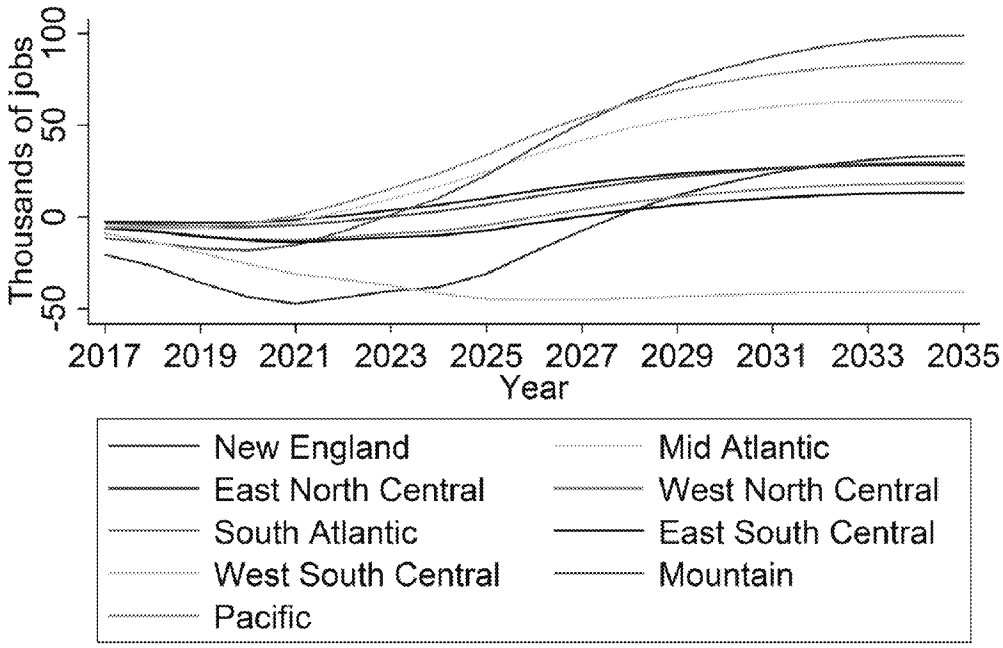


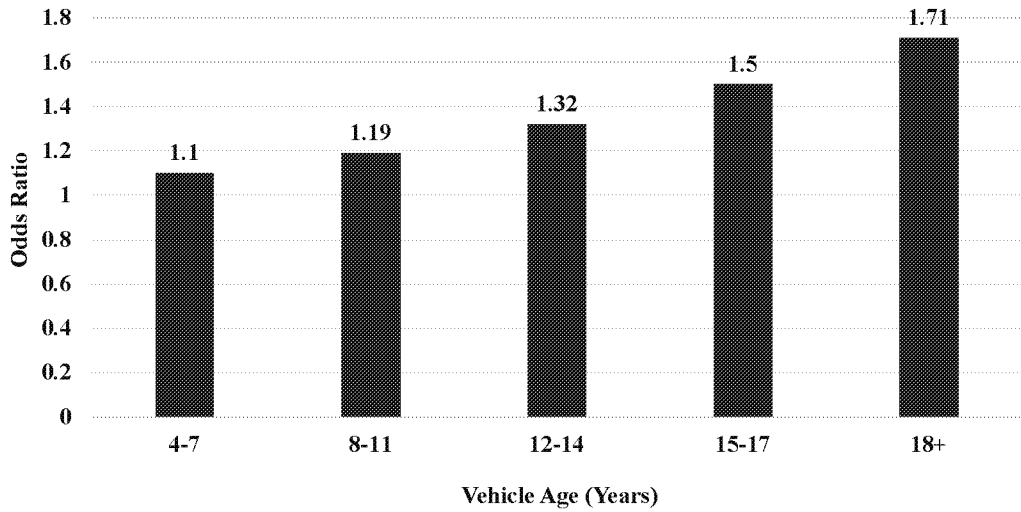
Figure 8.19, p. 103

IMPACT OF FUEL-SAVING REGULATIONS ON NEW VEHICLE SALES

Why Should Regulators Care about the Volume of New Vehicle Sales?

- US Economy (CAR, 2015; Goolsbee and Krueger, 2015)
- Safety Impacts (NHTSA, 2013: IIHS, 2015)
- Environmental Goals (Gruenspecht, 2001, NHTSA, 2009)
- Welfare of Used-Car Buyer (Jacobsen and van Bentham, 2015)
- Societal Cost-Benefit Analysis

Driver Fatality Risk Given Crash by Age of Vehicle



Comparison is made with new vehicles aged 1-3 years, using logistic regression.
Controls: Driver sex and age, vehicle type, alcohol, speed, time of day, collision type, road type.

Source: NHTSA (2013)

Total Cost of Ownership (TCO)

Initial Costs	Deferred/Operating Costs
Gross vehicle price	Insurance premiums
Sales tax	Fuel consumption
Loan financing fees	Loan Payments
Registration fees	Vehicle depreciation (resale value)

Key Assumptions

1. Technology cost is passed on to consumer
2. Regulation does not influence other vehicle attributes (performance, cargo space, interior volume)
3. Volume of new vehicle sales are related to TCO, not simply gross vehicle price.
4. If TCO rises (falls), volume of new vehicle sales falls (rises)
5. Consistent with NHTSA and CARB regulatory impact analyses

TCO Results from 2012 Perspective, 2017-2025 Federal Standards (NHTSA Inputs)

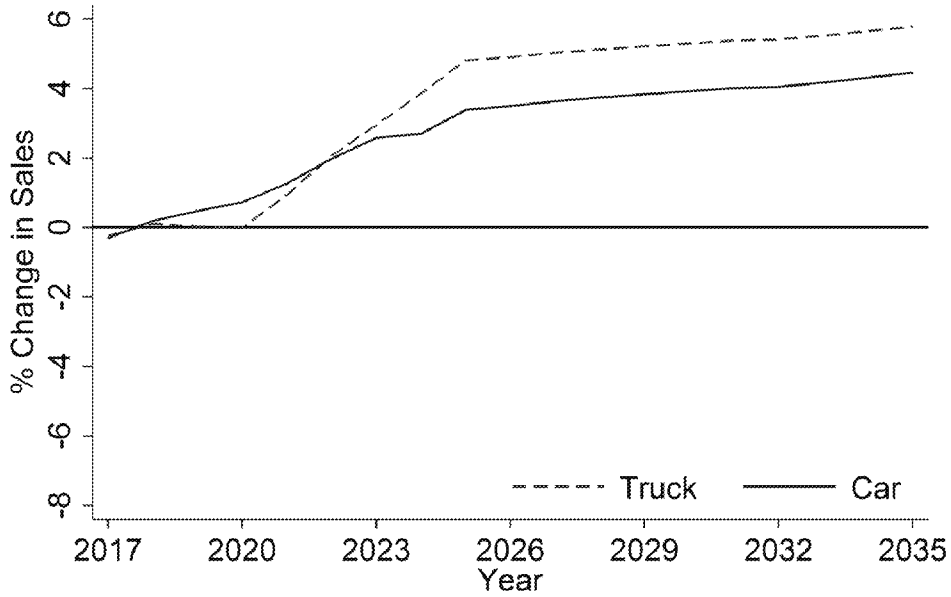


Figure 8.1, p. 113

2012 vs. 2016 Cost Inputs ($2010)

Variable	2012	2016
1. Unit Cost of 2025 CAFE	$1,060/v	+11%, +56%
2. Add Calif ZEV Cost	NA	+$400-$600/v
3. Fuel Price, 2025	$3.84/g	$2.74/g

2012 vs. 2016 Consumer Value of Fuel Savings

	2012	2016
Time horizon	5 years	1 or 3 years
Resale value at year 5	35% of new vehicle price premium (not sensitive to fuel price)	55% of present value of fuel savings (sensitive to fuel price)

Other Changes Discussed in Report

1. Consumer perception of future fuel prices
2. Vehicle miles of travel by vehicle age
3. Interest rate on new car loans
4. Consumer discount rate on fuel savings

Car-Sales Results Are Sensitive to Consumer Valuation of Fuel Savings*

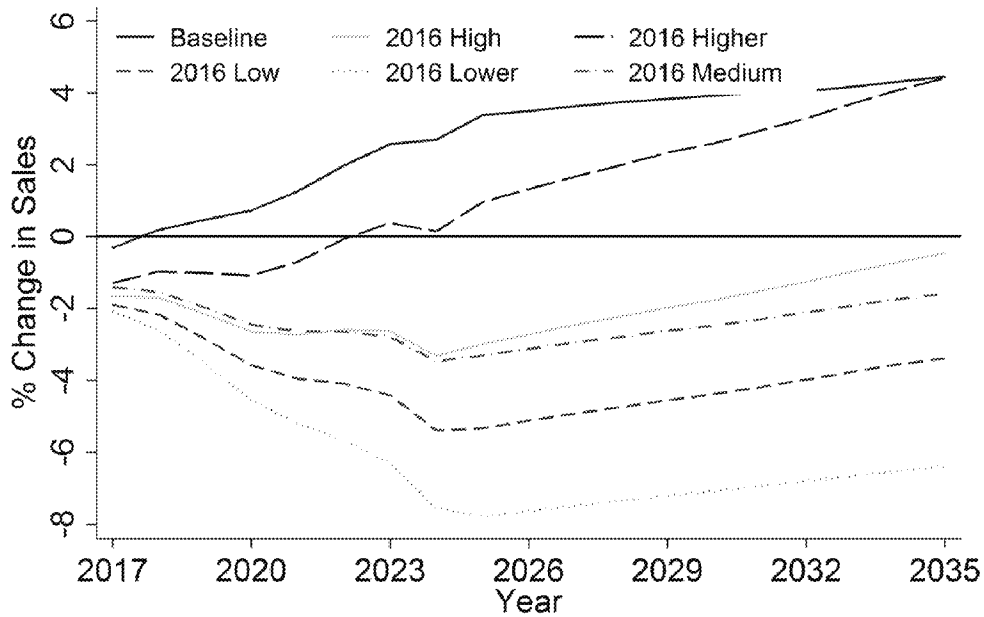


Figure 9.6a, p. 121 *2016 results, federal programs only; low NRC price premium; vary time horizon and resale value.

Car-Sales Results Are Sensitive to Price Premiums and CA ZEV*

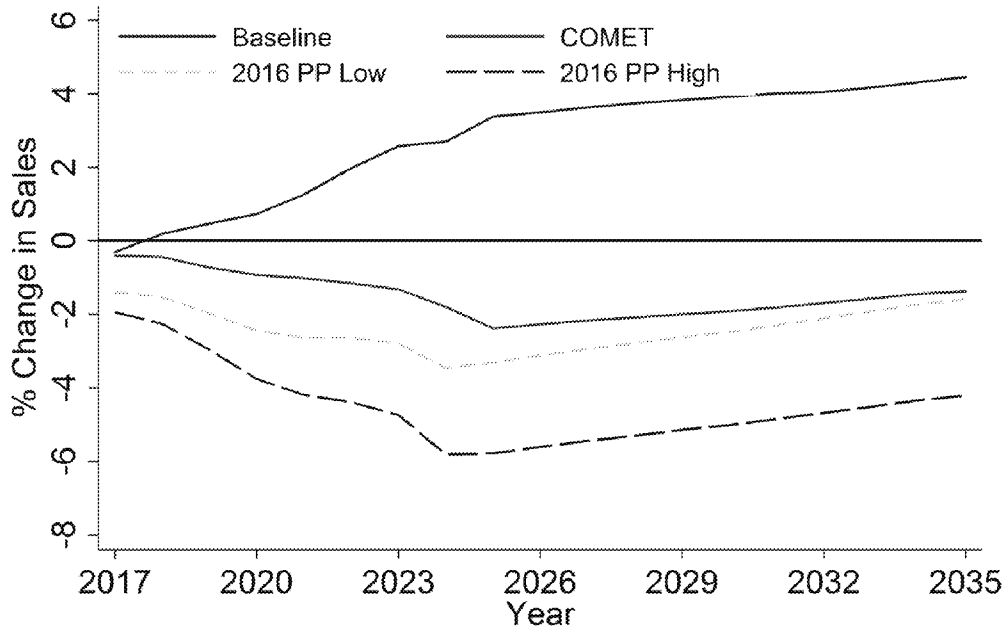


Figure 9.8a, p. 123

*COMET uses TAR cost data and allows ZEV credit in federal programs.

Consumer valuation bundles examined in Figure 9.6a	# of years of fuel valuation	Resale value	Fuel Prices obtained from	Price Premium	% Change in Sales for MY 2025
Baseline	5	35%	AEO 2012	NHTSA 2012	+3.38%
Higher	5	100%	AEO 2016	NRC Low +ZEV (DoE)	+0.96%
High	5	55%	AEO 2016	NRC low +ZEV (DoE)	-2.99%
Medium	3	35%	AEO 2016	NRC Low + ZEV (DOE)	-3.31%
Low	3	0%	AEO 2016	NRC High +ZEV (TAR)	-5.33%
Lower	1	0%	AEO 2016	NRC High + ZEV (TAR)	-7.79%

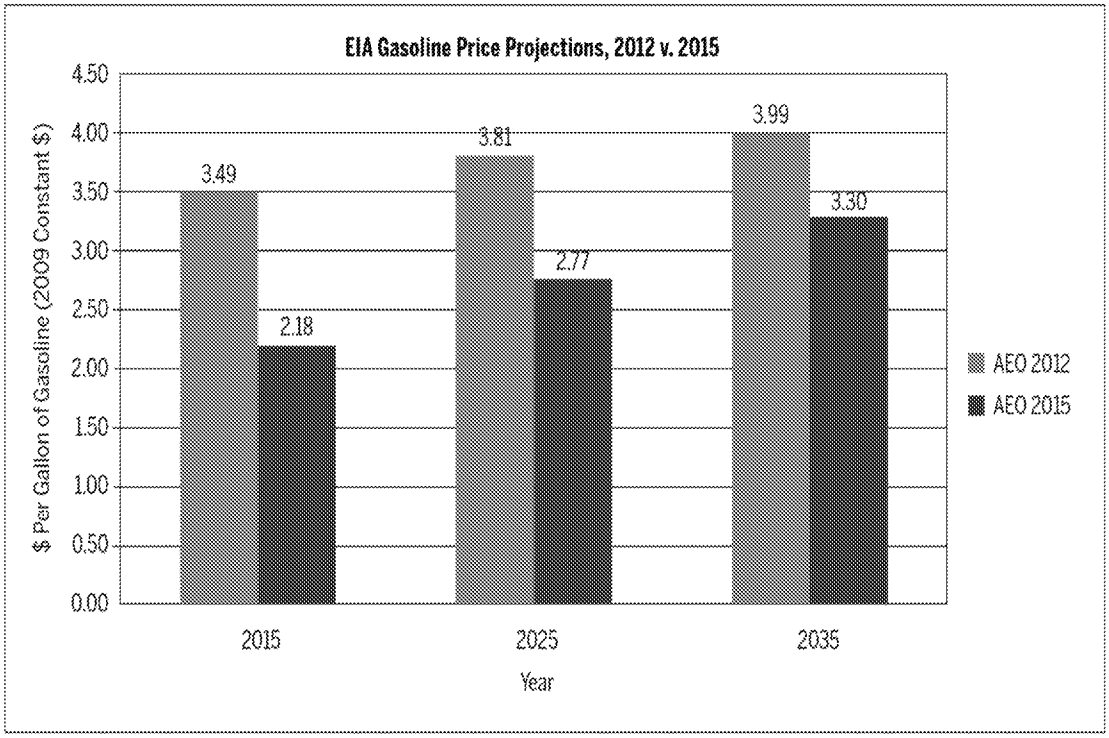
Key Uncertainties: Future Research

- How do consumers evaluate fuel economy at original purchase decision?
- Will 2025 standards impact performance, safety, and other attributes that consumers desire?
- Update price elasticities of demand
- More focus on light truck costs and pricing
- Spillovers to used car markets

POLICY RECOMMENDATIONS FOR FURTHER ANALYSIS

Reform of Federal Programs

- Stretch out compliance schedule?
- Cost or fuel-price reform triggers?



Source: EIA. (2012). Annual energy outlook 2012 with projections to 2035.; EIA. (2015). Annual energy outlook 2015 with projections to 2040.

Consumer Payback Period by Fuel Price ($2,000 Premium)

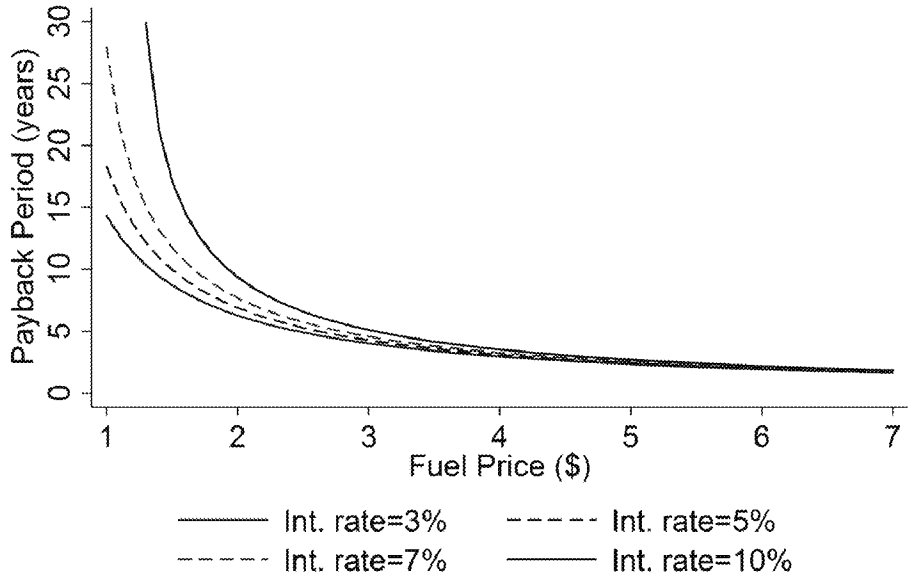


Figure I.2, p. 151

Reform of Federal Programs continued

- Robust off-cycle credit program?
- Credit trading: modernize and harmonize?
- Compliance incentives for AFVs: harmonize and update schedule?
- Better fuel-economy information for consumers?

Reconsider California ZEV

- Cost-benefit aspect to EPA ZEV waiver?
- National ZEV program?

Consumer Payback Period for ZEV, Vary Federal Standard and Fuel Price

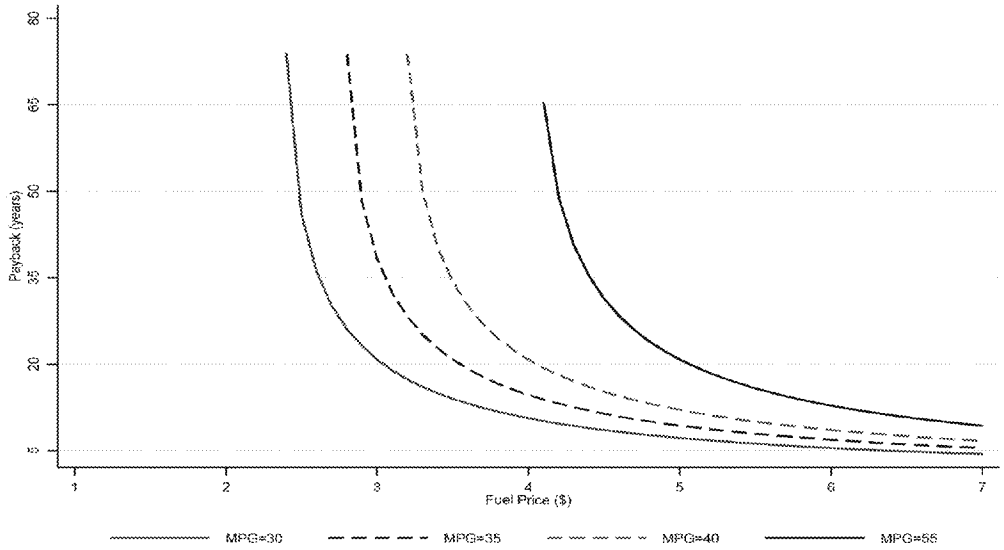


Figure 10.1, p. 132

Is California's ZEV Program Necessary to Commercialize EVs?

- Experience from Norway and Netherlands suggests the answer is "no"
- Those countries have experienced more rapid EV commercialization than California without a ZEV regulation

Reform California ZEV

- Stretch out compliance schedule?
- Extend “travel” and “regional-pooling” provisions?
- Reconsider value of PHEVs relative to BEVs?
- Enhance community readiness for PEVs?
- Support FCVs as compliance alternative?
- Coordinate federal and state fiscal policies toward PEVs?

Other Policy Directions

- Higher Gasoline Tax?
- National Carbon Tax?
- Replace ZEV with Norwegian or Dutch Incentive Schemes?
- Greener “Cash-for-Clunker” Programs?

Thank you!

Contact Information:
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EXTRA SLIDES

Fuel Economy Standards Around the World, 2016

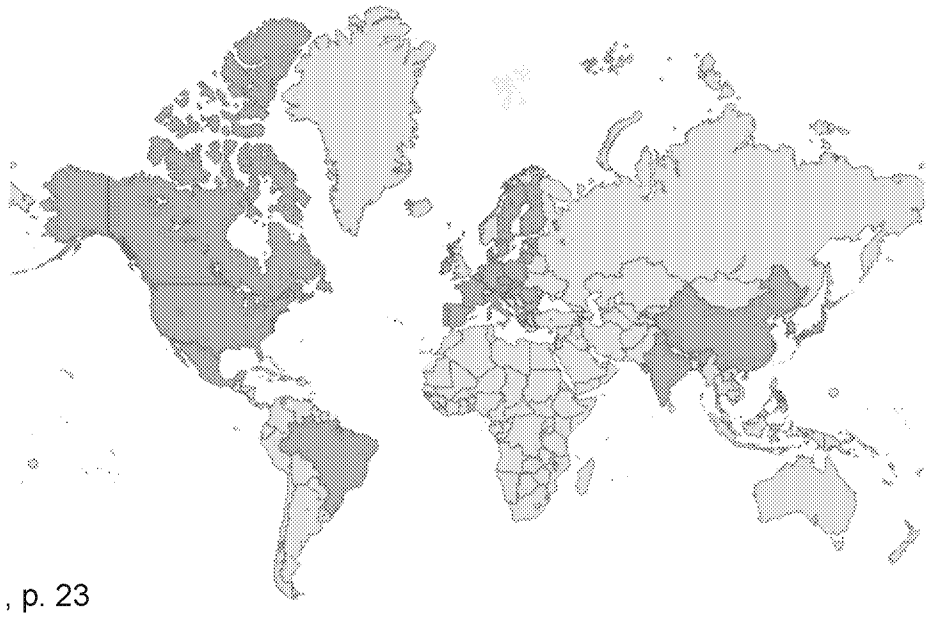
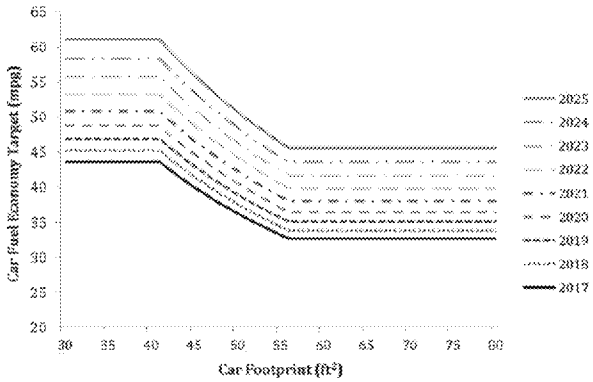


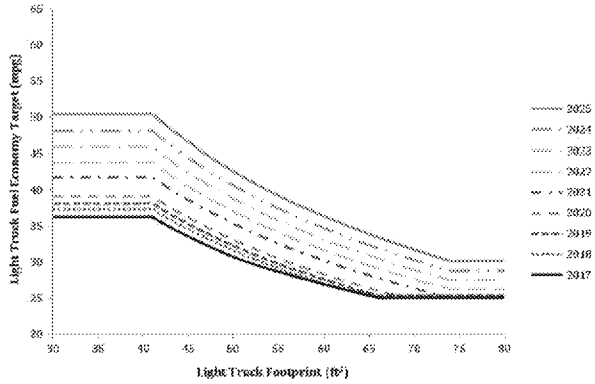
Figure 2.1, p. 23

Fuel Economy Targets for 2017-2025

CARS



LIGHT TRUCKS



Note that the footprint curve for cars has a faster ramp-up than it does for trucks, which, given the growing share of trucks, affects the final MPG target.

Source: NRC (2015)

Message

From: Helfand, Gloria [helfand.gloria@epa.gov]
Sent: 5/4/2017 11:47:57 AM
To: Pickrell, Don H (VOLPE) [Don.Pickrell@dot.gov]; Charmley, William [charmley.william@epa.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [Huang.Hsing-Hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Lie, Sharyn [Lie.Sharyn@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; Tamm, James (NHTSA) [james.tamm@dot.gov]; Green, Kevin (VOLPE) [Kevin.Green@dot.gov]; Keefe, Ryan (VOLPE) [Ryan.Keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6

Deliberative Process / Ex. 5

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Sent: Wednesday, May 03, 2017 7:30 PM
To: Helfand, Gloria <helfand.gloria@epa.gov>; Charmley, William <charmley.william@epa.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Yanca, Catherine <yanca.catherine@epa.gov>; Alson, Jeff <alson.jeff@epa.gov>; Bolon, Kevin <Bolon.Kevin@epa.gov>; Huang, Hsing-Hsiang <Huang.Hsing-Hsiang@epa.gov>; Shelby, Michael <Shelby.Michael@epa.gov>; Lie, Sharyn <Lie.Sharyn@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Davidson, Ken <Davidson.Ken@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Sherwood, Todd <sherwood.todd@epa.gov>; Tamm, James (NHTSA) <james.tamm@dot.gov>; Green, Kevin (VOLPE) <Kevin.Green@dot.gov>; Keefe, Ryan (VOLPE) <Ryan.Keefe@dot.gov>; McCarthy, Mike@ARB <mmccarth@arb.ca.gov>; Chen, Belinda@ARB <bchen@arb.ca.gov>; Simon, Karl <Simon.Karl@epa.gov>; Dickinson, David <Dickinson.David@epa.gov>; Burke, Susan <Burke.Susan@epa.gov>; Snapp, Lisa <snapp.lisa@epa.gov>; Jackman, Dana <jackman.dana@epa.gov>
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6

Thanks – I skimmed it but still need to give it a more careful read. How did his presentation go today?

Don Pickrell
Volpe Center

From: Helfand, Gloria [mailto:helfand.gloria@epa.gov]
Sent: Wednesday, May 03, 2017 3:34 PM
To: Charmley, William <charmley.william@epa.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Yanca, Catherine <yanca.catherine@epa.gov>; Alson, Jeff <alson.jeff@epa.gov>; Bolon, Kevin <Bolon.Kevin@epa.gov>; Huang, Hsing-Hsiang <Huang.Hsing-Hsiang@epa.gov>; Shelby, Michael <Shelby.Michael@epa.gov>; Lie, Sharyn <Lie.Sharyn@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Davidson, Ken <Davidson.Ken@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Sherwood, Todd <sherwood.todd@epa.gov>; Tamm, James (NHTSA) <james.tamm@dot.gov>; Pickrell, Don H (VOLPE) <Don.Pickrell@dot.gov>; Green, Kevin (VOLPE) <Kevin.Green@dot.gov>; Keefe, Ryan (VOLPE) <Ryan.Keefe@dot.gov>; McCarthy, Mike@ARB <mmccarth@arb.ca.gov>; Chen, Belinda@ARB <bchen@arb.ca.gov>; Simon, Karl <Simon.Karl@epa.gov>; Dickinson, David <Dickinson.David@epa.gov>; Burke, Susan <Burke.Susan@epa.gov>; Snapp, Lisa <snapp.lisa@epa.gov>; Jackman, Dana <jackman.dana@epa.gov>
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6

Here is the report itself, if you haven't already seen it.

Gloria Helfand, Ph.D.
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4688

-----Original Appointment-----
From: Charmley, William
Sent: Friday, March 31, 2017 9:49 AM
To: Charmley, William; Helfand, Gloria
Cc: Moran, Robin; Olechiw, Michael; Yanca, Catherine; Alson, Jeff; Bolon, Kevin; Huang, Hsing-Hsiang; Shelby, Michael; Lie, Sharyn; Sargeant, Kathryn; Davidson, Ken; Wysor, Tad; Sherwood, Todd; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green; Ryan Keefe (ryan.keefe@dot.gov); McCarthy, Mike@ARB; Chen, Belinda@ARB; Simon, Karl; Dickinson, David; Burke, Susan; Snapp, Lisa; Jackman, Dana
Subject: Meeting with John Graham Conference Line/Code / Ex. 6
When: Wednesday, May 17, 2017 9:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: C126

Message

From: Olechiw, Michael [olechiw.michael@epa.gov]
Sent: 8/15/2017 4:41:38 PM
To: Erika Nielsen [enielsen@borgwarner.com]
CC: Jim Tamm [james.tamm@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Moran, Robin [moran.robin@epa.gov]; Charmley, William [charmley.william@epa.gov]; Barba, Daniel [Barba.Daniel@epa.gov]
Subject: Draft Agenda for September 26th meeting
Attachments: EPA BW Meeting 26 September 2017 Draft Agenda.docx

Erika,

Please find attached to this email is a first draft agenda for our meeting next month. Please review it and let me know your thoughts.

In addition, we need to establish if this will be a conference call only, or if it can be a web meeting and audio call. I would anticipate that many of our colleagues from CARB and NHTSA may not attend in person.

Best Regards,

Mike

Michael R. Olechiw
Director - Light-duty Vehicles and Small Engines Center
USEPA/OTAQ/ASD
2000 Traverwood Drive
Ann Arbor MI 48105
Tel: 734-214-4297
Mobile: 734-546-8079
Fax: 734-214-4050
olechiw.michael@epa.gov

3-agency Meeting with BorgWarner
*** DRAFT*** Agenda
September 26, 2017
BW – Auburn Hills, MI

Agenda:

1:15 ~ 2:00 Pre-meeting tour of BW facility
2:00 ~ 2:15 Introductions and opening remarks (BW and 3-agencies)
2:15 ~ 2:30 MTE State of Play – EPA FR Notice, NHTSA Scoping Notice (EPA, NHTSA and CARB)
2:30 ~ 4:00 BorgWarner presentation on propulsion mix needed to meet the 2025 standards

- Advanced TGDI –high compression ratio turbocharged, Miller cycle, etc.
- Role of Hybrids (Mild 48V, Full HEV, PHEV)
- Process for off-cycle credits to add more technologies to the list to be transparent with automakers. Suppliers to aid in nominating and testing technologies to make the list but not change the role of automakers in choosing and implementing the technologies for safety and liability reasons.
- EV's
  - Challenges to overcome for higher penetration –Infrastructure, battery cost, battery capacity, raw material availability in mass volume, supply chain development
  - Well-to-wheel
    - Challenges and opportunities - Power consumption/fuel economy penalty and how to offset this in vehicle or propulsion system efficiency

4:00 ~ 4:15 Wrap-up, next steps
4:15 ~ 5:00 Ride and drive

Potential Demo cars available to see or drive in Auburn Hills

- Jaguar F-Pace – Combustion category – Production – Features BW EGR coolers, turbocharger, timing drives, phasers, transfer case
- Chevrolet Impala or Malibu – Combustion category – Production – Features BW stop/start solenoid accumulator system
- Ford 150 – Hybrid Category P0- Demonstrator - Features BW eBooster® electrically driven compressor and BAS
- Audi A3 eTron – Hybrid Category P2– Production- Features BW clutch plates for hybrid module
- Ford F150 – Hybrid Category P3 – Demonstrator- Features BW P3 electrified transfer case
- Chevrolet Volt – Hybrid Category PS – Production-Features BW Transmission chain and MDA solenoids
- BW Intern Buggy – Electric Category-Demonstrator – Features BW electric motor HVH120, power electronics, chain
- Tesla Model X – Electric Category-Production- Evaluation vehicle

Message

From: Julia Rege [JRege@globalautomakers.org]
Sent: 2/21/2017 8:18:34 PM
To: Pruitt, Scott [Pruitt.Scott@epa.gov]; pruitt.gscott@epa.gov
CC: John Bozzella [jbozzella@globalautomakers.org]; secretaryscheduler@dot.gov; Grundler, Christopher [grundler.christopher@epa.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Rebecca S. Yoon [rebecca.yoon@dot.gov]; James Tamm [james.tamm@dot.gov]; Kevin.Green@dot.gov; Alberto.Ayala@arb.ca.gov; Ellen Gleberman [egleberman@globalautomakers.org]; Charles Haake [chaake@globalautomakers.org]; Annemarie Pender [apender@globalautomakers.org]
Subject: Request to Withdraw Final Determination Re. MY 2022-2025 GHG Standards
Attachments: Request to Withdraw Final Determination.pdf

Importance: High

Dear Administrator Pruitt:

On behalf of John Bozzella, President and CEO of Global Automakers, I am sending you the attached correspondence related to the EPA's Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, which was announced by the Agency on January 13, 2017. A hard copy of this letter has been sent to your office via FedEx as well.

We welcome the opportunity to further discuss this matter with you at your earliest convenience.

Sincerely, Julia

Julia M. Rege
Director, Environment & Energy
Association of Global Automakers, Inc. (Global Automakers)
1050 K Street, NW, Suite 650
Washington, DC 20001
202.650.5559 (direct)
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jrege@globalautomakers.org
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Aston Martin • Ferrari • Honda • Hyundai • Isuzu • Kia
Maserati • McLaren • Nissan • Subaru • Suzuki • Toyota

February 21, 2017

Scott Pruitt
Administrator
Environmental Protection Agency
Office of the Administrator 1101A
1200 Pennsylvania Avenue, N.W.
Washington DC 20460

Attention: Docket ID No. EPA-HQ-OAR-2015-0827

RE: Petition for Reconsideration and Request to Withdraw Final Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (January 12, 2017)

Dear Administrator Pruitt:

The Association of Global Automakers, Inc. (Global Automakers)[1] respectfully petitions the United States Environmental Protection Agency (EPA) to reconsider its final Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (the "Determination"), and requests that the Determination be withdrawn. As explained below, EPA's premature Determination suffers from a multitude of procedural and substantive flaws. Most importantly, it is inconsistent with the coordinated process to which EPA committed in 2012 to ensure the development of "One National Program" to regulate fuel economy and greenhouse gas (GHG) emissions in coordination with the National Highway Traffic Safety Administration (NHTSA). Consequently, we are requesting that EPA withdraw the Determination and reopen the record so that EPA's rulemaking concerning GHG emission standards for model years (MY) 2022-2025 can be aligned with fuel economy rulemaking currently underway at NHTSA for those years.

[1] The Association of Global Automakers represents international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Our member companies have invested $56 billion in U.S.-based facilities, directly employ nearly 100,000 Americans, and sell 47 percent of all new vehicles purchased annually in the country. Combined, our members operate more than 300 production, design, R&D, sales, finance and other facilities across the United States. Working with industry leaders, legislators, and regulators in the United States, Global Automakers aims to create public policies that improve motor vehicle safety, encourage technological innovation, and protect our planet. Our goal is to foster an open and competitive automotive marketplace that encourages investment, job growth, and development of vehicles that can enhance Americans' quality of life. For more information, please visit www.globalautomakers.org.

Association of Global Automakers, Inc. 1050 K Street, NW, Suite 650 • Washington, DC 20001 TEL 202.650.5555 GLOBALAUTOMAKERS.ORG

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A. Background

On January 12, 2017—just one week before the end of the previous administration—EPA published its final Determination concerning whether the GHG emissions standards currently on the books for MY 2022-2025 remain appropriate. This Determination was part of a "Midterm Evaluation" of those standards, a key protective mechanism that was included, at the insistence of the auto industry as a condition of its support of these regulations, in the 2012 joint EPA and NHTSA rule setting fuel economy and GHG emission standards covering MY 2017 through 2025.[2] Given that NHTSA is statutorily prevented from promulgating fuel economy standards governing more than a five-year period, and that the EPA standards were being set more than ten years into the future, having an objective and data-driven Midterm Evaluation is necessary to ensure that the future standards are feasible, cost-effective, and achieve the goals of the two relevant statutes under the One National Program.

Throughout the process of the Midterm Evaluation, both EPA and NHTSA made several commitments to the stakeholders. First, the agencies promised to remain aligned from both a procedural and substantive standpoint.[3] As was the case with the 2012 rulemaking, during the Midterm Evaluation the agencies were to jointly issue a proposed rulemaking/determination and a final rulemaking/ determination. This was necessary to ensure that One National Program is maintained and to protect manufacturers from having to comply with multiple inconsistent standards.

Second, EPA and NHTSA consistently stated that the final NHTSA rule and EPA determination were expected by April 1, 2018,[4] with a proposed rule and a proposed determination expected in the summer of 2017.[5] This timeline would allow the agencies to account for the most up-to-date and robust information concerning the light-duty fleet and the costs and effectiveness of the technologies needed to meet the standards. In developing information for the record, in allocating scarce automotive engineering

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[2] *See* 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012). The State of California has its own GHG emission standards for light duty vehicles, but has amended its regulations to include a "deemed-to-comply" provision whereby automakers could show compliance with its state GHG emission standards by complying with EPA GHG regulations. Together, the California regulations and the EPA/NHTSA standards are referred to as the "One National Program."

[3] *See* 77 Fed. Reg. at 62,633 (stating that EPA and NHTSA will act jointly in their proposed and final rulemaking in the Midterm Evaluation "[i]n order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program.")

[4] *Id.*

[5] *See* https://www.epa.gov/sites/production/files/2016-10/documents/grundler-sae-naipc-2015-09-17-presentation.pdf at 24 (indicating that the EPA Proposed Determination and NHTSA notice of proposed rulemaking would be released mid-2017 and the final determination made in April 2018).

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resources, and in the expenditure of considerable sums, the industry relied upon this schedule and these repeated representations.

Finally, both EPA and NHTSA committed to a collaborative process that would fully account for the input of all stakeholders. To achieve this, the agencies stated that they would provide periods of public comment on the draft Technical Assessment Report (TAR) that EPA and NHTSA compiled in collaboration with the California Air Resources Board (CARB), and a separate period of comment with respect to EPA's and NHTSA's proposals concerning the MY 2022-2025 standards.[6] Given that the agencies' actions on this matter would affect billions of dollars of investments on the part of automakers as well as the types of vehicles that would be made available to customers for years (if not decades) to come, it is critically important that the agencies get it right.

Despite this carefully constructed (and fully promised) process, EPA unilaterally reversed course 22 days after the Presidential Election. On November 30, 2016, EPA abruptly announced that it was abandoning its previously committed-to plan on the Midterm Evaluation and published a lengthy "Proposed Determination" concerning the appropriateness of the MY 2022-2025 GHG standards. Signaling its new intent to rush through a final Determination before the end of the Obama Administration, EPA provided stakeholders with just 30 days from the release of the Proposed Determination on EPA's website to provide comments (which was only 24 days from the date the Proposed Determination was published in the Federal Register[7]). EPA was informed by many stakeholders that this comment period was far too short for an action of this magnitude and included a holiday period when many automakers are closed. Nevertheless, EPA's Final Determination was released on January 12, 2017.

When EPA announced the Proposed Determination, it styled its action as a "proposed adjudicatory determination."[8] EPA therefore took the position that its Determination could escape both the procedural requirements of Section 307 of the Clean Air Act[9] and the rulemaking provisions of the Administrative Procedures Act (APA).[10] In the Final Determination and Response to Comment, EPA rejected the argument made by Global Automakers and many other stakeholders that the Determination amounted to a rulemaking because it is a prospective action setting agency policy.[11] Consistent with its position that the Determination is not a rulemaking, EPA has not published the Determination in the Federal Register.

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[6] 77 Fed. Reg. at 62,784.
[7] 81 Fed. Reg. 87,927 (Dec. 6, 2016).
[8] See Proposed Determination at ES-2 and 2 n.2.
[9] 42 U.S.C. § 7607(d)
[10] 5 U.S.C. § 553
[11] *See* EPA Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation at 11, n.20.

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B. EPA Has Ample Authority to Reconsider the Determination

Regardless of whether the Final Determination is considered a rule or an adjudication, this EPA has the authority to withdraw and reconsider it. In the event that the Determination is an adjudication (as the prior EPA claimed), then the agency has inherent authority to reconsider that decision. "It is widely accepted that an agency may, on its own initiative, reconsider its interim or even its final decisions, regardless of whether the applicable statute and agency regulations expressly provide for such review."[12] This is especially true where the underlying determination has "serious procedural and substantive deficiencies."[13] Unless a statute expressly limits an agency's authority to reconsider its decisions—which is not the case here—then the agency may freely do so as long as reconsideration occurs within a reasonable time after the first decision and notice of the agency's intent to reconsider is given to the parties.[14]

In the event that the Determination did amount to a rulemaking, then it is subject to withdrawal and reconsideration for two separate and independent reasons. First, the Federal Register Act requires that all documents of "general applicability and legal effect" be published in the Federal Register.[15] The EPA Final Determination has not been published in the Federal Register in contravention of this clear requirement. Thus, under President Trump's Memorandum for the Heads of Executive Departments and Agencies; Regulatory Freeze Pending Review,[16] if viewed as a rule the Final Determination can and should be withdrawn by the new Administration.

Second, an agency has inherent power to withdraw and reconsider a rule that suffers from fatal legal and procedural flaws.[17] Adhering to the proper procedures is a fundamental prerequisite for valid rulemaking.[18] Here, the Determination is invalid as a rule because EPA did not follow any of the procedural requirements set forth in Section 307(d) of the Clean Air Act. EPA did not convene a hearing to allow interested persons to comment on the Proposed Determination, and did keep the record of the proceedings open for 30 days to provide an opportunity for interested persons to submit rebuttal and supplementary information to the

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[12] *Dun & Bradstreet Corp. Found. v. United States Postal Serv.*, 946 F.2d 189, 193 (2d Cir. 1991). *See also ConocoPhillips Co. v. United States EPA*, 612 F.3d 822, 832 (5th Cir. 2010) ("Embedded in an agency's power to make a decision is its power to reconsider that decision."); *Gun South, Inc. v. Brady*, 877 F.2d 858 (11th Cir. 1989) (holding that Bureau of Alcohol, Tobacco, and Firearms had the implied authority to correct the erroneous approval of firearms import application).

[13] *Belville Mining Co. v. United States*, 999 F.2d 989, 998 (6th Cir. 1993).

[14] *Dun & Bradstreet*, 946 F.2d at 193.

[15] 44 USC 1505(a)(2).

[16] 82 Fed. Reg. 8346 (Jan. 24, 2017).

[17] *Citizens Against the Pellissippi Parkway v. Mineta*, 375 F.3d 412, 416 (6th Cir. 2004)

[18] *United States v. Utesch*, 596 F.3d 302, 312 (6th Cir. 2010) (stating that a "reviewing court must focus not merely on the ultimate rule but on the process of an administrative rulemaking; otherwise, an agency could always violate the APA's procedural requirements based on the representation that it would have adopted the same rule had the proper process been followed.")

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record.[19] Presumably, the prior EPA ignored these requirements because to follow them would have prevented the agency from finalizing the Determination before the end of the Obama Administration. But politics is not a reason for running roughshod over important procedural protections found in the Clean Air Act.

C. EPA Should Withdraw the Determination and Reopen the Rulemaking Record to Maintain the One National Program EPA Promised

EPA's Determination is a significant action by the agency that will have far-reaching ramifications for the industry and the automobile driving public. EPA readily concedes that the MY 2022-2025 standards will increase the prices of new motor vehicles by a substantial amount (according to EPA's own estimates), and will impact the types of vehicles sold in the U.S. An action of this magnitude requires a thoughtful and collaborative decision-making process. Here, however, EPA opted for political expediency instead, and jammed through a Final Determination in the waning days of the lame-duck Administration.

The EPA Determination suffers from many procedural and substantive flaws, any one of which would justify withdrawing the rule and reopening the rulemaking record. Among them are:

- Failure to follow EPA regulations requiring coordination with NHTSA. The Midterm Evaluation was designed so that the actions of EPA and NHTSA would be carefully coordinated every step of the way. As explained in the preamble to the 2012 rulemaking, "[i]order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, if the EPA determination is that its standards will not change, NHTSA will issue its final rule concurrently with the EPA determination."[20] This requirement is codified at 40 C.F.R. § 86.1818-12(h)(1)(vii), which requires EPA's Midterm Evaluation to account for "[t]he impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program." Without providing any justification for its doing so, EPA violated this central tenet of the Midterm Evaluation by finalizing its Determination more than a year before NHTSA's rulemaking is expected to be completed and acted contrary to its own regulations. NHTSA is currently in the middle of its rulemaking process for MY 2022-2025 fuel economy standards, and its decision will be based on more up-to-date information than EPA's. Consequently, there is a risk that NHTSA will reach a different conclusion from EPA concerning appropriate standards for MY 2022-2025. This is the antithesis of the One National Program that EPA agreed to.

- Needlessly accelerating the timeline for the GHG Midterm Evaluation. Prior to November 2016, EPA had repeatedly represented that it would propose its determination/rulemaking in the summer of 2017 and finalize its actions by April 2018. Based on these representations, Global Automakers and other

[19] 42 U.S.C. § 307(d)(5).
[20] 77 Fed. Reg. at 62,633.

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members of the auto industry commissioned several studies concerning the baseline light duty fleets and the technologies necessary to meet the current MY 2022-2025 standards. EPA was informed that these studies will be important for its determination but would not be complete until the promised mid-2017 timeframe. Additionally, EPA was urged to delay its actions so that it could account for the most up-to-date information concerning the technologies needed to meet the standards, their costs, and their impacts on consumers—as NHTSA is doing with its rulemaking. EPA ignored these calls and finalized its determination based on a record that was far from complete solely to rob the incoming Administration of an opportunity to have input on this important matter.

- Failure to provide an adequate period for public comment. The Proposed Determination and the accompanying Technical Support Document consisted of almost 1,000 pages, and cited almost 1,100 references, many of which are new or significantly revised since the earlier Draft TAR. Additionally, EPA conducted 102 new runs of the computer models it uses to assess the effectiveness of fuel saving technologies. Thirty days is an insufficient time period for stakeholders to fully review, analyze, and prepare detailed comments on an action as significant and complex as EPA's Determination – especially in light of the intervening national holidays. EPA offered no reasoned explanation as to why it was short-circuiting the comment period on such an important agency action.

- Failure to address the GHG emission program as a whole. In its rush to finalize its Determination, EPA answered only half the question, *i.e.*, whether the numeric standards expressed in the footprint-based curves remain appropriate. However, the GHG regulations also include program flexibilities that automakers rely on to meet the standards. These flexibilities provide incentives for the early adoption of advanced fuel-saving technologies and help manufacturers smooth out annual variability in compliance over several model years. They are an important aspect of the One National Program, and they provide real and lasting environmental benefits. EPA's failure to look at the entire program as a whole was inconsistent with the very purpose of the Midterm Evaluation.

- Failure to respond adequately to comments concerning consumer acceptance, cost and technology effectiveness. EPA received more than 100,000 public comments on the Proposed Determination.[21] Many of the comments from industry focused on the extent to which lack of consumer acceptance may impact the ability to achieve the standards, as well as the costs and effectiveness of the necessary technologies. The fact that EPA finalized its Determination a mere ***13 days*** after the close of the comment period demonstrates that the agency could not have adequately responded to all of these comments. Indeed, a review of the final Determination and the Response to Comments reveals that EPA did not provide adequate responses to the many comments given.

[21] *See* Determination at 1.

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EPA's determination as to the appropriateness of the GHG emission standards for MY 2022 through 2025 was a significant action that will have wide-ranging implications for the automobile industry and the car-buying public. It was therefore important that EPA reach its decision based on an open and collaborative process, and only after fully considering all of the most up-to-date information concerning the costs and feasibility of the technologies necessary to meet the standards. Rather than adhering to such a process that it had agreed to and promised in 2012, EPA rushed through a Final Determination at the very end of the previous Administration. Therefore, we respectfully request that EPA: (a) withdraw the Determination, (b) reopen the record on the Midterm Evaluation, and (c) reset the timetable for EPA's actions so that they align with NHTSA's rulemaking.

Thank you for your prompt consideration of this matter.

Sincerely,

John Bozzella
President and CEO
Association of Global Automakers

cc: Secretary Elaine Chao, DOT
Kevin Green, DOT
Bill Charmley, EPA
Chris Grundler, EPA
Michael Olechiw, EPA
Rebecca Yoon, NHTSA
James Tamm, NHTSA
Alberto Ayala, CARB

Message

From: Susan Conti [sconti@autoalliance.org]
Sent: 2/21/2017 6:02:29 PM
To: Pruitt, Scott [Pruitt.Scott@epa.gov]; pruitt.gscott@epa.gov
CC: marianne.mcinerney@dot.gov; Grundler, Christopher [grundler.christopher@epa.gov]; Charmley, William [charmley.william@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Kevin.Green@dot.gov; james.tamm@dot.gov; rebecca.yoon@dot.gov; annette.hebert@arb.ca.gov; michael.mccarthy@arb.ca.gov; Chris Nevers [CNevers@autoalliance.org]; David Schwietert [DSchwietert@autoalliance.org]; Gloria Bergquist [GBERGQUIST@autoalliance.org]; John Whatley [JWhatley@autoalliance.org]
Subject: URGENT Letter from Alliance of Automobile Manufacturers to EPA Administrator G. Scott Pruitt
Attachments: Letter to EPA Admin. Pruitt Feb. 21, 2016 Signed.pdf

Importance: High

Dear Administrator Pruitt:

The attached letter, on behalf of the Alliance of Automobile Manufacturers, requests that the U.S. Environmental Protection Agency (EPA) withdraw the Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (Final Determination) which was announced on January 13, 2017 but never published in the *Federal Register*.

The Alliance is not asking EPA to make a different Final Determination at this time. All we are asking is that EPA withdraw the Final Determination and resume the Midterm Evaluation, in conjunction with NHTSA, consistent with the timetable embodied in EPA's own regulations. We believe that, if carried out as intended, the Midterm Evaluation can lead to an outcome that makes sense for all affected stakeholders and for society as a whole.

The Alliance welcomes the opportunity for further dialogue. Please contact me at your earliest convenience to discuss this matter further. Thank you.

Mitch Bainwol
President and CEO

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DRIVING INNOVATION®

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February 21, 2017

G. Scott Pruitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 1101A
Washington, D.C. 20460

RE: Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation

Dear Administrator Pruitt,

I write on behalf of the Alliance of Automobile Manufacturers (Alliance), an association representing twelve leading manufacturers of cars and light trucks,[1] to request that the U.S. Environmental Protection Agency (EPA) withdraw the Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation (Final Determination) which was announced on January 13, 2017 but never published in the *Federal Register*.

For the auto industry, the Final Determination may be the single most important decision that EPA has made in recent history. The Alliance requests that EPA withdraw the Final Determination and resume the Midterm Evaluation, in accordance with its original timetable, to remedy the severe procedural and substantive defects that have infected the process to date. We explain, in more detail below, EPA's authority to withdraw the Final Determination and why that withdrawal is appropriate and essential.

1. <u>EPA Should Exercise Its Authority to Withdraw the Final Determination</u>

As you know, on January 20, the White House issued a memorandum to the heads of all executive departments and agencies instituting a freeze on regulatory activity, pending review by the Office of Management and Budget (OMB) Director.[2] The Alliance urges EPA to withdraw the Final Determination on its own initiative in accordance with the regulatory freeze. Irrespective of whether EPA considers the Final Determination a rule or an adjudication, the Final Determination should be reviewed

[1] Alliance members are BMW Group, FCA US LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America, and Volvo Car USA.

[2] *See* Memorandum for the Heads of Executive Departments and Agencies, Jan. 20, 2017, https://www.whitehouse.gov/the-press-office/2017/01/20/memorandum-heads-executive-departments-and-agencies.

and withdrawn. As the Alliance has noted, a wealth of precedents confirm that the Final Determination is a rule, and all rules not yet published in the *Federal Register* are subject to the regulatory freeze.[3] Even if EPA continues to construe the Final Determination as an adjudication, however, it is still subject to the regulatory freeze as an "agency statement of general applicability and future effect 'that sets forth a policy on a statutory, regulatory, or technical issue or an interpretation of a statutory or regulatory issue.'" The Final Determination reaffirms and reinstates industry-wide greenhouse gas emissions standards for all light vehicles sold in America for MY 2022-2025, and thereby establishes a policy on a regulatory issue of central importance to the auto industry.

Furthermore, EPA has ample authority to withdraw the Final Determination on its own initiative, irrespective of whether EPA considers it a rule or an adjudication. If the Final Determination is a rule, it is clearly a nonfinal one, because it has not been published in the *Federal Register*. *See* 5 U.S.C. § 553(d); *Kennecott Utah Copper Corp. v. U.S. Dep't of Interior*, 88 F.3d 1191, 1209 (D.C. Cir. 1996). And, as a nonfinal rule, EPA can readily withdraw the Final Determination without engaging in notice-and-comment rulemaking. *Kennecott,* 88 F.3d at 1206.

Even if EPA continues to endorse the view that the Final Determination is an adjudication, however, EPA has broad inherent power to reconsider its decision "within the period available for taking an appeal." *Am. Methyl Corp. v. EPA*, 749 F.2d 826, 835 (D.C. Cir. 1984). Agencies have long exercised this power to fix determinations like this one that suffer from "serious procedural and substantive deficiencies." *Belville Min. Co. v. United States*, 999 F.2d 989, 998 (6th Cir. 1993). Regardless of how EPA classifies the Final Determination, EPA should promptly withdraw it in light of the many procedural and substantive flaws described below.

2. <u>EPA Has Abrogated Its Commitment to a Robust Midterm Evaluation</u>

As the Supreme Court has recognized, EPA's regulatory efforts to address greenhouse gases have already produced "the single largest expansion in the scope of the [Clean Air Act] in its history."[4] In 2009, EPA issued an Endangerment Finding that motor vehicle greenhouse gas emissions contribute to climate change and thereby threaten public health and welfare. Thereafter, EPA and the National Highway Traffic Safety Administration (NHTSA) began jointly setting greenhouse gas emissions and fuel economy standards for new light-duty motor vehicles, starting with Model Year (MY) 2012-2016. Then, in 2012, EPA and NHTSA took the unprecedented step of

---

[3] *See* Alliance Comments on Proposed Determination on Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation at 11-13, Dec. 30, 2016, Docket ID No. EPA-HQ-OAR-2015-0827; Memorandum for the Heads of Executive Departments and Agencies, Jan. 20, 2017.

[4] *Utility Air Regulatory Group v. EPA*, 134 S. Ct. 2427, 2436 (2014) (internal quotation marks omitted).

setting joint greenhouse gas and fuel economy standards over a decade in advance for MY 2022-2025 vehicles. 77 Fed. Reg. 62,628 (Oct. 15, 2012). No agency ever had set emissions standards so far into the future, and all stakeholders understood that no one could accurately project the circumstances affecting the technological and economic feasibility of these standards.

The Alliance supported these efforts—but only on the condition that EPA and NHTSA would reassess standards as data became available to test their feasibility. That commitment was essential because of the great uncertainty regarding the feasibility of the future standards. Based on the projections in the 2012 rule, manufacturers must achieve an average 54.5 miles per gallon equivalent across their new vehicle fleets by 2025. Even today, no conventional vehicle today meets that target, and conventional vehicles comprise 96.5% of the new light-duty vehicle fleet. Only some non-conventional vehicles (i.e., hybrid, plug-in electric, and fuel-cell vehicles), which comprise fewer than 3.5% of today's new vehicles, currently can do so.[5] Even under EPA's optimistic estimates, the automotive industry will have to spend a staggering $200 billion between 2012 and 2025 to comply, making these standards many times more expensive than the Clean Power Plan.[6]

EPA and NHTSA committed to a robust Midterm Evaluation that would take a fresh look at these standards by April 2018. The agencies promised that this review would be collaborative, so that the industry could offer the agencies real-life data to adjust their model-driven forecasts. The agencies also committed to developing greenhouse gas emissions standards and fuel economy standards in tandem.[7] And they repeatedly represented that they would not complete the Proposed Determination/Notice of Proposed Rulemaking until mid-2017 at the earliest.[8] The industry took the agencies at their word, commissioning complex studies critical to assessing the MY 2022-2025 standards and the processes used by EPA in its analysis, that we had expected to add to the administrative record for the Midterm Evaluation in 2017.

On November 30, 2016, EPA abruptly abrogated these commitments. EPA issued a Proposed Determination that the MY 2022-2025 standards should go into force

---

[5] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2016," at 118. U.S. Environmental Protection Agency. EPA-420-R-16-010, Nov. 2016.

[6] *See* EPA Regulatory Impact Analysis for 2012-2016 rule (EPA-420-R-10-009, Apr. 2010) at https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-model-year-2012-2016-light-duty-vehicle; EPA Regulatory Impact Analysis for 2017-2025 rule (EPA-420-R-12-016, Aug. 2012) at https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-model-year-2017-and-later-light-duty-vehicle.

[7] *See* 40 C.F.R. § 86.1818-12(h), 77 Fed. Reg. 62,784 (Oct. 15, 2012), 40 C.F.R. § 86.1818-12(h)(1) -(2); 81 Fed. Reg. 49,219 (July 27, 2016).

[8] *See* Alliance Comments on Proposed Determination at 10, Dec. 30, 2016, Docket ID No. EPA-HQ-OAR-2015-0827.

without modification. EPA issued the Proposed Determination without coordinating with NHTSA. EPA demanded comments by December 30, 2016, even though the Proposed Determination was not published in the *Federal Register* until December 6. The public and industry had a mere 24 days, spanning a major national holiday, to comment on nearly 1,000 pages of documents, plus additional cited documents and computer modeling, regarding requirements that will profoundly affect the automobile industry and the more than 900,000 American workers it directly employs.[9] After EPA denied requests by various stakeholders to extend the abbreviated comment period, we did our best to file substantive comments. EPA received more than 100,000 public comments, including 63 sets of comments from various organizations spanning hundreds of pages.[10] Many objected that the comment period was inadequate. EPA denied all requests to extend the abbreviated comment period and yet EPA issued the Final Determination on January 13, 2017, just 14 days after the comment period closed. EPA brushed aside objections to its procedural shortcuts and never justified the need for such an abbreviated comment period. EPA also rejected commenters' substantive and technical concerns by resting on its earlier analysis.

3. EPA Should Withdraw the Final Determination Immediately

The Final Determination is the product of egregious procedural and substantive defects and EPA should withdraw it.[11] In EPA's rush to promulgate the Final Determination before the new administration took office, EPA bypassed required procedures, failing for instance to provide an adequate period for meaningful notice and comment. The Final Determination asserts that there was no need for more time because the Proposed Determination did not include much new material. But that contention is belied by EPA's acknowledgement that the Proposed Determination adjusted a number of EPA assumptions in response to commenters who pointed out errors at earlier stages. The industry also had an unacceptably short period to try to ascertain why EPA rejected many of its objections.[12] These procedural defects are significant irrespective of whether the Final Determination constitutes rulemaking or adjudication.

EPA's unilateral announcement of its Final Determination also constitutes a failure to harmonize its greenhouse gas emissions standards with NHTSA's fuel-economy standards, contrary to the letter and intent of EPA's own regulations. NHTSA has not yet reached a determination on its fuel economy standards and continues its

[9] U.S. Department of Labor, Bureau of Labor Statistics, 2015, U.S. Vehicle and Equipment Manufacturing Employment equaled 909,700 people.

[10] Final Determination, Response to Comments at 1-3.

[11] *See* Alliance Comments on Proposed Determination, Dec. 30, 2016, Docket ID No. EPA-HQ-OAR-2015-0827.

[12] *See* Final Determination, Response to Comments at 7.

Midterm Evaluation rulemaking activities. EPA's failure to act in coordination with NHTSA also casts serious doubt on the legitimacy of EPA's data and conclusions, given the substantial discrepancies between EPA's and NHTSA's analysis of the technologies and costs associated with the MY 2022-2025 standards.[13]

Furthermore, EPA's Final Determination that the MY 2022-2025 greenhouse gas standards should remain unchanged, is riddled with indefensible assumptions, inadequate analysis, and a failure to engage with contrary evidence. Here are just a few examples:

- EPA estimated that these standards will cost the industry at least $200 billion. But EPA underestimated the burden. Contrary to EPA's assumptions, manufacturers will have to rely on much more expensive electrified technologies (i.e., hybrids and plug-ins), driving up vehicle prices and depressing auto sales.

- EPA refused to conduct an analysis of consumer acceptance and technology affordability needed for compliance, claiming this was too difficult.

- EPA refused to analyze substantively the economic impact of the MY 2022-2025 standards, instead making cursory assertions that downplayed the impact of its mandate on auto sales and employment.

- EPA refused to consider many of the Alliance's technical concerns even when supported by an outside consultant[14], asserted the Alliance provided insufficient data, and then refused further meetings for clarification.

4. <u>Studies and Data Highly Relevant to the Midterm Evaluation Have Not Been Submitted to EPA Because They Still Are Pending</u>

It is particularly critical that EPA withdraw the current Final Determination and reopen the Midterm Evaluation process because analysis commissioned according to EPA's original timetable is ongoing and the Alliance expects that new information relevant to the Final Determination's underlying assumptions and resulting analysis will soon emerge. EPA's rushed timetable, coupled with its about-face on the timing of the Midterm Evaluation, prevented consideration of this information.

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[13] *See* Alliance Comments on US EPA, US DOT, California's Air Resources Board Draft Technical Assessment Report of Greenhouse Gas Emissions and Fuel Economy Standards for Model Year 2022-2025 Cars and Light Trucks at ES-9, Sept. 26, 2016, Docket ID No. EPA-HQ-OAR-2015-0827, NHTSA's costs are approximately 42% higher than EPA's (NHTSA Table ES-2 v. EPA ES-4 Table ES-1).

[14] *See* Novation Analytics Comments on Draft Technical Assessment, Sept. 26, 2016; Docket ID No. EPA-HQ-OAR-2015-0827.

We urge EPA to reconsider imposing such a far-reaching mandate on an entire industry without adequately considering the consequences, and without giving stakeholders a meaningful opportunity to comment. The MY 2022-2025 standards threaten to depress an industry that can ill afford spiraling regulatory costs. If left unchanged, those standards could cause up to *1.1 million* Americans to lose jobs due to lost vehicle sales.[15] And low-income households would be hit the hardest.[16]

The Alliance is not asking EPA to make a different Final Determination at this time. All we are asking is that EPA withdraw the Final Determination and resume the Midterm Evaluation, in conjunction with NHTSA, consistent with the timetable embodied in EPA's own regulations. We believe that, if carried out as intended, the Midterm Evaluation can lead to an outcome that makes sense for all affected stakeholders and for society as a whole.

The Alliance welcomes the opportunity for further dialogue about ways to rekindle the industry's longstanding cooperation with EPA on these issues.

Sincerely,

Mitch Bainwol
President and CEO

Cc: Secretary Elaine Chao, DOT
Kevin Green, DOT
Bill Charmley, EPA
Chris Grundler, EPA
Michael Olechiw EPA
Rebecca Yoon, NHTSA
James Tamm, NHTSA
Mike McCarthy, CARB
Annette Hebert, CARB

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[15] McAlinden, Sean, et al., *The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy*, Center for Automotive Research (Sep. 2016) at 49. Referring to the $3.00 per gallon gasoline price $6,000 technology cost scenario.

[16] Walton, Tom, et al., *The Impact of Future Fuel Economy Standards on Low Income Households*, Defour Group LLC (Sep. 2016); Walton, Tom, et al., *Defour Group Response to EPA Rejoinders to Defour Group / Alliance of Automobile Manufacturers Submission Regarding the Regressivity/Affordability of EPA's Proposed Fuel Economy Standards*, (Dec. 2016).

Message

From: Lie, Sharyn [Lie.Sharyn@epa.gov]
Sent: 5/3/2017 9:43:42 PM
To: Helfand, Gloria [helfand.gloria@epa.gov]; Charmley, William [charmley.william@epa.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [Huang.Hsing-Hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green [Kevin.Green@dot.gov]; Ryan Keefe (ryan.keefe@dot.gov) [ryan.keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6
Attachments: Macroeconomic analysis CAFE_Graham and Carley_EPA.PPTX

And here are the slides they used today at the NCEE meeting, which I suspect they will use again next week.

From: Helfand, Gloria
Sent: Wednesday, May 03, 2017 3:34 PM
To: Charmley, William <charmley.william@epa.gov>
Cc: Moran, Robin <moran.robin@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>; Yanca, Catherine <yanca.catherine@epa.gov>; Alson, Jeff <alson.jeff@epa.gov>; Bolon, Kevin <Bolon.Kevin@epa.gov>; Huang, Hsing-Hsiang <Huang.Hsing-Hsiang@epa.gov>; Shelby, Michael <Shelby.Michael@epa.gov>; Lie, Sharyn <Lie.Sharyn@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Davidson, Ken <Davidson.Ken@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Sherwood, Todd <sherwood.todd@epa.gov>; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green <Kevin.Green@dot.gov>; Ryan Keefe (ryan.keefe@dot.gov) <ryan.keefe@dot.gov>; McCarthy, Mike@ARB <mmccarth@arb.ca.gov>; Chen, Belinda@ARB <bchen@arb.ca.gov>; Simon, Karl <Simon.Karl@epa.gov>; Dickinson, David <Dickinson.David@epa.gov>; Burke, Susan <Burke.Susan@epa.gov>; Snapp, Lisa <snapp.lisa@epa.gov>; Jackman, Dana <jackman.dana@epa.gov>
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6

Here is the report itself, if you haven't already seen it.

Gloria Helfand, Ph.D.
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4688

-----Original Appointment-----
From: Charmley, William
Sent: Friday, March 31, 2017 9:49 AM
To: Charmley, William; Helfand, Gloria
Cc: Moran, Robin; Olechiw, Michael; Yanca, Catherine; Alson, Jeff; Bolon, Kevin; Huang, Hsing-Hsiang; Shelby, Michael; Lie, Sharyn; Sargeant, Kathryn; Davidson, Ken; Wysor, Tad; Sherwood, Todd; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green; Ryan Keefe (ryan.keefe@dot.gov); McCarthy, Mike@ARB; Chen, Belinda@ARB; Simon, Karl; Dickinson, David; Burke, Susan; Snapp, Lisa; Jackman, Dana
Subject: Meeting with John Graham Conference Line/Code / Ex. 6

When: Wednesday, May 17, 2017 9:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: C126

A Macroeconomic Study of Federal and State Automotive Regulations

Sanya Carley, Ph.D.
Associate Professor

John D. Graham, Ph.D.
Dean and Professor

Coauthors: Denvil Duncan, Saba Siddiki, Nikos Zirogiannis

SCHOOL OF PUBLIC AND ENVIRONMENTAL AFFAIRS
INDIANA UNIVERSITY

U.S. Sets Higher Fuel Efficiency Standards

By BILL VLASIC AUG. 28, 2012

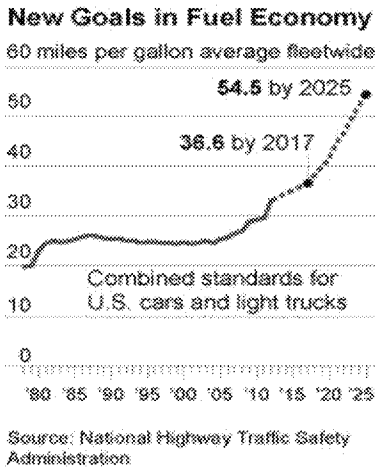
A Chevrolet Volt electric vehicle, front. Consumers so far have been slow to buy electric cars.
Rebecca Cook/Reuters

DETROIT — The Obama administration issued on Tuesday the final version of new rules that require automakers to nearly double the average fuel economy of new cars and trucks by 2025.

Light duty vehicle standards 2017-2025

- National Highway Traffic Safety Administration: 54.5 miles per gallon (MPG)
- Environmental Protection Agency: 163 g/mi CO_2

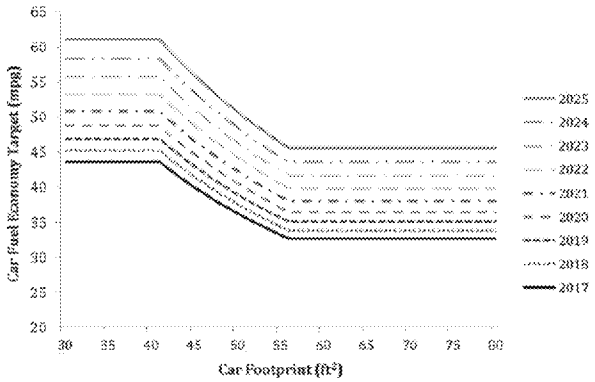
Agencies' **mid-term regulatory reviews** regarding 2022-2025 implementation period



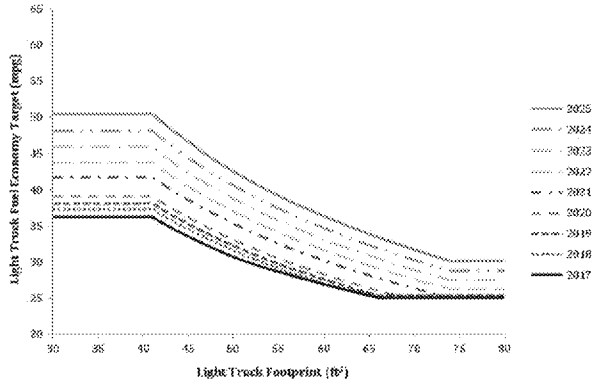
Source of image: http://www.nytimes.com/2012/08/29/business/energy-environment/obama-unveils-tighter-fuel-efficiency-standards.html

Fuel Economy Targets for 2017-2025

CARS



LIGHT TRUCKS



Note that the footprint curve for cars has a faster ramp-up than it does for trucks, which, given the growing share of trucks, affects the final MPG target.

Source: NRC (2015)

Fuel Economy Standards Around the World, 2016

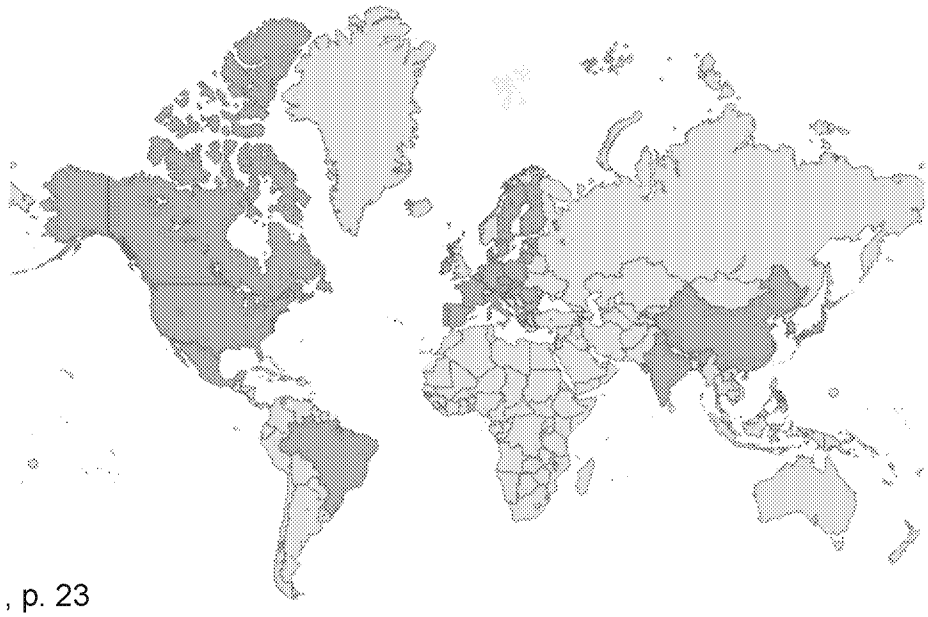
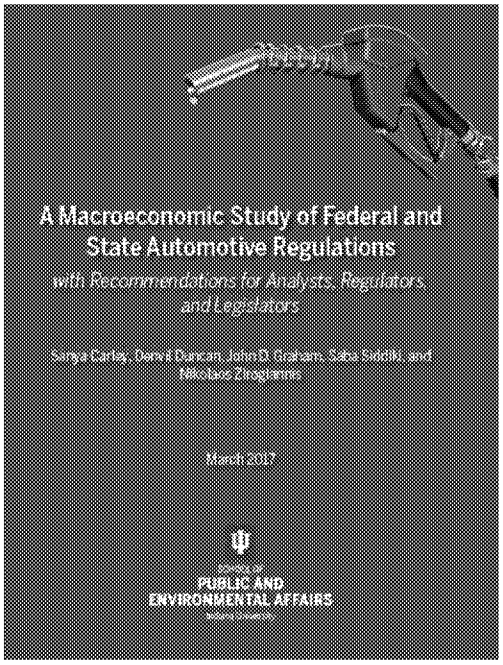


Figure 2.1, p. 23



Advisory Panel:

Dr. Joseph Aldy
Associate Professor Public Policy, Harvard University; former White House Special Assistant to the President for Energy and Environment

Gurminder Bedi
Former Vice President of Ford Motor Company

Dr. Rob Carey
Director of the Regional Dynamics and Economic Modeling Laboratory, Clemson University

Dr. Carolyn Fischer
Senior Fellow, Resources for the Future

Dr. Heather MacLean
Professor of Civil Engineering, University of Toronto

Dr. Edward Montgomery
Dean, McCourt School of Public Policy, Georgetown University; former Executive Director of the White House Council on Auto Communities and Workers

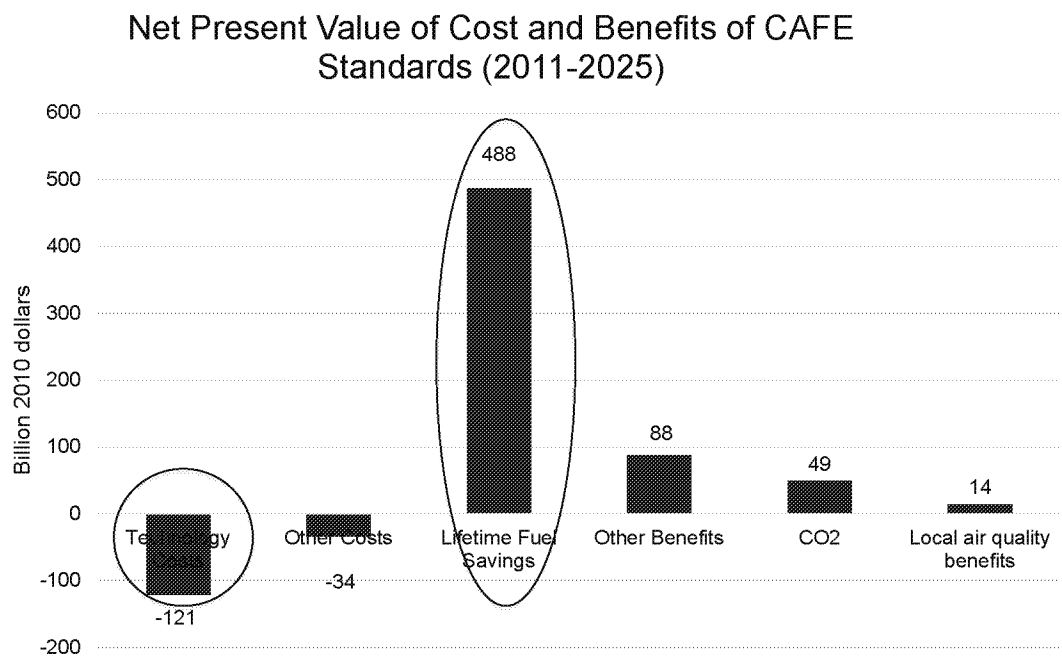
Project funded by the Alliance of Automobile Manufacturers

The authors are fully and independently responsible for the design, execution, and findings of the study

Presentation Outline

1. 2012 versus 2016 Perspectives
2. Macroeconomic Modeling
3. Impacts on New Vehicle Sales
4. Policy Recommendations

2012 VS. 2016 PERSPECTIVES



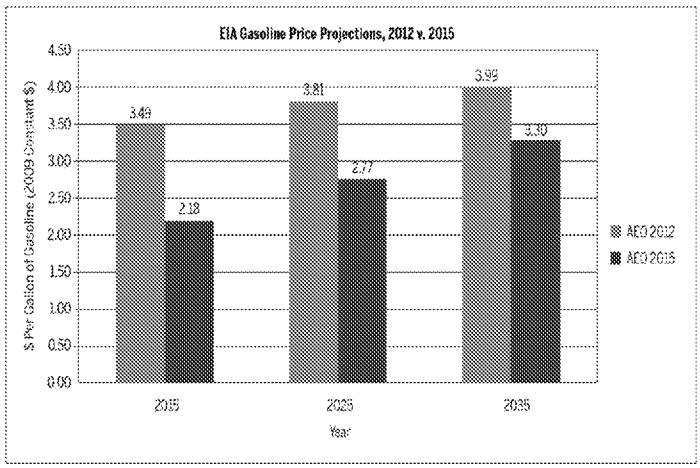
Source: NHTSA RIA (2012), Table 13, p. 49

2012 vs. 2016 Perspectives

	2012 Perspectives	2016 Perspectives
Gas Price	EIA, 2012 ($3.84 per gallon in 2025)	EIA, 2016 ($2.74 per gallon in 2025)
Price Premium	Original assumptions from regulatory impact assessments (NHTSA 2012; EPA 2012)	1) Apply NRC price adjustments to NHTSA 2012 data 2) Build a new OMEGA model that accounts for ZEV
Assumptions about ZEV included	No	Yes

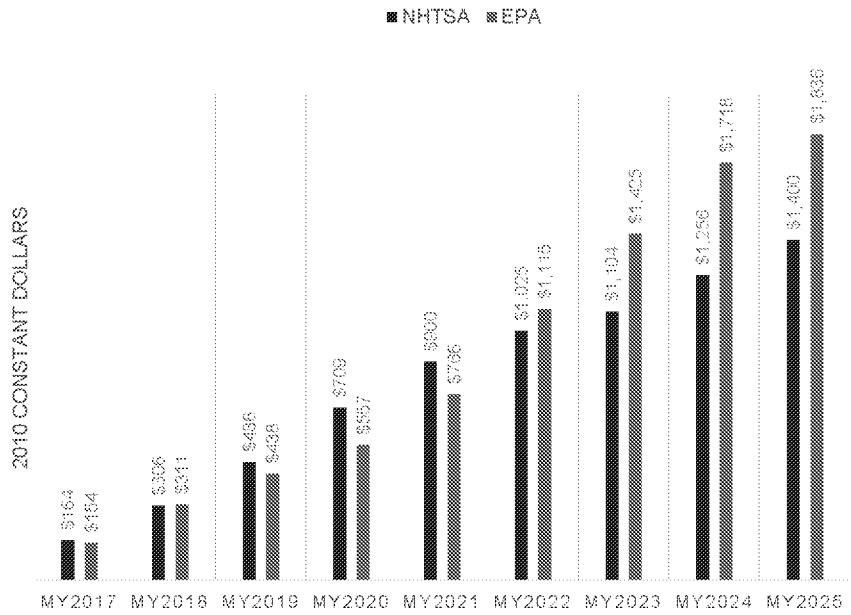
Unexpected Changes in Global Oil Market between 2012-2016

- Slowdown in global demand for oil (especially China)
- "Shale revolution" of oil and gas production in North America



Source: EIA. (2012). Annual energy outlook 2012 with projections to 2035.; EIA. (2015). Annual energy outlook 2015 with projections to 2040.

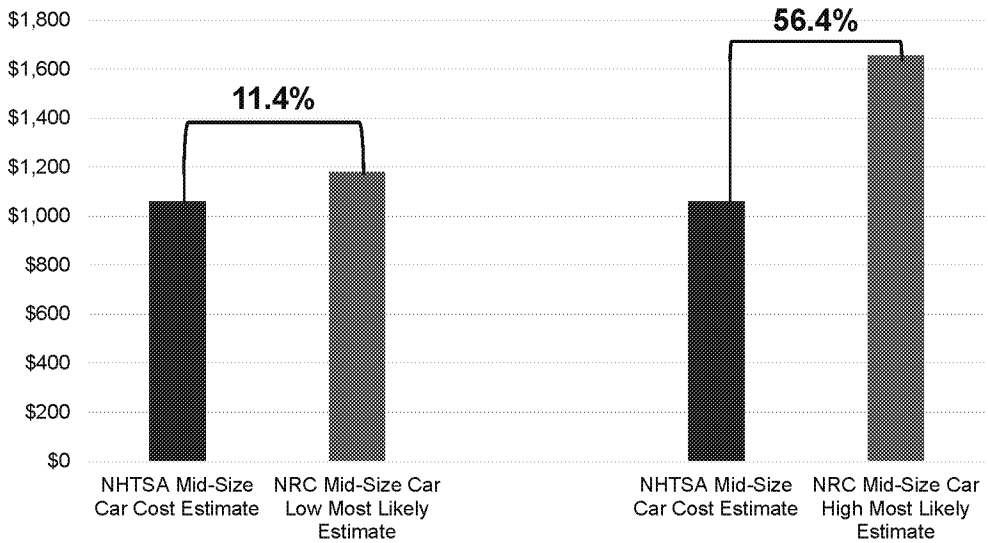
Price premium for the average Light-Duty Vehicle due to the CAFE/GHG standards



Source of EPA figures: Federal Register, Table I-24, page 62665
Source of NHTSA figures: Federal Register, Table I-15, pages 62659-62660

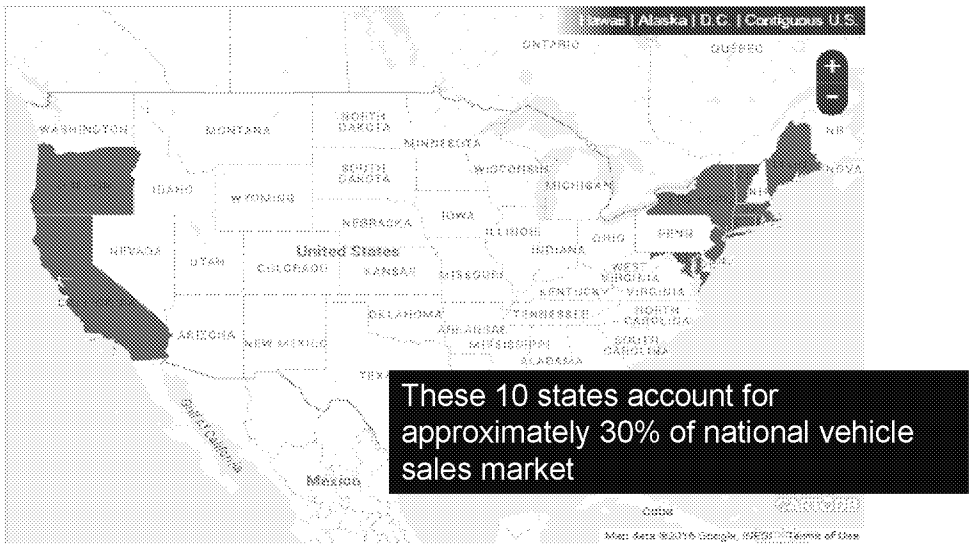
INDIANA UNIVERSITY

Incremental Cost of Producing a Mid-Size Car: NRC Low Most Likely and High Most Likely Estimates, MY 2025



Source of data: NRC (2015)

Zero Emissions Vehicle (ZEV) States



Source of image: *http://www.c2es.org/us-states-regions/policy-maps/zev-program*

Electric Vehicle Sales

2016 Electric Vehicle Sales	2025 Electric Vehicle Sales (To meet a 15.4% requirement in 30% of U.S. Auto Market)
159,139	785,400

Assumption about 15.4% requirement: CARB, 2012

Payback Period Analysis for a consumer investing a **$10,000** premium in a fuel efficient vehicle (PEV)

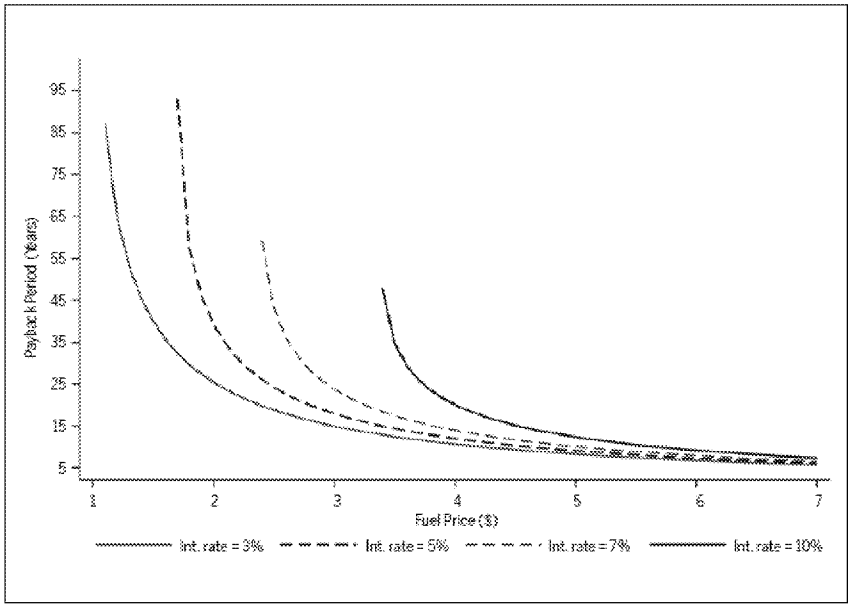


Figure I.4, p. 152

Price Premium per Vehicle to Comply with the ZEV (in constant 2010$)

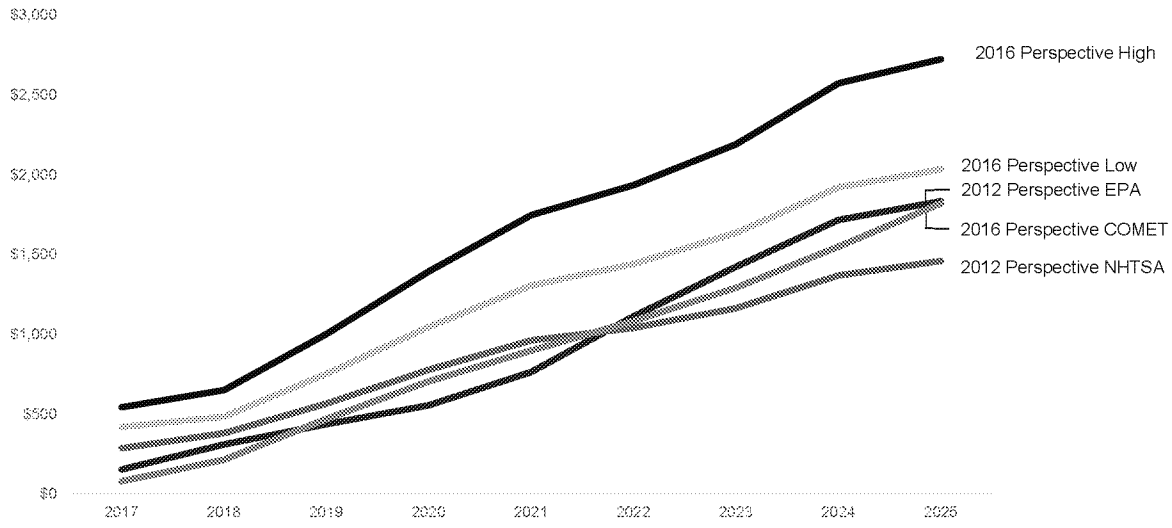
	Model Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZEV Premium (TAR)	111	72	141	208	271	331	388	442	440
ZEV Premium (DOE)	109	70	135	195	248	294	348	401	407

Table 7.8, p. 77. Details on how these numbers are derived are in Appendix V and Section 7.3.

Cost Optimization Modeling for Efficiency Technologies (COMET)

- Recreated EPA's OMEGA with both a GHG and a ZEV constraint
- Model accounts for each manufacturer separately
- Model is run using EPA 2012 data (OMEGA 1.4.1) and EPA TAR 2016 data (OMEGA 1.4.56)
- Hundreds of technologies and combinations thereof

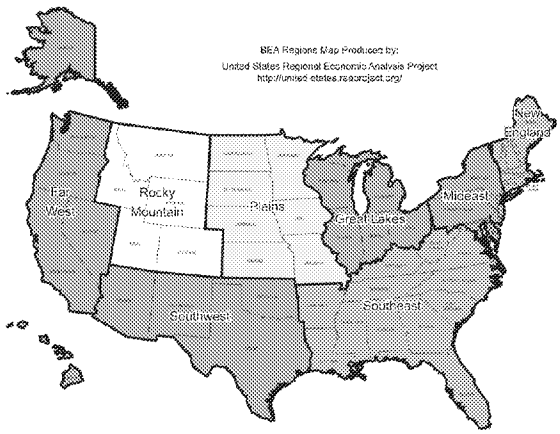
Vehicle Price Premiums, all Five Datasets



MACROECONOMIC MODELING

Model

- REMI PI+ 2.0.2: input-output, computable general equilibrium, econometric, and economic geography modeling components
- 160-industry-sector, 9-region
- Baseline: Standards freeze at 2016 (CAFE/GHG) and 2017 (ZEV)
- Analysis: 2017-2035
- Indicators: Employment, GDP, Personal Disposable Income



Regulatory Mechanisms

1. Price Premium on Vehicle Consumers (Individuals, Government, Industry)
2. Auto Industry Innovation in the auto supply chain
3. Gas Savings for all Vehicle Consumers (Individuals, Government, Industry)

- The scope does not include environmental or security impacts

Price Premium

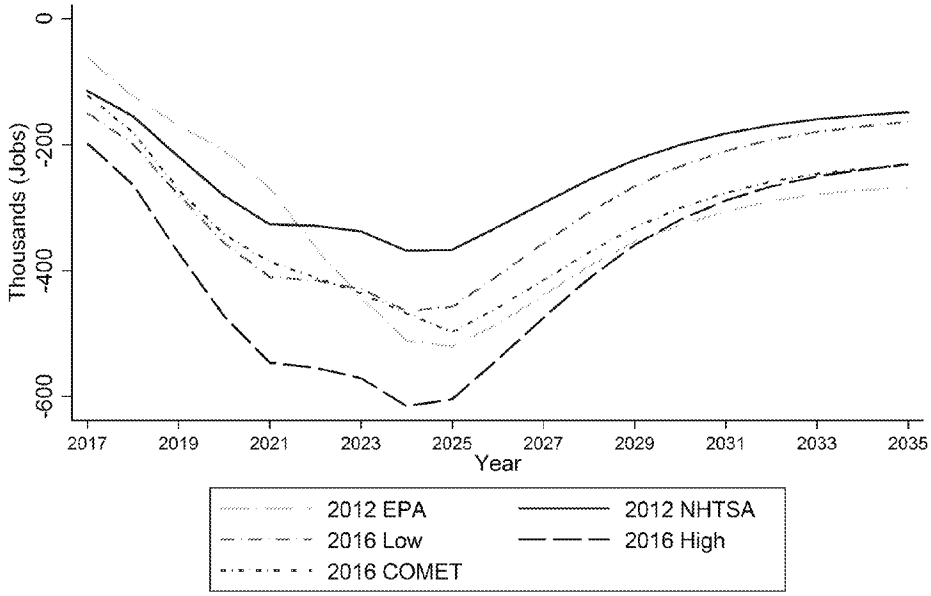


Figure 8.3, p. 92

Auto Industry Innovation

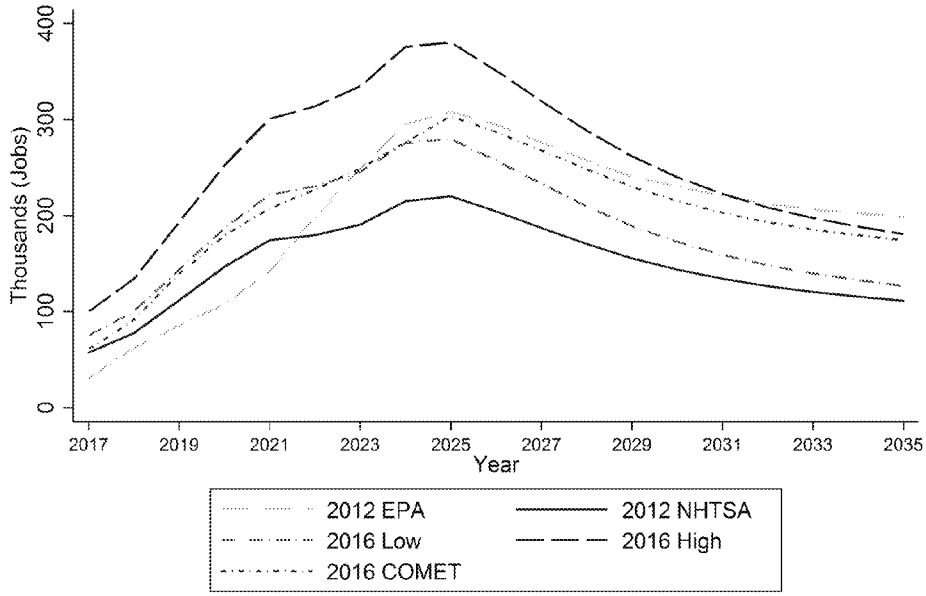


Figure 8.7, p. 95

Gas Savings (by Calendar Year)

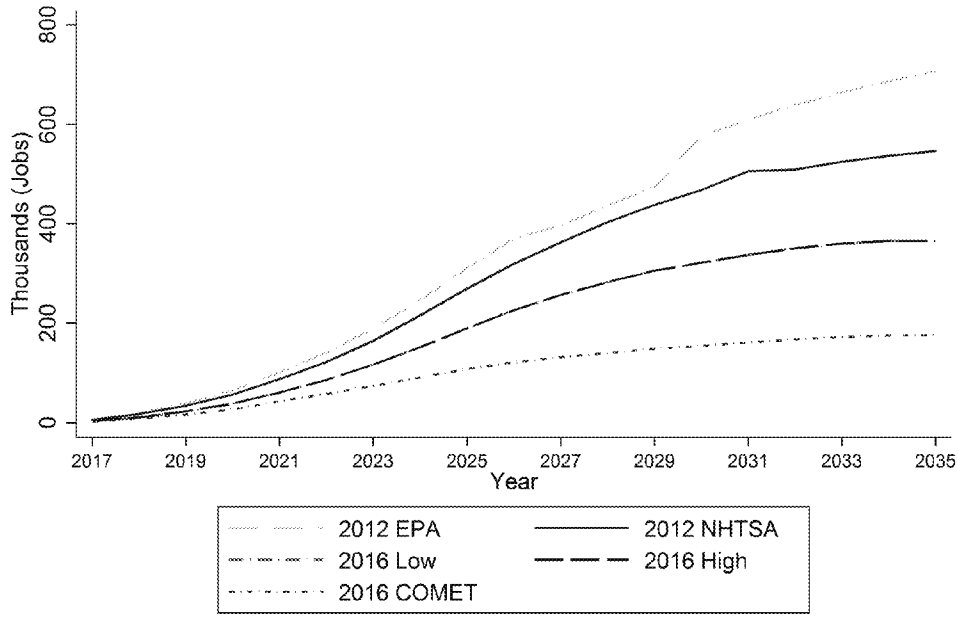


Figure 8.12, p. 99

Combined Effects

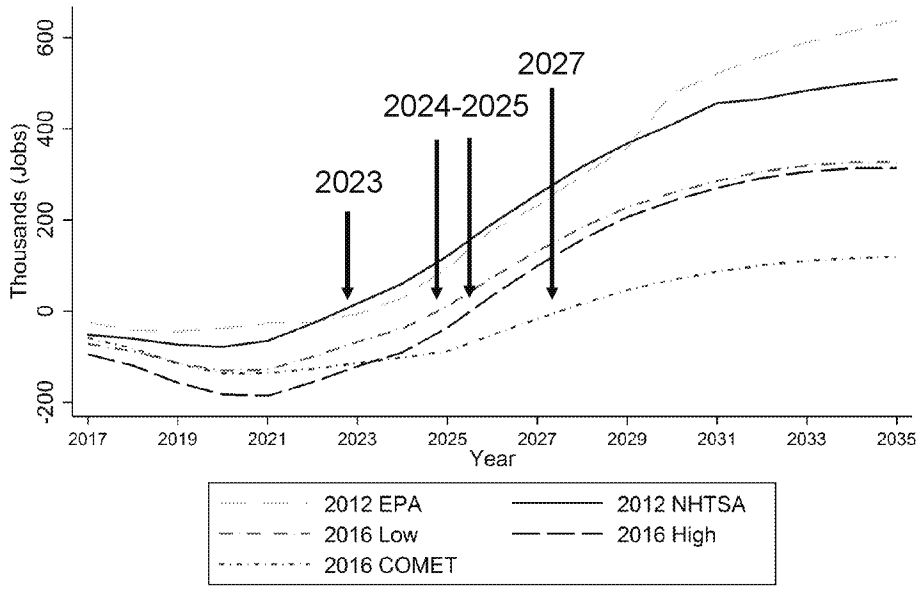


Figure 8.16, p. 101

Table 8.1. Macroeconomic Modeling Results, Cumulative 2017-2025 and 2017-2035		
Dataset and Indicator	**2017-2025**	**2017-2035**
EPA 2012 Perspective		
GDP	-27.2	332.6
PDI	-2.8	334.6
NHTSA 2012 Perspective		
GDP	-30.3	290.3
PDI	-6.6	285.8
2016 COMET Perspective		
GDP	-92.6	-52.1
PDI	-45.1	22.7
2016 Low Perspective		
GDP	-75.8	120.5
PDI	-33.7	158.2
2016 High Perspective		
GDP	-111.9	-67.4
PDI	-52.3	135.5

Note: GDP and PDI in billions of dollars.

Table 8.1, p. 105

Cumulative GDP and PDI

Market Share of Passenger Cars vs. Light Trucks

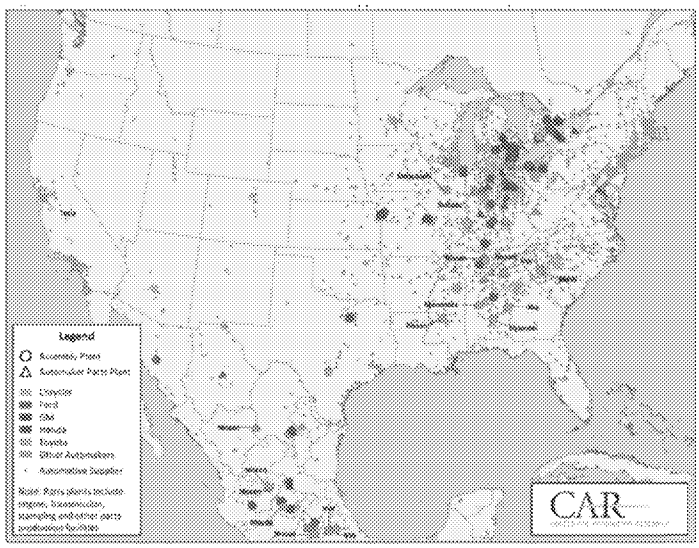
	2009	2010	2011	2012	2013	2014	2015	2016
Passenger Cars	52%	49%	48%	50%	49%	47%	43%	40%*
Light Trucks	48%	51%	52%	50%	51%	53%	57%	60%*

Table 5.1, p. 59

Accounting for these changes delays the macroeconomic benefits

Source of data: Ward's Auto. (2016). U.S. vehicle sales by vehicle type and source, 1931-2015; * = preliminary

Could ZEV Have Implications for the Geographic Distribution of U.S. Manufacturing?



Source of image: Center for Automotive Research

Regional Combined Effects

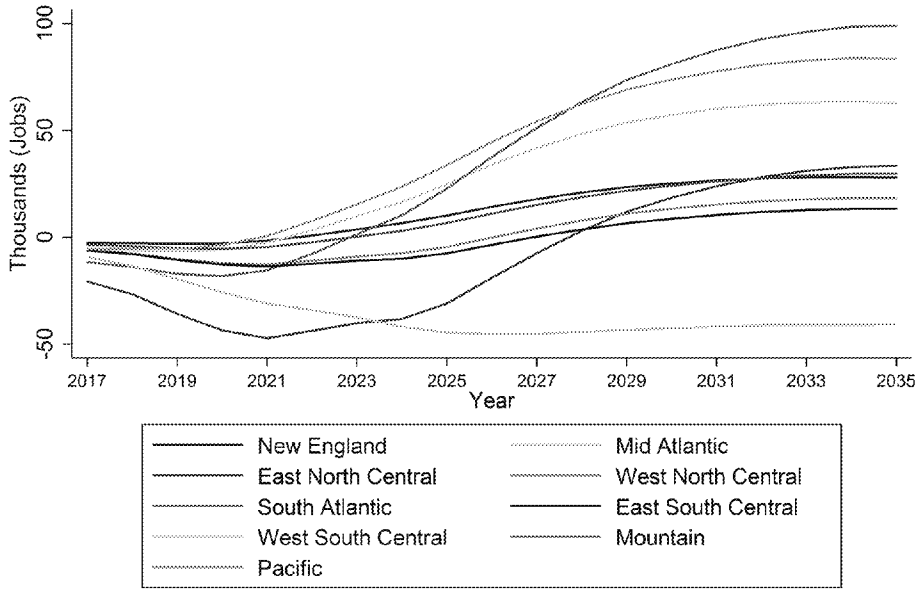


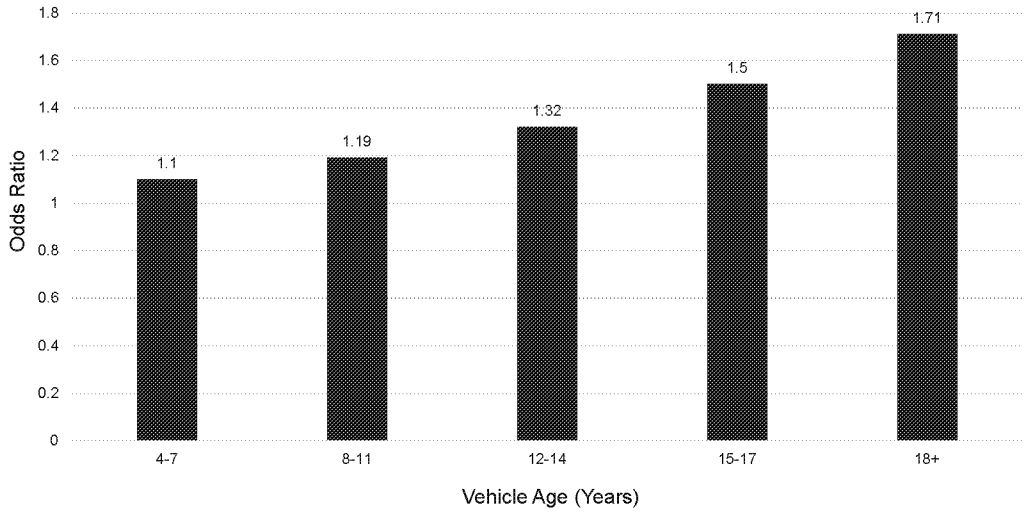
Figure 8.19, p. 103

IMPACT OF FUEL-SAVING REGULATIONS ON NEW VEHICLE SALES

Why Should Regulators Care about the Volume of New Vehicle Sales?

- US Economy (CAR, 2015; Goolsbee and Krueger, 2015)
- Safety Impacts (NHTSA, 2013: IIHS, 2015)
- Environmental Goals (Gruenspecht, 2001, NHTSA, 2009)
- Welfare of Used-Car Buyer (Jacobsen and van Bentham, 2015)
- Societal Cost-Benefit Analysis

Driver Fatality Risk Given Crash by Age of Vehicle



Comparison is made with new vehicles aged 1-3 years, using logistic regression.
Controls: Driver sex and age, vehicle type, alcohol, speed, time of day, collision type, road type.

Source: NHTSA (2013)

Total Cost of Ownership (TCO)

Initial Costs	Deferred/Operating Costs
Gross vehicle price	Insurance premiums
Sales tax	Fuel consumption
Loan financing fees	Loan Payments
Registration fees	Vehicle depreciation (resale value)

Key Assumptions

1. Technology cost is passed on to consumer
2. Regulation does not influence other vehicle attributes (performance, cargo space, interior volume)
3. Volume of new vehicle sales are related to TCO, not simply gross vehicle price.
4. If TCO rises (falls), volume of new vehicle sales falls (rises)
5. Consistent with NHTSA and CARB regulatory impact analyses

TCO Results from 2012 Perspective, 2017-2025 Federal Standards (NHTSA Inputs)

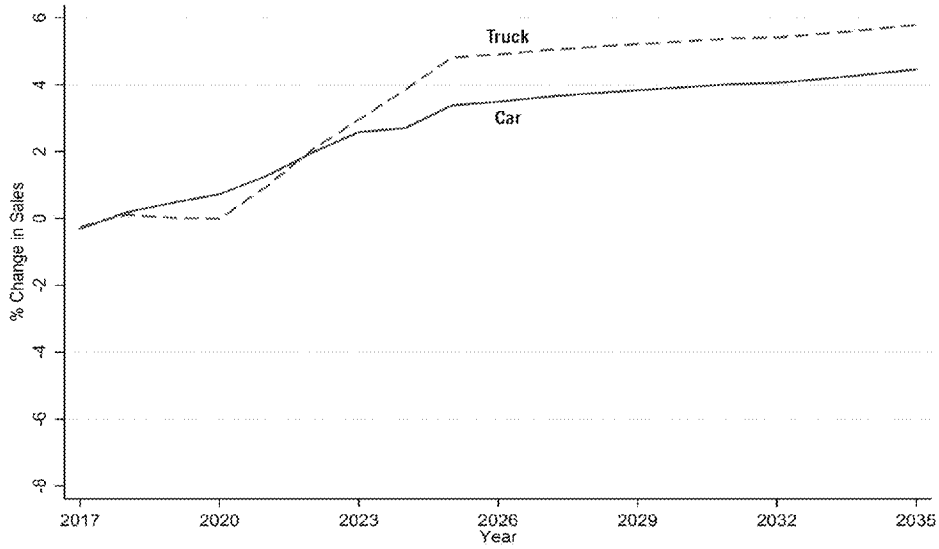


Figure 8.1, p. 113

2012 vs. 2016 Cost Inputs ($2010)

Variable	2012	2016
1. Unit Cost of 2025 CAFE	$1,060/v	+11%, +56%
2. Add Calif ZEV Cost	NA	+$400-$600/v
3. Fuel Price, 2025	$3.84/g	$2.74/g

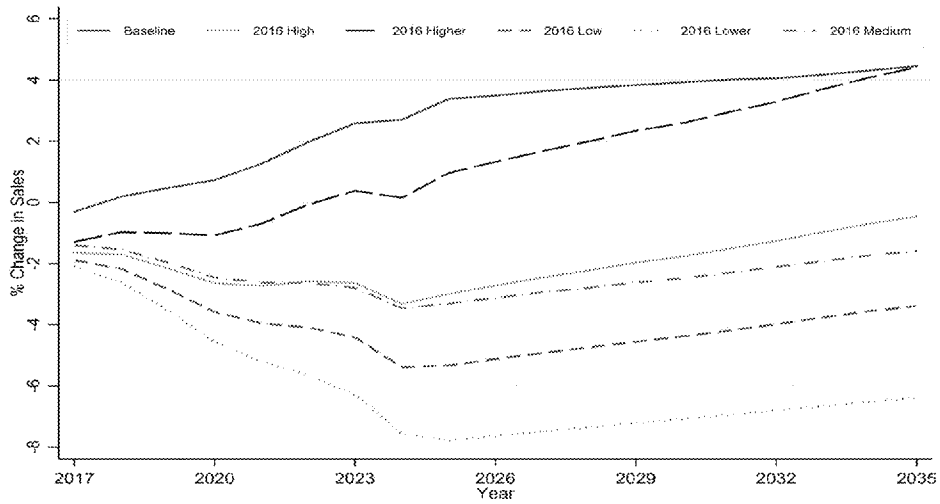
2012 vs. 2016 Consumer Value of Fuel Savings

	2012	2016
Time horizon	5 years	1 or 3 years
Resale value at year 5	35% of new vehicle price premium (not sensitive to fuel price)	55% of present value of fuel savings (sensitive to fuel price)

Other Changes Discussed in Report

1. Consumer perception of future fuel prices
2. Vehicle miles of travel by vehicle age
3. Interest rate on new car loans
4. Consumer discount rate on fuel savings

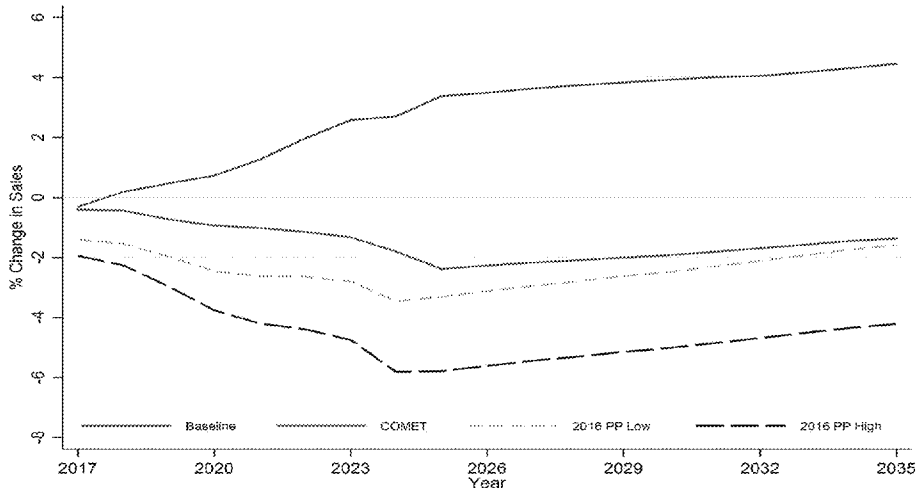
Car-Sales Results Are Sensitive to Consumer Valuation of Fuel Savings*



*2016 results, federal programs only; low NRC price premium; vary time horizon and resale value.

Figure 9.6a, p. 121

Car-Sales Results Are Sensitive to Price Premiums and CA ZEV*



*COMET uses TAR cost data and allows ZEV credit in federal programs.

Figure 9.8a, p. 123

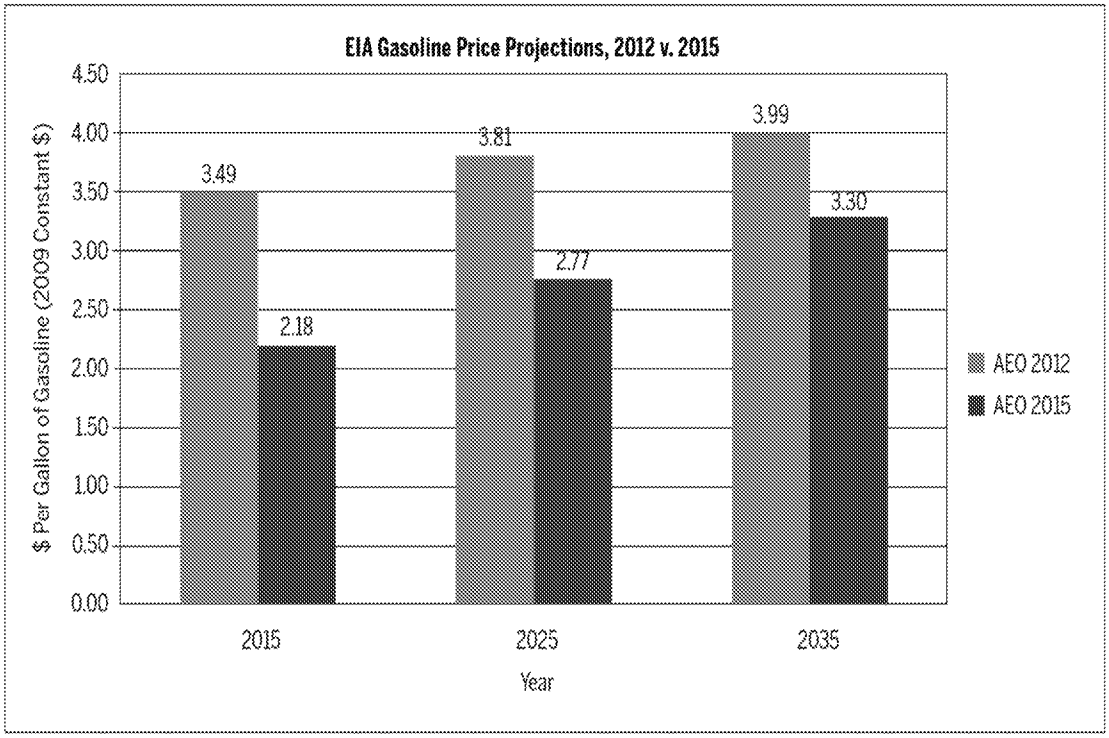
Key Uncertainties: Future Research

- How do consumers evaluate fuel economy at original purchase decision?
- Will 2025 standards impact performance, safety, and other attributes that consumers desire?
- Update price elasticities of demand
- More focus on light truck costs and pricing
- Spillovers to used car markets

POLICY RECOMMENDATIONS FOR FURTHER ANALYSIS

Reform of Federal Programs

- Stretch out compliance schedule?
- Cost or fuel-price reform triggers?



Source: EIA. (2012). Annual energy outlook 2012 with projections to 2035.; EIA. (2015). Annual energy outlook 2015 with projections to 2040.

Consumer Payback Period by Fuel Price ($2,000 Premium)

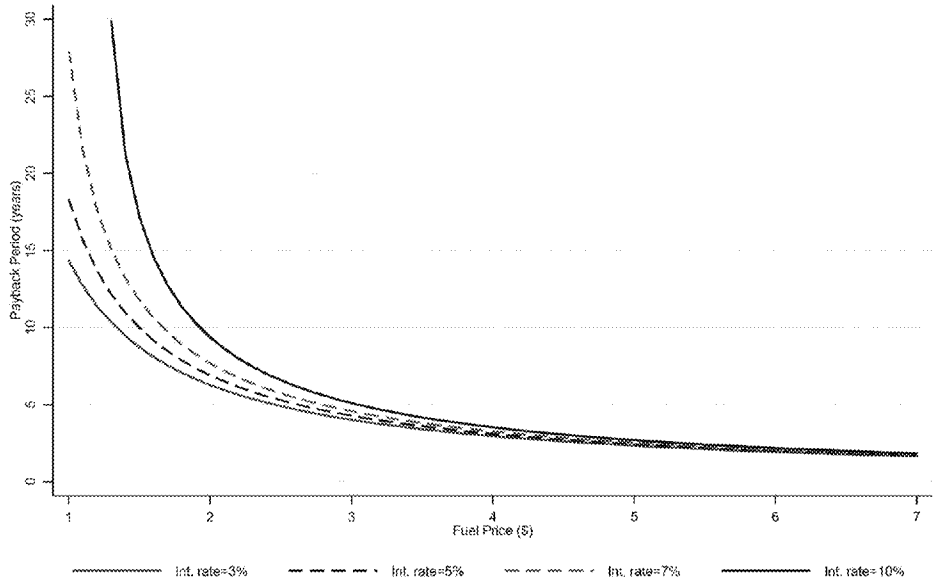


Figure I.2, p. 151

Consumer Payback Period by Fuel Price ($5,000 Premium)

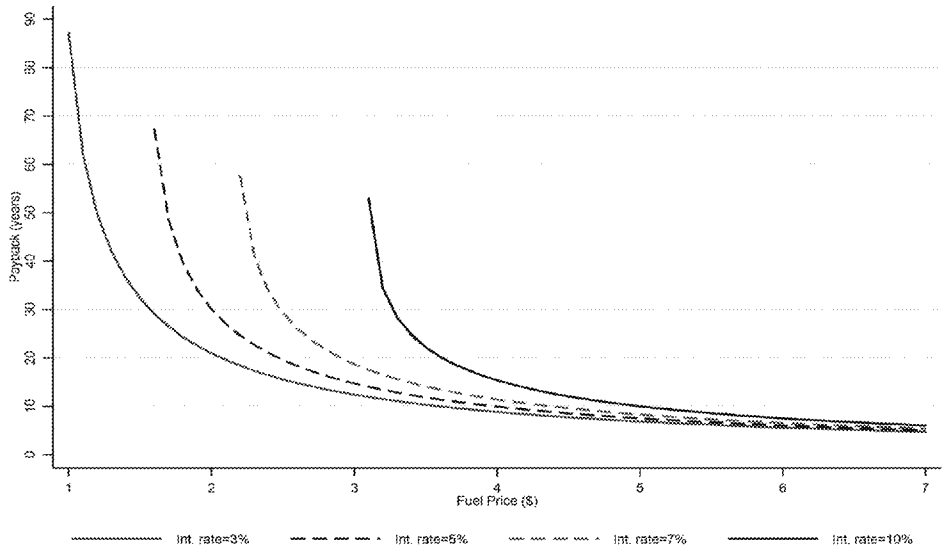


Figure I.3, p. 151

Consumer Payback Period by Fuel Price ($10,000 Premium)

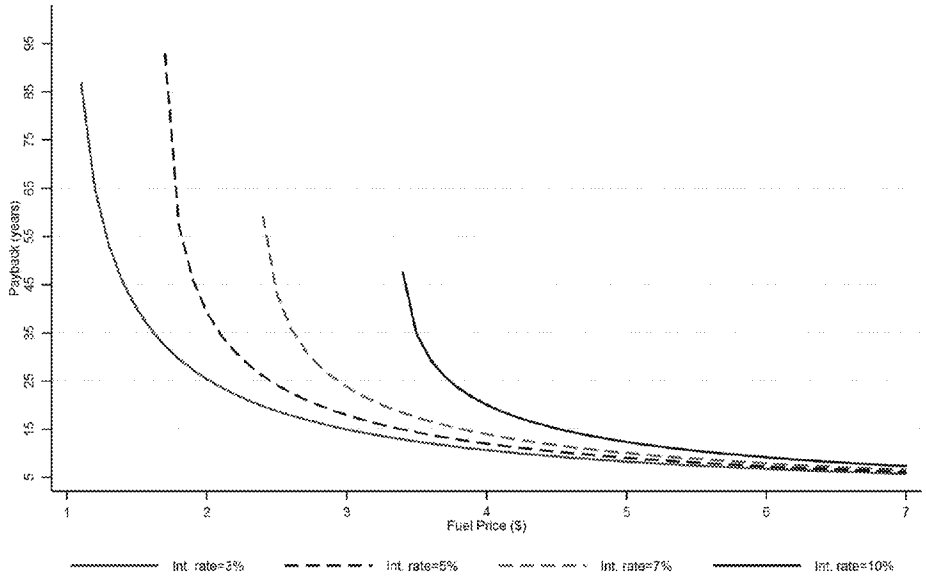


Figure I.4, p. 152

Reform of Federal Programs continued

- Robust off-cycle credit program?
- Credit trading: modernize and harmonize?
- Compliance incentives for AFVs: harmonize and update schedule?
- Better fuel-economy information for consumers?

Reconsider California ZEV

- Cost-benefit aspect to EPA ZEV waiver?
- National ZEV program?

Consumer Payback Period for ZEV, Vary Federal Standard and Fuel Price

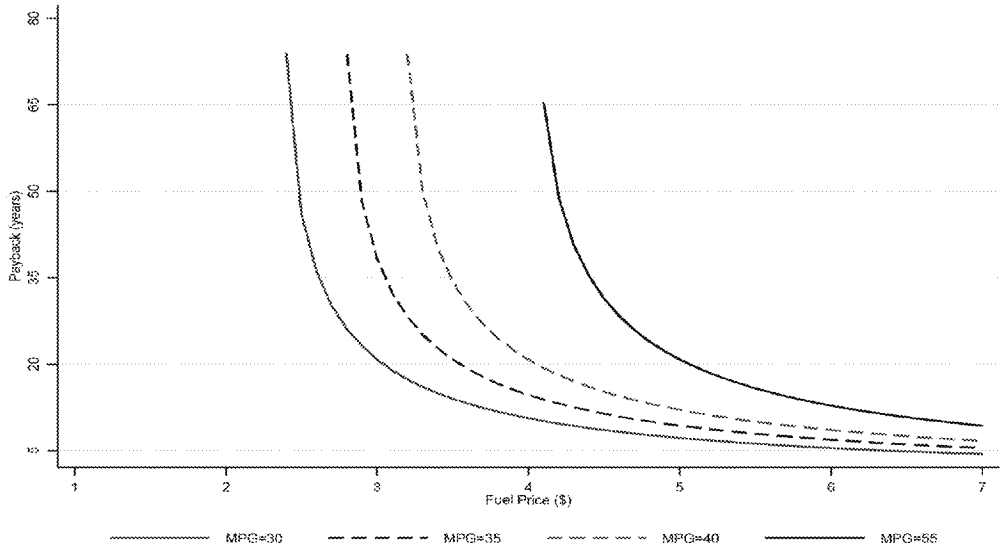


Figure 10.1, p. 132

Reform California ZEV

- Stretch out compliance schedule?
- Extend “travel” and “regional-pooling” provisions?
- Reconsider value of PHEVs relative to BEVs?
- Enhance community readiness for PEVs?
- Support FCVs as compliance alternative?
- Coordinate federal and state fiscal policies toward PEVs?

Other Policy Directions

- Higher Gasoline Tax?
- National Carbon Tax?
- Replace ZEV with Norwegian or Dutch Incentive Schemes?
- Greener "Cash-for-Clunker" Programs?

Thank you!

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Message

From: Helfand, Gloria [helfand.gloria@epa.gov]
Sent: 5/3/2017 7:34:21 PM
To: Charmley, William [charmley.william@epa.gov]
CC: Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]; Yanca, Catherine [yanca.catherine@epa.gov]; Alson, Jeff [alson.jeff@epa.gov]; Bolon, Kevin [Bolon.Kevin@epa.gov]; Huang, Hsing-Hsiang [Huang.Hsing-Hsiang@epa.gov]; Shelby, Michael [Shelby.Michael@epa.gov]; Lie, Sharyn [Lie.Sharyn@epa.gov]; Sargeant, Kathryn [sargeant.kathryn@epa.gov]; Davidson, Ken [Davidson.Ken@epa.gov]; Wysor, Tad [wysor.tad@epa.gov]; Sherwood, Todd [sherwood.todd@epa.gov]; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green [Kevin.Green@dot.gov]; Ryan Keefe (ryan.keefe@dot.gov) [ryan.keefe@dot.gov]; McCarthy, Mike@ARB [mmccarth@arb.ca.gov]; Chen, Belinda@ARB [bchen@arb.ca.gov]; Simon, Karl [Simon.Karl@epa.gov]; Dickinson, David [Dickinson.David@epa.gov]; Burke, Susan [Burke.Susan@epa.gov]; Snapp, Lisa [snapp.lisa@epa.gov]; Jackman, Dana [jackman.dana@epa.gov]
Subject: RE: Meeting with John Graham Conference Line/Code / Ex. 6
Attachments: Graham IU auto-report-032017.pdf

Here is the report itself, if you haven't already seen it.

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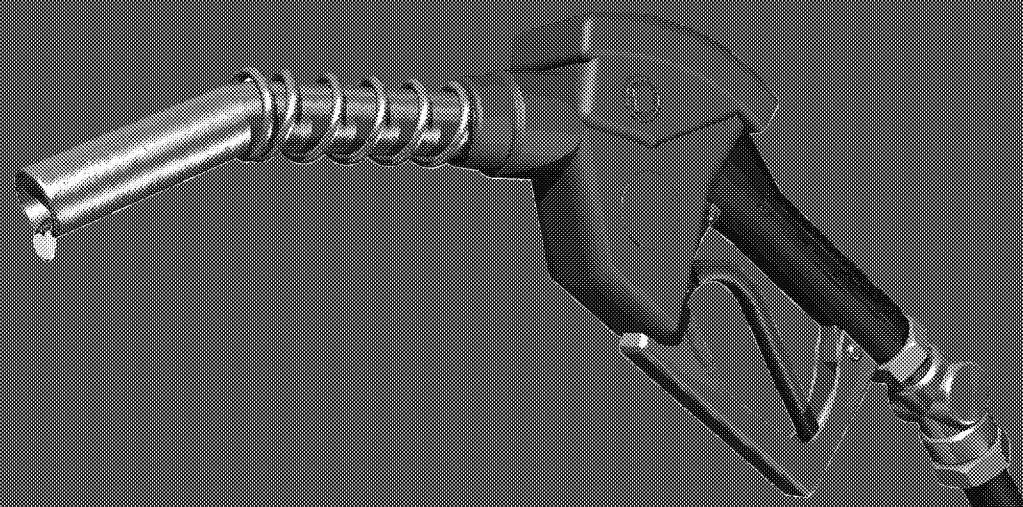
-----Original Appointment-----
From: Charmley, William
Sent: Friday, March 31, 2017 9:49 AM
To: Charmley, William; Helfand, Gloria
Cc: Moran, Robin; Olechiw, Michael; Yanca, Catherine; Alson, Jeff; Bolon, Kevin; Huang, Hsing-Hsiang; Shelby, Michael; Lie, Sharyn; Sargeant, Kathryn; Davidson, Ken; Wysor, Tad; Sherwood, Todd; james.tamm@dot.gov; Don.Pickrell@dot.gov; Kevin Green; Ryan Keefe (ryan.keefe@dot.gov); McCarthy, Mike@ARB; Chen, Belinda@ARB; Simon, Karl; Dickinson, David; Burke, Susan; Snapp, Lisa; Jackman, Dana
Subject: Meeting with John Graham Conference Line/Code / Ex. 6
When: Wednesday, May 17, 2017 9:00 AM-12:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: C126



A Macroeconomic Study of Federal and State Automotive Regulations

with Recommendations for Analysts, Regulators, and Legislators

Sanya Carley, Denvil Duncan, John D. Graham, Saba Siddiki, and Nikolaos Zirogiannis

March 2017

SCHOOL OF
PUBLIC AND
ENVIRONMENTAL AFFAIRS
Indiana University

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Indiana University

March 2017

REPORT INFORMATION AND ACKNOWLEDGEMENTS

This is the final report of an 18-month study conducted under a grant agreement between Indiana University and the Alliance of Automobile Manufacturers. It builds on our preliminary report, *Rethinking Auto Fuel Economy Policy: Technical and Policy Suggestions for the 2016-2017 Midterm Reviews*. School of Public and Environmental Affairs, Indiana University. February, 2016 (https://spea.indiana.edu/doc/research/working-groups/fuel-economy-policy-022016.pdf). The authors are fully and independently responsible for the design, execution, and findings of the study. The findings and views expressed in the report are those of the authors and do not necessarily represent the views of the Alliance of Automobile Manufacturers or Indiana University. The authors are especially grateful to have received guidance and constructive criticism from the project's Peer Review Advisory Board and consultants Alan Jenn of the University of California at Davis, and Wally Wade, a former chief engineer and technical fellow in Powertrain Systems Technology and Processes at Ford Motor Company, who is also a member of the National Academy of Engineering. We also appreciate helpful information from staff at several federal agencies (DOE, EPA, DOT, EIA, and OMB) and a variety of manufacturers, suppliers, and related associations. The February 2016 Preliminary Report, which covered the regulatory aspects, also benefited from written peer reviews supplied by the following experts across the U.S.: Hunt Allcott (New York University), John DeCicco (University of Michigan), Salim Furth (The Heritage Foundation), Ted Gayer (Brookings Institution), Rachel Krause (University of Kansas), Don Mackenzie (University of Washington), and one anonymous regulatory expert. Revisions in response to those peer reviews are reflected in this final report. The findings and views expressed in the report do not necessarily represent the views of any of these peer reviewers. We also acknowledge helpful informal comments from John German and Tom Walton, and from participants of the 2016 annual conference for the United States Association of Energy Economics, the 2016 annual conference for the International Association of Energy Economics, the 2016 University of South Carolina International Journal of Law and Business symposium, the 2016 Austin Energy Workshop, and the 2016 annual conference for the Association of Public Policy Analysis and Management. Rebecca Snedegar provided excellent administrative assistance throughout the project as well as leads on important studies and developments. Dan Esposito, Emily Hall, Alyssa Julian, and David Michael provided helpful research assistance. Comments on the report are welcome and can be submitted to bsnedega@indiana.edu.

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Dr. Carolyn Fischer, Senior Fellow, Resources for the Future

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Dr. Edward Montgomery, Dean, McCourt School of Public Policy, Georgetown University, and former Executive Director of the White House Council on Auto Communities and Workers (2009-2010)

EXECUTIVE SUMMARY

This study examines how the U.S. economy is likely to be impacted by the combined effects of three automotive regulatory programs that were adopted in 2012: the U.S. Department of Transportation's corporate average fuel economy (CAFE) standards for model years 2017-2025; the Environmental Protection Agency's greenhouse gas (GHG) emissions standards for model years 2017-2025; and the California Air Resources Board's Zero-Emission Vehicle (ZEV) requirements for 2018-2025.

A combined analysis of these three regulatory programs and their impacts is provided for several reasons: all three programs share similar policy objectives (e.g., reducing the greenhouse gases that contribute to climate change); cover products—cars and light trucks—produced by the same industry; become increasingly stringent in the same time frame; have interdependent practical consequences (e.g., it is more difficult for automakers and dealers to commercialize plug-in electric vehicles under the California ZEV program when the federal programs are making gasoline-powered vehicles more fuel-efficient than they would otherwise be); and can be modified—through legislative and/or administrative action—by the U.S. federal government.

2012 vs. 2016 Perspectives

A distinctive feature of this study is that the programs are analyzed from two perspectives. The "2012 perspective" uses inputs reflecting evidence that was available from 2009-2012, when the 2012 programs were being developed. The "2016 perspective" uses inputs that reflect new information that has become available since 2012 on the California ZEV program, technology costs, fuel-saving effectiveness, fuel prices, vehicle miles traveled, vehicle resale values, and consumer behavior. Thus, we seek to determine whether macroeconomic impacts looked differently in 2012 than they do today.

Compared to the 2012 inputs, the 2016 inputs reflect (1) a larger vehicle price premium due to the suite of federal and California regulations, which will grow in stringency from model years 2017-2025; (2) a large reduction in the federal government's official forecast for average gasoline prices in 2025, down from $3.84 per gallon to $2.74 per gallon; (3) new evidence on how vehicle purchasers perceive and value fuel economy, both during their ownership period and when they resell their vehicle; (4) new evidence on how many miles Americans travel each year over the long lifetime (up to 30 years) of a vehicle; and (5) new evidence and forecasts showing a rapid decline in the price of lithium-ion battery packs and the cost of producing plug-in electric vehicles (PEVs). The modeling explores how the new inputs, individually and in combination, change the macroeconomic forecasts of the impacts of the regulations.

Choice of Economic Indicators

Three macroeconomic indicators are considered: employment levels, gross domestic product (GDP), and real disposable income at the household level. Each of the three indicators are standard economic performance measures watched closely by policy makers, Wall Street and other financial analysts, investors, and stakeholders in the industry such as labor union leaders, car dealers, original equipment manufacturers, and parts suppliers.

We also undertake separate analyses of the impact of the regulations on the volume of new vehicle sales, since new vehicle sales are a key sectoral indicator as well as a closely-watched indicator of the overall health of the economy. In addition, the volume of new vehicle sales influences how fast the environmental objectives of the regulations can be accomplished and influences the societal costs and benefits of those regulations.

Causal Pathways for Economic Impacts

We consider three causal pathways for how the regulatory standards could impact the U.S. economy: (1) by raising the average cost of producing new vehicles, and passing those costs on to the average prices of new vehicles which will be felt by consumers; (2) by stimulating the automotive supply chain as original-equipment manufacturers

and suppliers innovate, hire additional workers, and produce new technologies such as turbocharged engines, new transmissions, lightweight materials, conventional hybrid engines, advanced diesel engines, and plug-in electric vehicles; and (3) by reducing gasoline consumption with positive spending reallocations for households, businesses, and governments, and negative effects in the U.S. petroleum sector, including the supply chains that are related to oil and gasoline production. We show results for each of the causal pathways individually as well as the combined impact of the three pathways.

Modeling Platform

The modeling platform chosen for the analysis is REMI PI 2.0.2, a well-known and versatile macroeconomic model that combines information on the U.S. economy from four general sources: input-output matrices, general equilibrium tools, econometrics, and economic geography. REMI is particularly appropriate for regulatory application because it accounts for impacts in different subsectors of the economy (e.g., automotive and petroleum) while also simulating the ripple effects through long supply chains and the indirect spending impacts on households and communities that depend on those supply chains.

To provide some capacity for regional analysis, we selected a version of REMI that breaks down the U.S. economy into nine Census regions, with each of the 50 states represented in one of the nine regions. Thus, the study simulates macroeconomic results for the U.S. economy as a whole as well as for each of its nine Census regions.

Basic Findings

Our basic findings from the REMI modeling are that (1) the vehicle price effects, which increase as standards become more stringent, cause significant losses of employment, GDP, and disposable income through a decline in new vehicle sales and higher vehicle prices for consumers, which in turn curbs spending on other goods and services; (2) the supply chain innovations induced by the regulations offset, on a national basis, at least half of the adverse effects of higher prices as additional investments in fuel-saving technology boost employment, output, and disposable income; and (3) the savings in gasoline expenditures trigger reallocations in spending that have a much more positive impact on the economy than the negative impacts on the U.S. petroleum sector and its supply chains.

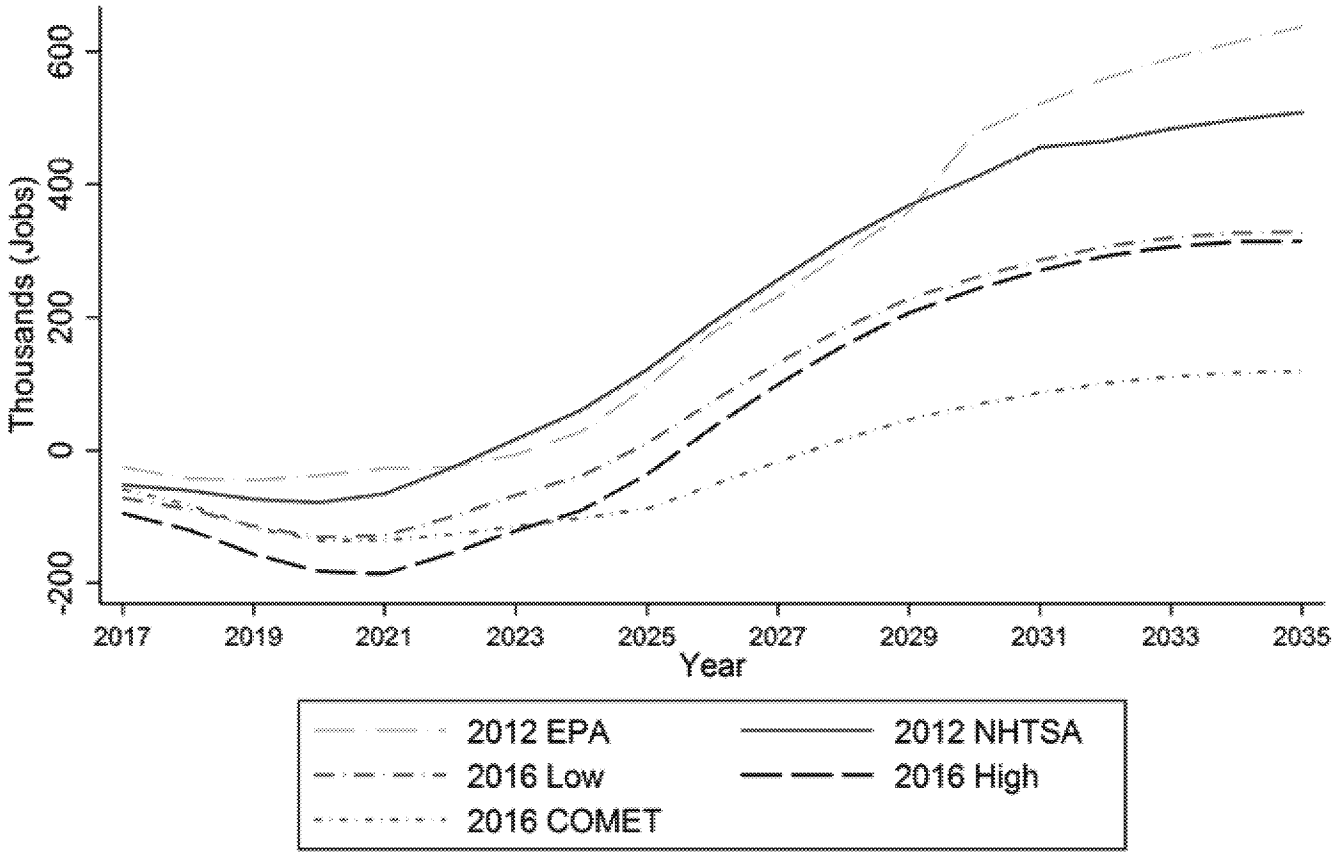
When the three causal pathways are modeled together, the overall annual impact of the regulatory programs on the national economy is negative in the near-term but positive in the long-term, a pattern that is consistent with theoretical expectations. The annual impact turns from negative to positive as early as 2022 and as late as 2035, depending on the inputs used in modeling. These trends are illustrated in Figure ES.1 below. In general, the positive effects on the economy are ultimately larger in magnitude than the negative impacts, primarily because the fuel savings are quite large relative to technology costs.

The national findings from the REMI modeling are consistent throughout the nine Census regions with two important exceptions: the oil-producing West South Central region of the U.S. (Arkansas, Louisiana, Oklahoma, and Texas) experiences net negative effects throughout the study period, and the East North Central region of the U.S. (Illinois, Indiana, Michigan, Ohio, and Wisconsin), where much of the automotive supply chain is concentrated, takes longer than the national average to experience net positive economic effects from the regulations.

When the 2012 inputs are replaced with the 2016 inputs, the pattern of macroeconomic impacts tend to be somewhat worse, though still positive in the long run. With the 2016 inputs, it generally takes longer for the economic impacts to become positive since most, though not all, of the new 2016 information is unfavorable to the 2012 regulations (e.g., lower fuel prices, higher cost estimates for compliant technology packages, and additional costs for the California ZEV program).

Results may also be viewed from a cumulative perspective, where each year's positive or negative effects are combined for a specified time period. In the long run, cumulative effects are ultimately positive but will take

Figure ES.1. Employment Estimates Measured as the Difference between Baseline and Federal and State Standards in Thousands of Job-Years, 2017-2035



Note: This graph includes five different scenarios. The first, "2012 EPA," uses data published in the Environmental Protection Agency's 2012 Regulatory Impact Assessment (RIA) and does not include the ZEV standard. The second, "2012 NHTSA," similarly uses data from the National Highway Traffic and Safety Administration's 2012 RIA and does not include the ZEV standard. These two scenarios represent the "2012 perspective," whereas the remaining three represent the "2016 perspective." The "2016 Low" and "2016 High" scenarios are based on NHTSA "2016 perspective" data, including fuel price adjustments, NRC (2015a) technology cost adjustments (one of a smaller magnitude and the other of a larger magnitude), and does include the ZEV standard. Finally, the "2016 COMET" is based on technology costs produced through the Cost Optimization Modeling for Efficiency Technologies (COMET) model, using EPA data, as well as fuel price adjustments. All five scenarios include three causal mechanisms to capture the impacts of federal and state regulations: (1) a price premium; (2) a corresponding investment in supply chain innovation; and 3) savings from reduced gasoline expenditures.

many years to become so because the negative annual effects are concentrated in the near term. Using the three 2016 datasets, we found that the cumulative effects on U.S. GDP from 2017 to 2025 were negative but the 2025 stopping point omits consideration of the large fuel-savings impacts of the vehicles produced in 2025. When we extend the time horizon to 2035, two of the 2016 datasets show positive impacts on GDP while one 2016 dataset shows negative cumulative impacts on GDP. Once again, the results of the cumulative modeling using 2016 inputs are worse for the U.S. economy than the results based on the 2012 inputs.

Total Consumer Cost of Ownership Model

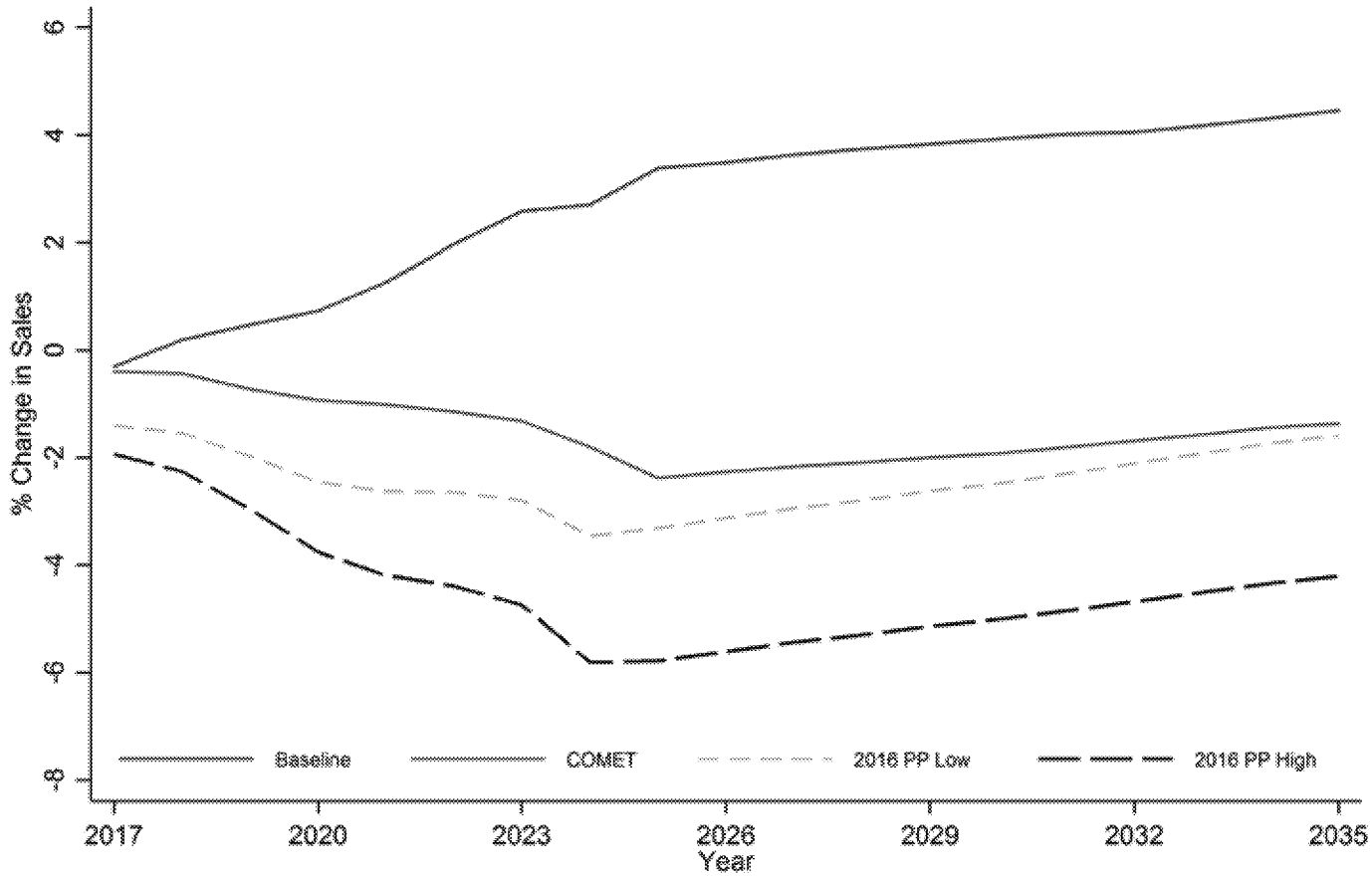
The REMI model is limited in its ability to consider recent evidence of consumer valuation of enhanced fuel economy. Thus, we also performed total-cost-of-ownership (TCO) modeling to simulate the impacts of the regulatory programs on new vehicle sales. The advantage of the TCO approach is that it considers recent evidence that consumers value fuel savings from new technology when they purchase a new vehicle.

Using a TCO approach similar to that used by the U.S. Department of Transportation over the last fifteen years, we estimate the combined impact on new vehicle sales for the 2012 perspective, when only the two federal regulatory programs are considered. For the 2016 perspective, we add the California ZEV program and consider new information on technology costs, fuel-saving effectiveness, vehicle miles of travel, consumer valuation of fuel savings, resale values, and fuel-price expectations of consumers. Separate estimates of vehicle-sales impacts are provided for passenger cars and light trucks.

Findings: Impacts on New Vehicle Sales

In general, the pattern of results indicates positive effects on new vehicle sales from the 2012 perspective but negative effects on new vehicle sales from the 2016 perspective. Figure ES.2 presents the TCO results on new vehicle sales for alternative price premiums. The results of the TCO modeling are somewhat sensitive to assumptions about how strongly consumers value fuel savings and thus, in the report, we present results for a wide range of assumptions about consumer valuation of fuel savings.

Figure ES.2. Percentage Change in Car Sales



Note: Percentage change in vehicle sales due to regulatory programs based on four perspectives. Baseline is drawn from NHTSA's 2012 data, and represents the 2012 perspective. The remaining lines represent the alternative 2016 perspectives. Of the three 2016 perspectives, COMET alone accounts for the interdependence between CAFE and ZEV. Consumer valuation of fuel savings differs between the 2012 and 2016 perspectives: baseline assumes that consumers value five years' worth of fuel savings, perceive resale value equal to 35% of gross price premium, and perceive future fuel price equal to the AEO projections. The 2016 perspective assumes that consumers value three years of fuel savings, perceive future fuel price equal to fuel price at time of vehicle purchase, and set the incremental resale value to 35% of the gross premium. Gross price premium is equal to: NHTSA 2012 projections in the baseline; NHTSA 2012 plus DOE estimate of ZEV plus NRC 'low most likely' adjustment in 2016 PP Low; and NHTSA 2012 plus TAR estimate of ZEV plus NRC 'high most likely' adjustment in 2016 PP High. The gross premium in COMET is obtained directly from the COMET model and accounts for ZEV and some NRC adjustments.

The potential for negative effects on new vehicle sales is not simply important for macroeconomic reasons; a slower volume of new vehicle sales diminishes the environmental benefits of the programs and creates safety risks (as consumers hold on to dirtier, less safe older cars longer), impacts consumers in used car markets since prices for used cars may rise, and affects the cost-benefit analyses of the regulatory programs in complicated ways.

Recommendations

Given our in-depth analysis of the three regulatory programs, the U.S. automotive industry, and the U.S. economy, we developed a series of 15 recommendations. Seven of these recommendations are for analysts, three are for regulators, and five are for legislators. Some of the recommendations flow directly from the macroeconomic analyses while others are stimulated by our qualitative policy analyses of the three programs and the industry.

For analysts, recommendations are designed to be helpful in the midterm review processes that are now focusing on the model-year 2022 to 2025 standards. For regulators and legislators, we ask more fundamental, probing questions about California's ZEV program. For the federal programs, we urge regulators and legislators to focus on refinements (e.g., schedule, fuel-price triggers, and off-cycle credits) rather than wholesale change. If the ZEV program is retained, a concerted effort should be made in states and communities to make it attractive for consumers to purchase and use a plug-in electric vehicle. We provide a wealth of information on how states and communities can increase readiness for electrification of the transportation sector of the economy.

For Analysts

1. Regulatory-reform options should be analyzed taking into account the unexpected drop in fuel prices that has occurred since the federal and ZEV rules were developed from 2009-2012, including the downward revision of fuel-price forecasts through 2025.

2. Regulatory-reform options should be evaluated based on the best available technology information, focusing on key issues that may distinguish one technology from another; realistic estimates of the impacts of multiple technologies need to be obtained.

3. When evaluating how consumers weigh fuel economy gains in new vehicle design, agencies should take into account new econometric studies that infer consumer valuations from short-term changes in fuel prices, decades of practical experience with fuel-saving technologies, and recent real-world experience with conventional hybrid engines.

4. Although agencies have made major steps forward in forecasting a realistic baseline set of vehicles for model years 2022-2025, refinements in the forecasted fleet are necessary in order to make valid comparisons to a regulated fleet subject to the 2022-2025 federal and ZEV standards.

5. Federal agencies should conduct a careful regulatory impact analysis of the combination of federal CAFE and GHG regulations and the ZEV program, including interactions between the programs that will influence incremental cost and benefit comparisons.

6. Federal agencies should estimate the impact of model year 2022-2025 standards on the volume of new vehicle sales. The vehicle-sales analyses are a crucial input to analyses of employment impacts, environmental and safety impacts, used-car market ramifications, and societal costs and benefits.

7. Agency analysts should estimate the macroeconomic impacts of combinations of regulations using at least several economic indicators (e.g., total employment, GDP, and real disposable income) and some regional or state disaggregation.

For Regulators

1. CARB and EPA should reconsider the design of the ZEV program, emphasizing ways to enhance the cost-effectiveness of the program and coordinate its requirements with the federal programs. If EPA determines that a ZEV-like program is in the national interest, EPA should consider expanding the California ZEV program into a national ZEV program that replaces or complements the federal CAFE and GHG performance standards.

2. Federal agencies should reconsider the schedule and explore a variety of refinements to the 2022-2025 performance standards to enhance cost-effectiveness.

For Legislators

1. The U.S. Congress should commission an independent assessment of the national costs and benefits of the California ZEV program, given the growing stringency of federal performance standards and fiscal policies designed to promote plug-in electric vehicles. Although federal agencies may decide to prepare such an assessment, the U.S. Congress should seek a separate look at the issue from an independent body such as the Congressional Budget Office or the National Research Council.

2. Both EPA and CARB are taking the position that a national cost-benefit assessment of the ZEV program is not permissible under the current statutory language of the Clean Air Act. Congress should consider whether to revise the Clean Air Act and require such a national cost-benefit assessment of ZEV waiver decisions.

3. The U.S. Congress should consider new legislation to fully harmonize federal CAFE and GHG programs, including the credit-trading programs, the penalties for non-compliance, and the compliance-flexibility provisions.

4. The U.S. Congress should commission a bipartisan commission of federal and state legislators and stakeholders to assess the future of consumer incentives for PEVs and FCVs, taking into account the recent reports from the National Research Council and new studies of the impact of consumer incentives in the U.S. and abroad. The Commission should consider how incentives should be coordinated with federal and state performance standards and when the incentives should be scheduled for phase out.

5. Given that older vehicles account for a disproportionate share of GHG emissions, smog-inducing pollutants, fuel consumption, and safety problems, legislatures should consider cost effective steps to accelerate the phase-out of older vehicles, taking into account lessons learned from the "cash-for-clunker" programs evaluated in the U.S. and Europe.

Our macroeconomic analysis does not include a societal cost-benefit analysis or an environmental or public health analysis of the regulations. Consequently, the study supplied here, by itself, does not address some issues vital to policy makers and stakeholders such as climate change, the public health impacts of pollution, and the overall societal benefits and costs of alternative standards. Therefore, policy makers should consider the findings of this macroeconomic analysis in conjunction with other forms of environmental, health, economic, and regulatory analysis.

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GLOSSARY

AFV: Alternative fuel vehicle
AT PZEV: Advanced technology partial zero-emission vehicle [California ZEV program classification]
BEV: Battery electric vehicle
CAFE: Corporate average fuel economy
CARB: California Air Resources Board
DOE: Department of Energy
DOT: Department of Transportation
EIA: Energy Information Administration
EISA: Energy Independence and Security Act
EPA: Environmental Protection Agency
EPCA: Energy Policy and Conservation Act
FCV: Fuel cell vehicle
GHG: Greenhouse gas
HEV: Hybrid electric vehicle
JNP: Joint National Program
MPG: Miles per gallon
NHTSA: National Highway Traffic Safety Administration
NRC: National Research Council
PEV: Plug-in electric vehicle
PHEV: Plug-in hybrid electric vehicle
PZEV: Partial zero-emission vehicle [California ZEV program classification]
RIA: Regulatory impact analysis
SUV: Sport utility vehicle
TZEV: Transitional zero-emission vehicle [California ZEV program classification]
ZEV: Zero-emission vehicle

1. PURPOSE AND SCOPE

This report covers the impacts of several regulatory programs that have four distinct but related public policy rationales: control greenhouse gas (GHG) emissions to slow climate change, enhance energy security by reducing oil dependence, increase consumer welfare by reducing the costs of operating motor vehicles, and boost economic development by creating "green jobs" in the automotive sector or boost consumer spending due to savings on gasoline expenses. These rationales are not rooted in the conceptual structure of welfare economics that is discussed at length in NHTSA (2012); instead, we frame them in ways that ordinary citizens and their elected representatives can comprehend.

1.1 Climate Change

The transportation sector will soon surpass the electric power sector as contributing the largest share (32.1% vs. 31.7%) of GHG emissions in the U.S. economy (EIA 2016; Sivak and Schoettle 2016b). The vast majority of GHG emissions associated with the transportation sector result from driving gasoline and diesel vehicles, specifically from the burning of gasoline and diesel fuels and resultant tailpipe emissions. A series of scientific reports, including those from the National Research Council of the National Academy of Sciences (Leung and Vail 2016) and the Intergovernmental Panel on Climate Change (IPCC 2014), stress that GHG emissions must be controlled to slow the pace of climate change. Within the transportation sector, cars and light trucks account for 56% of the GHG emissions in the U.S. (EIA 2016). If the U.S. is to honor its international commitments to GHG control, both those made in Paris under the auspices of the United Nations and those made in bilateral talks with China, control of GHG emissions from cars and light trucks must be a priority. Even absent these international commitments, no serious national climate policy can avoid addressing GHG emissions from the transportation sector.

The federal Corporate Average Fuel Economy (CAFE) standards, combined with the more recent EPA GHG standards, are the primary mechanisms through which the U.S. federal government regulates GHG emissions from the transportation sector. The federal programs are accompanied by two California programs aimed at slowing climate change: the California tailpipe emissions standards for GHGs and the ZEV regulation, which compels automakers to innovate through the invention, production, and marketing of ZEVs such as plug-in electric vehicles and hydrogen fuel-cell vehicles.

1.2 Energy Security

The Arab oil embargo of 1973-74 was associated with a rapid rise in the global price of oil and supply disruptions that impacted both the U.S. and its allies. Motorists were angered by rising fuel prices and long lines at refueling pumps in many states. Currently, threats to global oil markets could occur any day, since 20% of the world's oil supply and 40% of all oil traded in world commerce flow through the narrow Strait of Hormuz in the Persian Gulf, one of the most politically unstable areas in the world (Yergin 2011). Consequently, both energy security and national security may be enhanced by reducing U.S. dependence on petroleum (Wescott and Werling 2010).

Since the 1970s, the security rationale for CAFE regulation has receded in importance for a variety of reasons: the creation of the Strategic Petroleum Reserve, which can be deployed by the U.S. in periods of acute oil shortages; the removal of price controls in the U.S. market, which had exacerbated supply problems in 1973-1974; the surge of oil production in North America and in other non-OPEC countries, which has weakened the ability of OPEC to control global supplies and price; and a sharp reduction of U.S. oil imports, with allies Canada and Mexico now supplying almost 60% of U.S. oil imports (EIA 2016).

Some policy analyses continue to argue that the U.S. can moderate the global price of oil by curtailing the rate of U.S. oil consumption (Levi 2015; Sivaram and Levi 2015; Wescott and Werling 2010). However, that argument has been weakened as the U.S. share of global oil consumption has steadily declined, in part due to slower growth in travel volume in the U.S. and the success of CAFE regulation, but more so due to the rise in oil demand from

China and India (EIA 2016; Pugliaresi and Pyziur 2016). The U.S. share of global oil consumption has declined steadily from 30% in 1975 to about 20% in 2016, and that share is projected to dwindle further (e.g., as low as 10% by 2035) as the developing world grows (EIA 2016). As a result, NHTSA does not make quantitative projections of how much the world oil price is impacted by stricter CAFE standards (TAR 2016).

1.3 Consumer Welfare

A relatively new rationale for CAFE regulation is that it advances consumer welfare by compensating for tendencies among new vehicle purchasers to undervalue the long-run, personal benefits of purchasing enhanced fuel economy vehicles (NHTSA 2012a); for a skeptical view, see Gayer and Viscusi 2013. In addition to curbing externalities such as pollution, CAFE is aimed at correcting for this "internality" in consumer decision making (Allcott, Mullainathan, and Taubinsky 2014) by requiring automakers to sell consumers fuel-efficient vehicles that are less expensive on a total cost-of-ownership basis than the vehicles that consumers would have purchased and used without regulation (Fischer, Harrington, and Parry 2007; Helfand and Dorsey-Palmateer 2015).

The paternalistic nature of this argument is a source of consternation among libertarians and some rational-choice economists, but behavioral economists argue that ordinary consumers are particularly poor at making decisions that impose near-term pain for uncertain, long-term gain. This conundrum is a variant of what has become known in the academic literature as the "energy efficiency" paradox, which we explore in depth later in this report (Allcott and Greenstone 2012).

A complimentary rationale for the alleged under-provision of fuel-saving technology relates to the nature of decision making in the automotive industry (NHTSA 2012a). Automakers are uncertain about the extent of consumer demand for increased fuel economy, and consumer demand can change faster than the industry is able to adapt to the change. Making new passenger vehicles entails long lead times, since engineers must make decisions about the fuel economy of new vehicles long before the vehicles are brought to dealer showrooms for sale. Creating new technology, and the supply chain to support it, entail large capital investments that are irreversible. As a result, automakers are seen as "risk averse" toward making investments in new fuel economy technology, just as consumers are risk averse about paying a premium for an unfamiliar technology with uncertain payoffs (NRC 2015a). Fuel economy regulation is seen as a tool to overcome the alleged risk aversion in the automotive marketplace, even though risk aversion is not seen as a market imperfection in standard welfare economics.

1.4 Economic Development

In recent years, some proponents of the regulatory programs have begun to espouse economic-development arguments. Advocates argue that new investments in more sustainable automotive technologies will create jobs and spur the economy to higher levels of production and prosperity (Oge 2015; ICF 2015; Todd, Chen, and Clogston 2013).

For example, the Blue Green Alliance has released a study of the fuel savings and pollution reductions associated with the redesigned 2015 Ford F-150 pickup truck. The study highlights that CAFE regulation has stimulated new applications of Ford's Ecoboost engine and Ford's advanced electric power steering (EPS) system. Together, the two technologies contributed to a rise in the F-150's fuel economy from 15.9 MPG in 2010 to 19.2 MPG in 2015. The study finds that producing the EcoBoost "has meant reinvestment and job growth at Ford's Cleveland, Ohio, Engine Plant No. 1, which today employs 1,600 people." The EPS systems are made by the company Nexteer, which emerged from the bankruptcy of its parent company in 2010, and "today is the largest single employer in Saginaw County employing over 5,000 people and supplying the pickup truck market worldwide" (BlueGreen Alliance 2016).

The shift from steel to lightweight materials such as aluminum is also seen as having some positive impacts on economic development. In the fall of 2016, a joint venture of Constellium NV Amsterdam and UACJ Corporation of Tokyo launched a $150 million new factory in Bowling Green, Kentucky to supply aluminum production

parts for automobiles (Irwin 2016b). Later in this report, we take a careful look at what the shift from steel to aluminum might mean for U.S. employment.

Economic development is a key consideration among California policy makers. The State of California currently has few facilities that produce auto parts or assemble vehicles for sale (CARB 2011a, 68–9). However, California investors and startups (e.g., Tesla) are playing a pivotal role in the push for electrification of the transport sector. Silicon Valley is seen as a potential source of innovation in vehicle offerings that could couple ZEVs with driverless technology (Ramsey 2016). California Air Resources Board Chair Mary Nichols, when issuing the 2012 ZEV requirements, was explicit about the economic-development rationale: "The Board's action will create thousands of jobs, transforming California into the advanced car capital of the world. California is now in the pole position in the race to provide next-generation ultra-clean cars to the global market" (Clegern 2012).

At the national level, the Obama administration also portrayed the new NHTSA and EPA regulations as a strategy to help revive the domestic auto industry by stimulating companies to offer the fuel efficient cars that consumers have wanted and that will be demanded in Asia and Europe in the future (White House 2012). The administration also provided grants and federal loan guarantees (e.g., for companies that make lithium ion batteries for PEVs or HEVs) to facilitate a more rapid transition to a greener automotive economy (Canis 2013; Wescott and Werling 2010). In the regulatory impact analyses published in support of federal requirements, predictions were made that new jobs will be created in the green-technology industry. California's regulatory impact analysis in support of the ZEV program makes a similar claim, noting that some of the leading companies that sell recharging stations for PEVs are based in California (CARB 2011a, 68–9).

Many economists question whether it is useful to focus on the employment impacts of regulation (e.g., see Mannix 2014). Economic models typically assume a full-employment economy, so more jobs gained or lost in one sector will, at least over time, be offset by more jobs gained or lost in another sector (Ferris and McGartland 2013). Nonetheless, the employment issue is so salient to citizens and politicians that it merits careful consideration (Coglianese and Carrigan 2013). In 2012, the U.S. Bureau of Labor Statistics made an effort to quantify "Green Goods and Services Jobs" within existing NAICS code industries (BLS 2017). Ideally, labor impact assessments should address not only changes in employment levels but average earnings and the geographic distribution of employment and earnings. Worldwide, the literature on employment impacts of transportation regulation amounts to a few dozen studies that are generally weak in their economic argumentation and fragmented in their scope and depth of issues covered (de Bruyn et al. 2012).

A different macroeconomic case for investment in more sustainable passenger vehicles has been suggested using total cost of ownership models. If, for example, PEVs will have lower ownership costs than gasoline vehicles in the long run, then policies that shift the auto industry to PEVs will save consumers money in the long run. Those consumer savings are then treated as a tax cut, stimulating more consumer spending in other sectors of the economy (de Bruyn et al. 2012; Roland-Holst 2011). An early variant of this approach, with application to PEVs, was prepared by the Global Venture Lab at the University of California at Berkeley. They found that replacing the internal combustion engine with PEVs in the U.S. would be a net plus for the national economy in the long run (Draper et al. 2008). Thus, the regulatory programs under study must be looked at from an economic as well as an environmental perspective.

1.5 Multiple Regulatory Programs

There are four federal and state regulatory programs aimed at the automobile sector. They are administered by three separate agencies: The U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA), the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB).

NHTSA's fuel economy standard for passenger vehicles is on a schedule to reach an average of 41 miles per gallon by model year 2021, as established by NHTSA in collaboration with the EPA. The EPA also set a schedule for reducing GHG emissions from model years 2017 to 2025, culminating in a GHG standard (typically expressed in grams of carbon dioxide, CO2, per mile) that is equivalent to a CAFE average of approximately 54.5 miles per

gallon in 2025. The figure of 54.5 miles per gallon is a compliance value based on laboratory testing of vehicles. Real-world fuel economy, reflected on fuel economy labels, can be 20% lower than the federal compliance value. As such, the 2025 compliance value corresponds to approximately 43 miles per gallon in typical driving conditions (Bond and Bunkley 2013). The Energy Information Administration, which also accounts for manufacturer use of compliance flexibilities and credits, projects that the new federal standards will lead to on-road fuel economy of 37.6 miles per gallon in 2025 (EIA 2016).

The development of EPA GHG standards trailed GHG standards in California, where limitations on GHG emissions from cars and light trucks were legislated in 2002 and promulgated in 2006. Currently, the California and EPA GHG standards, coupled with the CAFE program, are largely harmonized into a single national program for automakers, dubbed the Joint National Program (JNP). The federal government has committed to a midterm review process which, by April 2018, could lead to an adjustment in the structure or stringency of the model year 2022-2025 standards. EPA recently finalized an accelerated decision that the agency will not seek any changes to the 2022-2025 standards (EPA 2016a).

Separately, California's Air Resources Board (CARB) decided in 2012 to substantially increase the mandate for zero-emissions vehicles (ZEVs), such as PEVs and hydrogen fuel-cell vehicles (FCVs). By 2025, the ZEV regulation will compel the industry to sell enough ZEVs to reach approximately 15.4% of California's new passenger-vehicle fleet. CARB has recently updated that estimate to 18% (2016). Nine other states, including New York, have also adopted California's ZEV regulation.

Technically, the ZEV program is not included in the JNP, even though its objectives are similar (e.g., GHG control) and it is focused on the same products (cars and light trucks) produced by the same companies. The State of California is also undertaking a midterm evaluation of the ZEV program that is scheduled for completion in 2017, prior to completion of the federal midterm assessment (CARB 2015).

EPA and NHTSA (2012), in collaboration with CARB, are scheduled to release a final Technical Assessment Report (TAR) by early 2018 building on the TAR that preceded the 2012 EPA and NHTSA rulemakings and a draft TAR that was released for comment last year (TAR 2016). (We refer to it as the TAR rather than a product of a single agency because EPA, NHTSA, and CARB prepared it with inputs from other federal agencies). The draft TAR covered, among other topics, the range of potential compliance technologies, technology costs and fuel-saving effectiveness, consumer behavior, and national impacts on gasoline consumption and GHG emissions. It did not evaluate specific regulatory reform options.

In this report, we do not provide a comprehensive analysis of midterm review issues (for a discussion of additional issues not covered in this report, see Krupnick et al. 2014). Instead, we focus primarily on the potential impact of the regulations on macroeconomic indicators such as the volume of new vehicle sales, employment, GDP, and income. We explain in the next section why trends in new vehicle sales should be of concern to analysts, regulators, and legislators.

1.6 Why New Vehicle Sales are Important to Regulators

The rate of new vehicle sales in the U.S. economy is of obvious commercial significance to automakers, suppliers, and dealers. What is not so obvious is why federal agencies and CARB, in their pursuit of reductions in emissions of GHGs and other policy objectives, should invest analytic resources in understanding the impact of regulatory alternatives on new vehicle sales. As we show below, agency analysts have not yet devoted much quantitative analysis to this question and EPA (2016a), again in the most recent draft determination, chose not to perform a quantitative analysis of changes in new vehicle sales. We argue that changes in new vehicle sales due to regulation are not only important from a macroeconomic perspective, but have ramifications for achievement of environmental objectives, the safety of motorists, the welfare of used car buyers, and for a proper societal cost-benefit analysis of regulatory alternatives.

First, the automotive industry plays a significant role in the health of the U.S. economy (CAR 2011; Hilsenrath and Spector 2015; MEMA 2013; Prusa 2015). Based on data from the Bureau of Economic Analysis (BEA) (2016), motor vehicle manufacturing accounted for 9.6% of the gross output of the entire manufacturing sector in 2014 (with an average contribution of 10.2% over the 1997-2014 period). In addition, motor vehicle manufacturing and motor vehicle retail trade together contributed 2.7% of U.S. GDP in 2014 (with an average contribution of 3.1% over the 1997-2014 period) (BEA 2016).

This first rationale, which is macroeconomic in nature, is supported by the fact that the resurgence of the U.S. automotive sector played a significant role in the slow but steady recovery of the U.S. economy from the Great Recession of 2007-2009 (Goolsbee and Krueger 2015). Indeed, 2016 has been one of the strongest years of the economic recovery, a year when the auto industry achieved a record for new passenger vehicle sales. But the recovery has not been uniform across the country.

The regional economic impacts of changes in new vehicle sales are salient to policy makers, as the South and Midwest are more dependent on the auto sector than the West and East Coasts. The regional impacts of changes in vehicle sales, and the ripple effects on supply chains, may also influence the political sustainability of the federal programs, as the history of CAFE reveals that the program has vulnerabilities that are rooted in political conflicts—conflicts that are at least as much regional in nature as they are partisan or ideological (Luger 2005; Graham 2010a).

Second, the rate of new vehicle sales affects achievement of environmental objectives by influencing the pace of retirement of old vehicles from the fleet, also called the scrappage rate (Goulder and Stavins 2012; Jacobsen and van Benthem 2015). Older vehicles exert a disproportionate influence on national gasoline consumption and GHG emissions because they tend to be less fuel efficient than new vehicles. This effect is more pronounced for "criteria" pollutant emissions that impact local air quality. Old vehicles emit a disproportionate share of local pollutants related to smog and soot, in part because the emissions controls for local pollutants tend to work less effectively as a vehicle ages (Drake 1995; Gruenspecht 2001, NHTSA 2009). The rate of GHG emissions from a vehicle does not change significantly as a vehicle ages (Greene and Welch 2016). Nonetheless, slowing the rate of new vehicle sales hurts efforts at GHG control because newer vehicles, in part due to regulation, emit fewer GHG emissions than the older vehicles they replace.

Third, the rate of retirement of old vehicles is also linked to adverse safety outcomes for motorists. The designs of new vehicles today provide much better occupant crash protection than new vehicles designed in the 1990s (IIHS 2015a; NHTSA 2009). Thus, a slower rate of new vehicle sales will hamper progress in automobile safety, since motorists will be exposed to the elevated risks of traveling in older vehicles for a longer time.

Fourth, changes in the rate of new vehicle sales affect the welfare of used car buyers because the markets for new and used cars are linked. If some consumers are priced out of the new vehicle market, they may instead enter the used-car market, which has the effect of bidding up prices on used cars (Jacobsen and van Benthem 2015). While the used car buyer will certainly welcome the fuel savings that a fuel-efficient or zero-emission vehicle provides (Greene and Welch 2016), any increase in the price of the average used car is an affordability concern, since it is lower- and middle-income Americans who access the used-car market. A recent study has examined the distribution of costs and benefits of CAFE by income class, and it found that the program is regressive, in part due to price distortions in the market for used cars (Jacobsen 2013).

Finally, any regulatory impact on new vehicle sales is relevant to an appropriate societal cost-benefit analysis of the regulations, since consumer welfare is affected. This rationale is microeconomic in nature, insofar as consumers care about the attributes of their passenger vehicles. In 2011-2012, neither California nor the federal government found evidence that the regulations would exert an adverse impact on new vehicle sales, and therefore did not perceive a need to address this issue in societal cost-benefit analyses at the time (CARB 2011a; NHTSA 2012a; EPA 2012a). We seek to determine whether conditions in 2016 justify a careful inquiry into this question. To this end we conduct a Total Cost of Ownership (TCO) analysis in order to assess the direct and indirect costs of new vehicle ownership under the CAFE, GHG, and ZEV standards (Roosen, Marneffe, and Vereeck 2015).

1.7 Study Process, Deliverables, and Outline

In preparing the report, we have: (1) reviewed the regulatory impact analyses (RIAs) and related technical documents underpinning the federal and California requirements, including EPA's most recent determination not to revise the 2022-2025 standards; (2) reviewed academic and other literatures that assess the impact of CAFE and ZEV on new vehicle sales, or are relevant to such an assessment; (3) reviewed key trends in the industry, especially factors that have changed since 2009-2012 when the regulations in question were developed and finalized; (4) assessed related federal, state, and local policies that might be modified to complement the federal and California requirements; and (5) considered reforms of the federal and California requirements that are worthy of more in-depth analysis in the midterm review. We have also incorporated feedback offered by expert reviewers and an independent Peer Review Advisory Board comprising experts in energy, the environment, transportation, macroeconomic and microeconomic modeling, and the structure and operations of the global automotive industry.

With our focus on new vehicle sales in mind, this report provides a series of recommendations for consideration in the midterm review processes based on a quantitative analysis of the regulatory impacts. The recommendations fall into three categories: technical suggestions for regulatory analysts, regulatory reforms for consideration by federal and state regulators, and legislative policy options. The sequence of the recommendations presented in the report generally follows those three categories.

This final report follows from a first phase of research conducted during the summer and fall of 2015 and an accompanying phase I report, "Rethinking Auto Fuel Economy Policy: Technical and Policy Suggestions for the 2016-17 Midterm Reviews." This final report expands on the Phase I recommendations based on results from a series of modeling exercises. This report also reflects consideration of public comments received on the Phase I report and continued feedback provided by our Peer Review Advisory Board.

This report begins with an overview of the federal and ZEV standards, with information on the political history of these regulations. We then review regulatory compliance procedures and previous industrial impact studies, particularly those studies that investigate macroeconomic variables such as new vehicle sales and employment. We then describe the consumer and producer's perspectives, including the structure of the industry and its importance to the U.S. economy and in the recovery from the Great Recession of 2007-2009. Next, we review and critique previous macroeconomic modeling approaches used to determine the impacts of the federal and California regulations and then present our own modeling results. Following the modeling results and discussion, we consider regulatory reforms that could be made to improve the current standards. Finally, we present our specific recommendations for analysts, regulators, and legislators.

2. PUBLIC POLICY CONTEXT

2.1 History of CAFE

The Arab oil embargo of 1973-74 led to a quadrupling of world oil prices, rapidly rising gasoline prices, and fuel shortages that caused long lines at refueling stations in the U.S. The Congress and President Gerald Ford responded with new legislation aimed at reducing America's dependence on petroleum. Enacted in 1975, the Energy Policy and Conservation Act (EPCA) authorized the U.S. DOT, through NHTSA, to set minimum miles-per-gallon (mileage) performance standards for all new cars and light trucks sold in the U.S.

The legislation, followed by NHTSA rulemakings, contributed to a doubling of average new car mileage from 13 miles per gallon (MPG) in model year 1974 to 27.5 MPG in model year 1985. Market responses to higher gasoline prices contributed to the average mileage gains from 1974 to 1985, but the stricter CAFE standards also played a significant role (Nivola and Crandall 1995; Greene 1990; 1998; Shiau, Michalek, and Hendrickson 2009). Savings in petroleum use were significant but less than projected because sales of light trucks grew more rapidly than sales of cars during this decade (NRC 2002). The federal mileage requirements for light trucks were more permissive, starting at 17.2 MPG in 1979 and rising to 19.5 MPG in 1985. Moreover, entire segments of the light-truck fleet—e.g., pickup trucks with a gross vehicle weight rating (GVWR) of more than 8,500 pounds—were exempt from federal mileage standards (NRC 2002).

Market conditions changed in the late 1980s. In the face of declining fuel prices and financial concerns expressed by GM and Ford, the CAFE standards were relaxed in 1986 for cars and in 1990 for light trucks. GM and Ford apparently had product plans that would have achieved compliance with CAFE standards, but they were deprioritized in response to increased consumer interest in low fuel economy vehicles spurred by low fuel prices (Luger 2005, 130).

Efforts to legislate stricter CAFE standards gained momentum in 1990-1992 due to a new environmental concern: climate change from GHGs emitted by motor vehicles (Luger 2005, 163). However, opponents of CAFE standards blocked stricter legislation in the Senate using the filibuster threat.

When President Clinton took office in January 1993, the CAFE standards for model year 1993 were virtually unchanged from 1985. While President Clinton and Vice President Al Gore had pledged tighter CAFE standards during their campaign, a bipartisan coalition in Congress preempted the administration with a series of appropriations riders that barred increases in CAFE standards. The CAFE "freeze" started in model year 1996 and persisted throughout the Clinton administration.

The politics of CAFE changed during the George W. Bush administration, in part due to a rapid rise in average retail gasoline prices from approximately $1.50 per gallon in 2000 to more than $3.00 per gallon in 2008 (Graham 2010). The Bush administration decided to both tighten CAFE standards and, in response to suggestions from an independent study, reform the program to reduce safety risks (NRC 2002). In order to discourage unsafe downsizing of vehicles but reward substitution of lightweight materials, the CAFE standard for each manufacturer was adjusted based on the size distribution of its products (German and Lutsey 2010).

When Congress agreed to lift the CAFE freeze in 2002, NHTSA responded by raising light-truck CAFE standards from 20.7 MPG in model year 2004 to 22.2 MPG in 2007. NHTSA followed with the safety-based reform of the light-truck program that adjusted each automaker's CAFE requirement according to the size distribution of its products. For model years 2008 to 2011, NHTSA tightened the light-truck standards based on footprint (the area between the four wheels) to achieve an industry-wide average of approximately 24 MPG (Graham 2010a).

When the Democrats secured a majority in Congress in January 2007, they worked with the Bush administration on a major reform of the CAFE law included in the Energy Independence and Security Act (EISA) of 2007. Support for the legislation in Congress was widespread and bipartisan. Members were moved by environmental

(i.e., climate change) and/or energy security rationales. EISA applied the footprint adjustment to cars as well as trucks, and established a minimum performance goal of 35 MPG by 2020 for the combined car and truck fleets. Higher standards were authorized for model years 2021 and beyond, with the specifics to be determined by technical analyses performed by NHTSA and EPA (Graham 2010).

Drawing on the authority given in EISA, the Obama administration tightened CAFE standards through rulemakings. A 2012 final rule sets standards that are expected to achieve an average of 41 MPG by model year 2021 (cars and light trucks combined), and a goal of 54.5 MPG, if met through fuel economy improvements alone, by model year 2025. The final CAFE standards for model years 2022 to 2025 will be set by a future NHTSA rulemaking, after the scheduled 2017-18 midterm review of the JNP.

2.2 California's GHG Standards for Motor Vehicles

The State of California has played an influential and innovative role in car-emissions control for decades (Carley, Betts, and Graham 2011). In fact, California began efforts to control motor vehicle emissions almost twenty years before the federal government applied its first standards to the auto industry in model year 1968 (MEMA v. EPA 1979).

During the Clinton and George W. Bush administrations, environmentalists and their allies in the California legislature became increasingly disenchanted with the federal government's handling of the CAFE program. Despite objections from the auto manufacturing industry and dealers, in 2002 the California legislature passed a new law, AB 1493, that authorized limits on GHG emissions from new motor vehicles sold in California. The law called for CARB to accomplish a sustained reduction in GHGs, and CARB set standards for vehicles starting in model year 2009. The standard set for model year 2016 is 250 grams of CO2 per mile, which is roughly equivalent to a 36 MPG CAFE requirement in model year 2016. Other states (e.g., New York and Massachusetts) began to join the California program, as concerns about climate change were increasing.

A legal battle ensued as to whether California possessed the authority to impose its own GHG standards (Graham 2010). Industry and the Bush administration argued that EPCA preempts any state regulation of motor vehicles related to fuel economy. California and environmentalists argued that the 1990 amendments to the Clean Air Act provide California with the power to set stricter auto emissions standards than the federal government. EPA, under the Bush administration, denied California the required waiver under the Clean Air Act, but a federal court ruled in 2007 that California does possess the authority under the Clean Air Act to set its own emissions standards for motor vehicles (EPA 2013).

When the Obama administration fashioned its policies from 2009-2012, the State of California was included as a key stakeholder in discussions with industry, labor, environmentalist, and consumer groups. The Obama administration decided to enact highly stringent CAFE standards, similar to what California had enacted for 2016 and was considering for 2017-2025.

As a result of the negotiations, the seemingly complex combination of the California GHG standards, the EPA GHG standards, and the NHTSA CAFE standards began to seem like a uniform national program because the compliance obligations for vehicle manufacturers were coordinated and measured only on a national basis. Specifically, on December 6, 2012, California adopted a "deem to comply" regulation that enables manufacturers to show compliance with California GHG standards by demonstrating compliance with federal GHG standards (EPA 2012b). Thus, at the present time, the California GHG standards do not impose any regulatory burdens on the auto industry that go beyond the federal requirements.

2.3 Federal GHG Standards for Motor Vehicles

The U.S. Supreme Court determined in 2007 that the EPA possesses the authority under the Clean Air Act to regulate GHG emissions from motor vehicles. Drawing on this authority, EPA made an "endangerment" finding

in 2009, as GHG emissions from mobile sources were determined to be a contributor to climate change and therefore a threat to public health and the environment.

In response to a 2009 instruction from President Obama, EPA, in consultation with NHTSA, created an entirely new performance standard governing GHGs emitted by new cars and light trucks. The new standards, which have been finalized through model year 2025, are essentially equivalent to NHTSA's CAFE standards except that they are slightly stricter, though the EPA performance standards allow automakers to earn extra compliance credits by modifying air conditioners to reduce GHGs as well as for producing certain types of vehicles (e.g., ZEVs and PHEVs). EPA has taken the position that the EPA and NHTSA programs have been harmonized as much as possible, given the existing legislative authority for the two programs (EPA 2016a).

2.4 California's ZEV Program

In the 1990s CARB created a ZEV program that requires each vehicle manufacturer doing business in California to sell a specified percentage of ZEVs to consumers. Although originally seen as a program to help Los Angeles and other areas address unhealthy levels of airborne smog, today the ZEV program is also considered a tool to reduce the GHG emissions linked to climate change (CARB 2011a; Graham et al. 2014). The ZEV requirement was initially defined as 2% of new vehicle sales in 1998, ramping up to 5% in 2001 and 10% in 2003.

Due to technical, legal, and economic setbacks, the ZEV requirements were delayed and amended by CARB several times over the last 20 years. In their current form, as finalized in 2012, ZEV requirements mandate approximately 15.4% of ZEVs in each automaker's fleet by 2025 (CARB 2011a; CARB 2011b).

Section 177 of the Clean Air Act allows other states to adopt California's vehicle-emissions standards without being required to seek EPA approval when they do so (EPA 2013). To date, nine states have decided to replicate California's ZEV requirements. As a result, approximately 30% of national vehicles sales are covered by a ZEV program. Thus, assuming a national sales rate of 17 million vehicles per year, a 15.4% requirement in 30% of the market translates into 785,400 ZEVs in model year 2025 (for a similar calculation, see NRC 2015a). By way of comparison, almost 160,000 new plug-in vehicles were sold nationwide in 2016 (EDTA 2016). There is no question that the ZEV requirements for 2018-2025 will compel vehicle manufacturers to make significant investments in ZEVs.

In the absence of the ZEV mandate, it is questionable whether the array of federal and state incentives for PEVs would be sufficient, given low fuel prices, to stimulate investment in an electric vehicle industry (Kahn 2016; NRC 2015b). EIA's 2015 modeling showed that market forces alone, coupled with gradually rising fuel prices and falling PEV prices, would cause only 2% of new vehicle sales in 2040 to be PEVs (EIA 2015b).

In this report, the term *plug-in electric vehicle* (PEV) is used to describe any vehicle that draws electricity from the electrical grid. A *battery-electric vehicle* (BEV) is a PEV that relies entirely on electricity for propulsion power (e.g., the Nissan Leaf). A *plug-in hybrid electric vehicle* (PHEV) is a PEV that draws power from both a gasoline engine and a battery pack (e.g., the Toyota Prius Plug-In). A *fuel cell vehicle* (FCV) is powered by a hydrogen fuel cell (e.g., the Hyundai Tucson SUV). A conventional *hybrid electric vehicle* (HEV), such as the well-known Toyota Prius, operates on both gasoline and battery power but does not have the plug-in feature. PEVs and FCVs are considered the most likely propulsion systems to be used by automakers to achieve compliance with the ZEV regulation.

2.5 Regulatory Systems Worldwide

The U.S. is not the only country to enact fuel economy standards or GHG standards for new vehicles. There are now nine governmental bodies around world that have enacted or proposed such standards: U.S., Brazil, Canada, China, the European Union (EU), India, Japan, Mexico, and South Korea, as displayed in Figure 2.1. The automobile production in these jurisdictions accounts for 80% of the global vehicle market (Kühlwein, German,

Figure 2.1. Countries with Fuel Economy or Greenhouse Gas Standards, as of December 2016.

and Bandivadekar 2014). The regulatory programs around the world vary in structure, stringency, flexibility, drive cycle, and vehicle certification test procedures.

Comparing fuel economy requirements in different countries is no small task. The U.S. measures fuel economy using a weighted average of testing procedures for city and highway driving conditions. The EU and China use the New European Driving Cycle (NEDC) to measure fuel economy, which similarly considers the differences in urban and extra-urban driving. Japan uses the JC08, which takes a weighted average of a cold start measurement and a hot start measurement. The United Nations Working Party on Pollution and Energy is developing a worldwide standard—the Worldwide Harmonized Light-Duty Test Cycle (WLTC)—which is intended to replace the NEDC and potentially other approaches. These fuel economy test cycles differ in several ways, including starting conditions, duration, distance, mean and maximum velocity, stop phases, and acceleration (Kühlwein, German, and Bandivadekar 2014).

The International Council on Clean Transportation (ICCT) developed a series of conversion factors that allow for the comparison of fuel economy standards among these countries. Table 2.1 shows a comparison of the fuel economy requirements for the U.S., the EU, Japan, and China, using the ICCT's conversions to keep all comparisons consistent with the CAFE-MPG approach. Although the U.S. standard appears to be more lenient than the European, Japanese, and Chinese standards, the U.S. auto market, as we explain below, has fewer small cars and more light trucks than the EU, Japan, and China.

Like the U.S., other countries such as Canada, India, Japan, and South Korea, and regions such as the EU, have enacted compliance incentives to encourage automakers to offer advanced technology vehicles such as PEVs (IEA 2016). Sometimes called "super credits," these incentives tend to give greater compliance credits to PEVs than would be justified by a strict accounting of their lifecycle GHG emissions.

At the present time, no other country in the world has implemented a regulatory program similar to the California ZEV mandate. In late 2016, Quebec became the first Canadian province—and the only other jurisdiction in the

Table 2.1. Fuel Economy Standards for Light-Duty Vehicles (MPG) in Selected Countries

	U.S.	EU	Japan	China
2017	35.4			
2018	36.5			
2019	37.7			
2020	38.9		45.9	47.7
2021	41.0	56.9		
2022	43.0			
2023	45.1			
2024	47.4			
2025	49.7	72.5-82.3*		

Note: *This standard is being studied but has not been adopted.

Source: ICCT. http://www.theicct.org/sites/default/files/info-tools/pvstds/Global_PV_data_20150803.xlsx

world—to enact a ZEV program. The Quebec program also includes an $8,000 purchase rebate, public grants for charging stations, and HOV lane access for some drivers of PEVs.

Some legislatures around the world are beginning to consider more radical proposals to boost the future of PEVs. The idea is to prohibit or phase out the PEV's dominant competitor: the internal combustion engine. Bills of this sort are apparently under consideration in the Netherlands, Norway, Germany, Austria, and India (C. White 2016; Mitchell 2016).

The strength of the demand-side pull for PEVs also varies considerably around the world due to differences in gasoline prices, electricity prices, public incentives for purchase and use of PEVs, the availability of recharging infrastructure, and other factors (IEA 2016). With lithium ion battery prices declining due to innovation and economies of scale in production, forecasts are being made as to when the total cost of ownership of a PEV will be comparable to the total cost of ownership of a gasoline or diesel-powered vehicle.

Primarily due to differences in gasoline prices at the pump, one study estimates that parity will be reached sooner in the EU (2021) and China (2025) than in the U.S. (post-2025) (Clark and Campbell 2016). In recent years, sales of PEVs have risen faster in the EU and China than in the U.S., with peak penetration rates highest in the Netherlands (23%) and Norway (10%). In 2015, China had a higher PEV penetration rate (1.0%) than the U.S. (0.7%), primarily due to enlarged public incentives and subsidies in China and low fuel prices in the U.S. (IEA 2016).

All large-volume automakers sell vehicles in multiple countries, yet they are looking to make as many vehicles as possible from a single global platform. Global automakers also face a global investment community, and investors are becoming more aggressive in their expectations of technological innovation from the industry (Institutional Investors Group on Climate Change 2016). Therefore, it can be expected that, during product planning and production-volume decisions, automakers will consider consumer demands, investor demands, and compliance obligations in multiple countries and regions (Laing 2017). On the other hand, the U.S. vehicle market is so large that global automakers can afford to tailor some product offerings specifically to the U.S. market. As the industry globalizes, it is reasonable to expect that regulators will come under increasing pressure for harmonization or mutual recognition of regulatory requirements.

3. REGULATORY COMPLIANCE AND CREDIT TRADING PROCEDURES

In order to appreciate the complexity of the regulatory system faced by automakers, it is useful to review how manufacturer compliance with the standards is determined and the penalties for noncompliance. The regulatory programs also provide some flexibility for manufacturers, and the terms of those provisions are explored briefly below.

3.1 NHTSA's CAFE Program

Congress has specified that CAFE standards be set at the "maximum feasible level," taking into account technological feasibility, economic practicability, the effects of other standards on fuel economy (e.g., safety or smog standards), and the need to conserve energy. The CAFE standards for individual manufacturers are specified in two product categories: passenger cars and light trucks. A manufacturer's standard is determined by computing the sales-weighted average, specifically the harmonic mean, of the mileage targets for individual vehicles in a manufacturer's fleet. Requirements for individual vehicles vary based on their size (footprint): vehicles with larger footprints have lower minimum fuel economy targets than vehicles with smaller footprints.

To assess manufacturer compliance, the average fuel economy of vehicles distributed for sale by a manufacturer is compared with the manufacturer's CAFE standard. A manufacturer's passenger car fleet is compliant if the aggregate fuel economy of this fleet is at or above the stated standard. A separate compliance determination is made for the manufacturer's light trucks. Most large-volume manufacturers sell both cars and light trucks. Additionally, under the CAFE program, manufacturers' car fleets are divided into domestic and foreign. Domestic vehicles are those that contain 75 percent or more U.S., Canadian, or post-NAFTA Mexican content (by value). Manufacturers' domestic and foreign car fleets must separately be in compliance with CAFE standards.

The CAFE regulatory program is credit based, such that each manufacturer has a credit account that can be debited or filled based on its compliance in a given model year. Any time a manufacturer exceeds compliance targets it earns a certain number of credits. Manufacturers can address under-compliance by using credits accumulated in previous model years or by paying a civil penalty set at $14 per tenth of an MPG. The value of the civil penalty was increased in the summer of 2016 (from $5.50 per tenth of an MPG) pursuant to the Federal Civil Penalties Inflation Adjustment Act of 2015. The Act requires federal agencies that administer civil monetary penalties to adjust penalty values to capture inflation that was previously unaccounted for in penalty values, and that they annually adjust penalty values to account for inflation henceforth (Office of the Federal Register 2016). The $5.50 penalty rate had not been adjusted by NHTSA since 1997.

With respect to credits, manufacturers can (1) carry excess credits earned in a given year forward up to five consecutive years following the model year in which these credits were earned ("carry forward provision"); (2) carry credits backward up to three consecutive years prior to the model year in which credits were earned ("carry backward provision"); (3) transfer excess credits earned for one vehicle product category to account for deficits in another; or (4) purchase credits from other manufacturers that have excess credits. However, vehicle manufacturers must be wary about relying heavily or primarily on credits. Regulatory agencies have a tendency to discount the value of accumulated credits through rulemaking actions, and manufacturers may face public, shareholder, or investor protests if they rely primarily on credits rather than innovative new vehicle designs.

3.2 EPA's GHG Standard

Similar to the CAFE program, EPA's vehicle emission standards for GHGs are set according to vehicle footprint, wherein larger footprint vehicles have more permissive GHG emissions targets than smaller footprint vehicles. Also like the CAFE program, EPA's program relies on a credit banking system.

Manufacturers under-/over-complying with GHG emissions standards can carry credits forward or backward to account for compliance shortfalls, or trade credits with other manufacturers. The incorporation of certain

types of vehicle technologies or vehicle design features earns manufacturers extra credits. For example, manufacturers earn credits for including efficient air conditioning systems that reduce refrigerant leakage and rely on alternative refrigerants with lower climate change potential. Manufacturers also earn credits for solar panels and engine start-stop technology, as well as for improvements in vehicle aerodynamics. When the benefits of the vehicle technology/design features are not reflected in emissions testing procedures, the credits awarded to the manufacturer are termed "off-cycle" credits.

Further, under EPA's program, manufacturers earn extra credits for certain types of advanced vehicles. In 2017, each BEV and FCV distributed for sale by a manufacturer will count as two vehicles. By 2021, the multiplier will be decreased to 1.5. PHEVs will be multiplied by 1.6 in 2017 and 1.3 in 2021. Additionally, electric and fuel cell vehicles will count as emitting 0 grams of carbon dioxide equivalents per mile during the 2017-2021 period, irrespective of upstream emissions. During the 2022-2025 period, there is no multiplier for specific vehicle technologies, and emissions related allowances are based on vehicle sales. Since these credits expire in model year 2021, they may not be relevant to the midterm review, which focuses on model years 2022-2025. The presence of such credits can be seen as an effort to coordinate federal regulatory policy with the California ZEV program.

When the EPA launched the new GHG program, it did not assign zero credit balances to all vehicle manufacturers. It recognized that some manufacturers (e.g., Toyota) had accumulated significant GHG credits from 2009-2011 and allowed those credits to be transferred to the start of the EPA program. In other words, in 2013 Toyota was posted with 86 million EPA credits at the start of the 2012 model year, credits that can be used until the 2021 model year (when they expire) (Nelson 2013a).

Manufacturers need to ensure, if they plan to use credits under the NHTSA program, that they also have sufficient credits under the EPA program. While some German manufacturers have a history of paying fines under the CAFE program, the Big Three have feared that they might be liable for civil damages in stockholder lawsuits if they paid fines, or they may squander political capital or public image (Jacobsen 2013; Kleit 2004). In any event, paying fines as a compliance technique will not work in the future because it is not a viable option under the EPA program. EPA has the discretion to administer fines in the range between $0 and $37,500 per vehicle, and there is little guidance as to how the agency intends to exercise its discretion. The EPA can also go beyond fines and stop a company from selling vehicles if it does not meet the standard or have credits to cover any deficit (Leard and McConnell 2015).

The EPA credit program was also designed to help start-up PEV manufacturers. New PEV manufacturers are permitted to accumulate credits each year relative to their sales volume. Those credits can then be sold to other vehicle manufacturers who are confronting an EPA compliance deficit. EPA reported in its 2015 annual report that Chrysler and Mercedes Benz were buying EPA GHG credits; Nissan, Honda and Tesla were selling them (EPA 2015).

3.3 The ZEV Regulation

A "ZEV state" is one that has adopted California's entire "Advanced Clean Cars Program," including requirements for control of smog, soot, and GHGs, and regulation to encourage greater numbers of ZEVs. The ZEV regulation requires that manufacturers selling vehicles in a ZEV state earn a certain number of "ZEV credits," which corresponds to a percentage of the total number of passenger cars and light-duty vehicles distributed for sale in the state. The ZEV regulation currently applies to large- and intermediate-volume manufacturers. Currently, large-volume manufacturers are defined as those that sell more than 60,000 vehicles per model year in California. Intermediate-volume manufacturers are defined as those that sell 4,501 to 60,000 vehicles per model year. Starting in 2018, any manufacturer that produces more than 20,000 vehicles per year will qualify as a large-volume manufacturer.

A ZEV is a vehicle that does not produce tailpipe emissions during operation and, given current technology, must be a BEV or FCV. They are referred to as pure ZEVs (CARB 2013). Currently, under the ZEV regulation,

CARB also grants credits for extremely low polluting technologies (i.e., those that are not quite zero emitting) to help automakers achieve regulatory compliance. These other types of vehicles include those categorized as Transitional ZEVs, Partial ZEVs, and Advanced Technology Partial ZEVs. Table 3.1 lists the types of vehicles that are included in each of CARB's ZEV categories. The number of credits awarded for any particular kind of ZEV currently depends on characteristics like vehicle type, how far the vehicle can travel on a zero-emission fuel source, and a vehicle's fast refueling capability.

Fast refueling capability is the ability to refuel to 95% capacity within 10-15 minutes, depending on a vehicle's zero-emission fuel range (i.e., similar to the rate of traditional gasoline or diesel fueled vehicles). A provision specific to fast refueling allows manufacturers to earn additional credits beyond the baseline credits based on demonstrated fast refueling capability. Currently, manufacturers can earn credit for up to 25 vehicles based on performing 25 fast refueling events on just one vehicle. The fast refueling credit will be eliminated altogether in model year 2018.

While the ZEV program does currently allow manufacturers to earn credits for transitional ZEVs, advanced technology partial ZEVs, and partial ZEVs, the awarded credit is lower for these vehicles than for pure ZEVs. Further, manufacturers can only fulfill a limited fraction of their requirements with non-pure ZEV vehicles. Table 3.1 also shows the range of credits that can be earned for different types of vehicles in model years 2012-2017 and 2018-2025. Note that no credits are provided for HEVs or partial ZEVs starting in model year 2018.

CARB publishes formulae that determine how credits vary based on the design of a ZEV and how credits translate to compliance percentages. For each model year, CARB sets a Total ZEV Percentage Requirement and a Minimum ZEV Floor Requirement. The Minimum ZEV Floor Requirement specifies the percentage of credits that must be earned with pure ZEVs alone. The Total ZEV Percentage Requirement can be met with credits earned from a combination of pure ZEVs and other allowed technologies. Table 3.2 shows the Minimum ZEV Floor and Total ZEV Percentage Requirements for model years 2018-2025 for large-volume manufacturers. Once manufacturers meet the ZEV floor requirement, they can meet the remaining ZEV requirement with credits from TZEVs.

Beyond 2025, ZEV requirements are expected to become increasingly stringent to help California accomplish its goal of reducing statewide GHG emissions to 80% below 1990 levels. In support of this goal, California Governor Jerry Brown recently issued a target of having ZEVs comprise 100% of new vehicle sales in 2050 as part of a non-binding agreement with several U.S. states, Quebec, and several European countries (Siders 2015).

Intermediate-volume manufacturers are granted some leniency in achieving ZEV requirements through model year 2017 because they generally have less revenue and capacity to engage in research and development than

Table 3.1. Credit Ranges by ZEV Vehicle Type

ZEV Vehicle Type	Definition	Vehicle Type	Credits Model Years 2012-2017	Credits Model Years 2018-2025
ZEV	Zero Emission Vehicle	Battery electric vehicle, hydrogen fuel cell vehicle	1 to 9 depending on range and fast-refuel	1 to 4 depending on range
TZEV	Transitional Zero Emission Vehicle	Plug-in hybrid or extended range electric vehicle, hydrogen internal combustion engine vehicle	1 to 3 depending on technology	0.4 to 1.3 depending on range
PZEV	Partial Zero Emission Vehicle	Extremely clean conventional vehicle	0.2	-
AT PZEV	Advanced Technology Partial Zero Emission Vehicle	Natural gas vehicle, hybrid electric vehicle	> 0.2 to 3 depending on technology	-

Source: Adapted from Center for Climate and Energy Solutions; http://www.c2es.org/us-states-regions/policy-maps/zev- program

Table 3.2. ZEV Requirements by Model Year

Model Years	Total ZEV Percent Requirement	Minimum ZEV Floor	TZEVS
2018	4.5%	2.0%	2.5%
2019	7.0%	4.0%	3.0%
2020	9.5%	6.0%	3.5%
2021	12.0%	8.0%	4.0%
2022	14.5%	10.0%	4.5%
2023	17.0%	12.0%	5.0%
2024	19.5%	14.0%	5.5%
2025	22.0%	16.0%	6.0%

Note: Each year over the regulatory period, manufacturers are subject to a total ZEV percentage requirement. Manufacturers must earn a certain number of credits from ZEVs only, equating to the minimum ZEV floor percentage requirement described in this table. CARB allows manufacturers to fulfill the remaining ZEV requirements with credits from TZEVs.

Source: CARB, 2012b; http://www.arb.ca.gov/regact/2012/zev2012/fro2rev.pdf

do large-volume manufacturers (CARB 2014). Through model year 2017, intermediate-volume manufacturers are allowed to meet ZEV requirements entirely with PZEVs. Starting in 2018, they will also be allowed to meet requirements solely through TZEVs.

Manufacturers that over-comply with ZEV requirements (i.e., earn more ZEV credits than required in a given year) can bank those credits for future use to accommodate compliance shortfalls, or sell excess credits to other manufacturers. Conversely, under-complying manufacturers must pay a fine or purchase credits from manufacturers with excess credits. Starting in 2018, manufacturers will be required to make up a ZEV credit deficit within one year (CARB 2014). While small-volume manufacturers—those producing 4,500 or fewer units per year—are not currently regulated under the ZEV program, they may earn, bank, market, and trade credits for the ZEVs and TZEVs they produce and deliver for sale (CARB 2012b, 3).

Under the federal Clean Air Act, states are allowed to opt in to California's ZEV program. The following nine states currently participate in the ZEV program (listed in parentheses are the dates each state joined the California program): New Jersey (2004), Connecticut (2004), Vermont (2005), New York (2005), Maine (2005), Rhode Island (2005), Massachusetts (2005), Oregon (2006), and Maryland (2007). States that opt to follow the California standards must adopt them in their entirety (even as they are amended by CARB) in order to maintain consistency and thereby simplify the compliance burdens on automakers.

Currently, manufacturers can apply the credits they earn for the sale of pure ZEVs in one ZEV state to count toward meeting regulatory requirements in any other ZEV state (CARB 2011a). This credit transfer allowance is referred to as the "travel provision," and is set to end in 2017. By eliminating the travel provision for pure ZEVs, CARB is compelling a minimum number of BEV sales in each of the ZEV states (CARB 2012c). The travel provision for FCVs has been extended indefinitely to allow ZEV states ample time to develop infrastructure to support these vehicles and to implement policies that will facilitate their adoption and use. Currently, there is not adequate hydrogen refueling infrastructure in any state to support widespread use of FCVs (Fleming 2015).

CARB also offers automakers the opportunity to pursue compliance through the "Optional Section 177 State Compliance Path" (Optional Path). This compliance path provides automakers the flexibility of meeting their ZEV obligation in three regional pools: California, other western states, and eastern states. The western pool includes all states west of the Mississippi River, excluding California. The eastern pool includes all ZEV states east of the Mississippi River. Thus, if a manufacturer's sales are short in Massachusetts, the company can compensate with a surplus of sales in another eastern ZEV state (e.g., New York). Credits transferred between states in the same regional pool transfer at full value. Credits transferred across regional pools do so at a reduced value. The

Optional Path also reduces TZEV requirements in 2015-18 model year and pure ZEV requirements in 2018-2020 model year for non-California ZEV states. Manufacturers choosing the Optional Path are subject to increased pure ZEV sales quotas in the 2016-17 model year in non-California ZEV states.

The fines for noncompliance with ZEV standards range from $5,000 per credit shortfall in California to up to $25,000 per credit shortfall in some northeastern ZEV states. No large auto company has yet paid a fine under the ZEV program because the requirements have been relaxed numerous times before a deadline, when it was apparent that multiple companies would not comply. Moreover, trading ZEV credits between companies may seem preferable to paying a fine, and both Tesla and Nissan have been selling ZEV credits for the last several years. On a regular basis, CARB reports the volume of ZEV credit trades but not prices. Some information on prices can be inferred from corporate annual reports and information reported by companies to the Securities Exchange Commission.

Overall, while the array of credit provisions under the ZEV program introduce some regulatory complexity, CARB maintains the position that these will provide some compliance flexibility and allow manufacturers more lead time for developing ZEV vehicle technologies (CARB 2011a). On the other hand, some analysts argue that the ZEV regulation has so much compliance flexibility that it will not stimulate enough commercialization of BEVs and PHEVs (Shulock 2016). Shulock (2016) argues that certain reforms are needed to make the requirements for ZEVs stricter: (1) increase the overall ZEV percentage requirements; (2) mandate that at least 25% of credits used to comply must come from pure ZEVs (BEVs or FCVs) produced in that model year, which would limit the practice of trading and banking and discourage over-reliance on PHEVs; (3) change the credit formula so that it awards fewer credits per vehicle, thereby forcing automakers to produce more ZEVs; (4) reduce the value of previously earned ZEV credits, thereby ensuring more production of ZEVs in the future; and (5) tighten the requirements on qualified PHEVs, especially their all-electric range, or enlarge the number of "high performance" PHEVs that may be used for compliance. Thus, CARB is being encouraged to make the ZEV program more prescriptive, at the same time that several of the compliance flexibilities in the program are scheduled for expiration.

4. THE CONSUMER'S PERSPECTIVE

An auto manufacturer's ability to meet federal and ZEV standards is contingent upon consumers purchasing its vehicles. Therefore, it is not enough for manufacturers to design and produce fuel-efficient and zero-emission vehicles; consumers must also prefer these vehicles to those that consume more fuel but potentially offer better performance, more desired features, or a lower price.

From 2009 to 2016, new vehicle sales recovered robustly. Thus, EPA (2016a) argues that there is no evidence that the federal programs reduced consumer welfare from 2009-2016.

It should be kept in mind, however, that fuel prices were relatively high and rising for most of that period, thereby spurring consumer interest in fuel economy. In effect, consumer preferences and regulatory forces were aligned, at least from 2009-2014. The industry has had much more difficulty making progress on fleet-wide average fuel economy since fuel prices collapsed in the U.S. and remained relatively low in 2015 and 2016 (Sivak and Schoettle 2017).

The situation will likely be different from 2017-2025. The federal and ZEV standards are scheduled to increase in stringency much more rapidly from 2017-2025 than they did from 2009-2016. The U.S. also appears to be entering a sustained period of relatively high levels of consumer confidence and low fuel prices (EIA 2016), with the possibility of some real growth in household income (Proctor, Semega, and Kollar 2016). As a result, regulators and manufacturers are likely to confront more misalignment between consumer preferences and regulatory demands, since consumers may not be as incentivized to favor fuel-efficient vehicles.

4.1 Consumer Decision Making about Transportation

For the retail consumer, purchasing a vehicle is a major investment of household income, second in size only to the decision to buy a house or condominium. Indeed, purchasing and operating a passenger vehicle is so expensive that some households try to organize their lives so that they need not own a personal vehicle. As a result, the share of young people seeking a driver's license declined from 1983-2014 (Sivak and Schoettle 2016a).

In the years ahead, auto manufacturers and dealers will be targeting the next generation of consumers (Gen Y: those born between 1977-1994) to replace lost sales from the aging Baby Boomers, implying that the preferences of Gen Y will influence the market. Similar to previous generations, Gen Y enjoys driving, provided driving is low cost, convenient, and accommodates varying personal lifestyle demands (B. Brown et al. 2014). Some segments of Gen Y seem to be more interested in living in urban settings and relying on alternative modes of transportation. The success of car-sharing services such as Uber, which are familiar to Gen Y, is expected to taper the demand for personal vehicles in the future (Litman 2016; Gardner 2016).

Some residents of urban centers can already access alternatives to owning a passenger vehicle (e.g., carpooling, biking, walking, or taking public transportation), but such alternatives are actually losing market share to the private automobile. More than three-quarters of U.S. workers drove to work without anyone else in the vehicle in 2012, up from 64% in 1980. The amount of carpooling has declined by 50% over the same period. The number of trips supplied by public transit systems has declined from 6% in 1980 to 5% in 2012. The number of employees working at home is growing rapidly, but that trend does not necessarily curtail interest in vehicle ownership (Tavernise and Gebeloff 2011; Shah 2013). In short, America's "love affair" with the personal vehicle is not likely to end soon.

The classic car-shopping studies (e.g., see NRC 1996, 82–83), have confirmed that consumers typically engage in a two-step process: first, consumers choose a type or class of vehicle (e.g., sedan, pickup truck); then they select a specific make and model within that class. Some consumers exhibit a high degree of brand loyalty over their lifetime while others do not. It should not be assumed that, at the outset of a search, all consumers understand the differences between sedans and crossovers or SUVs and minivans.

Vehicles differ in so many dimensions—price, financing arrangement, performance, appearance, safety, fuel economy, ride height, repair records, seating capacity, trunk space, towing capability, and so forth—that it is rational for buyers to simplify the decision by focusing on a subset of dimensions that are most important to them. There are established theories in behavioral economics (e.g., bounded rationality, satisficing, and decision making heuristics) that predict that consumers will make simplifications when they face complex decisions (Simon 1976; Kahneman, Slovic, and Tversky 1982; Thaler and Sunstein 2008).

To simplify the decision-making process when purchasing a new vehicle, consumers tend to focus on a limited number of dimensions. A 2013 survey of over 300,000 new vehicle buyers found that consumers rate reliability, durability, quality of workmanship, value for the money, and manufacturer's reputation as most important in their decision to purchase a vehicle. Fuel economy was listed as the 11th most valued feature—behind such features as seating comfort—even with gasoline prices at $4.02 per gallon at the time of survey distribution. The same survey revealed that a mere 5% of respondents who purchased vehicles were willing to pay a premium for environmentally friendly features.

JD Power and Associates reported similar findings from their 2015 Initial Quality Study (Murtha 2015). More than 84,000 new vehicle owners were asked, several months after purchase, about the factors that were important to them in their recent purchase of a new car, truck, van, or SUV. In order, the most commonly cited factors were expected reliability, exterior styling, previous experience with brand/model, reputation/reviews, ride/handling, price/payment plan, fuel economy, safety, quality of workmanship, and availability of 4-wheel drive. Thus, while fuel economy is salient, it is among a variety of important factors that consumers consider.

In the long run, widespread use of car-sharing services may simplify the valuation exercise for consumers, since purchasing a new vehicle (with all of its complexity) will be replaced by the purchase of a single trip. The provider will presumably charge the consumer for the trip based on cost and vehicle quality, and purchase vehicles to attract customers yet minimize lifecycle costs (i.e., original equipment costs plus operating and maintenance costs). However, the U. S. is a long way from widespread reliance on car-sharing services.

4.2 New or Used Vehicle?

In conjunction with a consumer's decision to consider a vehicle purchase, a classic dilemma is whether to purchase a new or used vehicle. Each year more than 40 million used cars are sold in the U.S., more than double the count (about 17 million) of new vehicles sold. The average selling price of a used vehicle ($17,000) is about half the average selling price of a new vehicle (Rogers 2014). When manufacturers design and market new vehicles, they are acutely aware that the consumer typically has the option to retain their existing vehicle longer or make a purchase in the used vehicle market.

4.3 Fleet Buyers

Auto makers cannot focus exclusively on the wants and needs of the individual retail purchaser. Government and commercial fleets account for about 20 percent of new passenger vehicle sales in the U.S., depending on the year (Snyder 2016). Fleet buyers are budget constrained and thus focus on purchase price when comparing vehicles. When fleet buyers also incur the operating costs of the vehicle, they will be sensitive to fuel expenses and the total cost of ownership. After fleet vehicles are used for a period of time, they typically find their way back to dealers and the used-car market.

4.4 How Retail Buyers Finance their Purchases

A consumer cannot purchase an appealing, well-designed vehicle unless they can finance the purchase. Since most households lack sufficient savings to pay $30,000+ for a new vehicle or $17,000 for the average dealer-offered used vehicle, the buyer will typically seek a loan to help pay for the purchase.

The loan may be offered by a bank, finance company, or credit union (direct lending). Alternatively, many dealers offer attractive financing for customers as a convenience, sometimes with backing from the vehicle manufacturer. About 70-80% of retail purchases of new vehicles are financed with loans (DeBord and Rudegeair 2014).

To make sure that consumers do not purchase a vehicle that they cannot afford, consumers are asked to construct a monthly spending plan. From monthly after-tax (take home) pay, the consumer subtracts housing and utility payments, typical credit card payments, and typical set asides for emergencies. The residual from this calculation is considered the maximum the consumer can afford to put toward monthly payments for a vehicle (including taxes, insurance and other vehicle-related expenses).

With support from manufacturers, dealers may offer a variety of incentives to make a vehicle affordable such as price discounts or cash rebates on certain models or favorable terms in financing arrangements. A loan agreement used to stipulate that the loan be paid off after five years (60 months). In recent years, the average loan duration has steadily increased, sometimes to 70 months (Mello 2016). The interest rate that the consumer can qualify for will depend on their credit history and how their credit score compares to other purchasers.

An alternative financial arrangement is a lease, where the consumer is allowed to use a vehicle for a fixed number of months and miles (e.g., 15,000). While using the vehicle, the consumer is responsible for wear and tear and repairs. At the end of the lease, the consumer returns the vehicle to the dealer, and may have the option of purchasing the vehicle at that stage.

For vehicles with untested innovations, leasing is a crucial option. Most PEVs are sold in leasing arrangements to ease consumer concern about the longevity of the electric propulsion system and to permit the consumer to readily return the PEV when an improved PEV is available.

4.5 Key Product Categories

Products in the U.S. industry are typically divided into two broad categories: cars and light trucks (crossover vehicles, sport-utility vehicles [SUVs], pickup trucks, and minivans), also called "light-duty passenger vehicles." The distinction between a car and light truck is not always clear and the definitions are not always consistent; indeed, EPA defines some crossovers as cars for regulatory purposes (EPA 2015).

A light truck vehicle is not defined by size or mass, but by whether it possesses all-wheel drive. From the consumer's perspective, the light truck will also typically have the ride height that many American consumers have come to enjoy (NRC 2015a). The evolving federal regulatory definition of a light truck—and the more permissive CAFE standards for trucks—has played a pivotal role in product innovation within the industry for decades (Sallee 2010).

In order to remain globally competitive, high-volume producers have gravitated to single platforms where multiple vehicles—including both cars and light trucks—can be produced for different regions of the world. However, the platforms must be flexible enough to tailor characteristics of the vehicles to consumer preferences in different regions. Thus, it is useful to consider some of the special features of the U.S. auto market that make it different from the comparably sized market in Europe and the larger and rapidly expanding market in Asia.

As a starting point, consider the volume and market shares of each vehicle product category in the U.S. in 2015, as shown in Table 4.1. Perhaps the two most distinctive features of the U.S. passenger vehicle market are the sustained popularity of the pickup truck and, in the last decade, the emergence of the crossover SUV coupled with the decline in interest in the large SUV. Most recently, the large market for mid-sized sedans has lost ground to the increasingly popular crossovers. The midsized sedan was the largest segment for decades but in 2016 it was overtaken in U.S. sales volume by the compact crossover (Bunkley 2016).

Table 4.1. Product Categories by Sales Volume and Market Share, 2015

Product Category	Total Vehicles Sold in America (2015)	Market Share in America (2015)	Example Model
Small/Compact Car	2,999,980	17.26%	Toyota Corolla/Matrix
Midsized Car	2,974,893	17.11%	Toyota Camry
Large Car	315,320	1.81%	Chevrolet Impala
Luxury Car	1,234,528	7.10%	BMW 3-series
Pickup	2,474,669	14.24%	The Ford F-Series
Crossover	5,208,360	29.96%	Honda CR-V
SUV	1,247,387	7.18%	Ford Explorer
Van	927,093	5.33%	Chrysler Pacifica

Source: Ward's Auto, 2016a

4.6 Choices: New Fuel-Saving Technologies and Alternative-Fueled Vehicles

Since 2012, substantial real-world experience has been acquired with fuel-saving technologies such as a refined gasoline engine and alternative fuel vehicles (AFVs) like the advanced diesel engine, HEVs, and PEVs. This experience with new fuel-saving technologies can help us learn more about consumer decision making. We do not address some alternative fuels (e.g., natural gas and propane) that seem unlikely candidates for rapid expansion in the light-duty fleet between now and 2025.

Since the CAFE program was revived in model year 2004, manufacturers have made steady progress in producing and selling vehicles with higher average fuel economy. Real-world vehicle fuel economy has increased from about 20 miles per gallon in model year 2005 to 25 miles per gallon in model year 2015 (EPA 2016d). Roughly half the gains have been attributed to better technology, as opposed to consumer shifts to more fuel-efficient products (Khanna and Linn 2013). The gains in model years 2014 and 2015 (preliminary data) slowed a bit, as consumers have increasingly purchased vehicles with lower average fuel economy (e.g., crossovers, pickup trucks, and other SUVs), virtually nullifying the effects of better technology (EPA 2015; 2016e; UMTRI 2016). Preliminary data for model year 2016 suggest progress toward higher fleet-wide fuel economy is continuing, though at a lower rate than observed previously (EPA 2016d). We explore here some key technologies and AFVs and their impact on consumer decision making.

4.61 Refinements to the Gasoline Engine

In the last five years, the bulk of the technology-based gains in fuel economy have been accomplished through refinements to gasoline-powered vehicles. Those refinements include variable valve timing, multi-valve engines, gasoline direct injection, turbochargers, 6+ speed transmissions, and continuously variable transmissions. Only a small portion of the gain in average fuel economy is attributable to AFVs such as HEVs, diesels, and PEVs (EPA 2015; 2016e).

There is much debate within the industry about the extent to which the 2025 standards will be met through continued refinements to gasoline-powered vehicles as opposed to AFVs (e.g., see Duleep 2016). On the one hand, some suppliers project that automakers will be able to achieve the 2025 federal EPA and NHTSA standards through a wide variety of refinements to the gasoline engine, without investing in alternative propulsion systems (Sedgwick 2014). On the other hand, several leaders of vehicle manufacturers have indicated publicly that significant sales of PEVs and/or FCVs will be necessary to comply with the federal standards in model year 2025 (Rechtin 2012; Beene 2015b).

An indication of the difficult path ahead is that only 3% of the model year 2015 vehicle production could meet the 2025 NHTSA goal for fuel economy and the 2025 EPA standard for GHG emissions. Those few vehicles are predominantly PEVs and FCVs (EPA 2015; 2016e). In its most recent industry-compliance report (EPA 2016c), EPA reported that three manufacturers (Fiat-Chrysler, Mercedes, and Kia) did not meet the 2015 EPA GHG standard without use of credits, and BMW met the 2015 standard with no margin of safety. The average manufacturer's compliance margin declined in 2015 by almost 50% compared to 2014 (EPA 2016c).

NRC (2015a) examined a wide range of fuel-saving technologies—some already in use, others in development—that could be used by manufacturers to help achieve the 2025 standards. According to the report, large gains in fuel economy are feasible through additional refinements to the gasoline engine, though new fuel-saving technologies will add to the price of new passenger vehicles with uncertain ramifications for consumer acceptance and new vehicle sales.

NRC (2015a) did not estimate compliance costs or impacts on new vehicle sales. But, they (2015a, 275) did find, for a mid-sized car, that the cumulative technology costs to meet the 2025 standard could be 11 to 56% greater than NHTSA's 2012 estimate. NRC (2015a) did not model the cost ramifications of the compliance flexibilities in the CAFE and EPA programs and did not consider the ZEV program. NRC (2015a) also calls for more research into the uncertain aspects of consumer decision making about fuel economy.

4.62 Substituting Lightweight Materials

Since 2012, an important development in vehicle fuel economy has been the contribution of mass reduction to fuel economy gains. Specifically, manufacturers are reducing mass by using lighter-weight materials. Downsizing vehicles is less attractive, in part because the federal programs impose stricter mileage and GHG control requirements on vehicles with smaller footprints (NRC 2015a).

In addition to its direct fuel-consumption benefit, a vehicle made with lighter materials can function with a smaller powertrain, braking systems, and crash management structures (NRC 2015a, 107). Because of these benefits, each 10% drop in vehicle weight can achieve a 5.7 to 7.4% drop in fuel consumption at a cost of approximately $700 per vehicle. Larger weight reductions require disproportionately larger costs, such as $1,600+ per vehicle for a 20% mass reduction (NRC 2015a, 113).

The NRC (2015a, 264) fuel-saving estimates for a 20% weight reduction are approximately 20% larger than NHTSA assumed in 2012. If this estimate holds up in the midterm review, weight reduction will look more attractive to consumers and manufacturers than NHTSA and EPA originally estimated.

Ford Motor Company is already making much greater use of aluminum (rather than steel) in its largest-selling vehicle: the F-series pickup truck. The 2015 F-150 is fitted with aluminum instead of steel for every panel except the firewall, resulting in a 700 pound loss of weight compared to the steel-based 2014 F-150. In effect, the new truck has a high-strength steel frame coupled with an aluminum body. For this rugged-vehicle application, the aluminum is strengthened with extra thickness and heat-treating after it is formed. EPA reports that Ford's 2015 F-150, due to weight reduction, a smaller engine, and other fuel-saving features, is much closer to compliance with the 2025 EPA truck target for GHG emissions and is rated overall at 22 MPG (Williams 2015b).

Ford's decision has triggered an aggressive competitive response from steelmakers. Advanced high-strength, light-weight steels (AHSS) that cost less and have fewer lifecycle GHG emissions than aluminum are being marketed. AHSSs have been incorporated into the 2015 Chevrolet Colorado, the 2015 Ford Edge, and the 2015 Nissan Murano (AISI 2015).

Given recent developments, the midterm reviews should address some issues with lightweight materials that were not considered adequately in the 2012 RIAs but may be of concern to consumers. These issues include not only lifecycle GHG emissions, since an older study touted the advantages of aluminum (Ungureanu, Das, and Jawahir 2007), but also new concerns regarding occupant safety and repair costs.

The Insurance Institute for Highway Safety (IIHS) tested both the four door F-150 SuperCrew and the smaller SuperCab version in a battery of crash tests (IIHS 2015a; Valdes-Dapena 2015). Both Ford trucks performed well in normal frontal and side-impact tests. However, the smaller version did not perform well in IIHS's new overlap frontal crash test. About one-quarter of serious and fatal injuries in real-world frontal crashes are caused by "small overlap" frontal impacts, such as collisions with trees and utility poles. IIHS noted that Ford added additional structures to the F-150 SuperCrew that prevented passenger compartment intrusion in the test. The SuperCab version, without the additional structures, experienced crushing of the passenger compartment and a risk of foot and leg injuries. The crash-protecting structures of the SuperCrew have since been added to the SuperCab. For 2016, both the SuperCrew (four doors, full back seat) and the SuperCab (two smaller rear doors, compact back seat) qualify as Top Safety Picks.

IIHS also tested the new 2015 F-150 in low-speed crash tests. The results show more vehicle damage and 26% greater repair cost than steel-based models (Valdes-Dapena 2015; IIHS 2015b). GM contends that the aluminum in the F-150 is susceptible to puncture under sharp loads (Colias 2016a). A related concern is that property-damage insurance premiums could rise due to aluminum substitution. Ford counters that early real-world experience with the 2015 F-150 shows lower repair expenses than experienced with the 2014 F-150 (Hirsch 2015b; Williams 2015a).

In summary, lightweight materials will have a significant role to play as the 2025 deadline for the federal standards approaches. Regulatory analysts need to go beyond initial cost comparisons and disclose any differences in safety and repair records/costs for different materials that may be of concern to consumers.

4.63 Advanced Diesel Technology

A major difference between Europe and the U.S. is the penetration of the diesel engine into the passenger vehicle market. Diesels account for 53% of new passenger vehicle sales in Europe compared to 2.75% in the U.S. (Clark and Sharman 2015).

Fuel taxes are generally 3 to 4 times higher in the EU than in the U.S., which generates consumer interest in the diesel due to its superior fuel economy. Europe also imposes higher taxes on gasoline than diesel fuel while the U.S. taxation favors gasoline over diesel fuel. The emission-control regulations for smog and soot from diesels have historically been stricter in the U.S. (especially in California) than in Europe, which has been a factor in facilitating the expansion of the diesel market in Europe and restrained diesel penetration in the U.S. Favorable diesel fuel prices have also been a factor (Cames and Helmers 2013; Walsh 2011).

As concerns about GHGs have become as important as fuel efficiency, the case for expanded use of diesel technology has weakened somewhat. Diesel fuel produces 15% more CO2 emissions per gallon than gasoline (NRC 2015a). Thus, even though diesel engines can achieve 30% higher fuel economy ratings than gasoline engines and thereby help comply with NHTSA's fuel economy requirements, the diesel engine offers only a 12% advantage in carbon emissions compared to a gasoline engine. As a result, shifting from a gasoline to a diesel engine may not, by itself, be sufficient to bring a light-duty passenger vehicle into compliance with EPA's 2025 GHG requirements.

For the consumer, the cost premium on a diesel engine (above a gasoline engine) is substantial. For a mid-sized sedan, the manufacturing cost premium for a base engine is approximately $3,300 to $3,600 per vehicle (NRC 2015a), or at least $4,600 (with a 1.5 retail markup). For applications to large pickup trucks and SUVs, the cost premium (without retail markup) will exceed $5,000. However, the Ford diesel reportedly lasts 100,000- 200,000 miles longer than the gasoline engine and is said to deliver better torque and towing capability (Ford Truck Enthusiasts 2014). Thus, the consumer may see significant practical value in a diesel-powered truck compared to a gasoline-powered truck.

The price of diesel fuel is also higher than the price of motor gasoline. The price spread is typically about 10%, but the spread fluctuates. EIA forecasts that the spread will be 12% ($3.49/$2.95) in 2025 (EIA 2015b). The

persistence of the unfavorable price spread for diesel is due in part to tax policy, as the long-run marginal cost of refining oil into diesel fuel is generally less than it is for gasoline.

Some recent news reports about the Volkswagen diesel scandal have suggested that VW's violations may jeopardize the commercial future of all light-duty diesel technology in the U.S. and Europe (Clark and Sharman 2015). This pessimistic scenario seems unlikely since other German manufacturers (BMW and Daimler), using different emissions-control technology (e.g., selective catalytic reduction with aqueous urea added to the exhaust gas before the catalyst), have had success with their diesel-powered sedans in the U.S. and Europe (Diesel Technology Forum 2017).

In September 2016, GM announced plans to offer a diesel option on the 2018 Chevrolet Equinox—the company's best-selling small SUV—seeking to gain a competitive edge on the Ford Escape and Honda CRV (Colias 2016b). GM has also added a diesel option to the Chevrolet Cruze hatchback, in part to woo customers disaffected by the Volkswagen scandal (Truett 2016a). In 2018 Ford will offer a diesel option on the F-150, seeking to appeal to customers with strong requirements for towing and hauling (Martinez 2017).

Advanced diesel technology is a promising federal compliance technology for vehicle manufacturers, but the price premium for the consumer will be significant. Moreover, a large investment in a diesel strategy will not help companies comply with the ZEV regulation and will help less with EPA's GHG requirements than with NHTSA's fuel economy requirements.

4.64 Conventional Hybrid Technology

Exemplified by the Toyota Prius, the HEV has one integrated propulsion system that draws power from two sources: a combustion engine and an electric motor. Hybrid models vary in the design of their propulsion systems, but they all reduce fuel consumption in three ways: capturing for reuse some of the energy lost during braking (through "regenerative braking"), reducing energy losses during idling, and enabling engine downsizing (NRC 2015a, 130). Mild hybrids are distinct from full hybrids because they embody only some of the fuel-saving features of a full hybrid (e.g., a mild hybrid may have only a stop/start system to reduce idling losses).

A full hybrid can deliver 30+% gains in fuel economy and corresponding declines in GHG emissions. For example, the Hyundai Sonata hybrid delivers 51.5 MPG compared to 36.6 MPG for its gasoline counterpart; the Toyota Camry LE hybrid delivers 57.4 MPG compared to 38.2 MPG for the Camry (NRC 2015a, 132). Since full hybrids often have other features that differ from gasoline comparators, it can be difficult to isolate the fuel economy gain that is attributable to hybridization per se (German 2015).

HEVs are costly because they rely on integrated propulsion systems. For a mid-sized car, full hybridization may entail $2,000 to $2,700 in direct manufacturing costs in high-volume production, or an extra cost to the consumer of at least $3,000 (assuming a retail markup of 1.5). For applications to large pickup trucks and SUVs, the cost penalty for full hybridization is likely much larger (NRC 2015b).

From a performance perspective, HEVs tend to have faster acceleration times from 0 to 30 miles per hour but slower times from 0 to 60 miles per hour compared to gasoline engines (NRC 2015a, 154). In terms of reliability, the nickel batteries in the Toyota Prius have been highly reliable over many years of use but some cautious consumers may have doubts about battery reliability (Consumers Union 2016; Carrns 2013). Thus, there may be some perceptions of hybrid performance or reliability that deter some buyers.

Due to the commercial success of the Toyota Prius (the #1 selling car in California in both 2012 and 2013), a reputable forecaster projected ten years ago that full hybrids might capture 7% of U.S. market share by 2015 (Shamit 2008; Hirsch 2015a). That forecast was overly optimistic, as HEVs accounted for less than 3% of sales in 2015 and 2016.

National hybrid sales grew steadily from 2000-2008, were hurt by the Great Recession in 2009-2010, but surged to their peak in 2013 (547,095). Despite a recovering new-vehicle market, hybrid sales declined in 2014, 2015, and 2016 (DOT 2015; Addady 2016). Survey researchers find that hybrids are favored by many respondents in "intent to purchase" studies, but many of those respondents do not follow through and purchase an HEV (Popiel 2011).

For a company like Toyota, which has a strong edge in HEV technology, one might think offering hybrid engines on a wide range of Toyota products would be a fruitful federal compliance strategy. Indeed, Toyota has expanded its offerings of HEVs significantly over the last several model years into a "Prius family" of vehicles (Undercoffler 2016a).

Following Toyota's lead, the number of HEVs offered industry wide grew from 24 in 2009 to 55 in 2016 (DOE 2016). However, the growth in HEV market share over the same period has been slower, from 2.4% to 3.0%, and the HEV share actually declined in 2015 and 2016 (McLain 2016a; Addady 2016; Libby 2014).

A variety of explanations have been offered for the unexpectedly slow growth of the HEV market share through 2014 and the more recent declines in market share. Each of the following explanations has some supporting evidence or reasoning.

From a financial perspective, the consumer is looking at a long payback period for a hybrid investment. Although the cost of producing hybrids is declining over time, there are still significant price premiums for HEVs compared to comparably-sized gasoline vehicles (German 2015). The recent 2015-2016 decline in gasoline prices has further lengthened the payback period (see our hybrid payback analysis in Appendix I).

Governments have hurt hybrids by rescinding the state and federal tax credits for HEV purchases (e.g., a federal income tax credit up to $3,400 for HEVs expired at the end of 2010) (Beresteanu and Li 2011; Diamond 2009; Chandra, Gulati, and Kandlikar 2010; Gallagher and Muehlegger 2011). Governments have also restricted HEV access to HOV lanes, which had helped boost HEV sales in California and other congested areas (Sewell, Mather, and Bloomekatz 2011; J. R. Healey 2011). California once awarded HEVs partial credits under the ZEV program but CARB has ruled that HEVs will no longer qualify for ZEV credits. The justification for these changes is that HEVs are a known technology that should no longer be subsidized. However, recent surveys have demonstrated that a majority of U.S consumers have a very poor understanding of what HEVs are, so it is hardly surprising that consumers are not willing to pay a premium for them (Kurani, Caperello, and TyreeHageman 2016).

HEVs are also confronting intensified competition from new technologies. Some consumers perceive greener versions of gasoline-powered vehicles (e.g., Ford's Ecoboost engine) as more cost-effective than an HEV. On the other hand, the growth in public subsidies and social marketing for PEVs has channeled "early adopters" away from HEVs to PEVs.

Proponents of the HEV argue that Toyota's new version of the Prius C, which appeared in most showrooms in early 2016, will be crucial in determining the near-term commercial success of HEVs (McCormick 2015). Consumers may have refrained from buying the old version of the Prius because they knew that the new version would be out soon. Preliminary 2016 sales figures for the new Prius suggest, however, that the multi-year decline in Prius sales has not been reversed (McLain 2016a).

Toyota's experience with the new 2016 RAV4 Hybrid, a crossover vehicle, will also be instructive. It is rated at 34 MPG-city, 31 MPG-highway, 33 MPG-overall compared to the gasoline version ratings of 22 MPG-city, 29 MPG-highway, 26 MPG-overall. The RAV4 Hybrid also delivers more horsepower and torque than the gasoline version. Toyota has priced the RAV4 Hybrid only $700 above the gasoline version and the new vehicle is receiving excellent reviews from consumer-facing car publications (Courtney Jones 2016; Edmunds 2016b; Sabatini 2016). One prominent car reviewer describes the RAV4 Hybrid as a "No Brainer Gas Saver," which is a blunt way of saying that the $700 premium is readily recouped in fuel savings.

WHAT HAPPENED TO THE FORD ESCAPE HYBRID?

Ford Motor Company, from 2004-2012, offered a hybrid version of its popular Ford Escape SUV. It was the first full hybrid offered on a light-truck product; the vehicle was visually indistinguishable from its gasoline-powered counterpart. Although the Escape SUV was a highly successful product, sales of the Escape Hybrid never exceeded 15% of total Escape sales. See Table 4.2 below for sales data on the Ford Escape, both total and hybrid sales, coupled with information on the fuel-price environment. In this insert, we consider the story of the Ford Escape Hybrid from the consumer's perspective.

Ford terminated the Escape Hybrid SUV starting model year 2013, when an entirely new Escape SUV was offered. The 2013 Escape was offered with the less expensive Eco-Boost gasoline engine. Ford argued that the Eco-Boost accomplished much of the fuel economy gain of a hybrid at a fraction of the cost of a hybrid system, although EPA certification data show that the fuel economy gain of the hybrid significantly exceeded that of the Eco-Boost.

Ford also launched the dedicated 2013 C-Max Hybrid, seeking to serve a variety of customers, including those interested in a compact SUV; it was Ford's first hybrid-only line of vehicles (Edmunds 2016a). Critics counter that the C-Max Hybrid is not a utility vehicle and lacks the all-wheel drive that attracted almost 50% of the Escape Hybrid buyers (Berman 2011; Voelcker 2016). EPA classifies the C-Max as a large car rather than an SUV. Because the C-Max is a dedicated model (with no gasoline counterpart), it is difficult—like it is with the Prius—to draw any comparative inferences about consumer valuation of fuel economy. Nonetheless, the C-Max has not been selling significantly better than the Escape Hybrid, except for its strong first year on the market (2013 sales: 28,956). So we turn to why the Escape Hybrid did not sell that well.

Table 4.2. Commercial Experience with the Ford Escape Hybrid, 2004-2012

Model Year	Total Escape Sales	Escape Hybrid Sales	% Hybrid	Gasoline Prices ($/gal)
2004	183,430	2,993	1.63*	1.895
2005	165,122	18,797	11.38	2.314
2006	157,395	20,149	12.80	2.618
2007	165,596	21,386	12.91	2.843
2008	156,544	17,173	10.83	3.299
2009	173,044	14,787	8.54	2.406
2010	191,026	11,182	5.85	2.835
2011	254,293	10,085	3.97	3.576
2012	261,008	1,441	0.55**	3.680

Notes: Gasoline prices are the retail national average--including all grades and all formulations--in nominal dollars. *partial year of sales due to late start; **Ford had already publicized new EcoBoost and C-Max offerings for model year 2013.

Sources: Ford Motor Company, as presented and referenced in Wiki; EIA, 2016.

The Escape Hybrid was offered with two trim levels: base and Limited. The comparator vehicles are the Escape XLS (base) and Escape Limited. Three engines were offered: I4, V6, and Hybrid with I4, but the Escape XLS was not offered with a V6. Moreover, the 2010 Escape Hybrid base vehicle had much more content than the Escape XLS (base), including the following 12 special features: 6-way power driver seat, premium cloth seats, digital keypad, compass (external temperature), trip computer, overhead console and storage, climate control, leather steering wheel, dual illuminating vanity mirrors, electrochromatic inside rearview mirror, satellite radio with 6 months service, and USB with external media control (Edmunds 2016a).

With respect to content, the Ford Escape Limited Hybrid and Limited Non-Hybrid are a closer comparison, as both were stacked with content but there were four differences, each favoring the Hybrid: sunroof and sunshade, automatic temperature control, front dual zone air conditioning, and power glass tilting and sliding roof (Edmunds 2016a).

The pricing of the Ford Escape (all variants) rose steadily during the Escape Hybrid's lifetime and the size of the difference between the MSRPs was not consistent from year-to-year. Depending on the year, which two vehicles are being compared, and whether or not adjustments are made for other content differences, the gross price difference for the Escape Hybrid ranged from +$3,000 to +$7,840.

During most of the Escape Hybrid's life, buyers were eligible for a $2,000-$3,000 federal income tax credit; a larger credit for the 2WD version, a smaller one for the 4WD; and the credit was somewhat larger for the second-generation Escape Hybrid (IRS 2006; IRS 2009; KRT 2005). The credit began to decline in size when Ford reached a production cap of 60,000 hybrid units in late 2008; the credit fell to zero in the spring of 2010. Some states added their own cash incentives for hybrids, plus access to the HOV lanes. And Ford and its dealers offered some incentives in some years in some locations.

The bottom line is that the average net price premium for an Escape Hybrid purchase, during the vehicle's lifetime, was probably in the range of $2,000 to $5,000, after taxes and incentives. It is not known whether the Escape Hybrid was priced adequately to achieve profit, since Ford's cost information is proprietary.

One car review makes a slightly different but useful comparison: the list price of the 2010 Ford Escape Hybrid ($29,860) relative to the list price of the average 2010 compact SUV/Crossover, which was $5,413 lower (Axelgeeks 2010). The net Escape Hybrid premium, after the federal tax credit, was $3,413. The reviewer also noted that the rated horsepower of the Escape Hybrid was slightly higher than average while trunk space was slightly smaller in the Escape Hybrid. Otherwise, the difference boils down to price and fuel economy.

Critics of the first-generation Ford Escape Hybrid, offered from model year 2004 through 2007, raised a variety of concerns, though it is far from clear how many consumers felt this way. Concerns were raised about somewhat diminished horsepower and torque compared to the gasoline version, especially the V-6 (Vanderwerp 2004; Edmunds 2016a). The air conditioner would not work when the gasoline engine was off. The stop-start system was a bit primitive, and thus the first movements from a stopping position were somewhat rough (noise and vibration). The regenerative brakes also felt a bit "spongy" to some drivers.

The second-generation Escape Hybrid, offered from 2008-2012, addressed all of these concerns: performance was boosted while the reprogrammed engine smoothed out the stop-start feature, so it felt more responsive like regular hydraulic brakes; an electrically driven air conditioning compressor was added; and, under full acceleration, with both batteries and the gasoline engine engaged, the second-generation Ford Escape Hybrid was considered quicker than the gasoline version. Despite the improvements and rising gasoline prices, sales of the Escape Hybrid did not increase.

The big, and undisputed, advantage of the Ford Escape Hybrid is much higher fuel economy compared to its gasoline comparators, somewhere between 6 and 10 miles per gallon (e.g., 29 vs 23 MPG for AWD or 33 vs 23 MPG for FWD, depending on exactly how the comparison is made). If the owner drives 15,000 miles per year, they would save 135-197 gallons of fuel per year, with corresponding reductions in the number of refueling trips. At an average fuel price of $2.50, $3.00, and $3.50 per gallon, the annual savings in fuel expenses were expected to be $338-493, $405-$591, and $473-$690, respectively. Those savings (undiscounted) are not enough to fully offset the premium price in a short time horizon (say, 3 years) but are large enough to recoup the price premium over the 15-30 year lifetime of the vehicle.

Thus, a short consumer time horizon on fuel savings (and/or a high discount rate on future fuel savings), in conjunction with an aversion to the purchase price premium, is a plausible explanation for the limited commercial appeal of the Ford Escape Hybrid. There are some possible complementary explanations. Some consumers may have been uncertain about the longevity of the batteries and other electrical components, though Ford was offering an 8-year, 100,000 mile warranty on hybrid powertrain components. There was probably some mistrust of the EPA fuel economy labels, especially as they applied to hybrids in real-world driving (Woodyard 2013a). And SUV buyers may simply have very limited interest in fuel economy.

Toyota, though, remains cautious, predicting that only 10-15% of RAV4 buyers will select the hybrid (Woodyard 2016a). The 10-15% range is remarkably similar to the take-up rate for the Ford Escape Hybrid.

Some analysts argue that mild hybrid systems are a more cost-effective investment than a full conventional hybrid, and that helps explain why the market has shifted away from the full hybrid. Although the term "mild hybrid" is somewhat ill-defined, it generally refers to selected components of a full-hybrid system. The "micro-hybrid system" refers to the combination of a stop/start system to reduce idling losses with replacement of alternator functions (e.g., an ultracapacitor to capture a limited amount of regenerative braking energy). An exciting "mild hybrid" development that has not yet been commercialized is the 48-volt system. It could deliver much of the fuel savings of a full hybrid at a lower cost to the manufacturer and consumer (German 2015). Innovation in mild hybrid systems appears to be a priority in the industry (Sedgwick 2016).

Overall, the midterm reviews should carefully explore consumer reactions to the conventional hybrid, as that response is directly relevant to how consumers value fuel economy in real-world choices (German 2015). HEVs should also be considered as to whether they can serve as an effective bridge to PEVs. However, the presence of the ZEV mandate may deter investments in HEVs since CARB has determined that HEVs no longer contribute to compliance with the ZEV mandate. EPA is offering some near-term compliance incentives for hybrid trucks, but CARB is discouraging hybrid trucks in its ZEV program. Innovation in mild hybrid systems, including consumer reactions to them, should be tracked carefully.

4.65 Ethanol Blending

Almost thirty years ago, EPA began to require that refiners blend ethanol with gasoline to reduce U.S. dependence on oil and boost the octane content of gasoline. Environmentally, ethanol was seen as preferable for local air quality because the blend leads to fewer carbon monoxide emissions and smog-forming pollutants than 100% gasoline. The transition from 0% to 10% ethanol—favored by policies of both the Bush and the Obama administrations—was implemented by a rapid increase in production of corn-based ethanol (Graham 2010; 2016).

Corn-based ethanol, although renewable, became a target of criticism because the resulting increase in corn prices triggered protests in the U.S. and abroad, and the clearing of vast amounts of land for ethanol production was seen as environmentally undesirable (Hayes et al. 2009). EPA regulations have been changed to cap the growth of corn-based ethanol but instead compel increased use of advanced cellulosic ethanol that is made from corn stover, switchgrass, or various waste products (Harder 2016). The commercial viability of cellulosic ethanol remains uncertain but demonstration projects are underway (Bomgardner 2016).

From a consumer perspective, ethanol blending has a downside because ethanol has less energy content than gasoline, which means that a car will go fewer miles on the blend than on 100% gasoline (DOE 2017b). Ethanol is also more expensive to produce than gasoline. Nonetheless, the use of "E10" (a 10% blend of ethanol) has become widespread in the U.S. and, in some Midwestern states where ethanol is popular, significant quantities of E85 are being sold. In order to run on E85, an adjustment to the vehicle's fuel system is needed in order to prevent corrosion and damage to the vehicle's emission control system.

For many years the NHTSA CAFE program and the EPA GHG program offered generous compliance credits—also called "flex-fuel credits" (FFV)—to vehicle manufacturers that designed fuel systems that could accommodate varying blends of gasoline and ethanol. Those credits are being phased out by the federal government, which is consistent with the decision of the U.S. Congress not to renew tax credits and certain subsidies for ethanol. As FFV credits are phased out, vehicle manufacturers will need to find new ways to enhance CAFE and GHG compliance values, since the ethanol credits were used widely in the industry. In 2014, for example, the average vehicle manufacturer subtracted 9 grams of CO2 per mile from its compliance value due to the availability of FFV credits (EPA 2016c).

4.66 Plug-In Electric Vehicles

Plug-in electric vehicles (PEVs) come in two general forms: the plug-in hybrid electric vehicle (PHEV) and the battery-electric vehicle (BEV). Large-scale studies show that a BEV with 75-100 miles of driving range is adequate to meet the energy requirements of 87% of vehicle days in the U.S. (Needell et al. 2016). The PHEV is more versatile because its driving range is typically as good as or better than a gasoline-powered vehicle. A 2016 survey of 1,052 U.S. adults suggested that two thirds of respondents are confused about the difference between a BEV and a PHEV (J. White 2016).

Compared to a gasoline vehicle of similar size, a BEV has several attractive features: electricity is generally a less expensive source of energy than gasoline; fewer maintenance costs such as oil changes; less interior noise and vibration from the powertrain; often better acceleration at lower speeds; the convenience of recharging at home; and zero tailpipe emissions. The tradeoffs for the consumer, however, can be significant: a higher initial cost due to the expensive lithium ion battery pack; uncertain battery longevity; restricted driving range (typically 75-100 miles, though ranges are improving); and long recharging times (3-4 hours if a Level 2 charging station is available).

The PHEV can be seen as a compromise between the conventional HEV, which cannot be plugged into the electrical grid, and the BEV. The big advantage of the PHEV is that the vehicle's driving range is superior to the BEV. Since PHEVs vary enormously in their electric-only range, they also vary in how much gasoline they save and in how clean they are.

In 2016, about 159,139 PEVs were sold in the U.S., about 0.9% of the 17.5 million new vehicles sold, as shown in Table 4.3 (Cole 2017). The PEV penetration rate is much larger in California (about 3%) than in most other states. The current market distribution of BEVs vs PHEVs is about 50-50, with Tesla's products dominating the BEV market and the Chevrolet Volt the best-selling PHEV. Consumers who decide against purchasing a PEV often express uncertainty with regard to their confidence in these vehicles' reliability and durability (Sierzchula et al. 2014; NRC 2015a). The key challenge for PEVs in the U.S. market is to move beyond the "early adopters" into the mainstream retail market for new vehicles.

4.67 Hydrogen Fuel Cell Vehicles

Several vehicle manufacturers (especially Toyota, Honda, Hyundai and General Motors) believe that a hydrogen fuel cell vehicle (FCV) could have greater long-term promise than a BEV. The FCV has no tailpipe emissions, no serious range limitations, and no performance disadvantages. It can be refueled by consumers in the same way that consumers refuel a gasoline-powered vehicle. The tradeoffs are initial cost (still much larger than a BEV), the need for a source of clean energy to produce the hydrogen, and the need for a network of hydrogen refueling stations. A large amount of space is required for the hydrogen fuel tank, which could compromise trunk space or interior volume, but some BEVs—due the large size of battery packs—have a similar problem. Progress in R&D

Table 4.3. U.S. PEV Sales: Number of Offerings, Total Sales, and Average Sales per Offering

Year	Number of PEV Models	Total PEV Sales	Average Sales per Model
2010-2011	3	17,425	5,808
2012	9	52,607	5,845
2013	16	97,507	6,094
2014	22	122,438	5,565
2015	28	116,099	4,146
2016	32	159,139	4,973

Source: Inside EVs. Monthly Plug-In Sales Scorecard; http://insideevs.com/monthly-plug-in-sales-scorecard/

is rapidly reducing the cost of producing FCVs and making them more appealing for consumers (Schoettle and Sivak 2016), but, for the foreseeable future, FCVs appear to be a less cost-effective approach to carbon control than PEVs (Felgenhauer et al. 2016).

Toyota, Hyundai, and Honda are, or once were, selling a limited number of FCVs in California. FCVs qualify as ZEVs and earn bonus compliance credits under the ZEV program. The State of California, in partnership with vehicle manufacturers, is using public money to establish a limited number of hydrogen refueling stations. Nonetheless, it is much too early to gauge how difficult it will be to sell FCVs to large numbers of consumers.

4.7 Special Behavioral Challenges Posed by AFVs

Switching to a fuel other than gasoline is appealing to many consumers, but there are several barriers to the deployment of any alternative fuel vehicle (AFV). Those barriers relate to lack of consumer awareness, misperceptions, cost, and inadequate refueling infrastructure.

A 2016 Harris survey commissioned by Ford (N=1,052 U.S. residents) found that 67% of respondents do not know anyone who has owned a hybrid, BEV or PHEV. Three-quarters of respondents were "not at all sure" about the maximum driving range of a PHEV on a single charge. Their guesses wildly underestimated the ranges of PHEVs, suggesting that respondents may have confusion about how PHEVs differ from BEVs (LeSage 2016).

For PEVs, the challenge of moving beyond the early adopter to the mainstream consumer is substantial. A September 2016 survey of U.S. adults (N=542) found that almost 80% of respondents reported "no prior experience" with PEVs (Schoettle and Sivak 2016). A recent review of surveys concluded that PEV awareness levels are low: a majority of adults cannot name a single PEV (Plug In America 2016). Even in California, where there has been substantial governmental promotion of PEVs, a 2016 survey found that a majority of consumers in the state have not yet made a decision as to whether they are interested in a PEV (Kurani, Caperello, and TyreeHageman 2016).

NRC (2015b) identified barriers specific to the adoption of PEVs. These include "limited variety and availability of PEVs; misunderstandings concerning range of PEVs; difficulties in understanding electricity consumption, calculating fuel costs, and determining charging infrastructure needs; complexities of installing home charging; difficulties in determining the 'greenness' of the vehicle; lack of information on incentives; and lack of knowledge of unique PEV benefits." Many other studies confirm these findings (Carley et al. 2013; Krause et al. 2013; Plug In America 2016).

Moreover, consumers are wary of new, unproven technologies. Some consumers might reason: I will let other people experiment with this technology before I take the gamble. In the face of risk and uncertainty, consumers will often turn to the familiar choice: a vehicle with an internal combustion engine (Egbue and Long 2012; NRC 2015a; NRC 2015b; Siddiki et al. 2015).

One of the big uncertainties is the availability of fuel. In much of the country, fuel infrastructure is underdeveloped for electricity, hydrogen, compressed natural gas, and even diesel in some areas. As more AFVs are sold, more fueling stations are added, and gasoline prices rise, demand for these vehicles should rise accordingly. However, consumer demand may not rise quickly enough to allow manufacturers to meet the federal and ZEV standards set for 2022-2025. In addition, the costs of AFVs are typically higher than that of conventional vehicles. Although consumers might see net savings over many years of ownership, current fuel prices are too low to generate large near-term benefits (Frades, Nigro, and Fazeli 2015).

The perceived value of a BEV will not be the same for all consumers. The real or anticipated travel behavior of the consumer can serve as a primary reason for a consumer's decision not to purchase a BEV. The average household takes approximately three trips and drives approximately 30 miles per vehicle per day, resulting in an average trip length of less than ten miles (FHWA 2011). These trips consist of about 71% of all trips and 25% of all vehicle

miles traveled. A more in-depth study found that the energy-requirements of 87% of vehicle days in major U.S. cities could be met by existing, affordable short-range PEVs (Needell et al. 2016).

Consumers also care about the less frequent, long-distance, high-energy trips. For instance, although long trips (of more than 100 miles) represent less than 1% of total trips taken (and 16% of vehicle miles traveled), a consumer's desire to have the freedom to take these trips may dissuade them from purchasing limited-range BEVs (NRC 2015b). Even if affordable 200-mile PEVs are offered, and recharging is widely available, owners may still require supplemental mobility services such as car sharing or a second vehicle for the highest-energy trips (Needell et al. 2016). This concern is especially weighty if a consumer anticipates that he or she will take several trips of long length each year. Additionally, the PHEV, with its ample driving range, may be more appealing than a BEV to the many buyers who seek a vehicle that can accomplish both long and short trips without refueling (Graham et al. 2014).

Studies are only beginning to sort out which demographic subgroups are more and less inclined toward specific AFVs. Helveston et al. (2015) found that older, wealthier, and more educated consumers—especially those who own multiple vehicles and have children in the household—are less sensitive to upfront and operating costs. Higher income consumers are also less interested in HEVs or PEVs. Consumers with lower incomes demonstrate more receptivity toward PEVs but, since PEVs tend to be expensive, lower-income households typically cannot afford them. Therefore, current purchasers of PEVs are on average more educated and have substantially greater incomes than purchasers of conventional vehicles (NRC 2015b).

In accordance with these findings, the states with the strongest PEV markets are those with high environmental consciousness, incentives in place for purchasing and owning these vehicles, and mandates for cutting carbon emissions (NRC 2015b). Nonetheless, even when financial incentives are available, consumers have been shown to be largely unaware of them. Krause et al. (2013), studied adult drivers in 21 large U.S. cities and found that 75% of respondents underestimated the value and advantages of PEVs, and 94.5% of respondents had no knowledge of state and local incentives for the purchase and use of these vehicles. On the other hand, Krause et al. (2013) found that consumers underestimate the price of a PEV. Many consumers may not fully value PEVs unless they are provided information on the monthly total cost of ownership of these vehicles, compared to an otherwise similar gasoline vehicle; current vehicle labels, however, do not provide this level of detail to potential car buyers (Dumortier et al. 2015).

Improved education about current incentives, and the potential U.S. application of other PEV incentives used around the world (Lane et al. 2013), could drive the market for these vehicles forward. However, it is not clear which public organizations have the responsibility and resources to undertake such a large-scale public education effort. CARB, EPA, and NHTSA are primarily regulatory bodies, with limited track records in public education. The Department of Energy (DOE) has strong technical programs, but much less experience in the social science aspects of promoting alternative fuel vehicles. DOE's Clean Cities program of AFV promotion is a coalition-based activity in over 100 cities but it lacks a strong research program in economics and the behavioral and social sciences. A priority for the midterm reviews should be a resolution about the responsibility for public education and research in this field.

Despite all of these barriers, PEVs have been experiencing relatively rapid commercialization—a more rapid rate of growth than that seen when HEVs were first introduced (see Table 4.4). Specifically, sales of PEVs in the U.S. grew at more than twice the rate of that of HEVs when comparing their first 34 months of sales (Graham et al. 2014).

Government subsidies and tax credits, coupled with relatively high gasoline prices, spurred much of the early growth in sales of PEVs. HEVs were eligible for only a small federal income tax deduction during the early years of Prius marketing. It was not until 2005 that Congress authorized a federal tax credit for the Prius (and other HEVs). Its maximum value ($3,400) was less than a half the $7,500 Congress authorized for PEVs in 2009. And it took several years for the Prius to acquire access to the HOV lanes in California and other states. Whether the next decade will see such favorable tax and HOV-lane treatment of PEVs in the U.S. seems increasingly uncertain.

Table 4.4. Recent Decisions by Selected High-Volume Vehicle Manufacturers to Offer PEVs

- Nissan is offering the 2017 Leaf, a BEV with 107 miles of range on a single charge, and has announced plans to offer a new low-cost BEV within two years (Cuthbertson, 2016).
- In addition to the Chevrolet Volt, a PHEV with 53 miles of all-electric range, GM is offering the new 2017 Chevrolet Bolt EV, a BEV, with 238 miles of range on a single charge (Team 2016).
- In addition to its 2017 i3, a BEV sedan with an optional gasoline range extender, and its 2017 i8 PHEV, BMW has announced plans to develop electric versions of its Mini, BMW 3 Series, and X4 SUV models (Reuters, 2016).
- Ford has announced plans to offer 13 PEVs and HEVs by 2020 in addition to an updated version of the Ford Focus Electric with new fast-charging capability (Naughton 2016).
- Volkswagen has announced global plans to boost the number of BEVs and PHEVs offered to 20 models by 2020 (Hetzner 2016; Boston 2016).
- Daimler has announced plans to bring more than six PEV models to the US market between 2018 and 2024 (Taylor and Sheahan 2016).
- Hyundai/Kia has announced plans to offer eight PHEVs and two BEVs by 2020 (Mims, 2016).
- Toyota is offering the 2017 Toyota Prius Prime, a PHEV, and has announced plans to offer one or more BEVs by 2020 (Schmitt, 2016).
- Honda has announced plans to offer the Clarity hatchback as a BEV and PHEV in 2017 as well as longterm plans to expand offerings of electrified vehicles (Kubota, 2016).

4.8 Consumer Valuation of Economy

4.81 The "Early Adopters"

A small percentage of "early adopters" care deeply about fuel economy and environmental protection (Helveston et al. 2015; NRC 2015a; 2015b). The size of the potential early-adopter population is a key statistic for fuel economy innovators but there is no consensus on precisely how small is small.

One method is to quantify the number of consumers who identify fuel economy as the most important factor in determining which new vehicle to purchase. According to the 2013 survey of the National Automobile Dealers Association (NADA) (at a time of relatively high fuel prices), 14% of respondents chose fuel economy as the most important factor (second only to "quality and dependability"). NADA finds somewhat greater interest in fuel economy among car buyers than among SUV/truck buyers (NADA 2015). Nonetheless, even consumers who value fuel economy highly do so in the context of a variety of attributes that they care about; and consumers who say fuel economy is a top concern do not necessarily purchase fuel-efficient vehicles (NRC 2015a).

The early adopters of PEVs in the U.S. and abroad have followed a familiar pattern in the auto sector. PEV buyers tend to be young, male, highly educated, live in urban areas, have high incomes, are technologically sophisticated or wish to make a pro-environment statement, are likely to have been an early adopter of the Prius, and often own multiple vehicles (NRC 2015a; Figenbaum et al. 2015).

Overall the purchasers of PEVs and HEVs have higher incomes than purchasers of new gasoline-powered vehicles. Recent U.S. data on the median household incomes of new car buyers ranged from $128,000-$148,000 for PEV buyers, $90,204 for HEV buyers, and $83,000 for buyers of gasoline vehicles (NRC 2015b). Median household income in the U.S. is just over $50,000 (U.S. Census Bureau 2015).

In 2016, a year of record total vehicle sales and PEV sales in the U.S. (see Table 4.3), it is revealing that high-end models are driving the upward sales trend: the Tesla Model S and X and the BMW i3. The more affordable PEV models (e.g., the Nissan Leaf and the Chevrolet Volt) are not keeping pace in sales volume (Woodyard 2016b; von Kaenel 2016). In other words, PEV sales are largely confined to the "early adopter" segment, with only limited penetration of the mainstream retail vehicle market.

In order to move beyond the early adopters, PEVs must have a compelling and tangible value proposition. For example, in California, where the market is moving beyond early adopters, the most frequent motivation for purchasing a PEV is to "save money on gasoline or diesel fuel" (Kurani, Caperello, and TyreeHageman 2016). The same study found that health hazards of local air pollution are also a key motivator in California but that sentiment may not be as strong in other states.

The temporary, unexpected decline in PEV sales in 2015 has been attributed to falling fuel prices but there is an alternative interpretation. Many upscale consumers may have been aware that a variety of new PEV offerings were scheduled for release in 2016, and thus they delayed their purchase (von Kaenel 2016).

What is clear is that the rate of growth in total PEV sales seems to be slowing in the U.S., despite a growing number of plug-in models for consumers to choose from (see Table 4.3). A possible explanation is that the population of early PEV adopters is nearing exhaustion, at least in those cities that have made the necessary start-up investments in public education and recharging infrastructure. Alternatively, it is possible that many early adopters are waiting for the arrival of new PEV models (e.g., Tesla's Model 3 or GM's Chevrolet Bolt). More growth in early-adopter sales should be expected as battery prices decline, the driving range of BEVs is lengthened, and more states and cities become ready for PEVs.

4.82 The Rational-Choice Buyer

From a rational-choice perspective, the new vehicle consumer will purchase a new vehicle with superior fuel-saving technology if, other things equal, the present value of the stream of fuel savings is greater than the upfront cost of the technology. As summarized by NRC (2015a, 312), federal regulators argued in 2012 that the 2025 standards are a good investment for consumers. While the 2025 CAFE standard was estimated to increase the average price of a new vehicle by about $1,800 (relative to the 2016 standard), the consumer was estimated to save $5,700 or $7,400 over the long lifetime of the vehicle (up to 30 years for cars, 37 years for light trucks), depending on whether a 3% or 7% annual discount rate is applied to future fuel savings (NHTSA 2012a). The investment appears to be so attractive that the 2025 standards might increase vehicle sales if consumers are aware of the large fuel savings and do not undervalue them (NRC 2015a, 312).

The above assertion, by itself, can be questioned because the vehicle-sales impacts of regulatory standards depend on affordability issues and on how consumers actually perceive and value fuel savings in the automotive market. With respect to affordability, many consumers have an upper limit on what they can pay for a new vehicle, a limit that is defined by how much they can borrow and how large of a car payment they can manage and get approved. If a costly new fuel-saving technology is mandated, consumers may need to delay their purchase, shift to the used-car market (where prices are lower), or forgo other features or options that they desire (e.g., downsize, or give up 4-wheel drive, or compromise on trim level or engine size). Fuel savings later in the life of the vehicle do not change the basic affordability issues for consumers that face a binding budget constraint in the short term.

If the fuel-saving technology is affordable, then there is the question of whether the perceived fuel savings, in the eyes of the consumer, are worth the price premium for the technology. Resolution of this question must account for a variety of real-world complications and insights from behavioral economics, in addition to the predictions of rational-choice theory. We consider here several real-world behavioral complications: (1) fuel-price expectations, (2) consumer time horizon on fuel savings (or the related concepts of time preference or discount rate), (3) perceived resale value of the vehicle, and (4) consumer valuation of non-monetary attributes of vehicles.

EPA analysts make a plausible defense of the above comparison by describing it as a measure of "experienced utility" (a prediction of consumer well-being after the regulation takes effect and the consumer experiences their fuel-efficient vehicle) rather than "decision utility" (how consumers perceive their well-being will be impacted at the time of vehicle purchase). Fischer et al. (2007) suggest it is possible for a regulation to make consumers better off over time than consumers thought they would be without a regulation or prior to adoption of the regulation (Helfand and Dorsey-Palmateer 2015). For our purposes, where impacts on new vehicle sales are based on a key behavioral variable, it is the "decision utility" approach that seems more appropriate since it simulates the choice of the consumer when the purchase decision is made.

4.821 Fuel-Price Expectations

The fuel-savings estimates of $5,700 or $7,400 are based on official EIA forecasts of gradually rising gasoline prices over the life of the vehicle. A consumer's perception of future fuel prices may deviate from the forecasts of federal agencies. Recent evidence suggests that consumers, when making purchasing decisions, do not forecast—as EIA does—that fuel prices will rise gradually after the vehicle is purchased. Instead, consumer beliefs about future fuel prices, absent any recent price shocks, are similar to a no-change forecast (Anderson, Kellogg, and Sallee 2013; Anderson, Kellogg, et al. 2011). In other words, from the perspective of consumers, the fuel prices observed in the months prior to their purchasing decision are assumed to persist for the foreseeable future, a phenomenon that we explore in depth in our own modeling work in section 8.

4.822 Consumer Time Preferences about Fuel Savings

When consumers purchase a new vehicle, they do not plan on keeping the vehicle for its entire lifetime. The average vehicle lifetime is 14 years and rising, while the maximum lifetime is 30 years for cars and 37 years for trucks. A majority of consumers own the vehicle for less than seven years, many for only three or four years, and then trade it in for a new vehicle or sell it in the used-car market (NRC 2015a; CAR 2011). Consequently, we need to understand how new-vehicle consumers value fuel savings during their anticipated period of vehicle ownership and how, if at all, they consider the resale value fuel economy technology in their original purchasing decision.

Practical experience with fuel-saving technologies over several decades has cast doubt on the notion that new vehicle purchasers are strongly interested in fuel economy. In the 1970s, after the Arab oil embargo, Chrysler had only limited commercial success with the Plymouth Feather Duster and Dodge Dart Lite (rated the most fuel-efficient small car). From 1990-2005, Honda consistently offered more fuel-efficient technology than any other major automaker (e.g., the Variable Valve Timing and Lift Electronic Control (VTEC) system). Indeed, Honda's hybrid Insight was offered in the U.S. slightly ahead of the Toyota Prius. However, according to one industry expert, the company was not rewarded with appreciable gains in sales relative to other automakers, and thus Honda chose to relinquish its role as U.S. industry leader in fuel economy, though it remains a fuel economy leader in many countries where fuel prices are high (German 2016b).

4.8221 Insights from Consumer Decisions about Conventional Hybrids

In response to rising fuel prices from 1990-2007, more automakers made efforts to sell fuel economy. Toyota led with the first successful hybrid car, the Prius, which (boosted by HOV lane access and federal and state tax credits) became the largest selling car in California in 2012 and 2013. The buyers of the Prius extended well beyond the "early adopter" population and included financially-oriented buyers (Klein 2007). The Prius success has not been easy to replicate by Toyota or other automakers.

Ford Motor Company licensed technology from Toyota to offer its precedent-setting hybrid SUV, a hybrid version of the popular Ford Escape SUV (Berman 2011). After almost a decade of sluggish commercial experience, Ford discontinued the Escape Hybrid in 2012 and pursued a different approach to fuel economy enhancement. See our case study of the Ford Escape Hybrid on pp.38-39.

In 2016, there were 29 conventional hybrids offered for sale in the U.S. in different vehicle classes where a comparator gasoline vehicle could be identified. Hybrids typically had a significant price premium ($5,322 on average) but offered sizeable (undiscounted) fuel savings to the purchaser over the life of the vehicle (Vincentric 2016). After five years of use, six of the 29 vehicle offerings had fuel savings that exceeded the hybrid's price premium; after 10 years of ownership, almost half (14 of 29) offered fuel savings greater than the price premium.

Previous versions of the same study (Vincentric 2014; 2015) found that, when fuel prices were higher (almost $4/gallon), a much larger percentage of the hybrids offered net consumer savings over five or ten years of ownership. However, only the Toyota Prius has achieved high sales volume in the marketplace. A reviewer of the 2014 study of hybrids, citing the low national rate of hybrid sales, noted that "the fuel savings were not large enough to motivate most consumers to pay for the incremental cost" (German 2015).

When new car shoppers asked questions from 2005-2015 about the financial case for a hybrid purchase, consumer-facing experts in the industry would typically respond that the payback period (using undiscounted fuel savings) is longer than three to five years but shorter than 10 years for most hybrid models (Ransom 2008; Krebs 2012). Notice that the refinements to the gasoline engine stimulated by the federal standards have shorter payback periods while PEVs have longer payback periods than the conventional hybrids.

As a result of decades of real-world experience with fuel-saving technologies, practitioners are in broad agreement that most new vehicle consumers tend to be somewhat impatient about fuel savings. NRC (2015a, 315), in its information-gathering process, "found that auto manufacturers perceive that typical consumers would pay upfront for only one to four years of fuel savings, a fraction of the lifetime-discounted present value." Repeated national surveys, which make use of the stated preference method of consumer valuation, also suggest that consumers focus primarily on fuel savings accrued during the three years after purchase (Greene, Evans, and Hiestand 2013).

As a result, the typical approach of analysts has been to include only a few years of fuel savings and/or apply a high real rate of discount to future fuel savings. For example, Small (2010) described "consumer myopia" as "the predominant view," and captured it in his model by considering only three years of fuel savings coupled with a 15% annual discount rate on those savings.

4.8222 Insights from the "Energy-Efficiency Gap" Literature

The growing academic literature on energy economics sheds further light on consumer valuation issues and has challenged some of the conventional wisdom in the auto industry. The literature uses the term "energy efficiency gap" to describe the situation where consumers and/or firms fail to adopt energy saving technology, despite the fact that doing so would lower energy expenditures by more than the cost of adopting the energy-efficient technology (Greene 2010). From an econometric perspective, the phenomenon of an "energy gap" or "consumer undervaluation" is difficult to distinguish from a setting where consumers with different preferences about fuel economy are sorting themselves into different types of vehicles (Bento, Li, and Roth 2012). Nonetheless, Allcott and Greenstone (2012) and Greene and Welch (2016) identify two main strands of the empirical literature on autos that have attempted to determine the existence of the energy gap.

The first strand, which covers engineering-economic studies, estimates the net present value of a set of possible energy efficient investments. This strand generally finds evidence of a substantial efficiency gap (Rosenfeld et al. 1993; Greene, German, and Delucchi 2008; Granade et al. 2009; Greene 2011). NRC (2015a) provides a useful summary of this literature as it applies to automobile fuel economy, and concludes that there is a good deal of evidence to support the gap. This line of evidence is generally consistent with validated concepts in psychology, decision theory, and behavioral economics such as consumer bias for the present (sometimes called "present bias"), inattention, and risk aversion toward new technologies (Allcott and Greenstone 2012; Greene and Welch 2016).

The second strand of evidence, based on econometric analyses of large market data sets, advances the hypothesis that changes in the fuel cost of a vehicle are capitalized in the vehicle's market price. Therefore, the energy gap exists if, relative to a fuel inefficient vehicle, the increase in market price of a fuel-efficient vehicle is less than the increase in the present discounted value of fuel costs. The evidence from this strand of the literature favors the conclusion that the gap either does not exist or is modest in magnitude (Busse, Knittel, and Zettelmeyer 2013; Allcott 2013; Allcott and Wozny 2014; Sallee, West, and Fan 2016).

The study by Busse et al. (2013) is particularly notable because it challenges the widespread view that consumers are "myopic" about fuel economy. The data are a 20% sample of all U.S. 1999-2008 vehicle transactions. They show the effect of short-term changes in gasoline prices on short-run equilibrium prices of vehicles. They also show that market shares of vehicles with different fuel economies are sensitive to changes in fuel prices. For both new and used vehicles, they show that fuel-efficient vehicles command higher prices when fuel prices are high than when fuel prices are low. In many of their simulations, the implicit consumer discount rates on future fuel savings are relatively low, near or below the real rates of interest on car loans. They "find very little evidence of consumer myopia" (Busse, Knittel, and Zettelmeyer 2013, 253).

Allcott and Wozny (2014) use short-term variation in fuel prices from 1999-2008 to examine consumer interest in fuel economy as revealed by 45 million used-car transactions at auctions. The Kelley Blue Book and other retail price guides are typically based on auction prices. The vehicles are ages 1-15 years old. Like Busse et al. (2013), Allcott and Wozny (2014) find that used-vehicle prices are sensitive to short-term changes in fuel prices. However, they find some evidence of consumer undervaluation; consumers value only 55% or 76% of future fuel savings, depending on how consumers are assumed to forecast future fuel prices. Allcott and Wozny (2014) find relatively little consumer undervaluation of fuel savings in the early years of a vehicle's life; undervaluation is concentrated later in the average vehicle's 15-year lifetime.

The results reported by Busse et al. (2013) and Allcott and Wozny (2014) are not necessarily inconsistent. Allcott and Wozny (2014) note that the implicit discount rates reported by Busse et al. (2013) are actually quite variable, ranging from -6.2% to +20.9%. When the assumptions in Busse et al. (2013) were aligned with the assumptions in Allcott and Wozny (2014, 782), the implicit discount rate was +13%, which is considerably larger than the typical 6-7% real interest rate on car loans applicable to the relevant study period. However, the implicit discount rate in Allcott and Wozny (2014) that is most consistent with a flat fuel price forecast and full valuation of fuel savings is 24% (Allcott and Wozny 2014, 790). Because this discount rate is substantially higher than the historical average auto-loan rate of 7%, this may be taken as evidence of undervaluation. In our own modeling in section 9, we make use of the 55% valuation estimate but we also report alternative results for 100% consumer valuation—the position favored by Busse et al. (2013) and Sallee, West, and Fan (2016).

The above studies, though based on a rich body of information about real-world consumer decisions, are of questionable relevance to assessing how new-vehicle consumers would evaluate innovative fuel-saving technologies stimulated by regulation. For instance, most of the data are drawn from the used-vehicle market. Only two of the studies (Busse, Knittel, and Zettelmeyer 2013; Allcott and Wozny 2014) contained data on new vehicles, and Allcott and Wozny did not analyze the new car data separately. It is well known that consumers of used vehicles are different from consumers of new vehicles, and it is not obvious how to adjust the findings from the used-car market for use in the new vehicle market.

Moreover, the recent studies draw their inferences from short-term movements in fuel prices. Behavioral scientists have speculated that consumers may be particularly sensitive to near-term changes in fuel prices, since consumers pump their own gas and watch price and expenditures as they do so (Ariely 2008). The consumer's short-term response to higher prices at the pump may be different from their long-term response as the consumer becomes accustomed to higher prices and modifies their original (over)reaction (Greene and Welch 2016).

Most importantly, all of this recent evidence drawn from fuel-price changes does not directly study consumer responses to new fuel-saving technologies mandated by regulation. For example, fuel-price changes often motivate consumers to choose a different size class of vehicle and/or size of engine. Both of those choices are

well known to affect fuel economy, but do not cause the same kinds of consumer uncertainty associated with purchasing a new fuel-saving technology or alternative-fueled vehicle. There is no doubt that consumer interest in AFVs is affected by changes in fuel prices but the econometric studies of fuel-price changes do not isolate the consumer's evaluation of new technologies. How a consumer values fuel economy due to a change in fuel price may not be the same as how that consumer values fuel economy due to unfamiliar new technologies. Consumer valuation is further impacted by uncertainties about potential fuel savings and the subtle effects on a vehicle's functionality or drivability due to new fuel-saving technologies.

Ideally analysts should study how consumers react to new fuel-saving technologies, since that is what the regulations stimulate, but this will be challenging. The growing body of real-world evidence of consumer reactions to hybrid offerings is arguably more directly relevant to the regulatory analysis questions faced by the federal agencies; it suggests that the typical consumer does not value a vehicle's entire lifetime of fuel savings at the time of original purchase. If the consumer did so, the rate of hybrid sales—which typically have payback periods less than the projected vehicle lifetime—would presumably have been much higher in the U.S. from 2000-2013, when fuel prices were high and rising (Vincentric 2016; 2014; 2015; Montoya 2014).

However, sluggish hybrid sales do not necessarily conflict with full valuation of fuel economy because the apparent energy efficiency gap may have other cogent explanations (Allcott and Greenstone 2012). For example, consumers may resist a new fuel-saving technology if the valued attributes of the vehicle may be compromised or if the consumer fears that they could be compromised. In fact, this possibly explains why the energy-economics literature explores the energy gap using changes in fuel price rather than changes in fuel-saving technology. It is very challenging to assess econometrically whether sluggish hybrid sales are due to undervaluation of fuel savings or concerns about the performance of hybrid vehicles (even if those concerns are unfounded). Some authors refer to such effects as "hidden amenity losses," since they are not reflected in the cost of the technology (Small 2010).

In short, consumers may be turned off by perceived compromises caused by new technology and therefore prefer to let other consumers try the innovation before spending money on what may be seen as a risky investment (NRC 2015a; NRC 2015b). We discuss the possible hidden losses below, after we consider the role of resale value in the market for fuel economy.

4.823 Resale Value of Vehicles

NHTSA (2012a) reported that the average residual value of a vehicle after five years of ownership was 35%; CARB (2011a) used a figure of 50%. Both values are undiscounted. Those agencies further assumed that new vehicle consumers make unbiased forecasts of these residual values, that the values are applicable to fuel-saving technology (as well as the vehicle as a whole), and that these values are unaffected by fuel price. As we explain below, these are strong assumptions that are not highly consistent with the literature on energy economics reviewed above.

A car with increased fuel economy will save consumers money throughout the entire vehicle lifetime. Since the average new vehicle consumer holds on to the vehicle for less than half of its useful lifetime, the resale value of a vehicle with new fuel-saving technology should be considered, at least from a rational-choice perspective. From a behavioral economics perspective, the role of resale value in the original consumer's choice of a new vehicle is uncertain and complicated.

Fuel economy may seem less salient to the used car buyer than to the new car buyer because the EPA fuel economy label, which supplies standardized MPG data for all new vehicles, is not available on used cars (Saulsbury et al. 2015; Austin and Dinan 2005). If the consumer is motivated to search, there are plenty of websites that supply information on the fuel economy and resale value of different makes and models (e.g., Kelley Blue Book, NADAguides.com, Edmunds.com, Fueleconomy.gov, and ALG). Nonetheless, the U.S. Department of Energy has launched an entire public education program to help used car buyers better understand fuel economy (Saulsbury et al. 2015).

In the used-car setting, there is a distinctive and crucial attribute—condition of the vehicle—that is of strong concern to the buyer. That focus may tend to reduce the significance of second-order attributes, such as fuel economy (German 2016b). Vehicle condition is obviously not an issue for the new vehicle purchaser.

Purchasers of used vehicles are more price constrained than new vehicle buyers, presumably because of differences in average income and assets. Their price sensitivity may make them particularly averse to the cost premium for a car with superior fuel economy technology. On the other hand, lower-income households spend a larger share of their after-tax income on gasoline than higher-income households (Greene and Welch 2016; Farrell and Greig 2015). Therefore, technology that decreases gasoline expenses may have special appeal to the lower-income, used car buyer.

Rational-choice theory also predicts that consumers will consider how the likely resale value of a vehicle is influenced by fuel prices. Other things equal, a vehicle with good fuel economy should command a higher price in the used-car market than a vehicle with poor fuel economy. Price data from used-vehicle auctions in 2008-9, when fuel prices were high, found a premium for vehicles with higher-than-average fuel economy, including hybrids and diesels (Gilmore and Lave 2013). Indeed, the econometric analyses reviewed above have shown that the price premium for a used vehicle with superior fuel economy is greater when fuel prices are high than when fuel prices are low (Busse, Knittel, and Zettelmeyer 2013; Allcott 2013; Allcott and Wozny 2014; Sallee, West, and Fan 2016). This insight needs to be incorporated into how NHTSA and EPA RIAs model consumer reactions to fuel-saving technology; our modeling in section 9 provides a starting point for the agencies.

There are consumer information problems related to depreciation rates and resale values. When a national sample of 1,004 Canadian drivers were asked what they think is the greatest monthly cost of owning a vehicle (from a menu of choices), responses were 33% insurance, 29% gas/fuel, 24% maintenance, 3% loan payments, and 9% other responses or don't know. Only 1% of respondents selected the correct answer: depreciation (Canadian Black Books 2016). New passenger vehicles lose about 11% of their value immediately after they are sold, and their value depreciates 15-25% per year for their first five years of age (Greene and Welch 2016). At the same time, assumptions about the annual rate of depreciation in comparative vehicle cost studies vary substantially. Sharma et al. (2012) use a constant rate of annual depreciation of 6%, Gass et al. (2014) assume a rate of 33% for EVs and 22.5% for diesel ICEs, while Al-Alawi and Bradley (2013) apply a rate of 13.8%, which is the historical rate of depreciation of the first generation Toyota Prius. If experts as well as consumers are uncertain about depreciation rates and resale values, one should not assume that new-vehicle consumers consider future resale value in a highly informed, rational manner.

The peer reviewed literature has, for the most part, failed to address the behavioral expectations of new-vehicle consumers on resale values. However, some constructive insights from recent surveys may be relevant here. About half of the respondents in the Canadian survey described above were planning to purchase a vehicle within the next 18 months. Many consumers consult information on resale values when they prepare to trade in their car or sell it in the used car market. New vehicle purchasers rarely do so, in part because historical data on resale values is limited and resale-value estimates may be unreliable for new models. Only 7% of consumers use online resale-value calculators when doing basic research on vehicle options; 60% do so when they are about to evaluate a trade in (Mertl 2016).

The new vehicle purchaser may see the resale decision as many years down the road, beyond the time horizon of their purchasing decision, especially since they may not know how long they will hold the vehicle. Indeed, insofar as the average new vehicle consumer is not inclined to consider fuel savings beyond three years after purchase, the question is whether that consumer would give much weight to the resale value of fuel-saving technology, since the first resale is typically at year six or seven of the initial ownership period (NRC 2015a). Some classes of new vehicle buyers seem likely to be sensitive to resale value issues: the buyer who regularly holds for only two to three years and resells, or the consumer who leases, since residual value is—at least implicitly—wrapped into the leasing deal. Consequently, the entire question of how much new-vehicle consumers consider resale value is uncertain and variable among the group.

We found no surveys that ranked resale value in the top 10 to 20 factors that influence new-vehicle consumers, though it is possible that other salient factors such as brand loyalty may be related to resale value. Resale value is certainly embedded in "overall value for the money" (which tends to rank high as a factor in consumer surveys) but that construct encompasses other important factors (vehicle price, durability, and reliability) that are known to be important. When "future trade-in or resale value" is included in such surveys, it tends to rank far below fuel economy. The fact that many surveys of new car buyers do not even include resale value as a possible decision factor reflects the view of industry experts that resale value does not make the cut as a top consideration for that group of consumers (German 2016b). Furthermore, resale value has been largely neglected by comparative vehicle cost analyses that cover different vehicle types. In a meta-analysis of 44 studies that conducted such a comparative analysis, only eight considered resale value or accounted for the residual value of the vehicle by assuming an annual depreciation rate (Roosen, Marneffe, and Vereeck 2015).

Consumers who have concerns about resale value at the time of original purchase may be less worried about a modest refinement to the gasoline engine (e.g., turbochargers or cylinder deactivation) than an entirely new powertrain or fuel in an AFV. In 2015, amidst low fuel prices, the annual depreciation rates for hybrids and plug-in vehicles ranged from 25-30%, about twice the average rate for gasoline-powered passenger vehicles (T. Healey 2016; Sawyers 2016). Some PEVs have very low resale value (Woodyard 2015). As an example, resale values for the Nissan LEAF fell from 43.5%, to 36.5%, to 25.3% in each of the first three years of the vehicle's life, respectively (NADA 2015). As fuel prices have declined, the residual values of plug-in hybrid vehicles, such as the Toyota Prius Two, also have fallen significantly (Sawyers 2016). Interestingly, Kelley Blue Book reported in 2016 that Tesla products are the only PEVs to hold their value well over a three-year ownership period (Woodyard 2016c).

In summary, it should not be assumed that new vehicle consumers are well informed or fully consider the future fuel-savings of new technology over the entire life of the vehicle. Nor should it be assumed that the resale value of new fuel-saving technology is unaffected by fuel price. A total cost-of-ownership model for fuel savings from new technology should incorporate insights from behavioral economics as well as actuarial evidence of the extent of fuel savings over a vehicle's lifetime. We have taken a step in this direction with our own modeling in section 9 and Appendix VIII.

4.824 Non-Monetary Attributes of Vehicles: Positive Intangibles and Hidden Amenity Costs

The possibility of non-monetary utility gains or losses from fuel-saving automotive technologies also needs to be examined. For example, advanced diesel engines tend to have greater torque, which assists in acceleration, towing, and hauling (NRC 2015a). Electric vehicles offer a quieter ride and some have performance advantages (NRC 2015b). However, some fuel-saving technologies have non-monetary drawbacks that may be missed in engineering cost studies (Roth 2014).

As regulators have imposed stricter fuel economy standards on automakers, industry surveys have found that the perceived quality of new vehicles has suffered, at least temporarily. Michelle Krebs of Edmunds.com has commented that "...automakers are tweaking their engines and transmissions to maximize fuel economy, but their experiments have taken their toll in terms of driving experience, and quality ratings are suffering as a result" (Woodyard and Maier 2011). On the other hand, federal agency analysts (TAR 2016) performed a content analysis of expert reviews of fuel-saving technologies in recent model passenger vehicles, specifically expert commentaries in consumer-facing publications. They found little evidence that fuel-saving technologies were associated with significant losses in other vehicle attributes that consumers desire (Helfand et al. 2016). In addition, the most recent J.D. Power's study of auto quality found that manufacturers are making "some of the highest quality products we've ever seen" (JD Power 2016).

Some consumer concerns have been raised about small turbocharged engines, dual-clutch transmissions (DCTs), and stop-start systems. Automakers have added turbochargers to smaller engines in order to boost fuel economy and performance. Consumers Union reports that some motorists who are unsatisfied with the acceleration capability of the turbocharged engine push down the pedal strongly, thereby dampening the fuel economy of

the vehicle. Thus, consumers may be frustrated by either poor acceleration or less real-world fuel economy than was advertised by the vehicle manufacturer (Truett 2013). Over time, though, manufacturers have responded to consumer concerns and improved the performance of turbocharged engines (NRC 2015a).

A similar pattern occurred with DCTs. Early versions of DCTs triggered complaints related to drivability, especially among consumers accustomed to conventional automatic transmissions. New designs of DCTs are expected to have higher rates of consumer acceptance (NRC 2015a, 5–51).

Consumer reactions to stop/start systems, which reduce idling losses, have been variable. Toyota has successfully used stop/start technology in the Prius for more than a decade. Some stop/start systems annoy consumers due to noise and vibration during restarting; these consumers may be accustomed to smooth acceleration from a stop. European consumers have been more receptive to stop/start systems than American consumers (NRC 2015a). A variant of the stop/start system is the mild hybrid system, as implemented in the eAssist system of the Buick LaCrosse and Regal and earlier Chevrolet Malibu, which may achieve both larger gains in fuel economy and improved customer acceptance (NRC 2015a, 131). Indications from the industry are that stop/start systems, in various forms, will soon be widespread in the American market (Truett 2016b; Taub 2016; Sedgwick 2016).

Consumers may also notice it when new materials are used in a popular vehicle. All-aluminum pickup trucks save fuel but also have downsides that are unrelated to vehicle price. Aluminum is more prone to contamination than steel in the painting process, and consumers report more paint problems and corrosion with aluminum. Ford Motor Company is addressing such issues through new production processes and consumer advisories (Travers 2015).

For a completely new powertrain, such as a PEV, consumers may be averse to the worry and hassle (as well as the repair/replacement cost) associated with a battery pack that proves to have poor reliability and durability. The nickel batteries used in the Toyota Prius have proven to have excellent reliability and durability, often lasting well past the 100,000-mile warranty (up to 150,000 miles). Only about one to three percent of the nickel batteries in the Prius need to be replaced due to accidents or product failure, with failure events reported to be extremely rare (CEC 2015). It is too early to tell how well the lithium ion batteries used in PEVs will perform in the long run. Evidence of Nissan's concern about this issue is their battery warranty policy on the Leaf. The policy covers defects or sharp declines in battery capacity for eight years or 100,000 miles in higher-trim versions of the Leaf, but only five years and 60,000 miles in the base version (Woodyard 2016b).

Thus, the rate of new vehicle sales will also be influenced by factors other than the production cost and fuel savings of new technology. Analysts also need to consider carefully the impact of the technology on the non-monetary attributes of the vehicle that consumers value, everything from drivability to trunk space.

5. THE PRODUCER'S PERSPECTIVE

5.1 Industry Structure

The new passenger vehicle market in the U.S. is dominated by high-volume producers that sell globally: Toyota, Volkswagen, General Motors, Hyundai/Kia, Nissan-Renault, Ford, Fiat Chrysler, Honda, Suzuki, BMW, Daimler, Mazda, and Mitsubishi. Although the Big Three (Ford, GM, and Chrysler) were once the dominant three producers (indeed some economists still model the industry as an oligopoly), they have been gradually losing market share for decades and were downsized during the financial crisis of 2007-9 (Goolsbee and Krueger 2015). Today, the U.S. auto industry, defined here as companies selling vehicles in the U.S. (including their supply chains and dealers), is highly competitive, with strong Japanese, Korean, and German manufacturers competing against each other and against the Big Three (CAR 2015). Today, perfect competition may be a more accurate simplification than oligopoly (Helfand and Dorsey-Palmateer 2015).

Previous studies have found that the adverse financial impacts of stricter CAFE standards did not affect all high-volume producers equally. Historically, a disproportionate burden was felt by the Big Three, though this conclusion does not fully reflect the impact of the relatively new footprint-based structure of the CAFE and GHG standards (Sallee 2010; Jacobsen 2013). This new structure is designed to make the CAFE program binding on all high-volume vehicle manufacturers (Helfand and Dorsey-Palmateer 2015). EPA's GHG program has a similar design, which should trigger compliance investments at all high-volume vehicle manufacturers. The ZEV requirements are also expected to impact all major automakers.

Automakers vary considerably in their access to the technology and capital necessary to implement major changes in vehicle propulsion systems. Fiat Chrysler is carrying the largest debt load among the high-volume producers, and faces significant compliance challenges (Vellequette 2015). EPA (2016b) reports that Fiat Chrysler is more aggressive than other automakers in making use of the special compliance credits available in the EPA GHG program.

One of the possible reasons that Fiat Chrysler is publicly looking for a merger partner is that it may lack the capital necessary to make aggressive investments in response to both the federal and California regulatory requirements. Even if companies do not merge to address regulatory challenges, they may form alliances to share technological expertise. Toyota and Mazda are sharing information on advanced diesel and gasoline engines, while GM and Honda are sharing information on fuel-cell vehicles (Rocco 2015).

5.2 The Big Three and the United Auto Workers

The U.S. industry has both a unionized and nonunion sector. Organized by the United Auto Workers of America (UAW), the Big Three have business models that depend primarily on sales of light trucks assembled in the U.S. and Canada. Of the 64 models offered by the Big Three in model year 2017, about two thirds were assembled at UAW-organized plants (Stoll, 2016). About 75% of the passenger vehicles sold by the Big Three are trucks; the comparable figure for Japanese firms is about 50% (Bennett and Stoll 2015).

Domestic producers of light trucks are protected by an internationally-sanctioned 25% tariff on the importation of light trucks, though this tariff is under discussion in the ongoing trade negotiations between the EU and the U.S. (Beene 2015a; Young 2015). In recent years, Japanese and other foreign producers, which generally operate nonunion plants in the U.S., have begun to challenge the Big Three's dominance of the light-truck market. Toyota now builds the Tundra (pickup truck) at a nonunion plant in San Antonio, Texas, in order to serve the North American consumer market.

Toyota, Honda, and Nissan dominate the passenger-car market, but Hyundai/Kia, Volkswagen, and the Big Three are offering a mix of new and remodeled products that challenge Japanese dominance. Daimler, BMW,

and Audi are major players in the U.S. market for upscale sedans and crossover vehicles; the latter being one of the most rapidly growing and profitable segments in the industry.

5.3 The Transplants

From 1950-1980, Japanese, Korean, and German automakers assembled their vehicles abroad and exported them to the U.S. for sale (Grossman 2009). To avoid unfavorable U.S. tariffs and currency valuations and to establish a credible presence in the U.S., those companies have increasingly located assembly plants in North America (Kurylko 2013).

The transplant share of U.S. auto production has steadily climbed from 22% in 2000 to 31% in 2005 and 46% in 2013; it is projected to exceed 50% by 2017 (Goolsbee and Krueger 2015; Kurylko 2013). Based on annual U.S. market shares, Toyota now rivals GM and Ford among the top three manufacturers selling vehicles in the U.S. market, and a majority of Toyota's U.S. sales are also assembled in the U.S.

The first "transplants" were located in Marysville, Ohio (Honda-1982), and Smyrna, Tennessee (Nissan-1983), but the largest plants today, in terms of vehicle production, are in Montgomery, Alabama (Hyundai-2005), San Antonio, Texas (Toyota-2006), Greenburg, Indiana (Honda-2008), Woodstock, Ontario (Toyota-2008), West Point, Georgia (Kia-2009), Blue Springs, Mississippi (Toyota-2011) and Chattanooga, Tennessee (Volkswagen-2011). Sometimes only the assembly of the vehicle occurs in the U.S. (e.g., to avoid a U.S. tariff on imported vehicles). For example, MercedesBenz used to assemble its Sprinter Van in Germany, disassemble it prior to shipment to South Carolina, reassemble it in South Carolina, and then sell the van in the U.S. market tariff-free. More recently, MercedesBenz has made a major commitment to a new production and paint facility in South Carolina (Henry 2016). As a result, the transplants are now major sources of local employment and fiscal stimulus in the U.S. economy.

5.4 Supply Chains and Parts

In order to appreciate the breadth of the industry and its workers, one must look beyond the assembly plants to the supply chains for engines, parts, batteries, and other components (MEMA 2013). GM, Ford, and Fiat Chrysler share a distinct network of suppliers often organized by the UAW (Goolsbee and Krueger 2015). When Ford publicly supported the rescue of GM and Chrysler in 2008-9, they did so because they shared a supplier base with GM and Chrysler. Had Chrysler and GM folded, the future of Ford would have been in question (Graham 2010).

The Big Three are diversifying their supplier base within North America while also importing more parts from outside the U.S. In model year 2010, 90% of the Ford Escape's content by value originated in the U.S.; in model year 2015, the domestic content of the Escape was only 55% (Hagerty and Bennett 2015). About half of the parts for the popular Ford Focus come from outside the U.S. and Canada, with about 20% from Mexico. Some of the Focus engines are from Spain; some of the Focus transmissions are from Germany.

The transplants vary enormously in how much business they have with U.S. engine and parts makers. Toyota is a large maker of its own engines and transmissions in the U.S. On the other hand, BMW assembles more than 200,000 luxury crossovers per year at a large facility in Spartanburg, South Carolina, but fewer than 10% of the parts come from the U.S. and Canada (Althaus and Rogers 2016).

The transplants assemble vehicles in North America but are even more likely to import the parts from overseas. Overall, importation of auto parts has grown from $31.7 billion in 1990 to $89 billion in 2008 and $138 billion in 2014 (Hagerty and Bennett 2015).

5.5 Mexico's Growing Role

Boosted by NAFTA, the role of Mexico in the North American auto industry is growing rapidly (Althaus and Rogers 2016). Both the Big Three and foreign automakers are locating an increasing share of their North

American production—especially small-car production—in Mexico, often in close proximity to the U.S. border. Nine of the last 10 new auto assembly plants announced for the NAFTA region are being built or have been built in Mexico (Wernle 2016).

The appeal of Mexico is multi-faceted: lower average wages ($6/hour), proximity to the many new assembly plants in the southern region of the U.S., and access to the global market through Mexico's free-trade agreements (Irwin 2016a; Wernle 2016). However, the supply chains for Mexican assembly plants often lead back to the U.S. In the average vehicle assembled in Mexico, 40% of the parts come from U.S. suppliers (Iliff 2016). Thus, the original equipment manufacturers and parts suppliers in Mexico, the U.S., and Canada are highly integrated.

5.6 The Startups, Silicon Valley, and China

The PEV could be considered a "disruptive technology" because it threatens to unseat the dominant technology: the internal combustion engine. Some disruptive technologies succeed; many others fail. A disruptive technology does not typically catch on until quality in mass production is established and widely recognized. Sometimes disruptive technologies remain a fringe offering for a long time; in other cases their pace of commercialization is astonishingly rapid (Christensen, Raynor, and McDonald 2015).

Several start-up producers of PEVs (e.g., Tesla, Atieva, Karma/Fisker Automotive, NextEV, Youxia, Lucid Air, and Faraday Future) are introducing even more competition into the U.S. and global auto industry (Ramsey 2015). Some of the recent start-ups have backing from Chinese companies and investors, reflecting the growing Chinese interest in PEVs (Lane et al. 2013; Millward 2015). The startups are part of a loose network of venture capitalists, suppliers of batteries and chargers, electric utilities, and environmental advocacy groups with a common goal: electrification of the transportation sector.

Major companies in Silicon Valley have also indicated an interest in offering new automotive components or entirely electric, driverless vehicles with the latest information technology (Boston 2015; Gibbs 2014). Many of the key companies and investors in the electrification network are based in California.

The California ZEV program was structured in a way that boosted the commercial fortunes of start-up EV makers. For example, Tesla, as a maker of BEVs, can sell ZEV compliance credits to large-volume vehicle manufacturers, such as Honda and Daimler, who may have near-term difficulty meeting their ZEV requirements (Webb 2010; Mulkern 2016). The federal programs are also designed to help PEV startups accumulate credits with market value. For example, the EPA program recognizes that PEVs produce emissions at the powerplant but, from model years 2012-2015, Tesla and other PEV producers were allowed to use a compliance value of 0 grams of CO2 per mile instead of the 103 grams of CO2 per mile that would account for some powerplant emissions (EPA 2016c). Tesla has reported profits in only two quarters since the company was launched, and in both of those quarters Tesla reported unusually large revenues from sales of regulatory credits (federal and ZEV program credits) (T. Higgins 2016).

In 2013, for example, each Model S that Tesla sold generated seven ZEV credits due to the vehicle's extended range and fast refueling capability. With the average credit selling for $5,000, Tesla earned $35,000 in extra revenue for each Model S sold (Knittel 2014). Even in years that Tesla reports losses, sales of ZEV credits have attenuated the annual financial losses. In 2014, Tesla was the largest seller of ZEV credits, earning $152 million or about 5% of the company's total 2014 revenue (S. Edelstein 2015). The role of the ZEV program in Tesla's commercial future illustrates a broader point: the dynamic structure of the U.S. auto industry is partly a reflection of the design of federal and state regulatory systems.

5.7 The Role of Dealers

The vast auto dealer network, with 710,000 employees at latest count, has national reach in order to maximize sales to consumers (CAR 2015). Vehicle manufacturers technically sell their products to dealers, who then have the responsibility of selling them to retail customers or fleet buyers. In contrast to Europe, where a large fraction

of sales are made to companies or fleet buyers, the U.S. market is dominated by the unaffiliated retail buyer who strives to meet the transport needs of his or her household and often buys the car on credit.

In recent years, the role of the dealer as a source of information, though still important, has declined due to the explosion of user-friendly information on the Internet and extensive consumer use of social media. By the time consumers begin communicating with a dealer, many have already selected the vehicle that they wish to purchase. Thus, consumers have access to many more sources of information about vehicles than they did a generation ago.

The commercial experience of Tesla with direct marketing to consumers has also challenged the traditional dealer role (i.e., orders for Tesla products are placed online to the factory). In fact, while Nissan now sells the Leaf through dealers, it initially sold the Leaf only on the Internet (NRC 2015b). The National Automobile Dealers Association has challenged Tesla's marketing practices in several states—with mixed success—and defends franchise laws that require new vehicles (including PEVs) to be sold by trained, licensed dealers. Opponents of state franchise laws argue that such laws are outdated and do not serve the interests of consumers. The fact that dealers may have multiple operations representing more than one automaker complicates the task of examining the impacts dealers will experience from changes in vehicle sales.

A stronger focus on how dealers and manufacturers can collaborate to promote PEVs is warranted (NRC 2015b). So far, manufacturers are offering PEVs primarily as small cars and only in selected cities and states. Some large-volume manufacturers (e.g., Nissan and General Motors) have made major investments in dealer education and marketing while other manufacturers have done relatively little to promote PEVs. A study by UC Davis found that dealerships are not enthusiastic about selling PEVs because they require different marketing strategies as customers are not familiar with new technologies (Cahill and Sperling 2016).

There may actually be some disincentives for dealers to sell PEVs: the time and cost associated with training staff on new technology, educating staff on federal, state, and local PEV incentives, and developing a new capacity to service PEVs (Plug In America 2016). Some states have tried public recognition programs for dealers that excel at selling PEVs while others have offered dealers financial incentives or cash bonuses for each PEV sold. Those efforts need to be evaluated rigorously so that it becomes apparent what works best. Now that an enlarged number of high-volume manufacturers have made public commitments to offer PEVs, the dealer-customer interface regarding PEVs needs to be a priority for PEV promotion efforts.

5.8 The Economic Impact of the U.S. Auto Sector, Direct and Indirect

Considering all automakers, about 7 million U.S. jobs are supported, directly or indirectly, by the automotive industry. Each job in auto manufacturing is linked to roughly seven jobs in other industries throughout the economy (CAR 2015).

A different way to express the economic importance of the U.S. auto sector is to trace its impact on state and federal tax revenues. Hill et al. (2015) have done so, and place auto-related state tax revenue at $110 billion in 2013, or about 13% of total state tax revenue. A lower bound on auto-related federal tax revenue is $95.5 billion, or about 3.4% of total federal revenue.

The auto parts industry, which is the sector responsible for the largest share of manufacturing employment in the U.S. (935,900 in 2014), is not spread equally around the country (BLS 2015). A large majority (more than 70%) of auto parts manufacturing employment is concentrated in ten states: Michigan, Ohio, Indiana, Tennessee, Kentucky, Illinois, Alabama, Texas, North Carolina, and South Carolina (CAR 2015). When combined with the assembly plants, which tend to be located in these same states, it is readily apparent why the health of the auto industry is of greater concern in the South and Midwest than it is on the East and West coasts (Goolsbee and Krueger 2015).

Despite the widespread importation of auto parts, foreign auto brands contribute significantly to employment in the U.S. (Greimel 2015). In 2014, the production of Japanese auto brands contributed both directly and indirectly to 730,000 jobs in the U.S. The dealer network for Japanese brands contributed directly and indirectly to an additional 760,000 jobs in the U.S. The total associated employment was approximately 1.5 million. The net number of new jobs created in 2014, due to Japanese auto brands alone, was approximately 157,000 (Prusa 2015). Toyota alone has been shown to have significant impact on employment and tax revenues in 19 states (Dziczek, Chen, et al. 2016).

5.9 Public Subsidies and the U.S. Auto-Sector Recovery

Annual sales of new passenger vehicles—cars and light trucks—in the U.S. averaged 16 million from 1998-2007. Those sales collapsed to 10.4 million in 2009, reflecting the combined impact of accelerating underemployment, declining incomes, falling consumer confidence, defaults on home mortgages, and lack of consumer access to affordable car loans. The Bush and the Obama administrations took aggressive steps to rescue the U.S. auto industry from financial collapse (Graham 2010; Graham 2016).

Public subsidies and federal loan guarantees have played an important role in the recent resurgence of the Big Three, in the emergence of Tesla, and in Nissan-Renault's leading position on BEVs (Dolan and Murphy 2009). GM and Chrysler (including their financing arms and suppliers) emerged from structured bankruptcy proceedings in 2009 with financial backing from the U.S. Department of the Treasury (Goolsbee and Krueger 2015). In 2009-10, Ford Motor Company and Tesla received large federal loan guarantees from the DOE to develop and offer greener automotive technologies. Nissan also received a large DOE loan guarantee to build new facilities in Smyrna, Tennessee, to make lithium-ion battery packs and assemble BEVs.

The U.S. auto industry has been a heavily subsidized and regulated industry. A challenge for the future is to put manufacturers and suppliers in this industry on a level playing field for competition.

5.10 National Recovery from the Great Recession

Since 2009, the auto recovery has been significant. After six straight years of sales growth, the industry, boosted by low interest rates, in 2015 and 2016 was selling more than 17 million new passenger vehicles, an annualized record for the U.S. Virtually all of the high-volume automakers have been reporting increasing revenue and profit in the post-recession period. Although the profit margins for investments in the auto sector are less than in other sectors, the recent period of profitability has allowed the Big Three to offer multiple years of bonuses to their workers and to make some new plant investments in North America. Foreign automakers have also announced new plant investments in the U.S. In total, about $70 billion in company-announced investments in new, expanded, or retooled investments in North America were made from 2010-2014. About two-thirds of those investments are in the U.S. (CAR 2015).

As a result, auto-related employment in the U.S.—both at assembly plants and at facilities that make engines, components, and parts—has rebounded significantly. In September 2005, direct auto-related employment in the U.S. was measured at 1,089,800, falling sharply to a trough of 653,400 in September 2009. It has grown each year since 2009, and was recorded at 928,900 in October 2016 (BLS 2015).

The U.S. economic recovery from the Great Recession (2007-2009) has been painfully slow, indeed the slowest recovery on record, but one of the positive developments has been the revival of the U.S. auto industry (Seefeldt et al. 2013). The multi-year auto recovery accounted for 25% of the rise of manufacturing industrial production in the U.S. from 2009-2014, more than twice the average share in the four previous U.S. recoveries (Goolsbee and Krueger 2015). One estimate is that the auto recovery was related to about 10% of the overall recovery of U.S. GDP in 2014 (Young 2014).

5.11 Accelerated Retirement of Older Vehicles from the Fleet

While the federal standards and ZEV requirements focus on the design of new vehicles, most vehicles in use on a daily basis are not new. The U.S. passenger-vehicle fleet is comprised of more than 250 million vehicles, 57% cars and 43% light trucks (NHTSA 2009).

Changing the environmental profile of the existing fleet is a very slow process if the sole focus is the design of new vehicles. In a good year, only 17 million cars and light trucks are sold in the U.S. and new vehicles last longer today than they did a generation ago. Instead of the exclusive focus on new vehicles from 2022-2025, the midterm reviews may consider policies to accelerate the retirement of older vehicles from the fleet (Alberini et al. 2016).

So-called "cash for clunker" programs seek to accomplish this objective by offering cash incentives to consumers who agree to retire their old vehicle and replace it with a new vehicle. The result might be a higher rate of new vehicle sales as well as lower rates of gasoline consumption and GHG emissions. Side benefits of such policies may include enhanced safety for motorists, reduced emissions of pollutants related to smog and soot, and a tangible benefit for limited-income households that depend on older vehicles for their work and personal transportation. However, the evaluations of such programs, which we review in Appendix II, have been quite mixed. Therefore, policy makers who seek to achieve environmental results from cash-for-clunker programs need to make sure that they are carefully designed to accomplish that purpose.

5.12 How Low Fuel Prices are Impacting the Industry

From 2009-2012, when the federal government and CARB were developing new regulatory requirements for model years 2017-2025, the automotive marketplace appeared to be increasingly receptive to more fuel-efficient vehicles and PEVs. From 2000-2012 the average fuel price (nominal) climbed from roughly $1.00 per gallon to almost $4.00 per gallon. The small-car market share was on the rise (from 15.2% in 2000 to 19.6% in 2012). The market shares of large SUVs and pickup trucks were declining. Additionally, both HEVs and diesels were capturing larger market shares. Not surprisingly, NHTSA (2012a) assumed that the gradual shift in market share from light trucks to cars would continue from 2017-2025.

In the four years since the regulations were finalized, the patterns of consumer purchasing decisions in the automotive marketplace have begun to change significantly. Responding to the global glut of oil supplies, national average fuel prices dropped to as low as $1.92 per gallon in December 2015. Fuel prices recovered modestly to $2.20/gallon in December 2016, as OPEC and Russia agreed—at least temporarily—to concerted production cutbacks (Clarissa Jones 2017). Some experts are projecting fuel prices to rise to a national average of $2.49 per gallon in 2017 but few experts are forecasting a return to $4.00 per gallon for the foreseeable future (Colias, Roberts, and Rogers 2016).

Low fuel prices have had predictable impacts on the market: the small-car market share has declined; the pick-up truck share is no longer on the decline; the SUV market share is rising, driven by crossover sales; and the market shares of HEVs and diesels are declining. Furthermore, after five years of significant growth (2010-2014), the absolute number (as well as share) of PEVs sold in the U.S. declined in 2015, despite numerous federal and state incentives (EDTA 2016). PEV sales rose again in 2016 but the volume of sales per model (on average 5,000 units) is extremely small compared to what is typical for a sustainable, profitable product in the auto industry.

A consumer investment of $1,000 to $10,000 in fuel saving technology may seem attractive when fuel prices are $4.00 per gallon and rising, but the payback period on this investment deteriorates at low fuel prices. In Appendix I we supply a graphical demonstration of how consumer payback periods for fuel economy investments are sensitive to the fuel-price environment.

Only a few years ago, market analysts were projecting a 60-40 split, cars over trucks. Now analysts are projecting 60% truck sales for the foreseeable future. In December of 2016, light truck sales in the U.S. were over 63%. Table 5.1 illustrates this trend in market shares from 2009-2015 (Market Data Center 2016).

Table 5.1. Market Share of Passenger Cars vs. Light Trucks, Industry Classification

	2009	2010	2011	2012	2013	2014	2015	2016
Passenger Cars	52%	49%	48%	50%	49%	47%	43%	40%*
Light Trucks	48%	51%	52%	50%	51%	53%	57%	60%*

Source: Ward's Auto, 2016b; * preliminary

A recent study of consumers who traded in their HEV or PEV found significant differences in their 2015 decisions compared to 2014 and 2013. The percentage of the consumers who traded in for a new SUV was 22% in 2015 compared to 18.8% and 11.9% in 2014 and 2013, respectively. Loyalty rates for HEV and PEV owners fell below 50% in 2015 for the first time (Edmunds 2016a).

There is an emerging body of real-world evidence that consumers are not particularly inclined to purchase the fuel efficient and zero-emission vehicles that automakers are offering pursuant to regulation. Such evidence lends credence to the hypothesis that the stricter federal and ZEV requirements planned between now and 2025 could have an adverse impact on new vehicle sales.

5.13 How Might a Shift from Steel to Aluminum Impact Employment in the Supply Chain?

A consumer, at the time of purchase, may not notice whether their pickup truck is made predominantly of steel or aluminum. However, materials substitution can have an impact on employment in the supply chains for the two materials.

Diminished automaker demand for steel would affect steelmakers in the U.S. as well as companies that sell steel into the U.S. market from other countries. Each year about 25% of steel used in the U.S. is imported, and a major trade dispute exists between China and the U.S. and the EU on steel-related issues (USGS 2016a).

Both basic-oxygen furnace steelmaking (also called integrated steelmaking) and electric arc furnace steelmaking could be adversely affected (SASB 2014). The two supply chains are somewhat different, as are the plant locations in the U.S.

Integrated steelmaking, which accounts for about one-third of U.S. production, is concentrated in Indiana, Ohio, Michigan, and Pennsylvania (SASB 2014). Several steps are involved in integrated steelmaking, each associated with separate facilities (Elgowainy et al. 2016). Metallurgical coal is used in the production of coke. Coke, iron ore, and limestone are then used to make molten iron in a blast furnace. Molten iron, often supplemented with manganese, is then blown with oxygen in the basic oxygen furnace to produce steel. Separate finishing facilities prepare and shape the steel for use in specific applications such as oil pipe and flat-rolled product for vehicle body panels. The auto industry consumes about 17% of the steel produced at basic oxygen furnace facilities (SASB 2014).

Electric arc steelmaking, which accounts for two thirds of U.S. steel production, uses primarily scrap steel, limestone, and iron as inputs; much of the scrap comes from the auto industry. The inputs are melted and refined through oxidation. The numerous "minimills" that perform EAS are spread across the country, with large ones located in Pennsylvania, Colorado, and Mississippi.

Diminished demand for steel may lower employment of U.S. workers in the supply chain for steel but greater use of aluminum should boost employment in the supply chain for aluminum. The supply chain, though, is quite different for aluminum.

Producing aluminum begins with the mining of bauxite, which occurs primarily in tropical countries. The U.S. relies 100% on imports, predominantly from Jamaica, Guinea, and Brazil. Bauxite is then transformed into aluminum oxide at alumina refineries. There are some domestic refineries (Texas and Louisiana) but most of the work is done at refineries in Canada, China, and Venezuela (the latter country is the dominant exporter to the U.S.).

Aluminum oxide is the key input at primary aluminum smelters, where an electricity-intensive electrolysis process is used to extract the aluminum. The U.S.-based smelters are operating in Indiana, Washington, New York, South Carolina, Kentucky, and Missouri, but the U.S. industry is declining rapidly due to import competition. In 2015 imports accounted for 40% of the aluminum consumed, with Canada serving as the largest exporter to the U.S. (USGS 2016b). Most of the world's new capacity in primary aluminum production is located in China, and the U.S. and the EU are also in trade disputes with China over aluminum supply and pricing (Glassman 2016). Use in automobiles accounts for about a quarter of U.S. aluminum consumption (Menzie et al. 2010).

Alternatively, aluminum is produced at recycling facilities, which entails scrap preparation, melting, and ingot casting. For high-quality automotive parts, the cast and wrought materials are typically separated to ensure that the chemistry of the recycled parts is desirable and consistent (Elgowainy et al. 2016). About 30% of the aluminum produced in the U.S. comes from recycled scrap.

As the midterm reviews consider the impact of regulatory requirements on the employment of workers in the U.S., as required by presidential executive order, it is crucial to consider all of the impacted supply chains, not just workers at assembly plants and dealers. Changes in materials use can have complex impacts, positive and negative, in different sectors of the economy and regions of the country.

5.14 How Might a Shift from the ICE to PEVs Impact Employment in the Supply Chain?

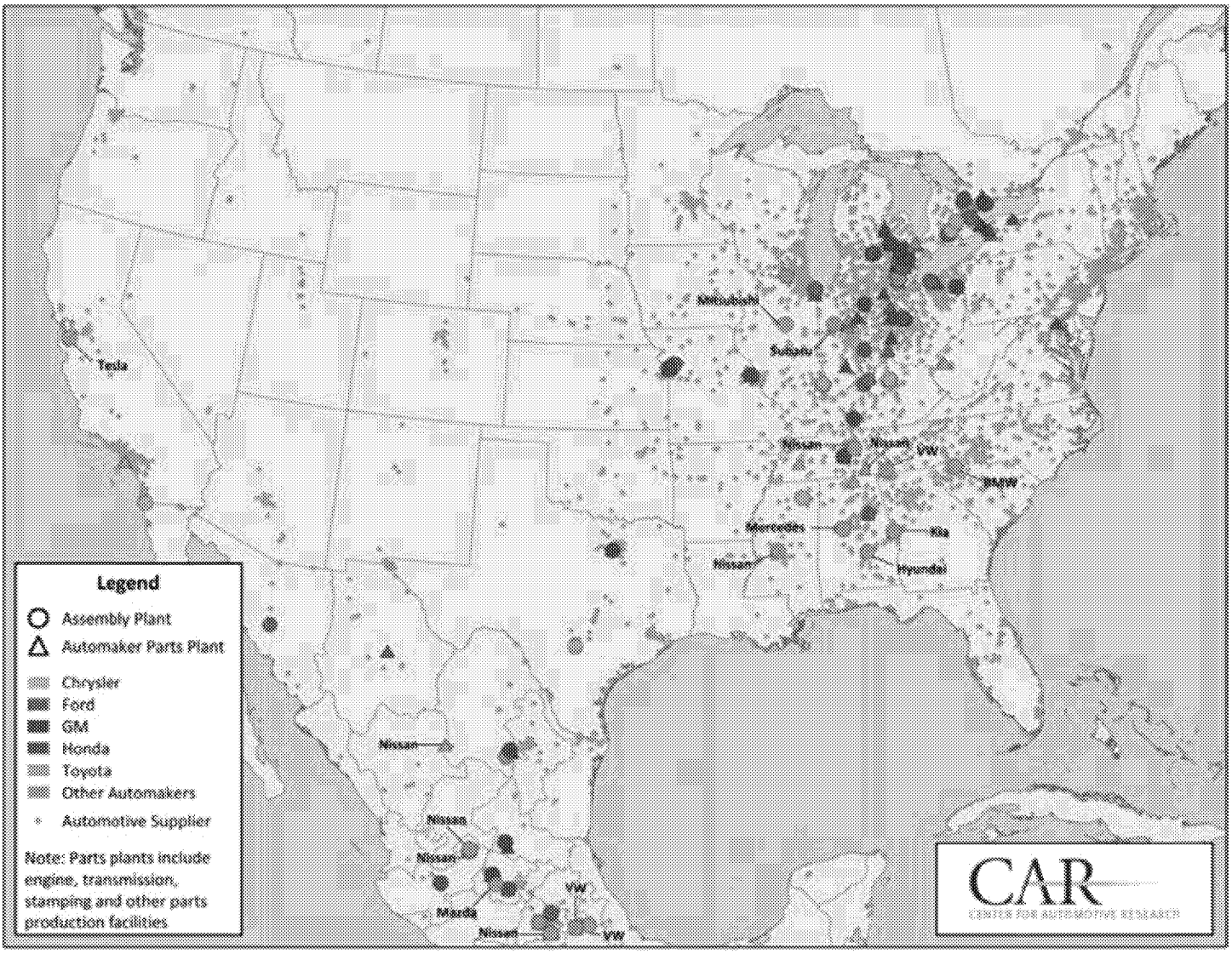
Passenger vehicles must be assembled regardless of whether the vehicle's energy comes from a gasoline engine or electricity. Although a shift from internal combustion engines to PEVs may not necessarily affect vehicle assembly plants, the shift could have a major effect on the level and geographic distribution of employment in the automotive supply chain (See Figure 5.1).

When shifting to PEVs, we should theoretically expect changes in employment due to the difference in the import ratios for the two propulsion systems and their supply chains, and the difference in the labor intensity of production of the two propulsion systems. The location of U.S. production facilities will reflect natural resource geography, access to markets, and other factors.

Table 5.2 lists the major U.S. plants that manufacture engines for use in passenger cars and light trucks. Their locations are concentrated in the Midwest and South, with none on the East or West coasts. It is more difficult to trace all of the component manufacturers that supply the engine/transmission plants, since they may have multiple customers in different sectors of the economy. Producers of the following components may also be at risk of diminished demand for their product: gasoline tank, gasoline pump, electronic fuel injection, alternator (for power to accessories), and pollution control equipment (e.g., catalysts and particulate traps).

A shift from gasoline engines to PEVs might lower production volumes and employment in some of the plants that produce engines and components, but there are several important qualifications. First, in the near-term, plants that produce engines for light trucks are less likely to be adversely affected than plants that produce engines for cars, since it is more economically efficient for automakers to electrify a car than a truck. Second, for competitiveness reasons, car manufacturing (including engines) in North America has been trending to Mexico for several years (CAR 2016), and, therefore, U.S. employment may decline in the car sector with or without

Figure 5.1. North American Automaker and Automotive Supplier Production Facility Locations



Source: CAR, 2015

Table 5.2. Engine Plants by State 2010-2015 (Number of Engine Plants/Number of Engine Components Plants)

	2010	2011	2012	2013	2014	2015
Alabama	3/0	3/0	3/0	3/0	3/0	3/0
Indiana	1/1	2/1	2/1	2/1	2/1	3/1
Kentucky	2/0	2/0	2/0	2/0	2/0	2/0
Michigan	8/4	7/4	7/4	7/4	7/4	7/4
New York	1/0	1/0	1/0	1/0	1/0	1/0
Ohio	4/1	4/1	4/1	4/1	4/1	4/0
Tennessee	2/0	2/0	2/0	2/0	2/0	2/0
West Virginia	1/0	1/0	1/0	1/0	1/0	1/0
Wisconsin	1/0	0/0	0/0	0/0	0/0	0/0

Source: Wally Wade, personal communication, December 5, 2016 based on Ward's data

a shift to PEVs. Third, a shift to PHEVs (rather than BEVs) might have little adverse effect, since PHEVs still require gasoline engines.

For comparison, we consider the manufacturing of BEV components, as BEVs have a relatively simple propulsion system: an automotive-grade lithium ion battery pack (which stores energy); a charger (which replaces expended energy); an electric motor (which provides the force for mobility); and converters (to power accessories). The most significant components in the value chain are the battery cells and packs, since they account for a majority of the cost of the electric propulsion system (NRC 2015a; NRC 2015b; Canis 2013).

Battery manufacturers in Japan, China, and South Korea have strong competitive advantages over new entrants for several reasons. Following the early success of Sony, Asian companies have dominated consumer electronics for more than a decade. Asian firms receive support from their governments, financially and otherwise (Canis 2013); (Chung, Elgqvist, and Santhanagopalan 2015). For these companies and their suppliers, batteries for use in PEVs are another exciting application.

The incumbent Asian producers of battery cells enjoy many technical and cost advantages: processing expertise from high cumulative rates of production for different applications; an ability to spread overhead and fixed costs across multiple products; strong purchasing power with suppliers; an established regional supply chain with clusters and collaborative relationships; and an ability to reassure vehicle manufacturers that they are financially strong and can produce with high quality. In this sector, there are high costs of entry, low margins due to intense competition, and limited opportunities for differentiation in vehicle performance.

The competitive advantages of the Asian companies are by no means permanent. Japanese firms were dominant in the 1990s for consumer applications, but the emergence of strong Chinese and Korean competition has caused less dependence on Japanese firms (Chung, Elgqvist, and Santhanagopalan 2015).

While there are intensive R&D programs underway in the U.S. aimed at developing alternatives, the lithium ion battery system is seen as crucial for near-term—next decade—applications in PEVs (NRC 2015a; Sandalow 2009). In 2009 the new Obama administration recognized the poor competitive position of the U.S. Several U.S.-based companies tried to enter this sector with generous subsidies and loan guarantees from the U.S. Department of Energy but the U.S. companies have had uneven success rates (Canis 2013). Battery maker A123 of Massachusetts, for example, ultimately filed for Chapter 11 and emerged from bankruptcy with a new owner and business plan that did not focus primarily on batteries for PEVs in passenger vehicles. In recent years, Asian battery makers have actually consolidated their dominant position globally. Meanwhile, the three largest-selling PEVs (by U.S. sales volume)—the Tesla Model S, the Nissan Leaf, and the Chevrolet Volt—are each making use of Asian battery technology.

The U.S. employment ramifications of a shift to PEVs require a careful look at each stage of the production of lithium ion battery cells and packs, and at potential opportunities for production by facilities located in the U.S., regardless of owner or headquarters location (Becker, Sidhu, and Tenderich 2009). The situation is complicated by a global overbuild of the battery industry that depressed prices and discouraged investments for several years (Chung, Elgqvist, and Santhanagopalan 2015).

The key raw materials for batteries are plentiful in multiple regions of the world but the U.S. is positioned poorly at the present time. Lithium is mined primarily in Chile and Argentina. The Democratic Republic of Congo is the primary producer of cobalt. Some of the rare earth minerals are mined predominantly in China. The U.S.-based company Molycorp (MCP) owned the Mountain Pass rare earth mine in California and made a multi-year effort to enter the rare earth mining business. They filed for bankruptcy in June 2015 (Yan 2015). Efforts are also underway in Australia to compete with the Chinese on rare earths (Lo 2015).

Once the raw materials are mined, they must be transported to specialized facilities for (1) processing, for purity and specific composition, (2) production of battery cells, and (3) production and assembly of battery packs,

including electronic control units and cooling systems. The integration of the battery pack into the vehicle is typically done at the vehicle assembly plant (Boston Consulting Group 2010).

There are numerous U.S. firms positioned to play a role in production of components for PEV-purposed lithium ion batteries such as lithium hydroxide, lithium carbonate, cathode and anode powders, cathode precursor materials, graphite anodes, separators, polypropylene and polyethylene films, battery management systems, and electric drivetrains. The potentially competitive U.S. companies are often large firms (e.g., 3M, DuPont, Celgard, ConocoPhillips, Superior Graphite, and Dow) that typically make individual components for PEVs that are also useful in other industrial applications, although usually with a specialized adaptation.

Production of battery packs will likely be concentrated in locations where PEVs are assembled because packs are not cost-effective to ship and are specific to the PEV models in which they will be employed (Chung, Elgqvist, and Santhanagopalan 2015). LG Chem of South Korea has a battery plant in Michigan to serve GM. As another example, NEC Corporation of Japan is a partner at Nissan's battery plant in Smyrna, Tennessee.

Tesla's plans for entering the lithium battery business are ambitious in size and scope (Clark-Sutton et al. 2016; Niedermeyer 2016). They've partnered with Panasonic of Japan in the massive Gigafactory that is now under construction near Sparks, Nevada. The Gigafactory will produce battery cells as well as battery packs, and is expected, when it opens in 2018, to be the largest battery manufacturing facility in the world. It appears that the Tesla packs will then be used to assemble PEVs at a vehicle assembly complex near Fremont, California, where GM and Toyota once produced vehicles in a partnership (Chappell 2016).

From a U.S. employment perspective, the Tesla approach is more promising than the Nissan and GM approaches but it remains to be seen whether Tesla will succeed commercially and whether other companies will replicate the Tesla approach. Tesla's sales volumes are increasing for its two upscale Models (the X and S) and they have 400,000 customers that have placed orders ($1,000 down) for the forthcoming mainstream Model 3 (Fehrenbacher 2016a). But Tesla has been running into unexpected product-quality problems as it rapidly increases production volumes, a problem that is common as start-ups strive to become profitable, high-volume producers (Fehrenbacher 2016b; T. Higgins 2017; Burke 2016).

The history of the Toyota Prius is a cautionary tale in this regard. Toyota has long considered making the popular Prius—and presumably its batteries—in the U.S., but instead continues to import the vehicle into the U.S. from Japan. In 2010, Toyota decided publicly against producing the Prius at its Mississippi plant and instead decided to build the Corolla there (Kim 2010). The Toyota decision has not changed since then, even though the Prius has achieved high U.S. sales volumes and was the number one selling passenger vehicle in California in 2012 and 2013. In fact, the Prius ranks among the lowest in domestic content among passenger vehicle models sold in the U.S. (DuBois 2016; Wade 2016).

Suppose the gasoline engine is compared to electric propulsion from the perspective of overall labor input throughout the supply chain. Which system requires more labor? Since a PEV is currently about $10,000 more expensive to produce than a comparable gasoline engine, it would seem that at least some of that extra cost is paying for labor. However, the cost of specialized materials comprise 70-80% of the cost of producing the battery cells, with labor less than 10%, and the cost of the cell production is the single largest contributor to the cost of the battery pack (Canis 2013; Chung, Elgqvist, and Santhanagopalan 2015).

There are no rigorous studies with hard data on the extent of labor inputs in the two supply chains. One European study, based on interviews of European auto producers and suppliers, speculated that the labor intensity of PEV production is probably lower than it is for gasoline engines. That study concluded that the long-run economic advantages of BEVs rest in ownership savings for the consumer, not higher employment levels throughout the supply chain (de Bruyn et al. 2012).

6. REVIEW OF PREVIOUS INDUSTRIAL IMPACT STUDIES

Regulation of the automotive industry is not a new phenomenon. CARB and EPA have extensive regulations covering the tailpipe emissions of "criteria" air pollutants, such as those that are related to smog and soot. NHTSA has extensive regulations on vehicle safety that cover issues as diverse as brake systems and fuel tank integrity. Even regulations of fuel economy are not new, as the largest increase in federal fuel economy standards occurred in the decade after the 1973-4 Arab oil embargo. Although there is extensive literature on the costs and benefits of these programs tracing back to the 1970s (e.g., see L. J. White 1981), little is known as to whether these regulations impacted the rate of new vehicle sales.

Casual empiricism can easily lead to contradictory conclusions. For example, after the decade of frozen standards (1996-2004), CAFE requirements were raised for light trucks beginning in model years 2004-7, and the automotive industry entered a deep recession starting 2008. Yet, it is well known that the unexpected bubble in housing prices and the financial crisis caused the Great Recession of 2007-9, and the severe contraction of liquidity crippled auto sales. The correlation with the onset of light truck CAFE standards is coincidental.

Likewise, the CAFE standards for cars and light trucks were gradually tightened from model years 2008 through 2016, the same period that the auto industry experienced a remarkable recovery in new vehicle sales. The recovery is related to record low interest rates, declining unemployment, rising consumer confidence, and increasing wealth and income at the top quartile of the income distribution (the group that dominates new vehicle sales). Whether the CAFE standards had any role in restraining or accentuating the recovery in the auto sector has not been studied explicitly; it is quite possible that the correlation between stricter CAFE regulation and auto recovery is coincidental, a point that (EPA 2016a) acknowledges.

6.1 Review of Existing Studies

Looking forward, the combination of the two federal programs and the two CARB programs could have a significant impact on the automotive industry, yet we found remarkably few studies of the possible industrial impacts. Our search for studies included both government reports and the academic, advocacy, and think-tank literatures. The following screening criteria were employed: the authors addressed the 2017-2025 federal and/or California standards, and the impact of the standards on new vehicle sales and/or employment. The eight studies we found are reviewed briefly below.

NHTSA (2012a) and EPA (2012a) provide the official regulatory impact analyses in support of the federal CAFE and GHG standards, respectively, for model years 2017-2025. Both reports include a detailed engineering-economic analysis of compliance technologies, including their costs and fuel-consumption benefits, but differ in their commitment to the likely employment effects. On the one hand, the NHTSA analysis provides alternative scenarios in which the quantitative impact of the standards on new vehicle sales is either positive or negative, depending upon consumer reactions to higher vehicle prices and estimated savings in fuel expenditures. Employment impacts are positive or negative, depending on the scenario. On the other hand, EPA (2012a) includes a qualitative discussion of possible impacts on new vehicle sales but no quantitative modeling. A consumer payback analysis is performed that shows that consumers will reap sufficient fuel savings to pay for the higher vehicle prices in a short period of time. Some positive employment impacts are quantified in sub-sectors that produce green automotive technology.

The official regulatory impact analysis in support of the California ZEV standards for model years 2018-2025 examines only economic impacts in California and does not address the other nine ZEV states or the national economy (CARB 2011a). With a methodology similar to NHTSA (2012a), CARB (2011a) finds that the ZEV program will increase new vehicle sales because the fuel savings from ZEVs will ultimately be larger than the incremental cost of the ZEV technology. Specifically, a consumer payback analysis shows that fuel savings from at least one type of BEV will be sufficient to cover the higher price of the vehicle over the lifetime of the vehicle.

Positive employment impacts are quantified for the State of California (e.g., in firms that produce recharging stations for plug-in vehicles).

We also reviewed economic impact analyses produced by four think tanks. Although most of the studies focus on the 2012-2016 and 2017-2025 standards, there is some variation in the MPG targets underlying the estimates. For example, CAR (2011) studies the impacts of the 2017-2025 standard under assumption of 47, 51, 56, and 62 MPG in 2025; Wagner, Nusinovich, and Plaza-Jennings (2012) study the impact of meeting the standards for model year 2017-2025; and Busch et al. (2012) assume a fuel economy of 54.5 MPG by 2025.

Busch et al. (2012) from the Blue-Green Alliance do not model vehicle-sales impacts but they do produce estimates of employment impacts. They combine technology cost estimates from the federal regulatory impact analyses with social accounting matrices that are taken from the Minnesota IMPLAN Group to estimate the macroeconomic effects of the federal standards using the Dynamic Energy Efficiency Policy Evaluation Routine (DEEPER) model. The model used in the analysis has 14 economic sectors and one household sector. Busch et al. (2012) assume that fuel savings are distributed across the economy in proportion to 2010 consumption, that 80% of the additional spending on technology required to meet the standard will go to the parts and supplies sector (and 20% to vehicles), and that the government's administrative costs will be $30 million per year in real 2010 dollars. They find that CAFE will create approximately 320,000 jobs by 2025 and 570,000 by 2030. A breakdown by sector reveals employment gains for every sector except oil refining and oil and gas extraction; the largest gain is in the business and personal services sector. They further find that net real (2010 $) wages and GDP increase by $49 billion and $75 billion, respectively, by 2030. Finally, they estimate the employment impacts of an increase in the domestic content of cars to 75% and find that direct auto-manufacturing jobs would increase by 3,300 by 2025 and 4,100 by 2030. Total number of jobs created by this increase in content is 10,000 by 2025 and 13,000 by 2030, in their estimate.

CAR (2011) prepared a study prior to the completion of the joint federal rulemaking, but the range of rulemaking options it examines includes the 54.5 MPG standard that was finalized by NHTSA/EPA. CAR begins its analysis with the technology-cost estimates from the NRC (2010), to which it makes several updates. CAR assumes a greater reduction in vehicle mass compared to the NRC (2010), and also includes cost estimates for PEVs, on the assumption that some PEV production will be necessary to comply with the federal standards. CAR then estimates the mix of technologies that is able to achieve four different levels of CAFE standards relative to a baseline of model year 2008: 47, 51, 56, and 62 MPG. The average per-vehicle cost of achieving each of the CAFE standards is determined based on the combined weighted cost of implementing that technology mix. CAR then estimates the fuel cost savings of each technology mix at two alternative gasoline prices ($3.50 and $6.00), and the authors net the fuel savings from the increased cost per vehicle. CAR determines economic impacts by first estimating the price elasticity of motor vehicle expenditure (% change in expenditure due to a 1% increase in price) and uses this estimate to determine the impact of the increased net price on vehicle demand. The change in vehicle sales is translated into U.S. vehicle production and employment using data on the domestic sourcing ratio and automotive labor-market productivity. All rulemaking scenarios analyzed by CAR produce a decline in vehicle sales and employment except one: a standard of 36 miles per gallon where the price of fuel is pegged at $6 per gallon.

In 2016, CAR released another report positing potential effects of the federal regulations covering the 2017-2025 period on the U.S. economy. CAR starts by considering expected changes in vehicle fuel economy over the regulatory period based on mandate standards, as adjusted for real-world driving conditions. Projecting that real-world fuel economy of the average vehicle will increase by 12.7 MPG between model years 2016-2025, CAR assumes three compliance cost estimates—$2,000, $4,000, $6,000—assuming that for every one mile-per-gallon increase in vehicle fuel economy the average per-vehicle cost would increase by a range of $200-400. CAR employs the EIA's most recent low ($2.44 per gallon), most likely ($3.00 per gallon), and high ($4.64 per gallon) gasoline forecasts for 2025 to estimate fuel savings over a 3.4 year period, accounting for average miles traveled and expected rebound effect. Based on the three mandate cost levels and three different gasoline price forecast values, CAR estimates nine scenarios to calculate the net cost of buying a 2025 vehicle. Based on the results, and assuming a long-run own-price elasticity of .61, CAR estimates effects on motor vehicle demand. The change

in vehicle sales is translated into U.S. vehicle production and employment using data on the domestic sourcing ratio and automotive labor-market productivity. Overall, CAR finds the effect of the federal regulations on sales revenue in 2025 ranges from +.82 percent at a fuel price of $4.64/gallon and a fuel economy mandate cost of $2,000 to -8.6 percent at a fuel price of $2.44/gallon and a mandate cost of $6,000. The changes in auto industry employment range from an increase of 15,700 at a fuel price of $4.64/gallon and a mandate cost of $2,000 to a loss of 137,900 at a fuel price of $2.44/gallon and a mandate cost of $6,000.

Wagner, Nusinovich, and Plaza-Jennings (2012) from the National Automobile Dealers Association (NADA) calculate the share of consumers who meet the minimum debt-to-income (DTI) ratio required to finance the purchase of the cheapest new vehicle available on the market before and after the stricter CAFE standards. Drawing on technological costs from the federal RIAs, they assume that the cheapest new vehicle will increase in price by between $2,937 and $12,349 (in 2010 $) after complying with the new CAFE standards. They further assume that a consumer will only receive a loan if their DTI is less than 40%. The main finding is that compliance with the new CAFE standards will lead to a significant drop in new vehicle sales because a large number of consumers fail to meet minimum DTI requirements. The cheapest new vehicle will cost approximately $15,700 under CAFE, and this price would reduce the number of people with qualifying DTI by approximately 5.8 to 6.8 million. The study's worst case scenario of a $12,349 price increase would cause approximately 27.7 million consumers to drop out of the market.

Baum and Luria (2010) do not model vehicle sales impacts but do supply employment estimates. They rely on the technological cost estimates produced by The Panning Edge to estimate macroeconomic impacts using the Regional Economic Model Inc. They report that every packet of 100,000 traditional U.S.-made vehicles is associated with 17,000 jobs; this estimate is made after making adjustments for increased labor productivity and reduced U.S. content. They then assume that employment is proportional to the cost of manufacturing the vehicle, which they further assume is approximately 80% of the listed price. From this calculation they conclude that an energy-saving technology that adds $500 to the cost of each vehicle is associated with 2.5% of the 17,000 jobs mentioned above. More recently, Baum and Luria (2016) examined the economic impact on the Big Three of the 2022-2025 federal standards compared to scenarios where the standards are weakened. Under most scenarios examined, they conclude that the Big Three and their suppliers will profit from the 2022-2025 standards because, unless fuel prices are below $2.60 per gallon, the Big Three can pass the full technology cost ($1,353 per vehicle) on to consumers. They do not model the impact of the higher prices on new vehicle sales.

6.2 Limitations of Existing Studies

This body of literature contains several major limitations that pertain to information and assumptions. First, none of the studies incorporate the California ZEV program in conjunction with the federal standards. The impact on industry is understated due to the omission of the ZEV program. Second, the studies make conceptually different assumptions about employment impacts: some assume that regulatory costs reduce employment because the resulting price increases reduce vehicle sales and vehicle-related employment; others assume that regulatory costs increase employment because regulatory costs are related to increased employment in the green technology sector. Different assumptions need to be reconciled. Third, few of the studies had access to NRC's (2015a) update of the costs and fuel-consumption benefits of alternative technologies. Fourth, the studies were typically performed before the collapse of global oil prices and the downward forecasts for fuel prices between now and 2025. Finally, the studies are inconsistent as to their baseline assumptions (i.e., how the industry—sales and employment—would have fared without the stricter federal and state requirements) and, in some cases, the baseline assumptions are not transparent. For example, in the absence of the tighter standards from 2017 to 2025, the baseline descriptions of vehicles do not account for future growth in fuel-expending features such as increased performance, safety, and new emission control standards for criteria pollutants. In Appendix III, we offer some suggestions for how the baseline issue should be handled in future RIAs such as reforms to the model year 2022-2025 federal standards.

In addition to these limitations, previous RIAs prepared by the EPA, NHTSA, and CARB are marked by three important methodological limitations as well. First, the approaches taken to model the macroeconomic impacts

of the regulations are overly simplistic and do not capture dynamics within the economy (e.g., the interactions of different subsectors of the U.S. economy such as gasoline consumption and motor vehicle production). Second, modeling exercises in these RIAs do not always treat consumer demand for vehicles as endogenous, but instead assume that consumers will continue to purchase vehicles at the same rate as they would in the absence of the regulations. Third, the RIAs present national-level estimates of new-vehicle sales and employment impacts but do not additionally disaggregate these results to the regional or state levels. The related analytic work published in TAR (2016) and the recent (EPA 2016a) determination suffer from similar limitations.

An enhanced methodological approach should account for two major real-world processes. The first is the technological component, in which auto manufacturers respond to federal and state mandates by altering their vehicle technologies. The RIAs and TARs (TAR 2016; EPA and NHTSA 2012) are generally strong in their treatment of these engineering issues, though important controversies remain. The second process is the macroeconomic component, in which the analyst simulates the effects of changes in vehicle prices, vehicle sales, and gasoline consumption on the performance of the U.S. economy. For example, one can model how the impacts of the regulations work through the economy and impact key macroeconomic variables such as U.S. gross domestic product, employment levels, income levels, or impacts on specific economic sectors or regions of the country. These two processes (technological and macroeconomic) are generally modeled as separate steps due to the methodological capabilities and limitations of available modeling platforms.

The two processes lend themselves well to bottom-up and top-down models, respectively. A bottom-up model is a techno-economic model—also referred to as a "process-oriented model"—that simulates market dynamics due to technological or policy scenarios. These models are often based on cost minimization for achieving a regulatory objective and they tend to provide significant detail across different vehicle technologies and alternative sources of energy. Often, a bottom-up model will treat the regulated firm as the unit of analysis. A top-down model, on the other hand, tracks market supply and demand over time and within aggregate economic sectors, regions, or the U.S. economy as a whole. Different top-down modeling techniques include input-output models, computable general equilibrium (CGE) models, and econometric models.

Previous studies of CAFE have used a combination of these types of models, or more simplified modeling approaches. Regulatory impact analyses of the GHG and CAFE standards, such as those prepared by the EPA and NHTSA, focus the majority of their efforts on bottom-up modeling to compute average vehicle production costs, and then use simplified calculations to derive potential employment impacts due to the changes in the costs of producing new vehicles. The EPA, for example, uses the Optimization Model for reducing Emissions of Greenhouse Gases for Automobiles (OMEGA)—a bottom-up model of the transportation sector—to simulate those vehicle packages that different manufacturers will use to comply with regulatory requirements. From this model, they extract estimates of the average upfront cost of producing vehicles that will be sold to comply with the standard. EPA is now taking the position in the draft TAR (2016) that it is not technically feasible to estimate changes in new vehicles sales, since not enough is known about how consumers will react to more costly vehicles that have higher fuel economy. The agency is working on a vehicle choice model that, when linked with the results of the OMEGA model, will generate estimates of changes in new-vehicle sales, but it is unclear when the agency will start using such a model in RIAs of vehicle regulations.

Furthermore, in the absence of estimates of changes in new-vehicle sales, the EPA relies solely on the cost information to determine the favorable employment impacts of the regulation. That is, the agency estimates the overall cost of compliance, and then applies a ratio of workers per $1 million spent in the automobile sector, weighted by the percentage of vehicles that are produced in the U.S. relative to those imported (also framed as the ratio of domestic production of vehicles to domestic sales of vehicles). EPA does not consider the fact that when consumers spend more money on vehicles, they have less money available to spend on other goods and services such as housing, food, and recreation. Nor does EPA analyze that the savings in gasoline will have two opposing effects on the economy: reduction of U.S. production, refining, and transportation of petroleum and petroleum products, and an increase in consumer spending on other goods and services such as housing, food, and recreation.

In a similar bottom-up process, NHTSA uses the Volpe model—also referred to as the CAFE Compliance and Effects Modeling System—to estimate vehicle costs. Like the OMEGA model, the Volpe model assembles vehicle-technology options from which manufacturers may choose in a constrained cost-minimization model.

For impacts on vehicle sales, NHTSA goes beyond the EPA approach and performs several scenario analyses using a total cost-of-ownership (TCO) model. Most of the scenarios show positive impacts on vehicle sales but some show negative impacts. They then take the derived vehicle-sales estimates and divide by the average number of vehicles that an employee produces in a year, as they assume this calculation can serve as a measure of "job years." They then multiply this estimate by the same ratio of domestic production to domestic sales as used in the EPA analysis. Both the NHTSA and EPA employment estimates only apply to the auto industry, and do not extend to other sectors of the economy through ripple effects or multipliers.

The CARB RIA examines macroeconomic impacts only from the perspective of the State of California using a modified version of a computable equilibrium model used by the California Department of Finance called the Dynamic Revenue Analysis Model (DRAM). The modified model is called the Environmental-DRAM and is designed to support analyses of economic impacts of large-scale environmental regulations. With regard to new vehicle prices, they estimate that the ZEV requirements reduce the operating costs of vehicles by a magnitude larger than the technology costs of ZEVs. As a result, net vehicle prices decline and new vehicle sales rise. CARB finds that the ZEV requirements have positive overall impacts on the state of the California economy. As explained earlier, the CARB analyses do not consider interaction issues with the federal programs or the economic impacts generated by the nine states that have chosen to enact and implement the California ZEV program.

This basic overview of the methodological approaches used in the RIAs highlights the observation that the regulatory agencies used simplified assumptions to derive employment impact estimates. It is important to note, however, that the main objective of the RIAs was to provide societal benefit-cost analyses of rulemaking, and not to produce estimates of macroeconomic impacts. Yet, as argued earlier in this report, an assessment of the effects of CAFE and other transportation regulations on the U.S. economy is fundamental to our understanding of how these regulations will perform.

Through the use of simplified assumptions about the manner in which vehicles sales will affect employment, and without considering these effects through a dynamic modeling structure, these previous studies may have produced unrealistic estimates. Top-down models that can account for interactions among different economic sectors and long-term supply and demand balances, to list just two possible additions, could be used to produce a more detailed understanding of the impacts of these regulations on the U.S. economy.

The second methodological limitation of previous RIAs pertains to the way in which consumer decisions are modeled and, in particular, an inability to treat consumer demand as endogeneous within the models. An extraordinary feature of the OMEGA and Volpe models is the degree of technological detail about the vehicle options from which the model may select. The OMEGA model, for example, includes a few hundred vehicle options, with variations in vehicle class, vehicle type, engine size, valve train configuration, and valves per cylinder. This detail, however, comes at a cost, as it focuses exclusively on technological alternatives among vehicles and manufacturer decisions without considering consumer responsiveness to these technological decisions. These models also do not account for broader energy sector dynamics, such as the price of gasoline. Yet, one should expect that both the price of a vehicle and the price of gasoline will affect a consumer's interest in purchasing a vehicle.

The third limitation of previous modeling efforts—not limited to the RIAs but also including the majority of other grey literature, save a study by Bezdek and Wendling (2005)—is the lack of consideration of regional or state impacts. Sub-national analysis is important for understanding the effects of regulations, since automobile production and consumption are not spread uniformly across the U.S. Manufacturing centers and supply chain companies are geographically oriented, as are oil and gas extraction activities and refining facilities.

These three fundamental limitations of previous studies led us to a series of modeling approaches that can provide macroeconomic estimates, both national and regional, of the federal and state standards, plus a more sophisticated treatment of consumer responsiveness when estimating vehicle sales. The macroeconomic impacts of the federal standards are modeled using REMI PI+ 2.0.2, a combined input-output, computable general equilibrium, econometric, and economic geography model, and a total-cost-of-ownership (TCO) model. The former is used to produce estimates of employment, GDP, and personal disposable income; the latter, which offers more flexibility in its treatment of consumer demand, is used to produce refined estimates of percentage changes in new-vehicle sales. These modeling approaches are presented in the next section.

7. DEFINING THE 2012 AND THE 2016 PERSPECTIVES

A key input of the macroeconomic modeling is the gross price premium of the average vehicle attributable to the combination of regulations. We define the gross price premium as the average additional cost of producing a vehicle, assuming that the cost is passed on to the consumer in the form of higher vehicle price.

Our modelling efforts use datasets that reflect five distinct gross price premiums between the years 2016 and 2025, two of which correspond to information that was available in the year 2012, when the federal agencies finalized the national standards, and three of which incorporate new information that became available by 2016. In all modeling exercises presented in this report, we start with (1) "2012 Perspective EPA" and (2) "2012 Perspective NHTSA." We then extend our analyses with (3) "2016 Perspective High," (4) "2016 Perspective Low," and (5) "2016 Perspective COMET." This section describes the data sources for the two "2012 perspectives" and explains how we generate values to represent the three "2016 perspectives."

7.1 The 2016 vs. 2012 Perspectives

The 2012 perspectives are based on information that was available to the agencies during the 2009-2012 period, when the 2017-2025 federal standards were developed, proposed, and finalized. To construct the 2012 perspectives, we obtained or derived gross price premiums and other relevant data such as gasoline savings and number of vehicles sold from the EPA and NHTSA RIAs (NHTSA 2012a; EPA 2012a).

Compared to the 2012 perspective, the 2016 perspective: (1) offers new estimates of technology costs and fuel-saving effectiveness supplied by the National Research Council of the National Academies (NRC 2015a) that, based on an NRC simulation exercise, correspond to somewhat larger vehicle price premiums in the 2016 perspective compared to 2012 perspective, specifically for vehicles equipped with an internal combustion engine; (2) recognizes that the California ZEV requirements, which are undertaken pursuant to an EPA waiver, interact with the federal programs and will impact the automotive industry and the U.S. economy through some of the same mechanisms as the federal programs and in roughly the same time frame; (3) accounts for the new state of global energy markets, as characterized by significantly lower EIA forecasts of oil and gasoline prices through 2030; (4) accounts for new government forecasts of declining costs of producing plug-in electric vehicles based on innovation in lithium ion battery technology and production scale economies; (5) incorporates new information from the U.S. Department of Transportation on vehicle miles of travel by vehicle age, showing somewhat higher travel volumes in the early years of vehicle ownership and substantially lower travel volumes in later years of ownership; and (6), specifically, in the analysis of the total cost of ownership, accounts for new evidence from markets for new and used vehicles concerning how consumers react to changes in fuel prices and new technologies.

The first two items in the list above affect the price premium of a new vehicle and represent the principal difference between the various 2016 perspectives. The remainder of this section describes how we adjust the 2012 price premium to reflect the NRC (2015a) assessment of the federal programs and the California ZEV regulation.

7.2 The 2016 Perspective: NRC Adjustments

NRC, following a request by NHTSA, established the "Committee on Assessment of Technologies for Improving the Fuel Economy of Light-Duty Vehicles, Phase 2." The Committee was asked to conduct an assessment of the CAFE standards and provide recommendations that would be considered by NHTSA as part of the midterm reviews.

In 2015, the Committee published a report the central focus of which was the fuel-saving effectiveness and direct manufacturing costs of a series of technologies that automobile manufacturers could use to comply with the CAFE standards in the 2020-2030 period (NRC 2015a). After examining numerous technologies of different types, the committee confirmed the validity of most of the estimates of cost and fuel-saving effectiveness reported

by NHTSA (2012a). However, for a limited number of technologies, NRC (2015a) found that both costs and fuel savings were underestimated or overestimated. NRC (2015a) also looked carefully at the estimated effects of multiple technologies, including the potential for interactions (synergisms or duplications).

Within the framework of their multi-technology assessment, the Committee provided a technology pathway example for a midsize car with an I4 DOHC spark-ignition (SI) engine and estimated the Direct Manufacturing Costs (DMC) for MYs 2017, 2020, and 2025 that would be required to comply with the CAFE standards. The two sets of estimates provided (namely a "low most likely" and a "high most likely"), as well as the original 2012 estimates from NHTSA, are illustrated in Table 7.1. All members of the Committee acknowledged uncertainty in the cost estimates, but some members believed that the low cost estimates were most likely to be correct while other members believed that the high cost estimates were most likely to be correct.

Table 7.1. Incremental Direct Manufacturing Costs (DMC) of a Mid-Size Car: Low Most Likely and High Most Likely Estimates

	Units	MY2017	MY2020	MY2025
NHTSA Mid-Size Car DMC Estimates	2010 $	1274	1184	1060
NRC Mid-Size Car Low Most Likely Estimates	2010 $	1381	1297	1181
Percent Difference (low)	%	8.40	9.54	11.4
NRC Mid-Size Car High Most Likely Estimates	2010 $	1923	1806	1658
Percent Difference (high)	%	50.9	52.5	56.4

Source: NRC, 2015, pages 276-277, 422-423.

Table 7.1 illustrates the percent difference in the DMC between the low/high most likely estimate and the DMC estimates based on the methodology that NHTSA adopted in the final rule. For MY 2025, the differences range from 11.4% (low most likely estimate) to 56.4% (high most likely estimate). We call these differences the NRC (2015a) high-cost estimate and low-cost estimate (adjustments), recognizing that both of them are considered most likely by some members of the committee. Table 7.2 shows how we have applied the NRC adjustments to NHTSA's (2012a) analysis.

The Committee notes that the cost estimates in Table 7.1 should not be considered forecasts of price premiums for a variety of reasons. Some of the sources of potential error were acknowledged by NRC; others have become

Table 7.2. Price Premium Adjustments Using the NRC (2015) Low Most Likely and High Most Likely Estimates

			Model Year								
Row ID	Source	Vehicle type	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	NHTSA	Car	$364	$484	$659	$858	$994	$1,091	$1,221	$1,482	$1,578
2	NRC low		$395	$526	$719	$940	$1,093	$1,203	$1,351	$1,646	$1,758
3	NRC high		$549	$733	$1,002	$1,309	$1,524	$1,681	$1,891	$2,307	$2,468
4	NHTSA	Truck	$147	$196	$397	$629	$908	$948	$1,056	$1,148	$1,226
5	NRC low		$159	$213	$433	$689	$998	$1,046	$1,169	$1,275	$1,366
6	NRC high		$222	$297	$603	$959	$1,392	$1,461	$1,635	$1,787	$1,918
7	NHTSA	Fleet	$287	$382	$567	$779	$964	$1,042	$1,165	$1,370	$1,461
8	NRC low		$311	$416	$619	$853	$1,060	$1,149	$1,289	$1,521	$1,628
9	NRC high		$433	$579	$862	$1,188	$1,478	$1,606	$1,804	$2,132	$2,285

Note: NHTSA refers to the data from the NHTSA 2012 RIA. NRC low indicates that the NHTSA numbers have been adjusted to reflect the NRC's low most likely estimate, and NRC high indicates that the NHTSA numbers have been adjusted to reflect the NRC's high most likely estimate. The price premiums in Table 7.2 account for both the Direct Manufacturing Cost (DMC) and the Indirect Cost (IC).

apparent since the NRC (2015a) report was published. We believe that use of the NRC cost adjustments in price-modeling exercises provides useful insight into some of the important uncertainties in estimating the impact of CAFE regulation on new vehicle sales.

Rows 8 and 9 in Table 7.2 capture the price premiums (i.e. DMC plus Indirect Cost) for the fleet that complies with the CAFE standards and is adjusted by the low (row 8) and high (row 9) most likely NRC estimates presented in Table 7.1. That is, the price premiums in rows 2, 3, 5, 6, 8 and 9 were calculated by applying the percentage differences from Table 7.1 to the NHTSA premiums in Table 7.2 (i.e. rows 1, 4 and 7). The percent differences for the low and high most likely estimates for MY 2018-2019 and 2021-2024 in Table 7.1 were calculated using a linear interpolation.

7.21 Cost versus Price

One of the main costs of the CAFE, GHG, and ZEV programs is the incremental increase in the cost of producing an average new vehicle. Since we make the standard competitive-market assumption that production costs are passed on to consumers in the form of higher prices, we refer to this incremental cost increase using the term "price premium." There are a series of analyses that support the view that most of the production cost increase will be passed on to the consumer in the form of higher prices (e.g., see Austin and Dinan 2005; CBO 2004; Anderson and Sallee 2011; Jacobsen 2013; CAR 2015). The federal agencies—NHTSA and the EPA—also adopt this assumption but they take different approaches in estimating the price premium by model year. We chose to adopt the approach taken by NHTSA since this is the approach that was examined and updated by the NRC committee described above.

NHTSA (2012a) identifies two types of price premiums: one based on the "estimated required" fuel efficiency, and one based on the "estimated achieved" fuel efficiency. The "estimated achieved" fuel efficiency considers a series of compliance tools or flexibilities that manufacturers have at their disposal in order to meet the CAFE standards. Those flexibilities, as described earlier in the report, encourage manufacturers to offer BEVs and PHEVs. Flexibility is also provided by allowing manufacturers to bank, carryback, and carry forward compliance credits, and to trade credits with other vehicle manufacturers. The analysis labeled "estimated required" does not allow for the compliance flexibilities mentioned above, but does consider the option to pay civil penalties. In the remainder of the report we focus on the "estimated required" analysis, since this is the one that NRC (2015a) critiqued, and it follows the mandate from Congress that NHTSA has, which is based on the EPCA.

Later in the report, we discuss the various factors that may cause an overestimation or underestimation of the vehicle price premiums. The presence of compliance flexibilities for manufacturers is one of those potential sources of error.

NHTSA used data on vehicles from 2008 and 2010 to develop a baseline in the final rulemaking—the 2010 data is considered to be a more up-to-date estimate. Table 7.3 includes the "estimated required" price premiums by model year based on the 2010 baseline. The data presented in Table 7.3 constitutes the "2012 Perspective NHTSA."

Table 7.3. Average Price Premium in Constant 2010 Dollars (2012 Perspective NHTSA)

	Model Year								
Vehicle Type	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Car	$364	$484	$659	$858	$994	$1,091	$1,221	$1,482	$1,578
Truck	$147	$196	$397	$629	$908	$948	$1,056	$1,148	$1,226
Fleet Avg.	$287	$382	$567	$779	$964	$1,042	$1,165	$1,370	$1,461

Note: The figures pertain to the "estimated required" analysis for the 2010 baseline fleet. The fleet average is the weighted average of the car and truck figures using NHTSA's sales mix forecasts.

Source: Federal Register, Table I-15, pages 62659-62660.

The "2012 Perspective EPA" is based on the information from EPA's 2012 RIA. The EPA data on the average price premium is presented in Table 7.4.

Table 7.4. Average Price Premium in Constant 2010 Dollars (2012 Perspective EPA)

	Model Year								
Vehicle Type	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Car	$206	$374	$510	$634	$767	$1,079	$1,357	$1,622	$1,726
Truck	$57	$196	$304	$415	$763	$1,186	$1,562	$1,914	$2,059
Fleet Avg.	$154	$311	$438	$557	$766	$1,115	$1,425	$1,718	$1,836

Note: The figures pertain to the 2008 baseline fleet. The fleet average is the weighted average of the car and truck figures using NHTSA's sales mix forecasts.

Source: Federal Register, Table I-24, page 62665.

7.22 Potential Sources of Overestimation of Price Premiums

Here we discuss a variety of factors that might cause the price premiums in Table 7.2 to be larger than what would actually occur in the real world, after the federal standards take effect.

1. Vehicle manufacturers can reduce costs by taking advantage of a variety of compliance flexibilities (e.g., banking of credits for use in later years, and trading credits with other manufacturers) that we described earlier in the report, although some of those flexibilities are temporary in nature (e.g., flexible fuel credits expire in 2018; alternative fuel vehicle credits expire in 2021). Additionally, companies must make sure that they have complied with the EPA program as well as the NHTSA program, and the flexibilities in those programs differ.

2. While NHTSA (2012a) and NRC (2015a) have forecasted that industrial innovation will cause some improvements in technology—lowered costs and/or higher fuel-saving effectiveness—by 2025, the rate of innovation may be larger than they have predicted, which would mean that the price premiums in Table 7.2 are too large. Indeed, NRC (2015a) pointed to promising new technologies in their report and some reviewers believe NRC should have forecasted even more innovation, based in part on the historical rate of decline in the costs of producing conventional hybrids (German 2015; German 2016a).

3. Federal agencies are providing compliance credits for some "off-cycle" technologies that were not fully evaluated by NHTSA (2012a) and NRC (2015a); insofar as those technologies are less costly or more effective than those considered by NHTSA and NRC, the price premiums in Table 7.2 will be inflated. For a review of off-cycle technologies and their significance in compliance for the industry, see EPA (2016c).

4. Instead of implementing new technologies, vehicle manufacturers may instead make other compromises in vehicle design that enhance fuel economy (e.g., less acceleration capability). Although performance decrements are contrary to the industry trend over the last 30 years, recent EPA (2016d) data suggest average horsepower is starting to decline. There is also some evidence that this happened in response to the early CAFE standards (Klier and Linn 2010) and, if that happens again in 2017-2025, the price premiums in Table 7.2 will prove to be too high, though consumers may be somewhat dissatisfied with the compromised design features (Duleep 2016).

5. Most vehicle manufacturers operate globally and therefore sell new vehicles in multiple countries around the world where consumers may differ in their sensitivity to price increases. Some of the costs of new technologies may be spread over products sold outside the U.S., thereby reducing the price premiums that will be observed on U.S. vehicles. However, U.S. consumers are among the wealthiest new vehicle purchasers in the world and may be relatively receptive to price increases.

6. Some of the technology costs may not be passed on to the consumer; instead, costs may be financed by lower wages, or benefits to workers, or by diminished returns to investors. Those financial ramifications would produce different macroeconomic impacts than are modeled in this report.

7.23 Potential Sources of Underestimation of Price Premiums

Here we discuss a variety of factors that might cause the price premiums in Table 7.2 to be lower than what will occur after the regulations take effect.

1. Some experts question whether the technology combinations selected in the algorithms used by NHTSA and NRC analysts—and in our COMET modeling—will be sufficiently effective in saving fuel to meet the model year 2025 standards (Novation Analytics, LLC 2015; Smith 2016). If not, vehicle manufacturers may need to resort to more widespread application of conventional hybrids and/or advanced diesel engines, which can easily add $3,000 to $8,000 in production cost per vehicle, especially for light trucks (NRC 2015a). In their most recent draft TAR (2016), NHTSA and EPA models produce conflicting estimates as to the extent of hybridization that will be required (NHTSA predicts more hybrids will be necessary than EPA does). These issues are being addressed in the public comment process related to the draft TAR.

2. The NHTSA 2012 cost estimates are based on the assumption that some vehicle manufacturers (i.e., those facing high costs of compliance) will choose to pay the historically small per-vehicle fines for noncompliance under CAFE rather than implement expensive technologies. This tactic is no longer available because the federal government has decided to adjust all noncompliance penalties for inflation, which may have the practical effect of enlarging the CAFE fines several fold (Beene 2016b). Moreover, the magnitude of the penalties under the EPA program are uncertain but are expected to be much larger than the penalties under the CAFE program. Thus, the cost estimates reported by NHTSA in 2012 are understated, since they assume that some manufacturers can pay small noncompliance fines to achieve compliance.

3. The NHTSA 2012 cost estimates are based on a carry-forward use of compliance credits that may not be comparably available under the EPA GHG program. Consequently, manufacturers may need to invest more in technology than NHTSA analysts estimated, since manufacturers must achieve compliance with both the EPA and NHTSA programs.

4. The NRC (2015a) cost adjustments were derived from a pathway analysis that was applied to a basic mid-sized car with a gasoline engine in the 2008-2010 period. As incomes grow, and if fuel prices remain low, by 2025 a basic mid-sized car with a gasoline engine is likely to have more fuel-consuming features (e.g., additional horsepower, interior volume, cargo-hauling capability, and safety features) than are apparent today. As a result, by 2025, more fuel-saving technologies will be needed for the basic vehicle. Thus, more expensive technologies will be required to comply with the federal standards (Duleep 2016).

5. The NRC (2015a) cost adjustments were derived for a mid-sized car. NRC did not calculate the cost premium for all cars and trucks. However, pathway analyses performed using NRC cost and effectiveness estimates for other vehicle classes were found to provide generally similar trends as the ones estimated for the mid-sized car (Wade 2016). In light of that finding, we assume that the cost premium increases that NRC estimated for the mid-sized car also apply to the average passenger vehicle, which includes small cars, large cars, premium cars, crossovers, SUVs, minivans and pickup trucks. That said, since new vehicle sales are moving rapidly away from mid-sized sedans to cross-overs, SUVs, and pickup trucks, and since the cost-effectiveness of technologies for larger vehicles may be weaker, the price premiums in Table 7.2 could be too low. We are already aware of some concerns that the costs of fuel-saving technologies for light trucks have been underestimated in the TAR (2016) (Dziczek, Smith, et al. 2016).

6. Federal agencies are changing the fuel used in compliance tests from 100% gasoline to a real-world mix of ethanol and gasoline. Because ethanol has less energy content than gasoline, the CAFE and GHG compliance tests could be more difficult to achieve with the blend than with pure gasoline, although federal agencies

are required to make a corresponding adjustment so that the standard is not more stringent due to ethanol blending. The more difficult it is to achieve compliance with a blended fuel, the more manufacturers will have to utilize expensive fuel-saving technologies.

7. If federal agencies underestimate the future market shares of light trucks relative to cars (e.g., due to low fuel prices), and because unit compliance costs are higher for trucks than cars, then the fleet-wide average price premiums will be too low.

7.24 Qualitative Uncertainty Assessment of Price Premiums

A key question is whether the actual price premiums for model years 2017-2025 could prove to be higher than those based on the NRC high-cost adjustment or lower than those based on the NRC low-cost adjustment. Taking into account all of the evidence that we have reviewed, we are not highly confident that the actual price premiums will be in the range of those reported in Table 7.2. However, our opinion is that it is more likely than not that the actual price premiums will be consistent with the figures in Table 7.2. Note that this opinion refers to the federal programs, without consideration of the cost implications of the ZEV program. We now turn to the ZEV issues.

7.3 The 2016 Perspective: California ZEV Program Adjustment

In order to estimate the effects of the ZEV program on vehicle price premiums, we employ a simulation approach, which is distinct from the formal COMET modeling described below. We begin by examining the projected penetration of BEVs and PHEVs in the ten states that have adopted the ZEV requirements. Table 7.5 presents the penetration rates projected by CARB (2011a) for TZEVs (mostly PHEVs) and BEVs in the State of California.

Table 7.5. Number of PHEVs and BEVs Expected Annually, 2018-2025

Year	BEVs	PHEVs	Total	% PHEVs	% BEVs
	(absolute number of vehicles)				
2018	13,900	61,300	75,200	82%	18%
2019	27,300	75,300	102,600	73%	27%
2020	37,700	89,100	126,800	70%	30%
2021	46,300	101,900	148,200	69%	31%
2022	52,600	116,300	168,900	69%	31%
2023	59,500	131,200	190,700	69%	31%
2024	64,200	146,900	211,100	70%	30%
2025	65,400	161,700	227,100	71%	29%
TOTAL	366,900	883,700	1,250,600	71%	29%

Note: We have excluded Fuel Cell Vehicles from the above table.

Source: CARB, 2012, Table 3.6, page 49.

We assume that the ZEV penetration rates projected by CARB in 2012, percentage wise, will be the same in the nine other states that have adopted the ZEV mandate, since CARB's "travel" provision and east/west pooling arrangements expire in the near future.

Our next step is to obtain estimates for the penetration of various categories of BEVs and PHEVs in the fleet, namely PHEV40, PHEV10, BEV200, and BEV100. Table 7.6 presents penetration rates estimated by the EIA (2016), with respect to each vehicle category. For example, in year 2017 the EIA (2016) estimates that PHEV40 will represent 54% of all PHEVs sold, while PHEV10 will make up the remaining 46%. Similarly, for 2018, BEV200 will make up 65% of all BEVs sold in that year, with BEV100 accounting for the remaining 35%. Note that the EIA projections presented in Table 7.6 do not account for BEV75 and refer only to cars (not light trucks).

Table 7.6. Shares of PHEV40, PHEV10, BEV200, and BEV100 as a Percentage of all BEV and PHEV Sales

Year	PHEV40	PHEV10	BEV 200	BEV100
	(shares expressed with respect to all PHEV sales)		(shares expressed with respect to all BEV sales)	
2017	54%	46%	54%	46%
2018	54%	46%	65%	35%
2019	59%	41%	69%	31%
2020	59%	41%	68%	32%
2021	58%	42%	67%	33%
2022	58%	42%	64%	36%
2023	56%	44%	61%	39%
2024	55%	45%	60%	40%
2025	52%	48%	60%	40%

Source: AEO, 2016

Next, we calculate the price premiums for BEVs and PHEVs. We use data from the draft TAR (2016) and capture the following cost components that are unique for BEVs and PHEVs: (1) batteries, (2) non-battery items, (3) in-home charger, and (4) labor costs for in-home charger installation. Our calculations are conducted for the small and standard car size classes, as they are the ones that will see the highest penetration of PEVs.

Given the uncertainty about battery costs, we conducted a supplementary analysis for the price premiums of BEVs and PHEVs using projections from the (DOE 2013). Table V.1 (provided in Appendix V) presents the price premiums for the different PEV categories by vehicle class (i.e., small and standard car) as well as by data source (i.e., TAR 2016 assumptions about battery costs vs. DOE assumptions about battery costs). A more detailed description of how those values were calculated is provided in Appendix V.

The final step in calculating the ZEV price premium consists of weighting the incremental price changes presented in Table V.1 by the shares of each PEV technology captured in Tables 7.5 and 7.6. Additionally, we incorporate the fact that the 10 ZEV states account for 30% of all vehicle sales in the U.S. and consider the minimum ZEV floor requirement from CARB (2011a) presented in Table 7.7. Equation 1 in Appendix V illustrates how the formula was used to derive the ZEV premium.

Table 7.7. ZEV Sales as a Proportion of Total LDV Sales According to the ZEV Regulation

	Model Year							
	2018	2019	2020	2021	2022	2023	2024	2025
Minimum ZEV Floor	2.00%	4.00%	6.00%	8.00%	10.00%	12.00%	14.00%	16.00%

Source: CARB, 2012, Table 2.10, page 29.

The results for the ZEV premium calculated from that equation are provided in Table 7.8.

We use the ZEV premiums calculated in Table 7.8 in order to determine the 2016 Perspectives, namely 2016 Perspective High and 2016 Perspective Low (presented in Table 7.9). The 2016 Perspective High is the sum of the NRC High premium (presented in row 9 of Table 7.2) and the ZEV premium based on the TAR data (presented in Table 7.8). The 2016 Perspective Low is the sum of the NRC Low premium (presented in row 8 of Table 7.2) and the ZEV premium based on the DOE data (presented in Table 7.8). The premiums for the two perspectives start at relatively low levels in MY 2017 ($420 for 2016 Perspective Low and $544 for 2016 Perspective High) but by

Table 7.8. ZEV Price Premium Based on TAR and DOE Data

	Model Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZEV Premium (TAR)	111	72	141	208	271	331	388	442	440
ZEV Premium (DOE)	109	70	135	195	248	294	348	401	407

Note: Values are expressed in constant 2010 dollars. We have assumed a 3% minimum ZEV share for 2017 and have set the ZEV shares for 2018 in Table 7.5 equal to those of 2017.

MY 2025 they become substantially higher ($2,035 for 2016 Perspective Low and $2,735 for 2016 Perspective High).

As a rough check on the 2025 result, we performed a back-of-the-envelope calculation and compared it to the result that was discussed by EPA (2013) when CARB's request for a ZEV waiver was approved. If the incremental

Table 7.9. Average Price Premium due to Federal and State Regulations for the 2016 Perspective, High and Low, by Model Year

	Model Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
2016 Perspective Low	$420	$486	$754	$1,048	$1,308	$1,443	$1,637	$1,922	$2,035
2016 Perspective High	$544	$651	$1,003	$1,396	$1,749	$1,937	$2,192	$2,574	$2,725

Note: 2016 Perspective High is the sum (by Model Year) of the following premiums: NRC High (row 9 on Table 7.2) + ZEV premium (TAR) (Table 7.8). 2016 Perspective Low is the sum (by Model Year) of the following premiums: NRC Low (row 8 on Table 7.2) + ZEV premium (DOE) (Table 7.8).

cost of producing the average ZEV is $10,000, and if ZEVs penetrate 15.4% of the light-duty market in 10 states comprising 30% of the new vehicle fleet in 2025, then the average price premium in 2025 due to the ZEV requirement should be about $462 per vehicle ($10,000 x 0.154 x 0.3). By way of comparison, EPA—when deciding to approve the ZEV waiver request—referred to CARB's average cost estimate of $500 per vehicle (EPA 2013, 2143). Our comparable estimate using the simulation approach is about $440 per vehicle.

Given that BEVs and PHEVs are powered by immature propulsion systems, indeed potentially disruptive technologies, our estimates of the production costs in 2025 could easily err far on the high or low side. Because cost information about battery packs is proprietary information, the cost-estimation exercise is particularly challenging. Public statements made by suppliers and vehicle-assembly companies about costs may be shaded somewhat to influence debate in the public and private sectors. Here we discuss some of the potential sources of forecasting error in the ZEV premiums.

7.31 Potential Sources of Overestimation of ZEV-Related Costs

We start by considering potential sources of overestimation of the price premium for ZEVs.

1. Lithium ion battery packs are the single most expensive component used in producing BEVs and PHEVs (NRC 2015a; NRC 2015b) but costs are reportedly declining as innovation occurs and scale economies are experienced. If those costs decline faster than the large declines forecasted in the draft TAR (2016), then the ZEV price premiums used here will overestimate the actual premiums experienced by consumers.

2. We have assumed that, in the absence of the ZEV requirements in California and the nine ZEV-aligned states, market forces for BEVs and PHEVs in the U.S. would be minimal. If, instead, market forces—boosted by federal and state subsidies, tax incentives, and non-monetary inducements such as HOV lane access—achieve

significant BEV and PHEV without any ZEV regulation, then the incremental price premiums we are using for the ZEV regulation are too high.

3. The 15.4% BEV/PHEV penetration rate in 2025 is based on CARB's calculation of the number of BEVs and PHEVs necessary to achieve industry-wide compliance with the ZEV requirements. If vehicle manufacturers choose to produce fewer PHEVs (which earn as few as 0.6 credits per vehicle), and produce more long-range BEVs or more fuel-cell vehicles (FCVs) (which earn 4+ credits per vehicle) than predicted in 2025, and if BEVs and FCVs experience unexpectedly large declines in production costs, then the number of BEVs/PHEVs/FCVs required to achieve compliance will be less than expected (Shulock 2016). Thus, the average price premium attributable to the ZEV requirements will be smaller than thought.

4. It is also possible that high-volume vehicle manufacturers, instead of incurring incremental ZEV production costs, will expend accumulated ZEV credits from the pre-2018 ZEV program ("banked" credits) or purchase ZEV credits from other BEV/ZEV producers (e.g., Tesla) to satisfy their regulatory obligations under the ZEV program. If those compliance actions are less expensive than making PHEVs/BEVs, then the price premiums we are analyzing in this report are too high—although large vehicle manufacturers may be vulnerable to public criticism and hostile shareholder resolutions if they do not invest resources in the actual production of BEVs and PHEVs.

5. The ZEV costs assume that buyers cannot recoup some of the energy value of lithium batteries at the end of the battery-life, even though significant energy value will remain for non-automotive applications. Some of the materials, such as cobalt, also have recycled value, though efforts at battery cost reduction are reducing cobalt use in new battery design. Barriers to reusing batteries in non-automotive applications include uncertain degradation rates in second uses; high cost of battery refurbishment and integration; low cost of alternative energy solutions; lack of developed market mechanisms for reuse; and negative perceptions of used batteries (CEC 2015).

6. We have assumed that a 3% ZEV penetration will occur in 2017 in the 10 ZEV states as a result of pre-existing ZEV requirements and other factors. If this 3% figure turns out to be too low (PEVs were about 3% of California sales in 2016 but the share is much smaller in the nine other states), then we have overestimated the incremental compliance cost for the 2018-2025 ZEV requirements.

7.32 Potential Sources of Underestimation of ZEV-Related Costs

Now we consider potential sources of underestimation of the ZEV price premium.

1. If the costs of lithium ion battery packs decline less rapidly than the large declines forecasted in the draft TAR (2016), then the ZEV price premiums used here will underestimate the actual premiums experienced by consumers. In 2015-16, the rate of decline in battery costs appears to have slowed (IEA 2016).

2. NRC (2015a) found that NHTSA (2012a) had underestimated the non-battery costs of plug-in electric vehicles and it is not clear whether the TAR (2016) has adequately addressed the concerns raised by NRC (2015a). If not, the ZEV price premiums we are using may underestimate the actual costs experienced by consumers.

3. The 10 ZEV states vary enormously in their ability to accommodate consumers who purchase a BEV or PHEV. Insofar as states and cities do not invest adequate resources in facilitating commercialization of plug-in vehicles, vehicle manufacturers and dealers will be forced to cut BEV and PHEV prices even further to make them acceptable. In that case, price cuts will need to be financed by even higher prices on non-ZEVs sold throughout the U.S. Under that scenario, the price premiums presented here are too low.

4. The replacement costs for lithium ion batteries will be substantial but the frequency of replacement is unknown. One study assumed that 20% of batteries would be replaced after eight to 10 years of use; the remaining 80% of owners would purchase an entirely new vehicle with a new battery (Commission for

Environmental Cooperation 2015). If those parameters prove to be accurate, the lifecycle costs will be larger (and fuel saving benefits of PEVs will be smaller) than estimated here.

5. Complex issues emerge during the collection phase of spent lithium ion batteries, including which party (battery vs. vehicle manufacturer) holds the liability, and how risks will be allocated for improper management or accidents. Refurbishing lithium ion batteries must be managed carefully as the process can pose safety risks to workers. The associated costs of liability and regulation are not yet known.

6. Procedures for the collection, transportation, disposal, and recycling of spent batteries have not been fully worked out and the associated costs are somewhat unknown. Incentives for recycling are declining due to less reliance on cobalt and other valuable materials in battery design; a long-term net cost of battery recycling is likely (CEC 2015).

7. We have assumed that a 3% ZEV penetration will occur in 2017 in the 10 ZEV states as a result of pre-existing ZEV requirements and other factors. If this 3% figure turns out to be too high (PEVs were about 3% of California sales in 2016, but the share is much smaller in the nine other ZEV states), then we have underestimated the incremental compliance cost for the 2018-2025 ZEV requirements.

7.33 Qualitative Uncertainty Assessment of ZEV-Related Costs

The effect of the ZEV regulation in the ten states on the average prices of new vehicles is quite uncertain. In absolute terms, the uncertainty is less than what exists for the price premium in the federal program because, in 2025, only about 4.6% of the new vehicle fleet (30% x 15.4%) is directly impacted by the ZEV regulation, whereas 100% of the new fleet is covered by the federal programs. In relative terms, however, the degree of uncertainty about the ZEV-related price premiums is greater than for the federal price premiums because (1) it is quite difficult to predict the path of lithium ion battery prices (IEA 2016) reports that the rate of decline in 2015-2016 has slowed), and (2) it is not clear what supportive BEV and PHEV policies (e.g., fiscal and nonfinancial incentives) would be in place in the absence of the 2018-2025 ZEV requirements. However, we could not find a plausible way to put numerical bounds on the unstructured degree of uncertainty.

7.4 The 2016 Perspective: COMET Approach

The previous two sections described how we devised the first two 2016 perspective price premiums, one based on an assumption of high NRC parameter adjustments and the second based on an assumption of low NRC parameter adjustments. We also created a third 2016 perspective based on a formal "bottom-up" technology modeling exercise using the most recent EPA data on vehicle characteristics (TAR 2016).

We first considered using one of the agencies' pre-existing models, either OMEGA or the Volpe model. Because the models do not include constraints for PEVs that would allow us to capture the ZEV program, we elected instead to recreate the OMEGA model with such constraints. We chose the OMEGA model for replication in order to generate a 2016 perspective based on EPA data, as a complement to the other two 2016 perspective datasets built with NHTSA data. Moreover, the EPA data on vehicle characteristics in OMEGA is more up to date than the RIA-based NHTSA data we used in the 2016 perspectives.

An additional advantage of our adaptation of OMEGA is that it accounts for the cost savings that manufacturers will experience through the federal programs due to the additional cost of offering ZEVs in California and the other nine ZEV states. In other words, since ZEVs have zero tailpipe emissions and offer greater fuel economy than gasoline engines, compliance with the ZEV regulation means that manufacturers can make smaller investments in fuel-saving and GHG-reducing technologies in order for their gasoline engines to achieve compliance with the federal standards (NRC 2015a).

The model, which was constructed by Alan Jenn of the University of California Davis in coordination with the IU research team, has been termed Cost Optimization Modeling for Efficiency Technologies, or COMET. It is an optimization tool that applies vehicle technology packages that improve vehicle fuel efficiency to a fleet of

vehicles. The simplified model is built to be flexible with a range of inputs and can incorporate a variety of different policy requirements.

The COMET model minimizes individual automaker cost by choosing the appropriate technology package for each vehicle or vehicle class, while simultaneously complying with regulatory policies. The objective function and constraints are explained in greater detail in Appendix VI.

Since each manufacturer faces a separate set of regulatory requirements (e.g., based on the types and footprint distributions of vehicles produced), COMET is applied individually for each automaker, and therefore, is run 21 times for each of the major automakers in the U.S. The raw output of the optimization model is simply the assignment of technology packages for each of the vehicles included as inputs.

We built a credit banking allowance into the model so that automobile manufacturers can choose to comply with the regulations in later years through the purchase of credits. In order to replicate a credit banking allowance, the cost in a particular year is modified by a discount rate that provides an automaker the ability to shift their costs to later years. For compliance with the federal fuel economy standard, the automaker is not required to meet a hard constraint in each year but rather the total constraint must be met over the entire regulatory period under study.

OMEGA contains a feature that applies a specified vehicle redesign cycle, so that a manufacturer does not need to continually change vehicle packages every year to comply with the increasing standard. Instead, a manufacturer can redesign every several years. (The COMET model does not incorporate this feature.) In order to allow the model to operate continuously and avoid using integer optimization, the redesign cycle was simplified to allow manufacturers to change the application in any given year. It is important to note, however, that the results show that most vehicles are not re-designed every year. The credit banking allowance described above helps maintain this flexibility in technological choices across time.

The OMEGA model also included a "fleet protection" feature that controlled mass reduction and safety class. Similar to the cycle redesign, we elected to not include this feature in COMET in order to simplify model computation.

7.41 Input Data and Constraints

We run the COMET model using EPA OMEGA input data, and make modifications to these data, to account for the 2016 perspective. Data inputs for the COMET model include (1) market data such as manufacturers, volume of vehicle sales, vehicle characteristics (including recent forecasts of the likely mix of light trucks vs cars), (2) technology data such as technology package descriptions, costs, technology application ranking factors based on cost, reduced fuel opportunity, and fuel efficiency improvements, and (3) equations with which to comply, as are presented in Appendix VI. The majority of the data inputs used to run the model are from various applications of the EPA's OMEGA model. In particular, we rely on input data OMEGA 1.4.1, which was the dataset used in the 2012 EPA Regulatory Impact Assessment, and OMEGA 1.4.56, which was the dataset used in the TAR (2016).

The market data consists of the full list of automakers regulated under the CAFE and GHG standards. The market data are then broken down by vehicle category (i.e., car or truck), vehicle class and model, average vehicle emissions rate, average footprint, and annual expected sales. In addition, each vehicle is classified by two indices to track the category and class/model, which can then be matched to the suite of technology packages.

The vehicle sales provided in both OMEGA v1.4.1 and OMEGA v1.4.56 are estimated annual sales that are repeated for the years under analysis. Thus, the sales from year to year are identical, but the technology applications are not. A different set of exogenous inputs can be applied to vary the sales based on external assumptions, but the vehicle sales are not endogenous to the model.

It is important to note that the EPA revised their estimates of total vehicle sales, and the distribution of sales between cars and trucks, between the v1.4.1 and the v1.4.56 versions. In the v1.4.1 version of the dataset, total vehicle sales between 2017 and 2025 are assumed as approximately 92 million cars and 51 million trucks. In the

v1.4.56 version of the dataset, total car sales over this same period of time are assumed to be 59 million and total truck sales to be 85 million. This switch in the distribution of cars to trucks has important implications in our macroeconomic modeling of gas savings, as we will discuss in the next section.

Each vehicle class/model has an affiliated "technology type" index that maps a possible set of technology packages that can feasibly be added to an existing vehicle. These packages are obtained from both OMEGA v.1.4.1 and v.1.4.56 input files. Each package has several attributes associated with it: a percentage cap, identifying the maximum proportion of vehicles that the technology package can be applied to; efficiency improvement, the percentage increase in efficiency resulting from the use of the technology package; and incremental cost, the cost of installing the technology package. Additionally, the technologies are pre-ordered by efficiency and cost through the EPA's technology application ranking factor, which allows the optimal package to be chosen by simply going down the list of technologies for each vehicle class/model.

For vehicle fuel technologies, OMEGA v.1.4.1 does not include PEV technologies in their input and output files. Therefore, to model both the CAFE/GHG standards and the ZEV standards, it is necessary to use the OMEGA v.1.4.56 dataset. In OMEGA v.1.4.56, the technology files include a range of pure electric drivetrains at 75-, 150-, and 200-mile ranges (BEVs). There are no technology packages included for PHEV drivetrains, although the default market inputs include several PHEV models such as the Chevy Volt. The presence of PHEVs is therefore a function of currently existing models that have the drivetrain installed, but it is not possible for the technology to be included in any vehicle models in the future.

Some of the inputs from OMEGA v.1.4.1 are modified by updating values to match estimates from NRC (2015a). The various scenarios that use OMEGA v.1.4.1 data are run at a low bounds assumption that matches the assumptions used in the EPA RIA (2012a), and at a high bounds assumption based on those NRC estimates that we were able to match across the NRC report and the OMEGA v.1.4.1 input data. In the high scenarios, for example, these technologies include the following (the additional dollar value added to the technology to match the NRC estimates are included in the parentheses):

- Dual Cam Phasing (+$9)
- Discrete Variable Valve Lift (+$15)
- Integrated Starter Generator (+$130)
- 6-speed automatic (+$153)
- 8-speed automatic (+$68)
- Turbocharging and Downsizing (18 bar BMEP) (+$38)
- Stop Start (+$50)
- Strong Hybrid (Power Split System) (+$500)
- Vehicle Integration (NVH, Thermal Management) (+$25)

We were able to match approximately 76% of the technologies across the NRC report and the OMEGA input database. We were unable to match all technologies because the NRC estimates of fuel-saving effectiveness and technology cost were based on the NHTSA data and technology classifications, and not on the EPA data. We were also unable to incorporate NRC estimates of fuel-saving effectiveness into the COMET modeling. Thus, the resulting fleet-wide cost estimates obtained from the cost optimization model are likely lower than they would be if we were able to match all NRC parameters within our OMEGA v.1.4.1 input dataset.

7.42 Model Results

There are two primary sets of scenarios run by COMET: one using the OMEGA v1.4.1 data inputs used in the RIA for CAFE/GHG standards and the other using the OMEGA v1.4.56 input files used in the draft TAR (2016).

The baseline scenario assumes that the CAFE and GHG emissions standards ramp up until 2016 and are then held constant thereafter. With the OMEGA v1.4.1 data, we run a scenario in which the standards rise to their 2025 levels (scenario 1), and a second scenario that matches the first but has revised technology cost parameters based on NRC suggestions and outlined above (scenario 2). We then replicate this same federal standard using

the OMEGA v1.4.56 dataset which, again, is what EPA used in the draft TAR (2016) (scenario 3). None of the first three scenarios, therefore, include the ZEV standard, which we subsequently introduce in scenarios 4 and 5. With the OMEGA v1.4.56 data, we run a scenario in which the federal standards increase up through 2025 and the ZEV standard also increases up through 2025 (scenario 4). We also run an additional scenario in which we introduce the federal GHG standard multiplier for PEVs and FCVs, and have built in the ability to count these vehicles as zero-emitting (scenario 5). Assumptions about the multiplier and emissions credit match the policy design, as outlined in section 3.3. All scenarios have a base vehicle year of 2014.

The resulting average price premium per vehicle is presented in Table 7.10, along with information about which dataset the scenario used and the exogenous specification of total car and truck sales. As these data reveal, we were able to replicate the original (EPA 2012a) price premium results from their OMEGA model quite well for scenario 1, with less than a $100 difference in the year 2025. Adding the NRC parameter adjustments (scenario 2) does not significantly increase the resulting price premium values, likely due to some mismatch between the NRC technology categories and those contained within the OMEGA v1.4.1 dataset, perhaps because NRC fuel-saving effectiveness estimates could not be incorporated, and that NRC adjustments were based on NHTSA data.

The price premium results in scenario 3 using OMEGA v1.4.56 data are lower than in scenarios 1 and 2, as well as in the NRC suggested adjustments to the NHTSA 2012. These results are due to the model inputs, which are (1) based on EPA data, where EPA and NHTSA are not completely identical, and (2) based on data that EPA updated when working on the draft TAR (2016).

For example, EPA now includes data on a relatively new, cost-effective Atkinson engine that NHTSA and NRC did not include in their list of commercially likely innovations. In its most recent proposed determination on

Table 7.10. Average Price Premium per Vehicle Due to Specified Regulations Based on COMET 2016 Perspective Scenarios

Scenario	Input Data	Vehicle Sales 2017-2025	2017	2018	2019	2020	2021	2022	2023	2024	2025
Scenario 1: EPA GHG standards through 2025	v1.4.1	92,044,659 cars and 50,715,137 trucks	$137	$282	$491	$697	$907	$1,150	$1,383	$1,566	$1,760
Scenario 2: EPA GHG standards through 2025; some NRC adjustments	v1.4.1	92,044,659 cars and 50,715,137 trucks	$265	$404	$603	$813	$1,027	$1,269	$1,500	$1,672	$1,881
Scenario 3: EPA GHG standards through 2025	v1.4.56	59,348,125 cars and 84,652,992 trucks	$56	$203	$362	$489	$599	$706	$847	$1,046	$1,249
Scenario 4: EPA GHG standards through 2025; ZEV standards through 2025 (referred to as "2016 Perspective COMET" in this analysis)	v1.4.56	59,348,125 cars and 84,652,992 trucks	$80	$216	$471	$707	$899	$1,085	$1,293	$1,550	$1,821
Scenario 5: EPA GHG standards through 2025; ZEV standards through 2025; includes GHG standard multiplier and emissions credit	v1.4.56	59,348,125 cars and 84,652,992 trucks	$67	$202	$447	$684	$889	$1,077	$1,277	$1,527	$1,798

the 2022-2025 standards, EPA adjusted downward the penetration rate of this new engine in conjunction with other technology adjustments (EPA 2016a; TAR 2016). Since this issue is now in a public comment process and is likely to remain controversial through the development of forthcoming RIAs, it may be some time before the issue is properly handled.

When we introduce the ZEV standard in scenario 4, the price premium rises above those values for only the federal standards. In 2025, the premium is almost $600 more expensive per vehicle with both the state and federal standards than if just the federal standards were in place, after accounting for the savings manufacturers experience in the federal programs.

The $600 figure is larger than the comparable $440 figure we estimated based on the simulation using TAR (2016), CARB, NHTSA, EIA, and DOE data. One of the possible contributors to the $160 per vehicle difference is that the baseline rate of ZEV penetration in 2017 was 3% of all light-duty vehicles in our simulation approach but was smaller in the formal COMET model (2.1% for cars and 0.8% for trucks). We have chosen to use the COMET-derived ZEV premium in the macroeconomic modeling for a conceptual reason: it accounts for the compliance interactions between the federal and ZEV regulations while the simulation approach does not. We refer to this scenario as the 2016 COMET Perspective from here on out.

Scenario 5 also combines the state and federal standards, and additionally provides a bit more nuance into the ways in which these policies could interact. More specifically, scenario 5 introduces the federal GHG multiplier and GHG credit provisions for electric and fuel cell vehicles. Since these two provisions should make it easier for auto companies to comply with the GHG standards, we should observe a decline in the price premium relative to scenario 4, as we witness to be the case in Table 7.10.

Although there are some limitations to the results of our COMET modeling—primarily our inability to perfectly match all NRC parameters with the simplifications that we made to the model for computational ease—the key advantages of the COMET-based results are that they (1) capture some of EPA's technical perspectives on the issues of fuel-saving effectiveness and technology cost, (2) are based on the most up to date information on vehicle characteristics, (3) are based on the most up to date information on the costs of BEVs, and (4) capture the interaction of the federal and ZEV programs in the choices made by individual vehicle manufacturers.

7.5 Summary of 2012 and 2016 Perspective Datasets used in Macroeconomic Modeling

In sections 8 and 9, we present our macroeconomic results, using much of the input data we have just described. The distinction between sections 8 and 9 is that section 8 focuses on the economy as a whole (employment, GDP, and income, as simulated through a macroeconomic model called REMI, which we define in the next section) whereas section 9 presents more specialized analyses of consumer demand for new vehicles based on total cost of ownership (TCO) modeling.

Table 7.11 lists all the datasets that will be used in sections 8 and 9 along with a description of their key characteristics. The table also serves as a way to distinguish between how the various datasets are considered in the REMI vs. TCO modeling. The main differences pertain to a series of parameters—resale value, consumer fuel price projections, number of years of fuel savings valued by consumers, and vehicle miles traveled—that are considered in the TCO but not in the REMI model. Additional parameters that are considered by the TCO but not the REMI model (and do not appear in Table 7.11 as they have less of an effect on car sales) are sales taxes, auto-loan financing costs, and auto-insurance costs. National gasoline savings from the regulatory programs, as used in the REMI modeling, are not all based on the same data. In particular, for the 2012 and 2016 perspectives that rely on NHTSA data, national fuel savings are based on vehicle sales data reported in NHTSA's 2012 RIA. For the 2016 COMET perspective, the national fuel savings are based on vehicle sales data from the 2016 draft TAR. For the REMI modeling in section 8, where national estimates of gasoline savings play a crucial role, it is useful to remember that the COMET 2016 dataset has a much larger mix of light trucks relative to cars from 2017-2035 than is assumed in all of the other datasets.

Table 7.11. Distinction between REMI and TCO Datasets

Model	Dataset	Price Premium	ZEV Regulation	Resale Value	Consumer Fuel Price Projections	Years of Fuel Savings Valued	VMT
REMI	2012 EPA Perspective	EPA 2012 RIA	Not included	N/A	N/A	N/A	N/A
TCO	2012 NHTSA Perspective	NHTSA 2012 RIA	Not included	35% of premium	AEO projections	5	NHTSA 2012 RIA
REMI	2012 NHTSA Perspective	NHTSA 2012 RIA	Not included	N/A	N/A	N/A	N/A
TCO	2016 High Perspective	NHTSA 2012 RIA + high NRC adjustment + ZEV (TAR data on battery costs as reviewed in section 7.3)	BEV200, BEV100, PHEV10 & PHEV40	35% of premium	Tomorrow's fuel price equal to today's fuel price	3	NHTSA version in TAR 2016
REMI	2016 High Perspective	NHTSA 2012 RIA + high NRC adjustment + ZEV (TAR data on battery costs as reviewed in section 7.3)	BEV200, BEV100, PHEV10 & PHEV40	N/A	N/A	N/A	N/A
TCO	2016 Low Perspective	NHTSA 2012 RIA + low NRC adjustment + ZEV (DOE data on battery costs as reviewed in section 7.3)	BEV200, BEV100, PHEV10 & PHEV40	35% of premium	Tomorrow's fuel price equal to today's fuel price	3	NHTSA version in TAR 2016
REMI	2016 Low Perspective	NHTSA 2012 RIA + low NRC adjustment + ZEV (DOE data on battery costs as reviewed in section 7.3)	BEV200, BEV100, PHEV10 & PHEV40	N/A	N/A	N/A	N/A
TCO	2016 COMET Perspective	Estimated via the COMET model with updated technology costs and the ZEV standard (as reviewed in section 7.4)	COMET only selects BEV75 since it is the cheapest type of ZEV	35% of premium	Tomorrow's fuel price equal to today's fuel price	3	NHTSA version in TAR 2016
REMI	2016 COMET Perspective	Estimated via the COMET model with updated technology costs and the ZEV standard (as reviewed in section 7.4)	COMET only selects BEV75 since it is the cheapest type of ZEV	N/A	N/A	N/A	N/A

Note: This table highlights some of the main differences between the way the datasets are defined for REMI and Total-Cost-of-Ownership (TCO) models. The main difference is that the TCO accounts for consumer valuation of fuel savings. In addition to the differences highlighted here, the TCO definitions also include sales taxes, auto-loan financing costs, and auto-insurance, which are not factored into REMI. All of the 2012 perspectives use fuel price projections from the AEO 2012 while the 2016 perspectives use AEO 2016 projections. Other variables such as vehicle miles traveled, survival rate, fuel price projections, and fuel economy are similar between the two models; they enter the TCO directly and REMI indirectly through fuel savings. TAR is technical assessment report, DOE is Department of Energy, RIA is regulatory impact analysis, ZEV is zero-emissions vehicle, BEV is battery electric vehicle, PHEV is plug-in hybrid electric vehicle, NRC is National Research Council, and N/A is not applicable.

8. EVALUATING IMPACTS ON EMPLOYMENT, GDP, AND INCOME

We now turn to our modeling of the impacts of the federal and California standards on employment, GDP, and real disposable income. Changes in the levels of these three standard macroeconomic indicators are watched closely by policy makers, stakeholders, investors, and Wall Street and corporate analysts.

Our objective for this macroeconomic modeling is to simulate the national and regional economic impacts of the federal and California standards. We do so from both the 2012 and 2016 perspectives, using the five datasets described previously. We begin with a statement of theoretical expectations, then describe our modeling platform, present the details about the inputs that were used to generate the results, and present our analytic results. We conclude with a discussion of uncertainties and promising future research directions.

As we present our results, we urge the reader to consider that macroeconomic impacts, though obviously important, are not the only impacts of the federal and California regulations. The results presented here do not account for environmental impacts, such as climate-related emissions of greenhouse gases or pollutants related to local levels of smog and soot. Nor does our analysis provide an overall cost-benefit analysis of the regulations from a societal perspective.

The scope of our analytic work is specialized and focused, seeking to determine how technology costs and fuel savings, largely through private-market channels, may impact the U.S. economy (nationally and by region) as a whole in the years ahead. Thus, we urge readers to consider our results in conjunction with other kinds of analyses (e.g., environmental, and cost-benefit analyses) that are informative for regulatory policy making.

8.1 Macroeconomic Theoretical Expectations

We postulate that the macroeconomic impact of the regulatory programs occurs as if the U.S. economy were subject to both a tax increase on new vehicle sales (CBO 2004; Jacobsen and van Benthem 2015) and a tax cut expressed in the form of savings in gasoline expenses, perhaps similar to what might result from a reduction in the gasoline tax (Morath 2014; Arora 2015). The tax increase is more immediate, since it is reflected fully in the prices of new cars and light trucks (or the somewhat deferred payment of car loans), while the tax cut is more gradual but grows in magnitude as fuel savings accumulate over the 30-year maximum lifetime of a cohort of cars (37 years for trucks). We do not model how the rise in new vehicle prices ripples through used-vehicle markets, though that would be a useful extension for future work (Jacobsen and van Benthem 2015).

Unless one suspects different macro effects depending on the type of tax, the long-run effect on the U.S. economy is determined by the relative magnitude of the tax increase compared to the magnitude of the tax cut. Since the federal agencies estimated in 2012 that the vehicle price effects of the 2017-2025 standards are small compared to the present discounted value of the fuel savings, we expect the 2012 perspective to show that the federal programs exert a long-run positive impact on the U.S. economy.

If the regulatory programs applied to only one model year of vehicles, then the impact on the U.S. economy after year one would depend on the size of the vehicle price increase compared to the size of the fuel savings in the first year. In the second year, assuming that there is no additional price increase, there would now be two years of fuel savings offsetting the initial price increase. Those fuel savings continue to accumulate each year, though at a decreasing rate, as vehicles in the initial cohort age, are driven less, and are removed from the fleet.

If the vehicle price increase is larger than the fuel savings in the first year, as the 2012 NHTSA and EPA RIAs suggest is the case, then the interesting question is how long it will take for the fuel savings to overtake the initial price premium increase. When we add the complication of a rising price premium due to a schedule of stricter standards from 2017-2025, the same temporal question presents itself, assuming that each incremental rise in the price premium is ultimately overwhelmed in magnitude by future fuel savings. How long will it take for the

economic impacts of the schedule of price increases to be overwhelmed by the accumulated savings in gasoline expenditures? We seek to answer that question using data from 2012 and 2016.

As the economic impact of the vehicle price increase is modeled, we are careful to consider that the impact on the U.S. economy (e.g., employment, income, and output) will not be entirely negative. Higher prices for new vehicles fund economic activity in the automotive supply chain. Fuel-saving technologies such as turbochargers, stop/start systems, and lithium ion batteries are being added to vehicles, and those investments in innovation have positive employment, output, and income effects (Baum and Associates 2016). We expect that those stimuli arising from a vehicle price increase will offset, at least to some degree, the adverse effects of increased vehicle price premiums on consumers.

Given the uncoordinated interaction of the ZEV program with the federal programs, the ZEV program acts as a tax increase on new vehicle sales without any offsetting tax cut for the average consumer (i.e., the purchaser of the PEV saves fuel but the average new-vehicle consumer in the U.S. does not save fuel due to the PEVs produced under the ZEV regulation). We discuss this uncoordinated interaction issue in more detail in section 10. From a macroeconomic perspective, the ZEV program prompts an interesting dynamic change in the automotive supply chain: the replacement of internal combustion engines with batteries and electric drivetrains. Although we do not formally model the impacts of this shift in the supply chain, we examined this dynamic qualitatively in section 3.

8.2 Modeling Platform

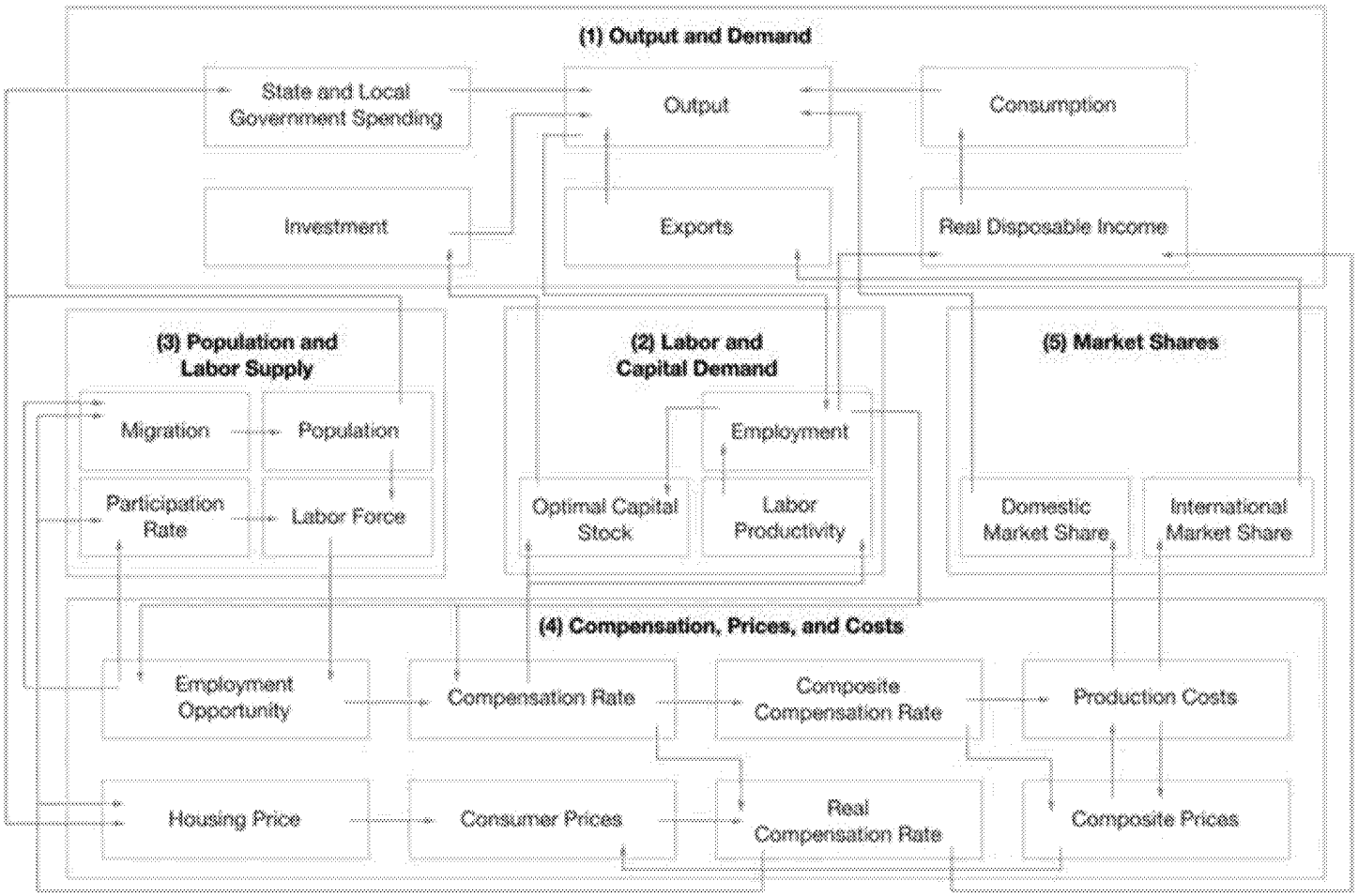
The tax increases and decreases we are modeling will have ramifications beyond the automotive and energy sectors. For each loss or gain in new vehicle production, there are ripple effects that occur throughout the supply chain for vehicles, sometimes referred to as "backward linkages" (PwC 2013; The Perryman Group 2014). A change in the demand for new vehicles changes the demand for steel, which in turn changes the demand for iron ore and coal. Likewise, when consumers save money on gasoline, there is a consumer reallocation effect, which means households have more income to spend on other goods and services such as eating out at restaurants, outdoor recreation, and consumer electronics. The supply chains of these sectors are in turn stimulated indirectly when consumers save money on gasoline.

The tools of input-output analysis were devised in the 1930s and 1940s, building on the theoretical work of Nobel Laureate Wassily Leontief (Leontief 1986). These tools were devised to help characterize and quantify the interactions between different sectors of the economy, and they are now commonplace in economic analysis (BEA 2009). A variety of modeling platforms are available to capitalize on the growth in understanding about how sectors of the economy are interconnected.

The modeling platform that we use to simulate the macroeconomic impacts of the regulations on the national economy is REMI PI+ 2.0.2, as constructed by the Regional Economic Models, Inc. PI+ is a dynamic structural economic forecasting and policy analysis model. It combines input-output, computable general equilibrium, econometric, and economic geography modeling components. The model contains thousands of different simultaneous equations pertaining to output and demand, labor and capital demand, population and labor supply, prices and costs, and trade ratios. The interactions among these categories in the REMI model is presented in Figure 8.1.

Following the introduction of the REMI model (Stevens et al. 1983) and subsequent additions to the model (Fan, Treyz, and Treyz 2000), it has been used extensively by researchers. The peer-reviewed literature has employed the model to analyze regional clean air incentives markets (Johnson and Pekelney 1996), business incubator outcomes (Sherman and Chappell 1998), development benefits of highway decision making (Weisbrod and Beckwith 1992), economic impact of retirement migration (Deller 1995) and economic benefits of environmental management at U.S. nuclear weapons sites (Frisch et al. 1998). The grey literature has used the model to analyze the future availability of family caregivers (Redfoot, Feinberg, and Houser 2013), solar power generation in Nevada (Schwer and Riddel 2004), economic impact of the Mashantucket Pequot tribal nation operations in Connecticut (Carstensen et al. 2000) and highway congestion (NHCRP 2001).

Figure 8.1. REMI Model Linkages.



The REMI model can be run at different geographical levels and with varying degrees of economic sector granularity. For this project, we use a 160-industry-sector, 9-region version of the model. These nine regions, as delineated in Figure 8.2, correspond to the Census Bureau's nine major divisions of the U.S.

We present results for three different economic indicators: employment, gross domestic product (GDP), and real disposable personal income. As also used by the U.S. Bureau of Economic Analysis, the employment output captures full-time, part-time, and sole proprietors. Employment is a stock concept, meaning that it should not be aggregated over time but instead interpreted in a single year relative to a base year. GDP accounts for all business transactions minus demand for intermediate goods and services. Thus, this output only reflects net new economic activity. Real disposable personal income captures the change in after-tax real income.

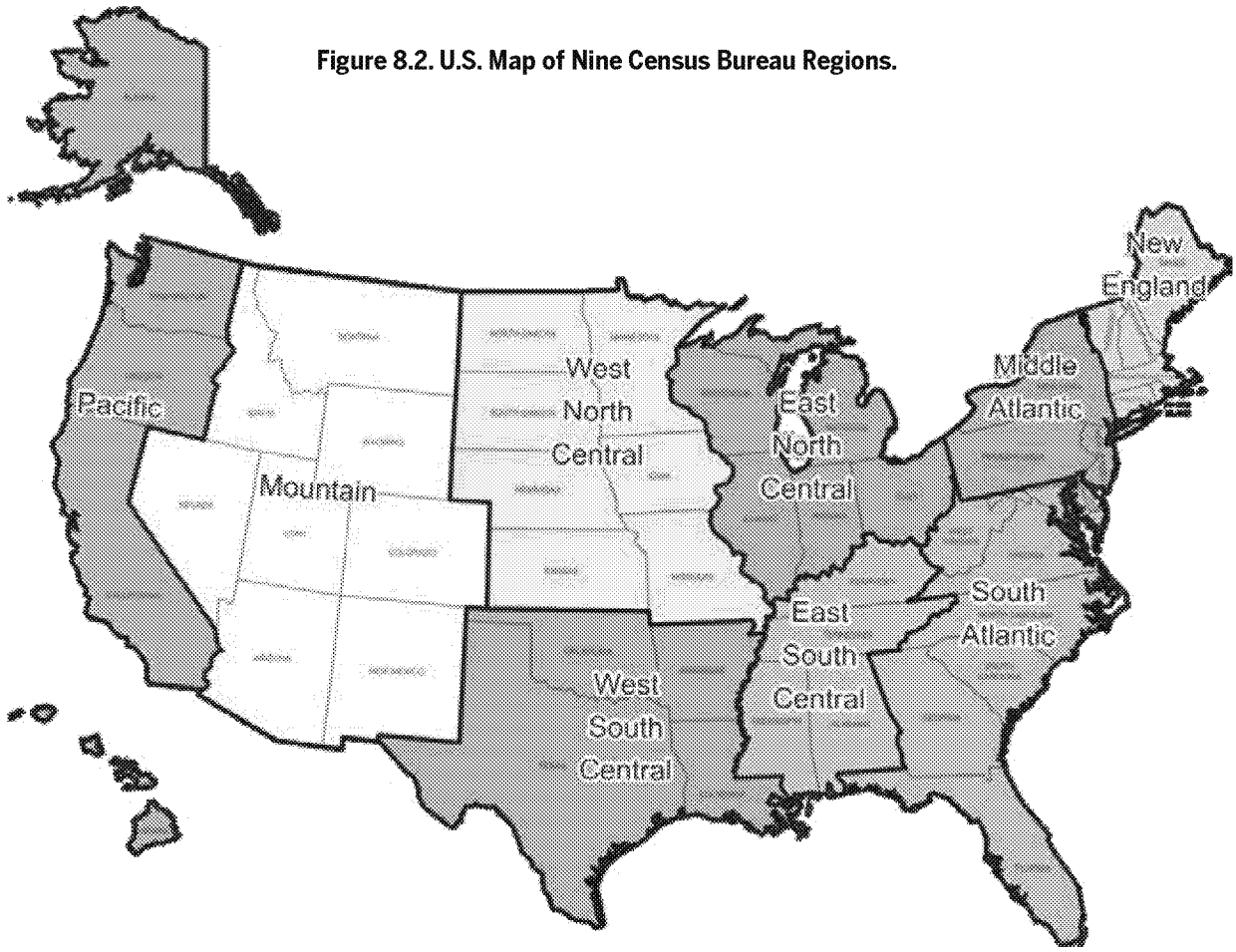
8.3 Constructing Policy Mechanisms in REMI

The federal CAFE/GHG and California ZEV regulations affect the U.S. economy through several mechanisms. We begin by describing each mechanism separately and then explain how the mechanisms are combined to model the overall impact of the regulations. It is important to consider each aspect separately, since each has its own set of input assumptions and also affects the economy in different ways.

8.31 Vehicle Price Premium

In order to capture the impact of the vehicle price premiums associated with the regulations, we began by dividing vehicle consumers into two categories: those that purchase vehicles for personal use and those that purchase vehicles for use in private (i.e., industry or commercial) or government fleets. We assume that 80% of vehicle

Figure 8.2. U.S. Map of Nine Census Bureau Regions.



Source: United States Regional Economic Analysis Project, available at https://united-states.reaproject.org/

purchases are for individual consumers, 19% are private industry fleet purchases (e.g., rental car agencies and corporate fleets), and the remaining 1% is for government fleet purchases. This distribution is based on historic vehicle sales data, as gathered by Polk (2016), and on the registration category breakout outlined by Polk (2002). The regional distribution of sales are allocated to the nine Census regions in proportion to total light-duty vehicle sales, as specified by the EIA (2012).

For consumers, the total additional expenditures on light-duty vehicles due to the regulations are treated as an automobile price increase. For government, the additional expenditures are treated simply as additional government spending on automobiles. For private industry, the additional expenditures are operationalized as additional production costs, and spread across 160 sectors according to the amount of total light-duty vehicle transportation-related GDP output each sector accounts for.

8.32 Automobile Supply Chain Reinvestment and Technological Innovation

Increased expenditures on vehicles pay for economic activity, which occurs originally in the supply chain of the automotive sector (Baum and Associates 2016). We frame this activity as investment in technological innovation and deployment, since that is the functional purpose of the regulations. Like any form of economic activity, the supply-chain investments due to regulation stimulate employment, output, and income.

We assume that 100% of the vehicle price premium is translated into spending in the automobile industry sector, but a certain percentage of that stimulus will occur entirely outside of the U.S. economy (Hagerty and Bennett 2015). For example, all of the global automakers, including the Big Three, are allocating a significant share of new investments to China and other emerging markets, especially India, Southeast Asia, and Latin America. The forecasted rate of growth in new vehicle demand is higher in these regions than it is in North America and

Europe (Greimel 2016). Within North America, about 65% of new automotive (OEM) facility investments are being allocated to the U.S., with Mexico's share rising, the U.S. share declining, and the Canadian share stable (CAR 2015; Swiecki and Menk 2016; Boudette 2016).

Since the leakage of stimulus spending outside the U.S. reflects strategic decisions of specific manufacturers, it has been suggested that descriptor variables of manufacturers may have explanatory power, at least as surrogates. The most common variables that have been suggested for consideration are the location of the company's global headquarters, whether the company has R&D centers in the U.S., whether the company assembles its vehicles in the U.S., whether a company assembles its engines and/or transmissions in the U.S., and the domestic content of the parts used in a company's vehicles (Burroughs 2013). We are aware of no statistical data showing how each of the descriptors of manufacturers relate to the probability that a dollar of revenue from the U.S. market will be reinvested in the U.S.

A recent study of Toyota's operations provides significant evidence that investments may occur in the U.S. even though the company's global headquarters are located outside of the country and they make extensive use of non-U.S. companies in its supply chain (Dziczek, Chen, et al. 2016). The leadership of Toyota's North American operations was recently consolidated and moved from Torrance, California, to Plano, Texas. The company currently has seven North American assembly plants: four in the U.S., two in Canada, and one in Mexico. Plans for a new assembly plant in Guanajuato, Mexico, were recently announced. A majority of the Toyota cars and light trucks sold in the U.S. are currently assembled in the U.S. Toyota also has three engine plants and a dedicated transmission plant in the U.S. In recent years, Toyota has been a net exporter of engines from the U.S. to the rest of the world. In terms of R&D, Toyota has 11 identifiable centers or institutes in the U.S. with different foci, three of which have formal linkages to U.S. universities (Stanford, MIT, and the University of Michigan). Over the last decade (1996-2015), Toyota's new investments in North America have been distributed 66% in the U.S., 23% in Canada, and 11% in Mexico.

Information on the U.S. orientation of other global automakers is less well documented. In section 3 we showed that the Japanese OEMs and their suppliers and dealer networks are well integrated into the U.S. economy. Honda, for example, launched the first assembly plant in the U.S. in the 1980s (Ohio) and currently has 14 R&D facilities in the U.S. (Honda 2017). Volkswagen is known as the global leader in auto-related R&D spending but most of that spending does not occur in the U.S. (Sharman 2014).

To simplify a complex issue, we assume that 30% of all investments by OEMs (excluding investments by parts makers) will occur outside of the U.S. That figure may seem low, since the U.S. market share of the Big Three in 2015-2016 was only 45.3%. Insofar as Toyota is treated more like the Big Three than like the other global automakers, with respect to investment interest in the U.S. market, the U.S.-related market share rises from 45.3% to 59.5%. Adding in Honda (9.2%) ups the total from 59.5% to 68.7% (Wall Street Journal 2017). We maintain the 30% assumption in the 2012 and 2016 perspectives but we also run a series of sensitivity analyses using different percentages.

The uncertainty here is partly related to policy. There is growing pressure on OEMs from U.S. politicians to reinvest revenues from the U.S. market in the U.S. automotive sector. The recent disputes between the new Trump administration and automakers over investments in Mexico are a microcosm of a much larger policy uncertainty.

REMI also assumes regional purchase coefficients in auto industry supply chains of approximately 70%, plus or minus depending on the specific supply chain. In other words, REMI assumes that for each dollar invested in the U.S. auto supply chain, approximately 70 cents stays in the U.S. economy. This estimate matches the U.S. Department of Commerce's Economics and Statistics Administration's finding that, of all domestically-produced motor vehicles and parts, the average domestic content is 71% (DOC 2014).

The 70% of the OEM reinvestment that stimulates the U.S. economy is allocated in several categories of economic activity: 4% goes toward research and development (R&D), 7.8% toward increased production in labor, 32.1%

toward increased production of motor vehicle parts manufacturing (i.e., materials), 39.1% toward overhead and management, 7.1% toward shareholder income, and 9.6% toward auto dealership income. All of these mechanisms affect only the automobile industry (i.e., NAICS codes 3361, 3362, and 3363). Appendix VII provides a detailed explanation of how those percentages were derived.

In the REMI model, regulation is modeled as increasing investment in R&D by increasing industry sales for scientific research and development services. The increase in labor is modeled as an increase in industry sales for motor vehicle manufacturing. Materials are modeled through motor vehicle parts manufacturing. The increase in overhead is entered into the model through industry employment for management of companies and enterprises. Shareholder income is operationalized as proprietor income in the auto industry, and dealership income is operationalized as automobile dealership income.

8.33 The Gasoline Savings Mechanism

Savings in gasoline expenditures again operate through the same three categories of consumers: individual consumers, government fleet consumers, and private industry fleet consumers. All three groups of consumers are modeled as saving money on gasoline expenditures but are then subject to a macroeconomic balancing mechanism in which they spend an equivalent amount on all other goods and services, since savings and debt are held constant in REMI.

For consumers, expenditures on gasoline are operationalized in REMI through a decrease in consumer spending on motor vehicle fuels, lubricants, and fluids. Since consumers retain the extra money that would have been spent on gasoline, they ultimately spend this money on other goods and services, which is entered into the model as a consumption reallocation to other goods and services. For industry, we enter gas savings in REMI as a production cost decrease, and those savings are spread across all industry sectors, according to their shares of transportation-related GDP. Similar to individual consumers, the government spends less on fuels, lubricants, and fluids, but has more money available for other types of expenditures. It is important to note that taxation and deficit spending are held constant (Appelbaum 2016; Conoscenti 2011).

The reduced consumption of gasoline is expected to reduce U.S. demand for oil, which in turn reduces oil imports and U.S. oil production. REMI is structured to generate a 50-50 split in the relative impact on importation vs U.S. production of oil, and we assume that there is no change in that distribution throughout the time horizon of the study. As U.S. oil production changes, there are ripple effects throughout the energy supply chain such as changes in refining activity, oil and gasoline transport, purchases of equipment for exploration and development, and sales at wholesale and retail gasoline outlets.

In the public debate on CAFE, the argument is sometimes made that the gasoline savings from CAFE have no net impact on the U.S. economy because, in effect, the economy does not respond differently from a dollar spent on gasoline (oil) and a dollar spent on other goods and services in the economy (Appelbaum 2016). This assumed dollar-for-dollar equivalence is not consistent with the findings of input-output models where the multiplier effects in the supply chains of different sectors are quite different, in part due to differences in sector-specific import ratios in the supply chains. For example, in section 3 we reviewed a recent study showing that, for each job gained or lost in the assembly of new vehicles, another 7 jobs are gained or lost in parts production and in other sectors of the U.S. economy (CAR 2015). Similar studies of the U.S. oil and gas sector (by different authors but with similar input-output methods) found that each job gained or lost in U.S. oil and gas extraction is associated with another 2.7 to 3.5 jobs gained or lost in the U.S. economy as whole (PwC 2013; Conoscenti 2011). Thus, the net effects of gasoline savings on the U.S. economy require formal modeling, and cannot be assumed to be neutral based on first principles.

8.4 Time Horizon for the Analysis

Our modeling compares the combined impacts of the federal and California standards for model years 2017-2025 to a baseline scenario where the federal standards are frozen at their 2016 levels and the California ZEV

standard is frozen at its 2017 level. The theoretical time horizon is long, through 2055 or 2060, since some of the new vehicles produced in 2025 (and their design-based impact on the economy) will last for more than 30 years.

For practical reasons, we report results for the period 2017-2035, since the underlying assumptions, inputs, and forecasts are more plausible for the shorter time horizon, and because intervening policy, technological, and economic variables can change in unexpected ways as the time horizon is lengthened by decades. On the other hand, the time period through 2025 is too short to fully reveal the powerful impact of gasoline savings on the U.S. economy. Fuel-efficient vehicles produced in 2025 will save some gasoline in their first year of operation but a disproportionate share of gasoline savings will occur over the initial 10 years of use, when vehicle miles of travel are relatively high and rates of vehicle scrappage are low. Consequently, the impact of the 2025 standards on the U.S. economy will have both a short run and long run effect, with temporal trends apparent by 2035. In a few exceptional cases where we found important trends after 2035, we discuss them in the text.

8.5 Summary of Modeling Results

We begin by presenting the results of the "tax increase" effect: the rise of vehicle price premiums and their impact on employment, GDP, and real disposable income. We then consider the reinvestment/innovation effect of the price increase, as the supply chain is stimulated, to provide more fuel-saving technologies. We finally consider the "tax cut" effect: the savings in gasoline expenditures that permit consumers to shift from purchasing gasoline to purchasing other goods and services in the economy.

All graphs presented in this section reflect the difference between the baseline scenario—in which federal standards do not rise above 2016 values and ZEV standards do not rise about 2017 values—and the policy scenario of interest. In the case of the 2012 perspective, the scenarios measure the difference between federal standards staying at 2016 levels and fuel economy standards rising to 2025 levels. In the 2016 perspectives, the policy scenario also includes the ZEV standard (technically, the ZEV regulation under study begins in 2018 and extends to 2025).

8.51 The Vehicle Price Effects

Within REMI, when vehicle production costs increase, prices rise for new motor vehicles. Consumers pay higher prices for these vehicles, which is entered into the model as an increase in consumer price for new motor vehicles. An increase in consumer price causes a decrease in the real compensation rate of households, since overall prices in the economy are higher for the same level of compensation. Real disposable income decreases due to higher consumer prices. Because of decreased real disposable income, consumption decreases and this causes output to decrease. The effect of the increasing consumer price causing real compensation and consumption to decrease is a variant of the well-known income effect (the change in consumption from a change in real income).

The other mechanism at work in REMI is the price elasticity effect: the lowered consumer demand for vehicles due to the higher price of new motor vehicles. Both the income and substitution effects work together to result in a decreased demand for new motor vehicles.

The increase in consumer price of new motor vehicles affects output of the automotive industry the most. But, with any increase in consumer price, industries such as construction, retail trade, wholesale trade, and real estate also experience decreases in output.

The increase in government expenditures on vehicles in REMI causes the amount of money available to spend elsewhere to decrease. As a result, there is a decrease in government spending. Government spending is also affected by changes in gas savings and operations and maintenance expenditures, as we discuss in more depth below.

A decrease in government spending causes output to decrease, which causes employment to decrease. The decrease in employment affects real disposable income and consumption, both of which decrease and subsequently cause

output to decrease. The other effect of decreasing employment is that it causes the optimal level of capital to decrease, and thus there is a decline in investment. This also affects output negatively.

For private industry, higher vehicle costs translate into greater production cost. Increases in private industry expenditures on vehicles cause an increase in the cost of creating output, or production cost. The production cost increase is weighted by the amount of intermediate inputs associated with transportation, which affects those industries the most that rely more heavily on transportation. An increase in production costs causes composite prices to increase, which subsequently causes consumer prices to increase. It also causes domestic market share, as well as output, to decrease.

In summary, the higher vehicle price premium operates through several mechanisms in REMI. The price premium associated with regulations has a negative effect on the economy because it causes cars to be more expensive for consumers, resulting in decreased sales of new motor vehicles. Government also experiences increased costs associated with more expensive vehicles and has less revenue available to spend. Private industry's cost of production increases, leading to goods being more expensive to produce, and that makes U.S. producers less competitive, increases imports, and reduces exports.

The impact of higher vehicle prices on total employment, GDP, and real disposable income are presented in Figures 8.3-8.5, respectively. As expected, the employment impacts of the price premium for vehicle consumers—retail consumers, and government and industry fleet purchasers—are negative and increasingly so, until the employment losses reach their peak value around 2025.

The negative employment effects are larger for the 2012 EPA inputs than for the 2012 NHTSA inputs because EPA estimated a higher vehicle price premium than NHTSA. The maximum loss in employment level for the 2012 perspective is over 500,000 jobs in 2025. The modified 2016 perspective has a larger vehicle price premium

Figure 8.3. Difference in Employment Between Baseline and Price Premium Scenarios.

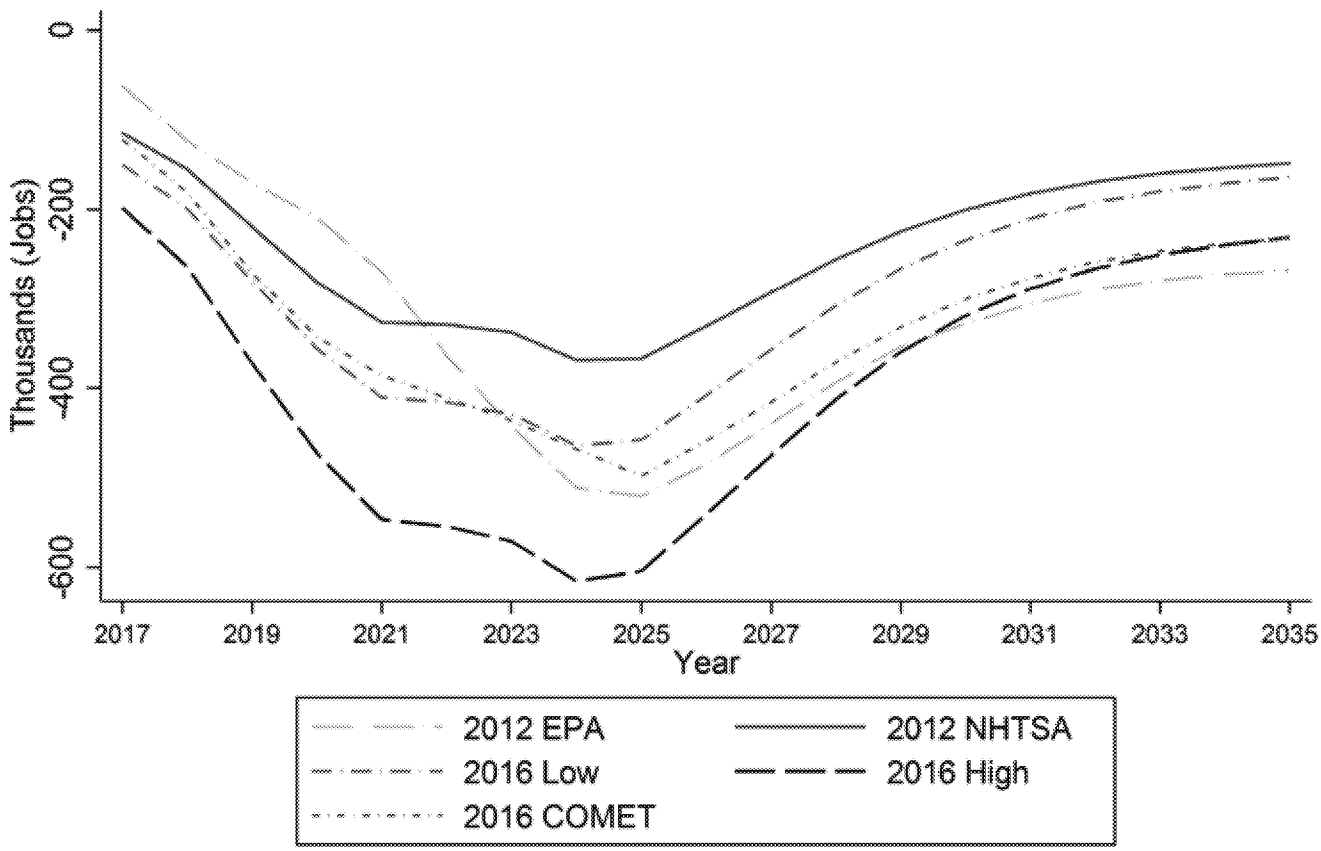
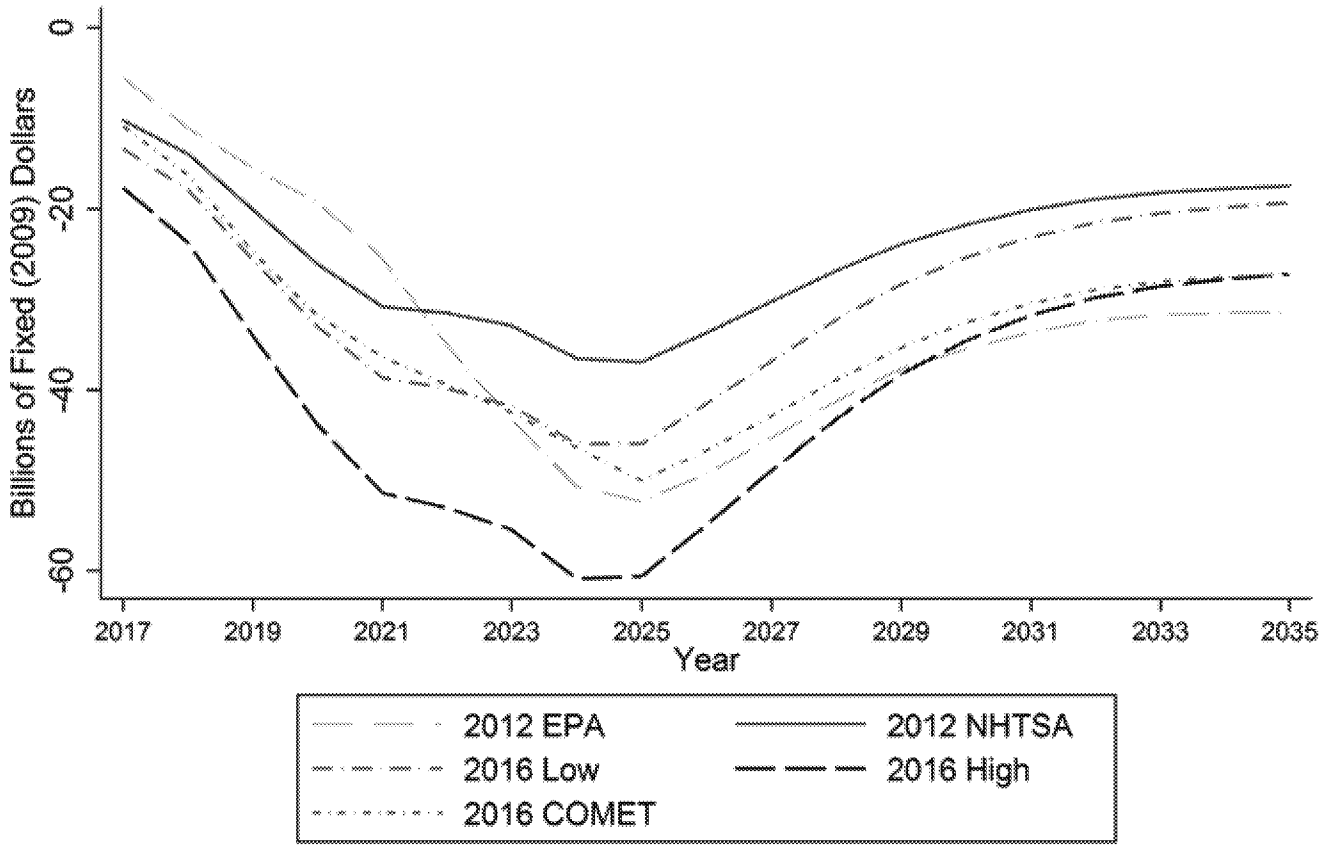
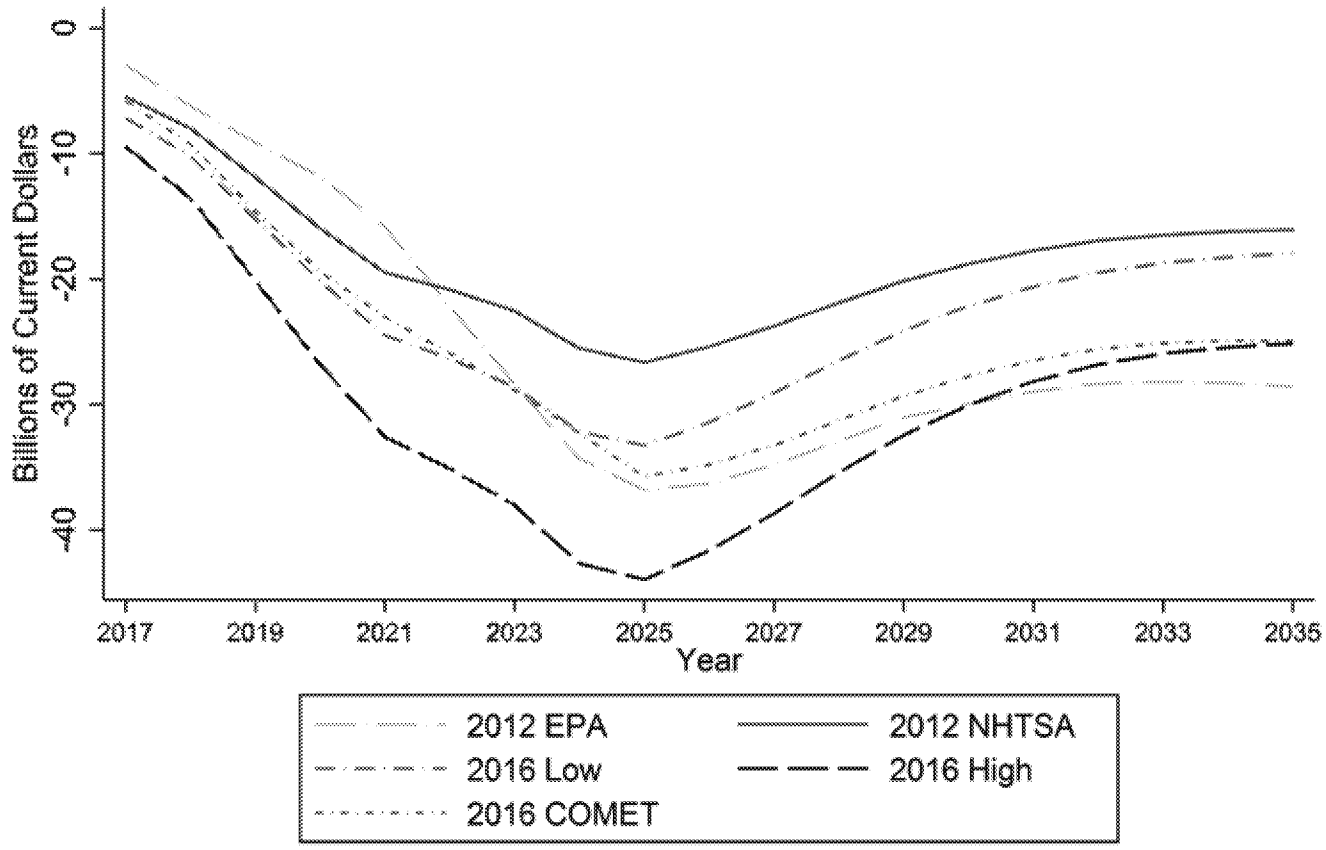


Figure 8.4. Difference in GDP Between Baseline and Price Premium Scenarios.



8.5. Difference in Disposable Personal Income Between Baseline and Price Premium Scenarios.



due to the NRC adjustments and ZEV regulation and, as expected, the declines in the level of total employment are larger, with the maximum loss estimated at over 600,000.

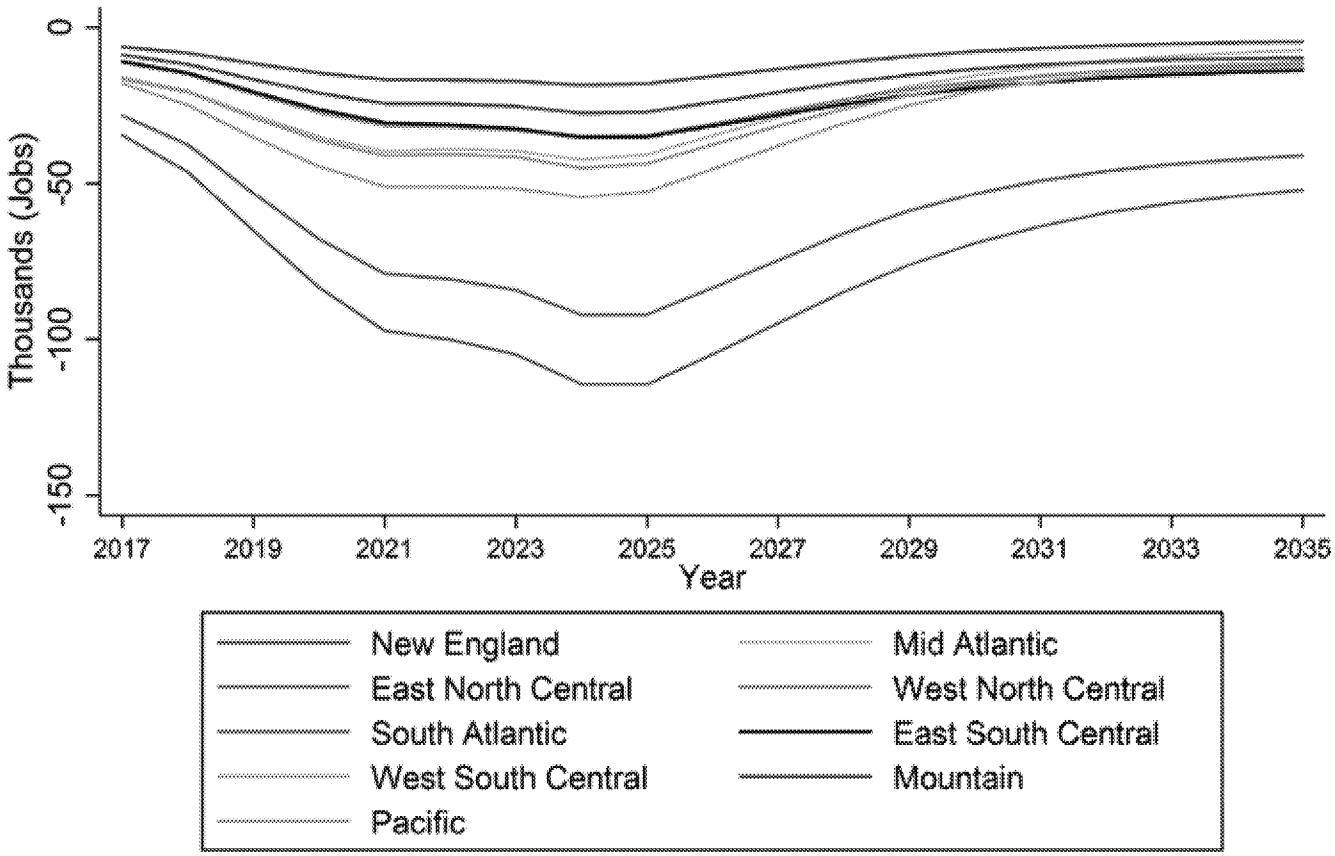
For GDP, the pattern of results is similar. The 2012 perspective shows a loss of $37-$50 billion in GDP around 2025, an effect that is enlarged to a peak of -$60 billion in the modified 2016 perspective. The same pattern of results holds for real disposable income.

Figure 8.6 presents the price premium effect across all nine regions using the 2016 low perspective input data. This graph demonstrates that the price premium mechanism hits the East North Central region the worst, which reveals a loss of over 115,000 jobs in this region around 2025. The South Atlantic region is also negatively affected disproportionately. This finding is consistent with the geographic portrait of the U.S. automotive industry that we presented in section 5. The two regions that are least negatively affected by the price premium are New England and the Mountain region.

Results for GDP and personal disposable income demonstrate similar trends across the regions, thus we do not present them here (but can be made available upon request). Results vary in magnitude for the other 2016 perspective input datasets but not in general trends.

Note that adverse effects of the regulation through higher vehicle prices dissipate from 2026-2035 for two independent reasons: we have assumed that the price premiums decline gradually each year after 2025, as the industry finds more cost-effective ways to comply with the regulations. REMI is built to represent an economy that responds and recovers to external shocks such as an exogenous increase in vehicle prices due to regulation. Our results do not account for the possibility that regulators could tighten or relax the regulations from 2026-2035.

Figure 8.6. Difference in Employment Between Baseline and Price Premium Scenarios Using the 2016 Low Perspective Dataset, by Region.



8.52 The Automobile Supply Chain Reinvestment (Innovation) Effects

The stimulus to the supply chain from the vehicle price increase is expected to boost the economy. Specifically, the increase in sales for R&D, labor, and parts is equivalent to an increase in output, which should cause the optimal level of capital to increase, and thus investment, and results in a feedback effect that increases output further. An increase in employment has a similar effect in REMI. More employment causes the optimal capital stock to increase, which raises investment. Higher investment causes output to increase, which again feeds back to employment.

The isolated effects from this innovation investment, in the absence of the negative price premium effect on consumers, total employment, GDP, and real disposable income are presented in Figures 8.7-8.9. In other words, we imagine a hypothetical scenario where the supply chain is boosted without experiencing any adverse effects of the vehicle price increase.

By 2025, GDP is $25-32 billion above baseline in the 2012 perspective and $30-40 billion above baseline (due to the higher price premium) in the 2016 perspective. Real disposal income in 2025 is up $19-26 billion in the 2012 perspective and $24-33 billion in the modified 2016 perspective. Employment increases in the 2012 perspective range from about 215,000 to 300,000 jobs in 2025. Employment increases in the 2016 perspective range from about 280,000 to 390,000 jobs, the majority of which occur in the South Atlantic and East North Central regions (see Figure 8.10).

Comparing the aggregated innovation effects to the vehicle price effects, as presented in the previous section, reveals that the positive effects from innovation are at least half the size of the losses from the vehicle price effect. For the employment indicator, the losses from the vehicle price effect ranged from 380,000 to 600,000 (2025)

Figure 8.7. Difference in Employment Between Baseline and Automobile Supply Chain Innovation Scenarios.

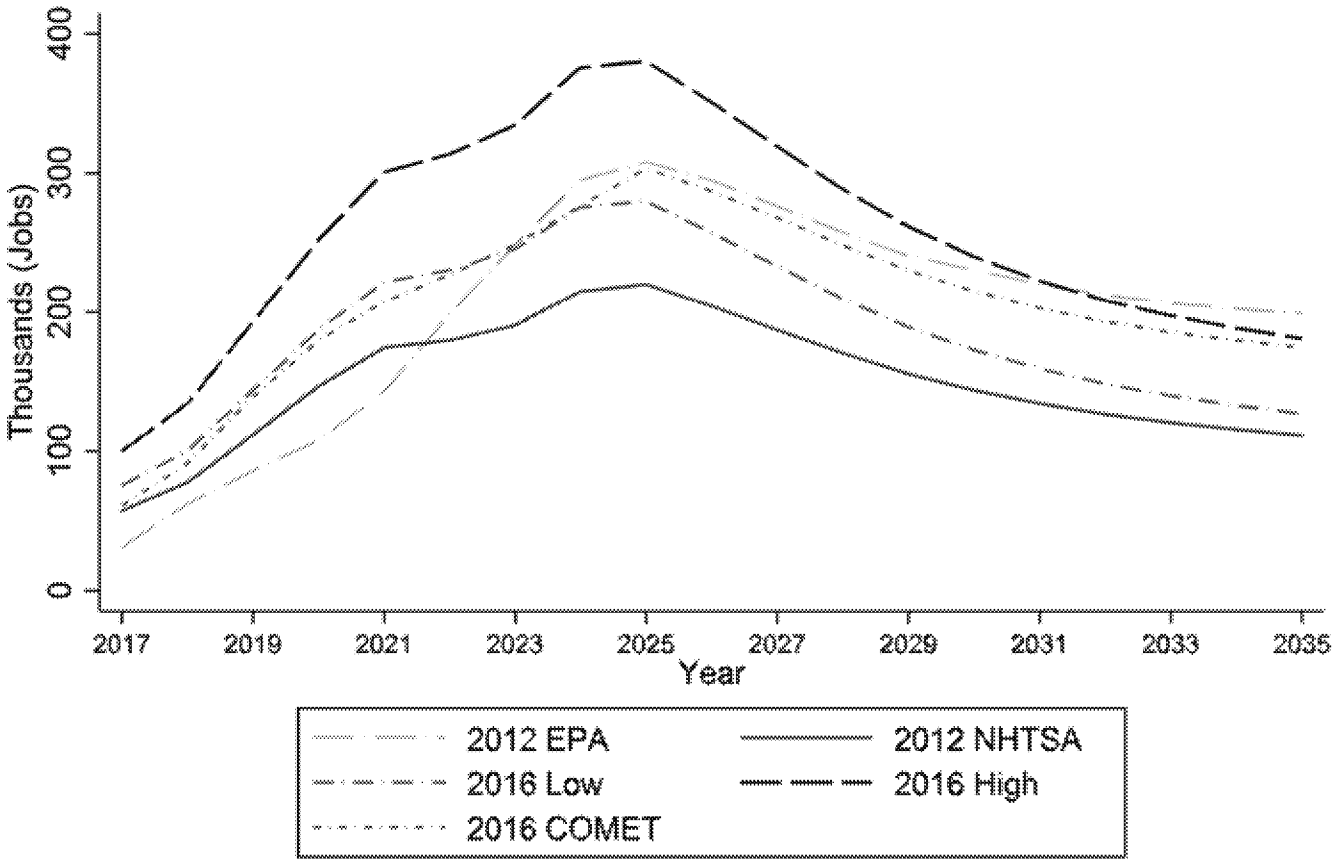


Figure 8.8. Difference in GDP Between Baseline and Automobile Supply Chain Innovation Scenarios.

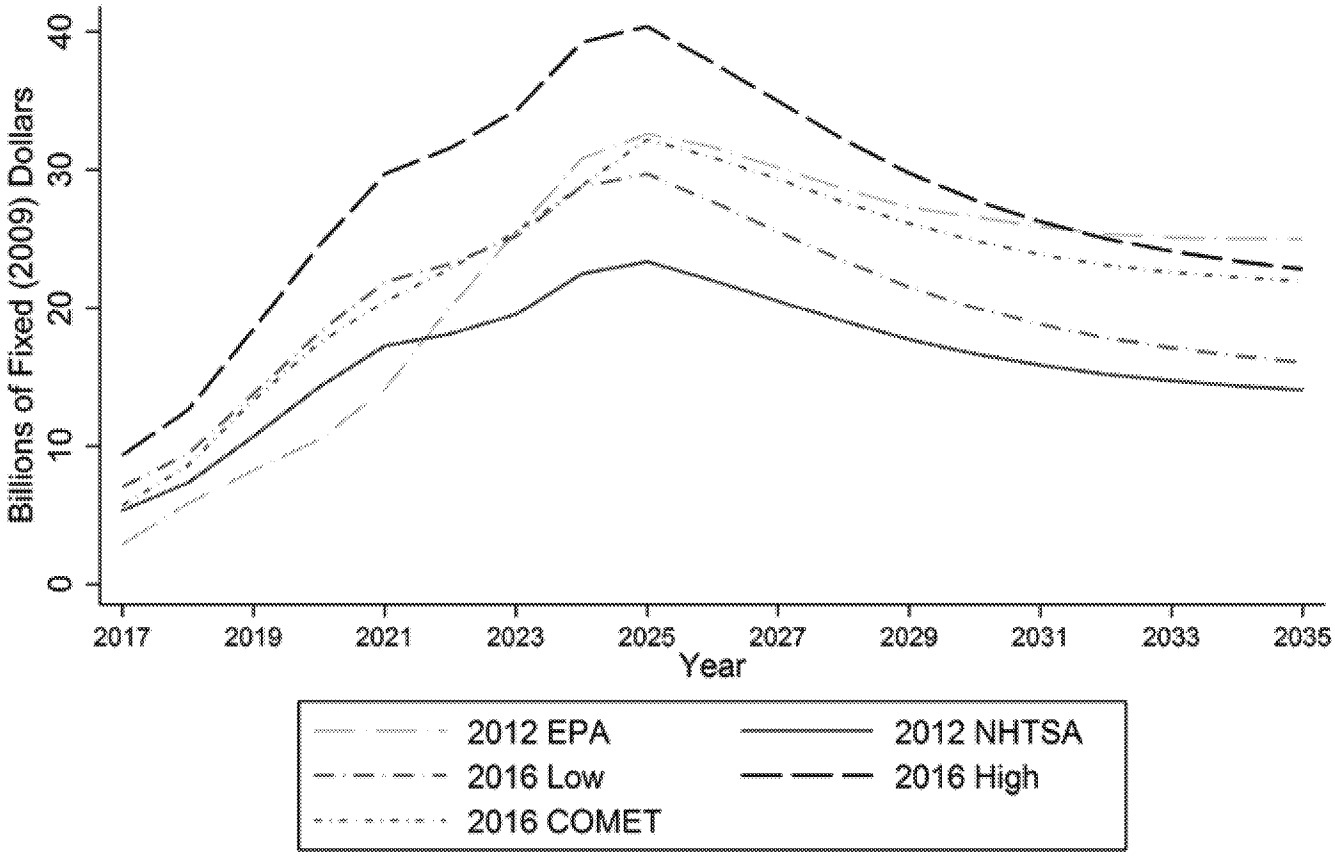


Figure 8.9. Title: Difference in Disposable Personal Income Between Baseline and Automobile Supply Chain Innovation Scenarios.

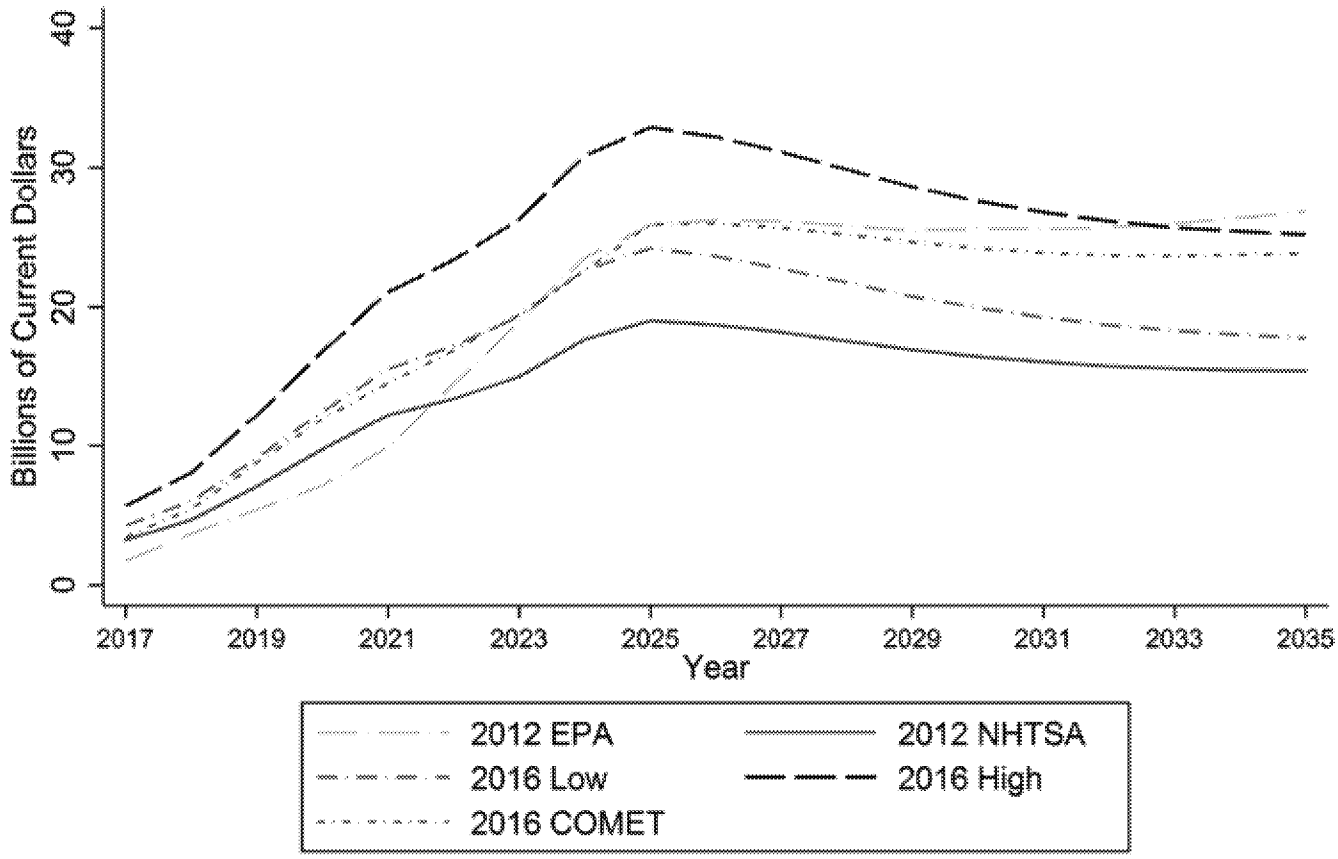
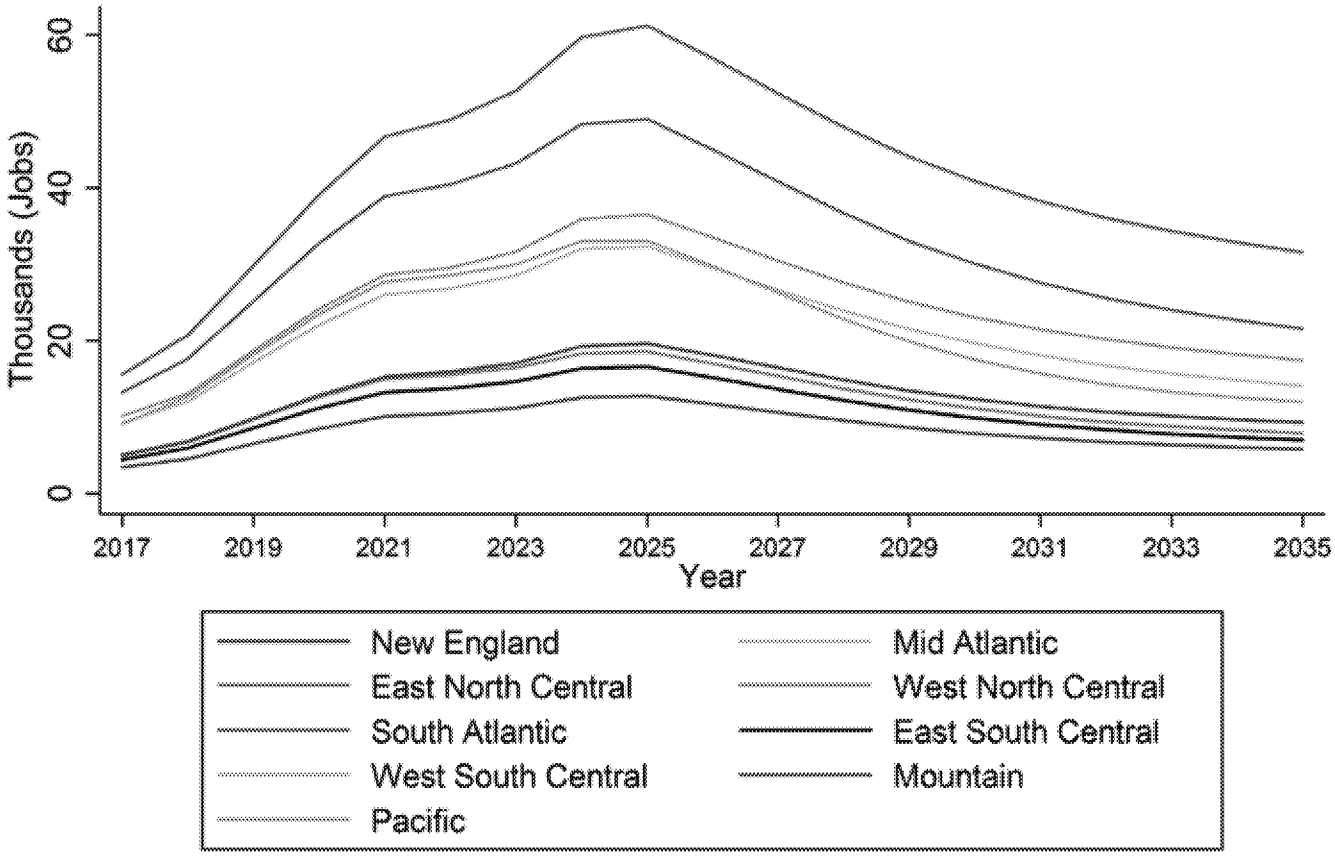


Figure 8.10. Difference in Employment Between Baseline and Automobile Supply Chain Innovation Scenarios Using the 2016 Low Perspective Dataset, by Region.



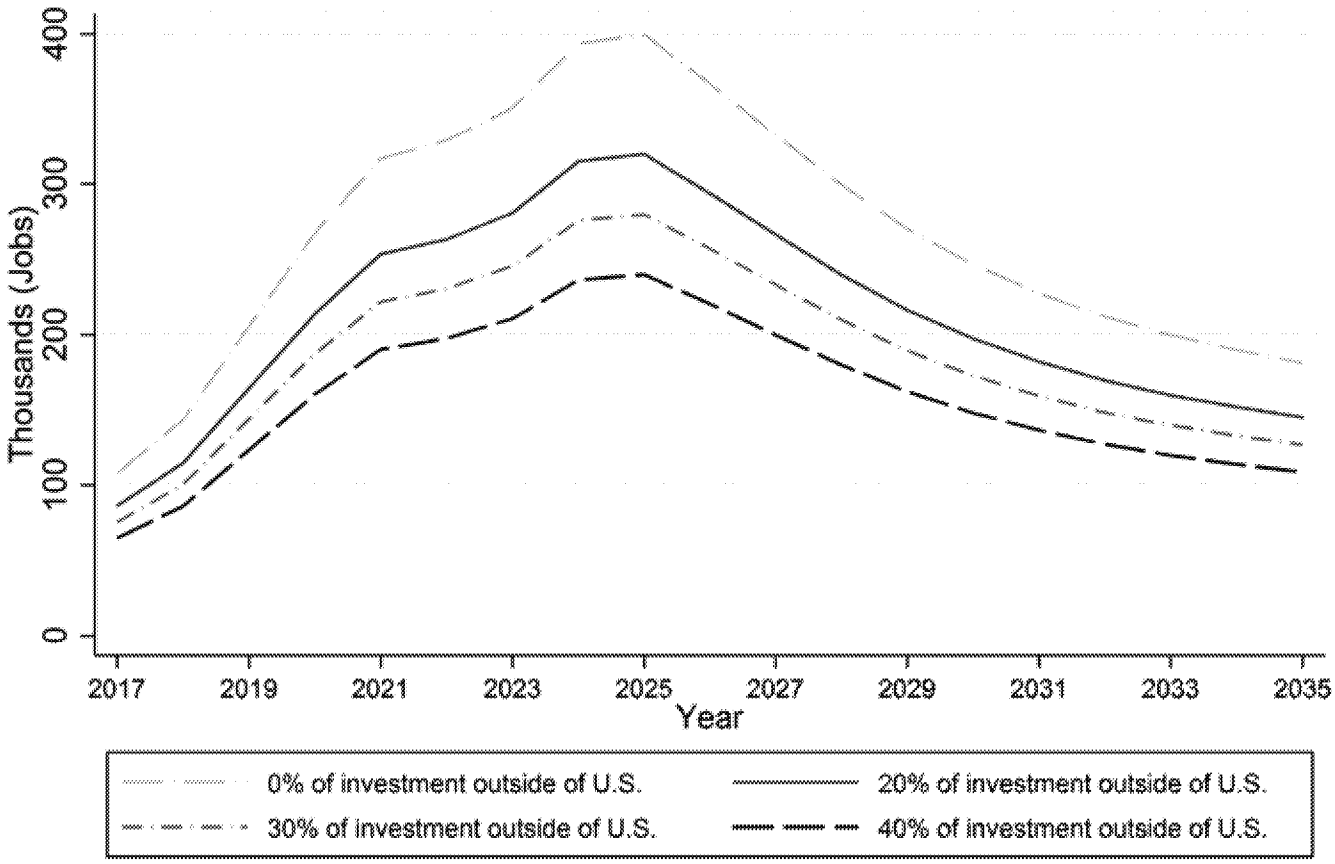
whereas the gains from the innovation effect ranged from 200,000 to almost 400,000 (2025). Note the gains from the innovation effect relate not just to the development of fuel-saving technologies but also to their application (deployment) to large volumes of new vehicles. The attenuation of the gains from 2026-2035 occurs for the same reasons that were explained earlier on the vehicle price effect (i.e., gradually declining price premium and economy-wide adjustments).

We also ran a sensitivity analysis on the assumption that 30% of all supply chain innovation investments are made outside of the U.S. Figure 8.11 displays employment estimates due to the supply chain innovation in which the assumption about percentage allocation outside the U.S. economy varies from 0% to 40%. As this graph demonstrates, the percentage selected matters. If we assume that 0% of all the innovation investments within the auto industry triggered by U.S. regulations happens in other countries (i.e., 100% of the supply chain reinvestment occurs within the U.S.), then the U.S. could experience as many as 400,000 new jobs in 2025. Of course, this estimate is unrealistic, as some of the marginal revenue from the U.S. price increase is used to finance new investments in emerging markets, and some manufacturers are more likely than others to reinvest in North America. Even those manufacturers who reinvest U.S. revenues in North America may allocate some of the investment to Mexico and Canada as opposed to the U.S. Nonetheless, the 0% analysis provides insight as a bounding calculation. If we instead assume that 40% of all innovation occurs on foreign soil, then the employment benefit from these regulations would be closer to 240,000 jobs in 2025.

8.53 The Fuel Savings Stimulus

Both consumption reallocation and consumer spending increase consumption, which positively affects output, employment, optimal capital stock, and investment. Industry production cost reductions make U.S. industry

Figure 8.11. Sensitivity Analysis on the Difference in Employment Between Baseline and Automobile Supply Chain Innovation Scenarios.



more competitive, which has favorable trade ramifications such as more exports and less vulnerability to import competition.

A losing sector in this process is oil, since the decline in demand for gasoline reduces the U.S. demand for oil, which in turn reduces oil imports and reduces the demand for U.S. oil extraction. These conditions affect not only oil extraction but also the supply chain for oil production (e.g., oil refining, transport and refueling stations, equipment for exploration and drilling, and materials used in oil and gas development).

The macro impacts of the fuel savings are large but, as expected, it takes time for them to accumulate due to the long lifetimes of vehicles. The effects on total employment, GDP, and real disposable income are presented in Figures 8.12-8.14. Under the 2012 perspective, the gains in employment reach about 225,000 to 325,000 in 2025 and continue to climb to between 550,000 and 700,000 million in 2035 (notice the y-axes are more compressed than was the case for the vehicle price and supply-chain effects). These gains are attenuated in the modified 2016 perspective. They rise to about 160,000-200,000 in 2025 and 190,000-380,000 in 2035.

As Figure 8.15 reveals, the South Atlantic region benefits the most from the gas savings effect while the oil-producing West South Central region is negatively affected across the entire study period. The pattern of results for GDP and real disposable income are similar to the employment effects.

Across all three macroeconomic indicators, the results for the COMET 2016 Perspective, while favorable to the economy due to fuel savings, are not as large as found with the other data sets. The difference in results between the COMET and the other 2016 perspectives is due to the significantly lower estimates of national fuel savings derived from the COMET 2016 perspective. The lower fuel savings are, in turn, due to differences in the composition of the new vehicle fleet used in COMET compared to the other datasets. The COMET 2016 perspective is based on

Figure 8.12. Difference in Employment Between Baseline and Gas Savings Scenarios.

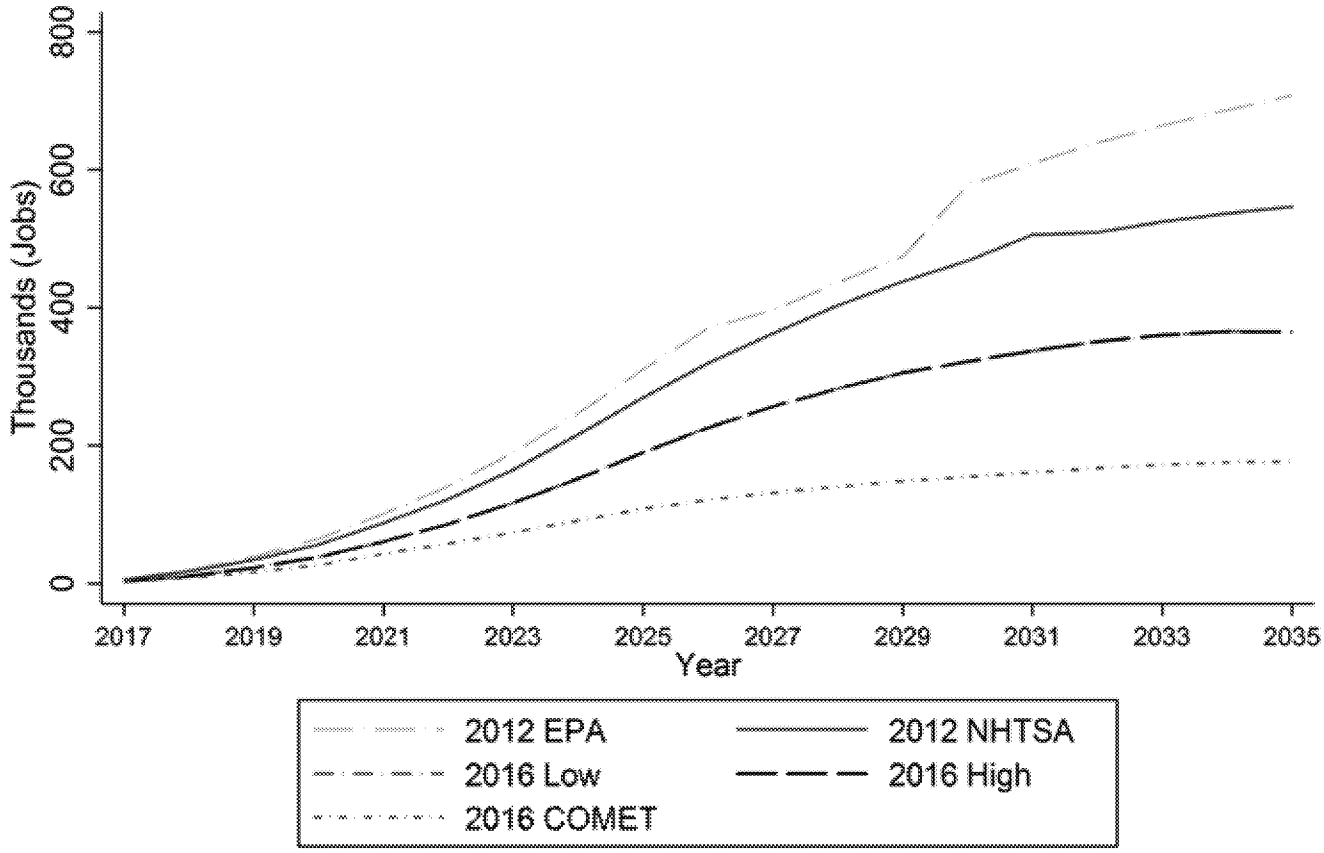


Figure 8.13. Difference in GDP Between Baseline and Gas Savings Scenarios.

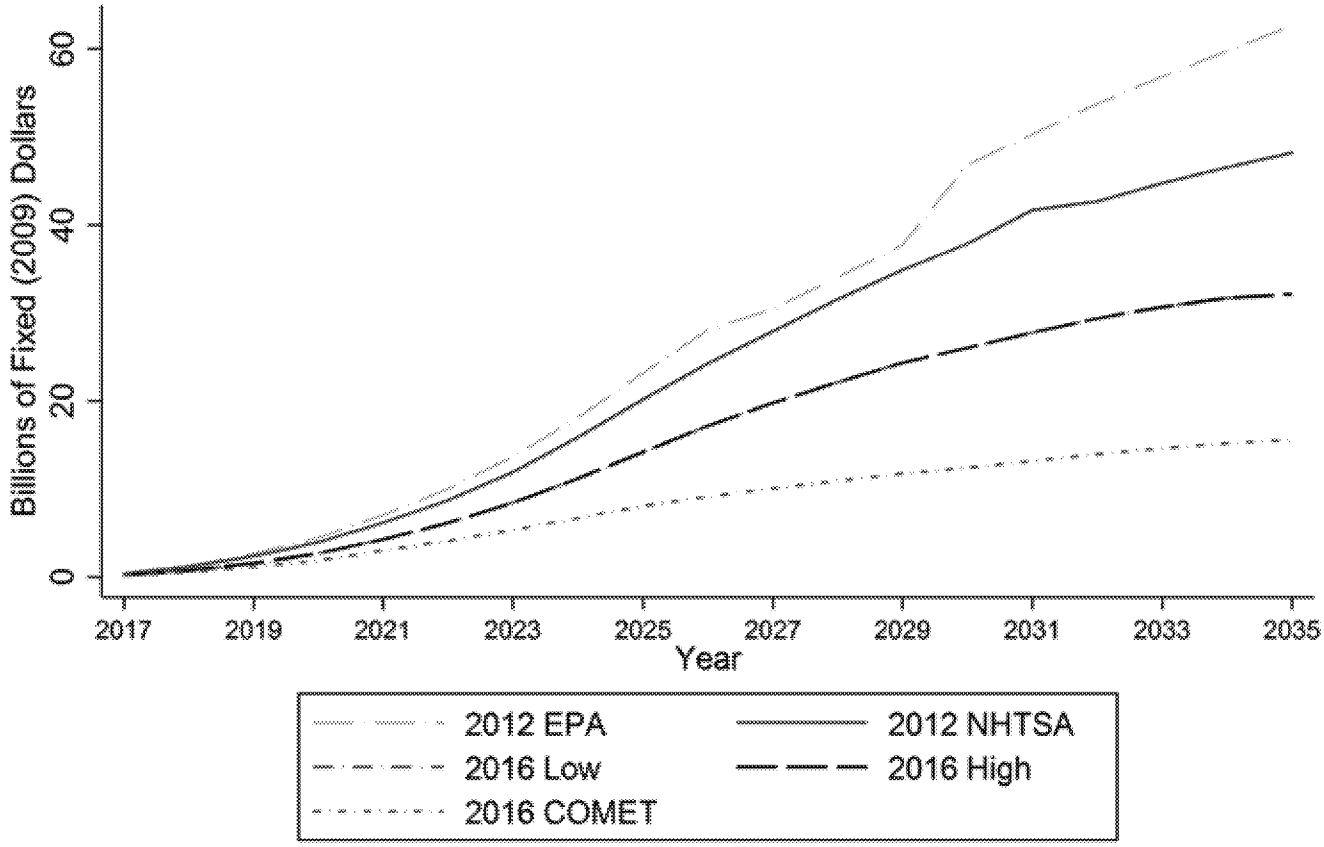


Figure 8.14. Difference in Disposable Personal Income Between Baseline and Gas Savings Scenarios.

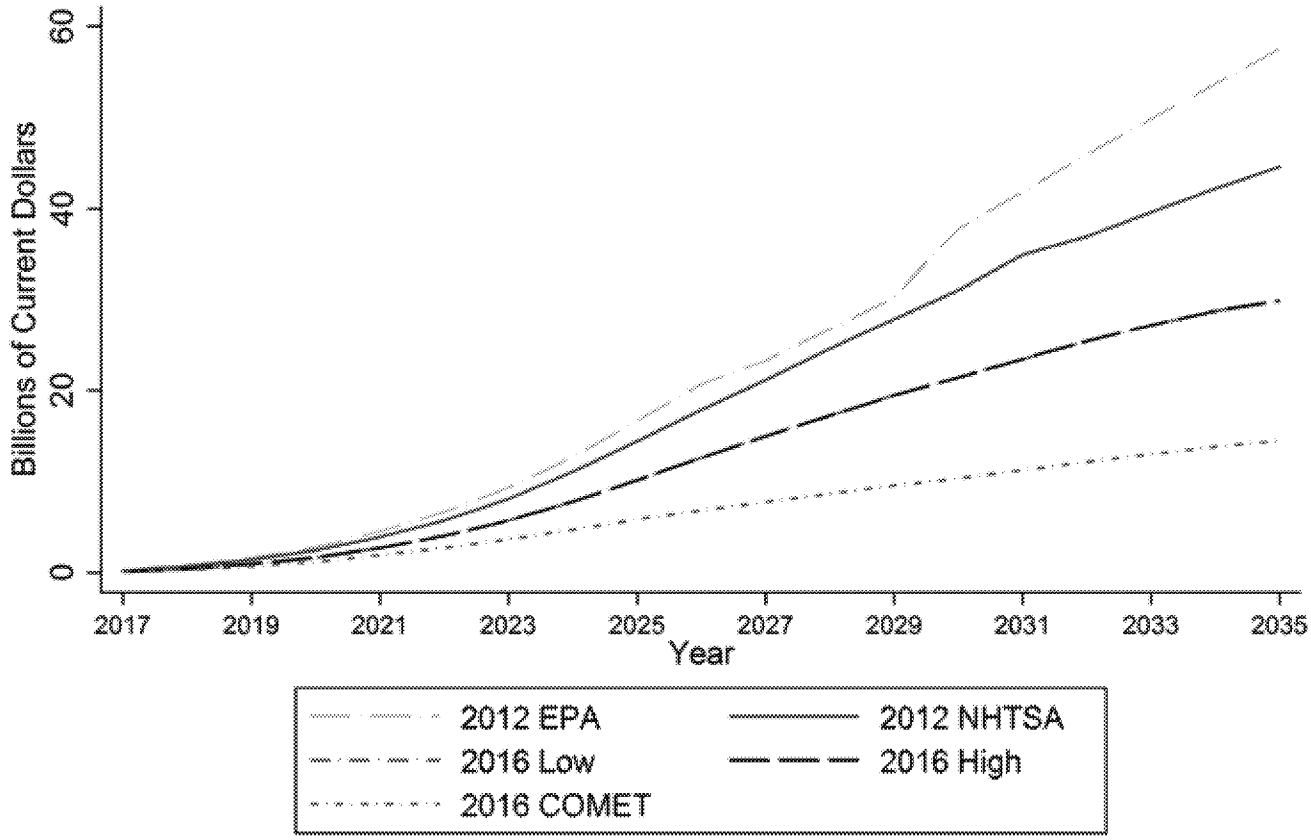
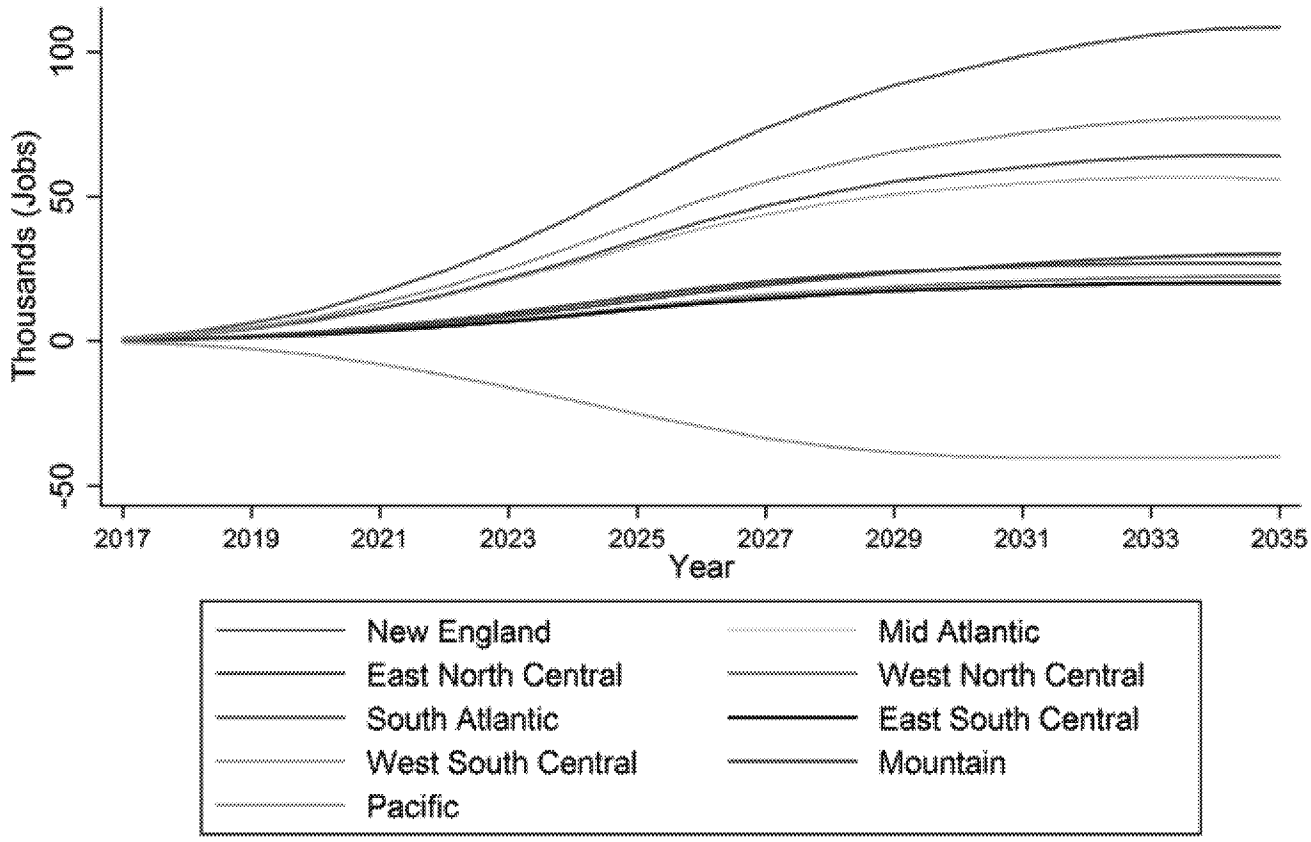


Figure 8.15. Difference in Employment Between Baseline and Gas Savings Scenarios Using the 2016 Low Perspective Dataset, by Region.



an updated version of OMEGA, which assumes that 41% of all vehicles sold between 2017 and 2025 will be cars, while the other 2016 perspectives are based on sales data from the 2012 NHTSA RIA, which reports that 65% of all vehicles sold between 2017 and 2025 will be cars. This shift in the mix of vehicle sales is coupled with another influential factor: the scheduled ramp up in fuel efficiency is much higher (and occurs sooner) for cars than for trucks. Together, those two factors explain the significant difference in fuel savings between COMET and the other perspectives, and hence the difference in fuel savings and macroeconomic impacts.

We explored this difference in fuel savings using a simple simulation on gasoline consumption and found that the total annual gallons of fuel saved between 2017 and 2039 based on the 2012 RIA vehicle data exceed that based on the 2016 TAR vehicle data. In other words, the switchpoint year when the national annual fuel savings from the 2016 COMET perspective become larger than from the other 2016 datasets is 2040. However, the RIA-based (2012) accumulated gallons of fuel saved remains higher than the TAR-based (2016) fuel savings through 2056; the difference is approximately 715 million gallons in 2056, but declining. These observations suggest that the macroeconomic effect of the 2016 COMET perspective should converge toward the fuel savings of the other 2016 perspectives in the years after our data analysis period.

8.54 Combining all Fuel Economy Mechanisms

The combined effects of the vehicle price increases, the supply chain reinvestment innovation effects, and fuel-savings stimulus are presented in Figures 8.16-8.18. We first focus our discussion here on the temporal issue: when do the positive supply-chain and fuel-savings effects outweigh the adverse effects of higher vehicle prices? We then consider cumulative results as well as sensitivity analyses.

For total employment, under the 2012 perspective, it takes about five years, around 2022, for the annual change in the level of employment to switch from negative to positive. Under the modified 2016 perspective, which is influenced by lower fuel prices and a higher vehicle price premium, the annual net positive effects on employment

Figure 8.16. Difference in Employment Between Baseline and Combined Regulatory Scenarios.

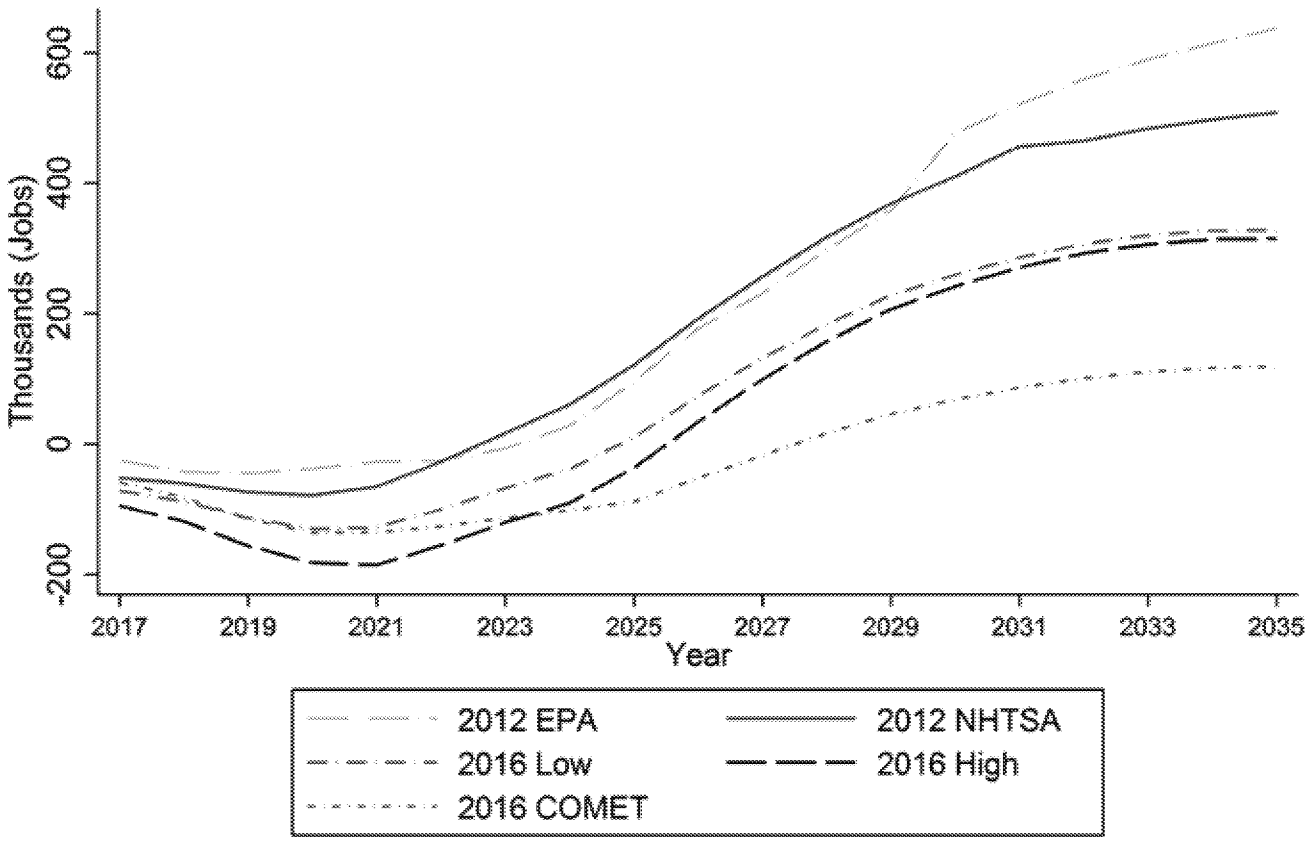


Figure 8.17. Difference in GDP Between Baseline and Combined Regulatory Scenarios.

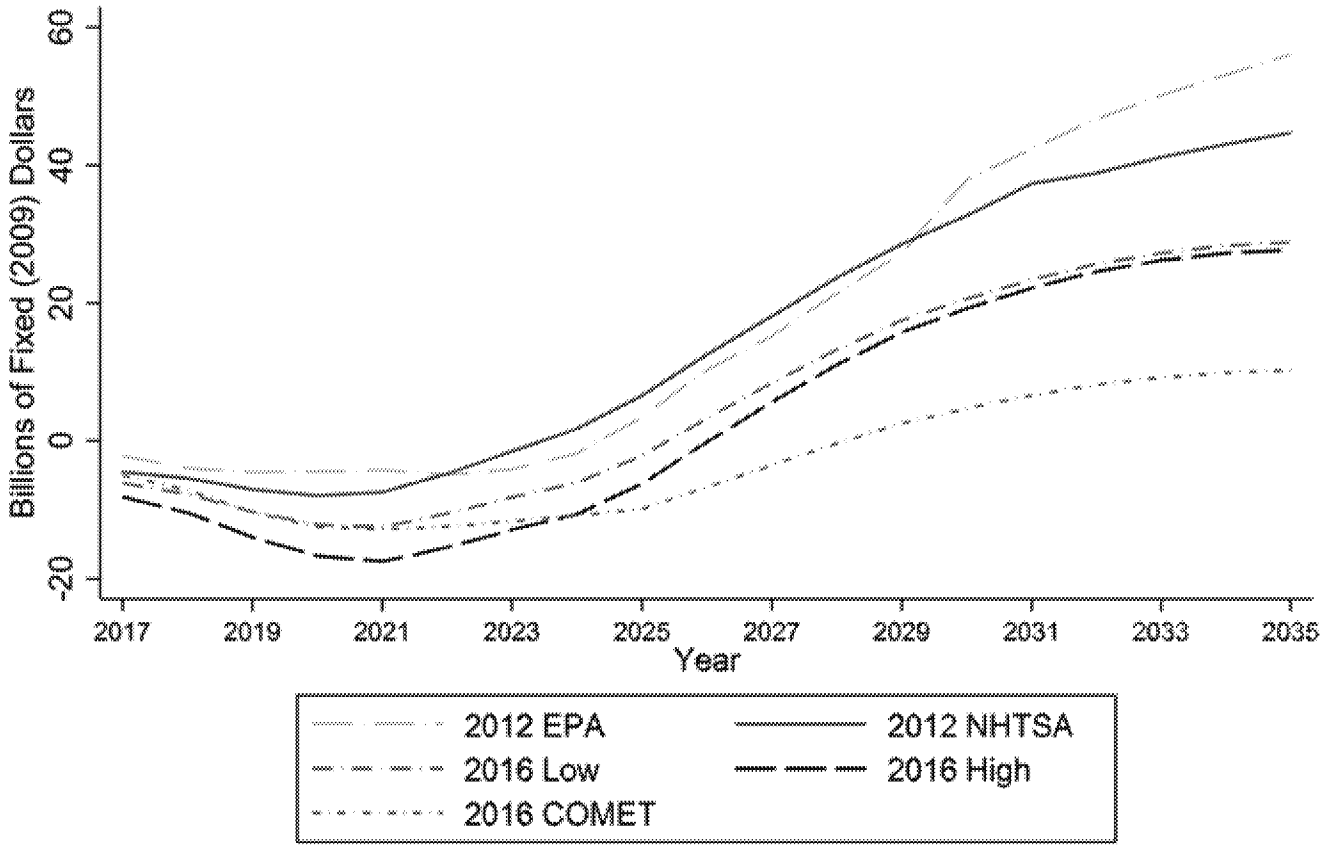
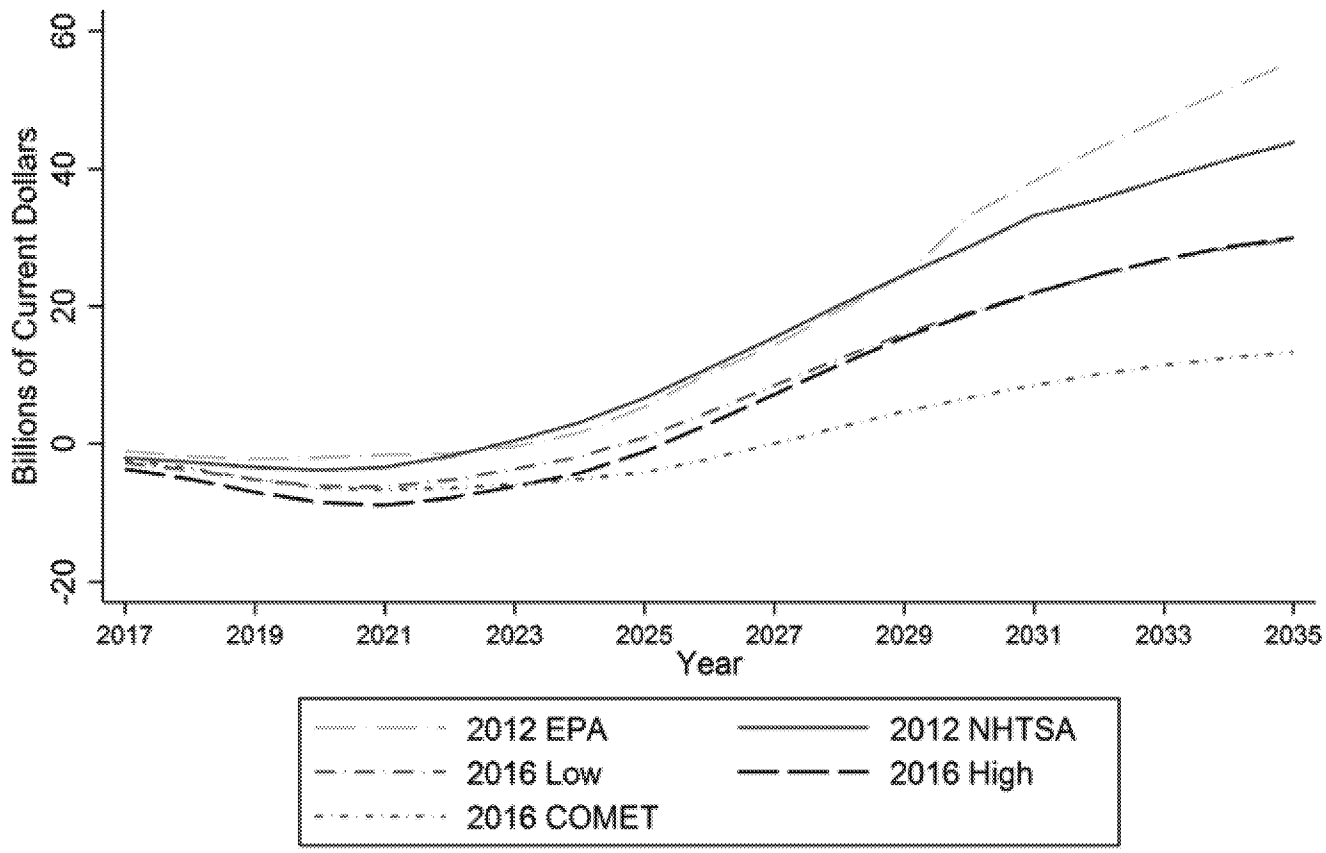


Figure 8.18. Difference in Disposable Personal Income Between Baseline and Combined Regulatory Scenarios.



are delayed until 2024 and 2025 for the low and high 2016 perspectives, and until 2027 for the COMET 2016 perspective. Note that, when employment figures turn positive, they grow steadily and substantially thereafter.

In the case of GDP and personal disposable income, we find similar trends. The 2012 perspective results in positive annual values by 2024, and the annual values for the 2016 perspectives turn positive sometime between 2024 and 2028, depending on the dataset.

Figures 8.19-8.21 show that the annual impacts are not the same across all geographic regions. Here again we present results only for the 2016 low perspective dataset, since the trends are similar across all datasets but with different magnitudes. Three regions appear to benefit the most from the regulations across employment, GDP, and disposable personal income indicators: South Atlantic, Mid Atlantic, and Pacific. The East North Central region starts with the lowest values for all three of these indicators but then recovers faster than other regions, beginning around 2022 and 2023. Unlike all other regions, the West South Central Region never fully recovers from adverse price effects and continues to measure losses through 2035. This region is a large oil producing region, and much of the U.S. supply chain for oil production is also located in this region. Consequently, a decrease in demand for oil hits this region harder than others, even though consumers of gasoline in this region still experience benefits.

8.55 Cumulative Effects

Next we present "cumulative results" where the annual changes in U.S. economic performance are summed over a specified time period. The change in each year is weighted equally in the cumulative assessment. For example, if changes in GDP were -100,000 in year one but +200,000 in year two, the cumulative result for the two year period is +100,000.

Figure 8.19. Difference in Employment between Baseline and Combined Regulatory Scenarios, by Region (2016 Perspective Low).

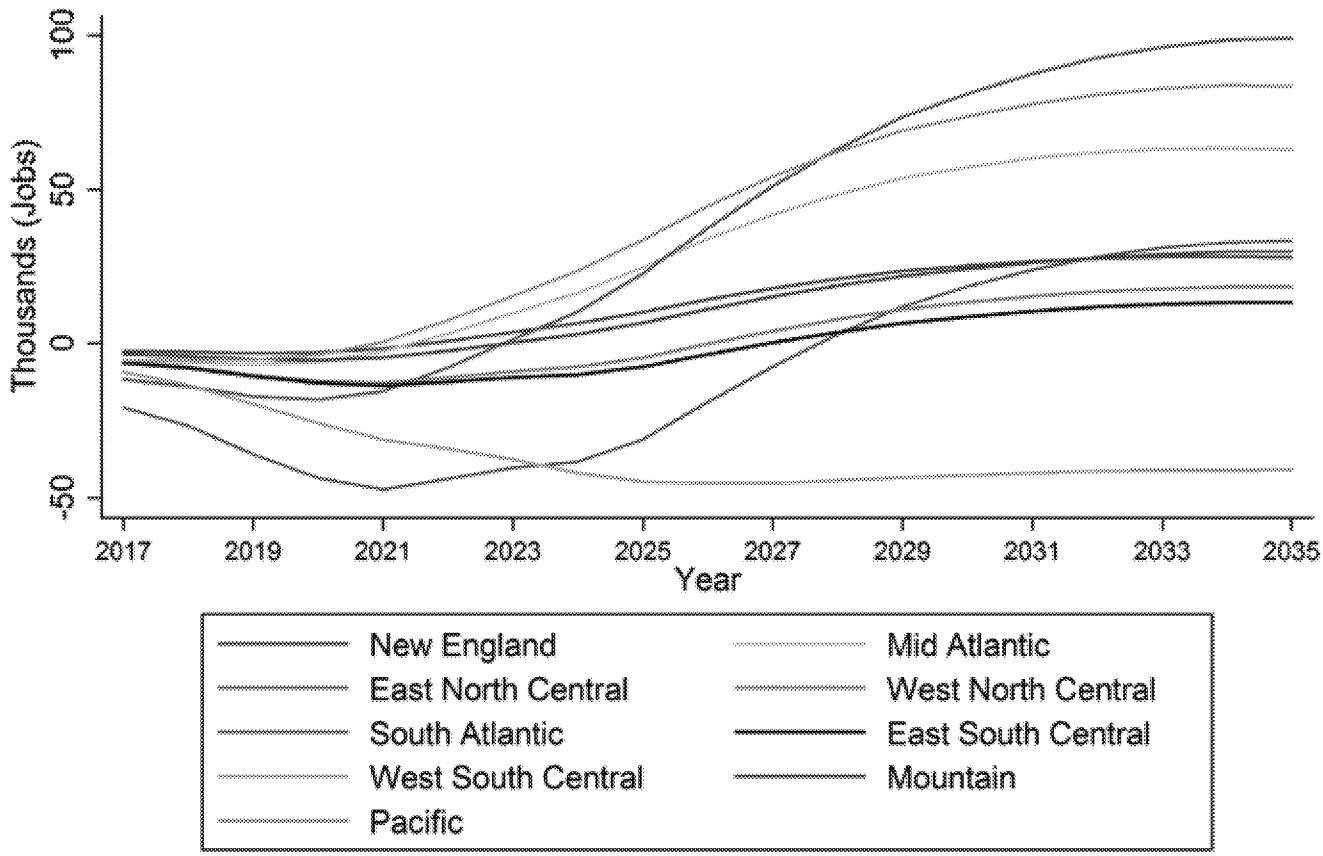


Figure 8.20. Difference in GDP between Baseline and Combined Regulatory Scenarios, by Region (2016 Perspective Low).

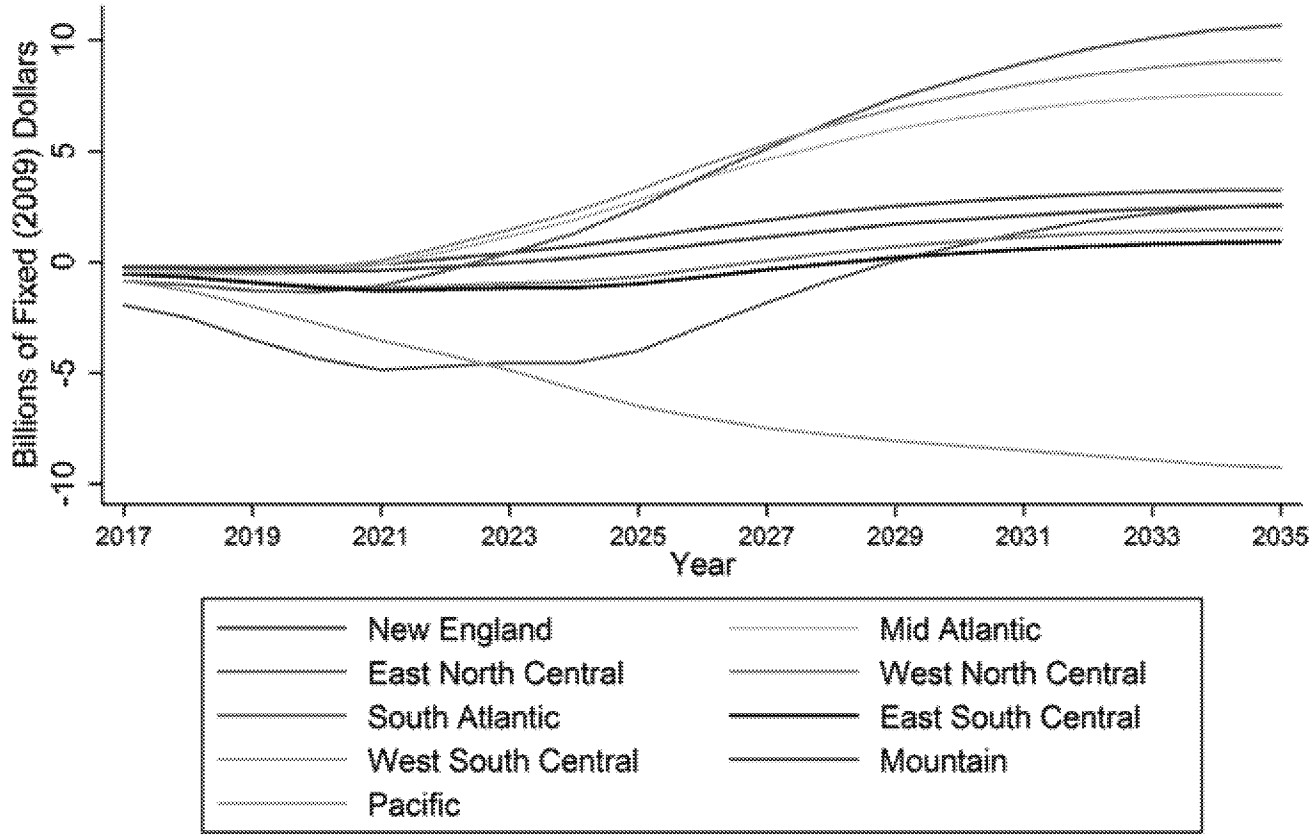


Figure 8.21. TDifference in Disposable Personal Income between Baseline and Combined Regulatory Scenarios, by Region (2016 Perspective Low).

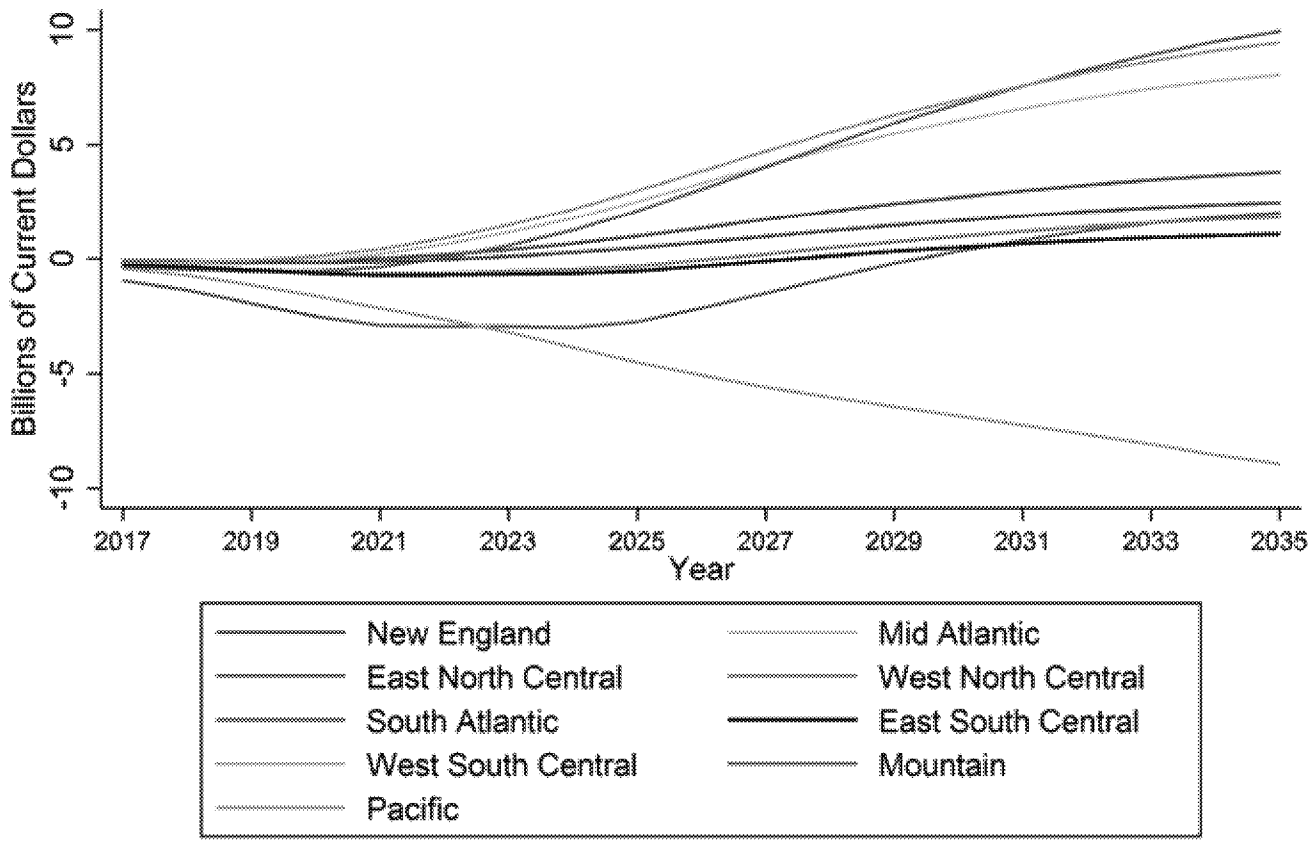


Table 8.1 presents cumulative results across all five datasets and two of the macroeconomic indicators. The first column presents cumulative results between 2017 and 2025, and the second between 2017 and 2035. Employment is not included because the employment estimates are stock variables, and represent job-years; adding these estimates up over time does not result in any meaningful value. The results in this table turn more favorable for two reasons: the gasoline savings continue to accumulate from the fleets of vehicles produced since 2017; and the vehicle price premium stops increasing after 2025, since we have assumed that the regulations remain the same after 2025 (although EPA has begun planning stricter regulations after 2025, according to Beene 2016a).

Table 8.1. Macroeconomic Modeling Results, Cumulative 2017-2025 and 2017-2035

Dataset and Indicator	2017-2025	2017-2035
EPA 2012 Perspective		
GDP	-27.2	332.6
PDI	-2.8	334.6
NHTSA 2012 Perspective		
GDP	-30.3	290.3
PDI	-6.6	285.8
2016 COMET Perspective		
GDP	-92.6	-52.1
PDI	-45.1	22.7
2016 Low Perspective		
GDP	-75.8	120.5
PDI	-33.7	158.2
2016 High Perspective		
GDP	-111.9	67.4
PDI	-52.3	135.5

Note: GDP and PDI in billions of dollars.

The 2016 COMET perspective has net negative impacts on GDP over the longer time period, through 2035. (As we explained earlier, the 2016 COMET perspective will take much longer to produce positive economic impacts because of the assumed high proportion of light trucks). All 2016 perspective datasets result in less favorable estimates of cumulative economic impact than the 2012 perspective datasets.

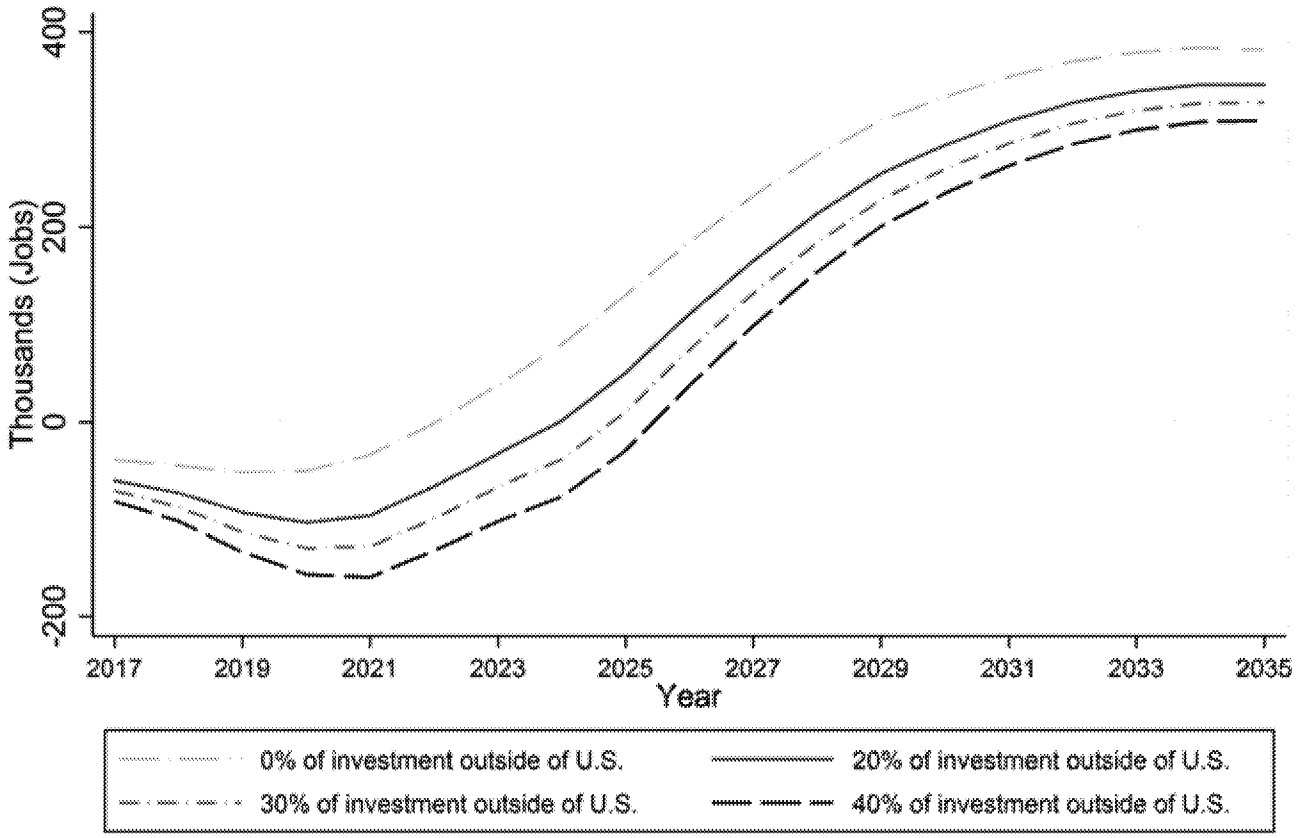
Notice that, although 2025 is the end of the model-year period for the regulatory standards, 2025 is of no particular significance for the purpose of macroeconomic analysis. Indeed, we have shown that the positive fuel-savings effects continue to accumulate for many years beyond 2025. Nor is there anything magic about 2035, though the extra ten years allows the model to capture much of the growing fuel-savings effects. On the other hand, the vehicle price premium stops increasing after model year 2025, and thus it should not be entirely surprising that the gasoline-savings effects gradually overwhelm the vehicle-price and supply-chain innovation effects, which are assumed to take effect from 2017-2025. It is quite possible that more stringent regulations will be enacted after model year 2025, thereby causing additional price premiums, but we have not analyzed those possibilities. More generally, the decades after 2035 introduce many additional uncertainties that are difficult to model. Nonetheless, since the gasoline savings are larger than the vehicle price premiums, the ultimate impacts on the economy will be favorable if the time horizon is lengthened enough.

8.6 Sensitivity Analyses

We also ran two separate sensitivity analyses on the combined results. One addresses the amount of reinvestment in the U.S. automotive supply chain; the other addresses future fuel prices.

In the first, we return to supply chain innovation and the amount of reinvestment that will occur within the U.S. versus elsewhere in the world. In Figure 8.22 we vary this percentage from 0% to 40%, as we did above with the innovation mechanism in isolation. This figure presents only those results for the 2016 low perspective and the employment indicator, since other datasets and indicators are all marked by similar trends. We find again that the model is sensitive to the assumption about the geographic allocation of auto industry reinvestments. When the cumulative results are compared at the extreme input assumptions of 0% and 40% of innovation spending occurring outside the U.S., the break-even point for net gain to the U.S. economy varies by about three years. Whether the three-year difference matters that much is less clear: in either case the regulations under study are a negative for the U.S. economy in the near term, but become a positive for the U.S. economy once a sufficient number of years of gasoline-savings have occurred.

Figure 8.22. Sensitivity Analysis on the Difference in Employment Between Baseline and Combined Fuel Regulatory Scenarios.



Second, we ran sensitivity analyses on gasoline price using the 2016 low and high perspective datasets. In Figures 8.23-8.25, we introduce lower and higher gasoline price projections, as provided by EIA (2016). Results are less positive when the price of a gallon of gasoline is lower, and more positive when the price is higher. The sensitivity adjustments do not result in either scenario switching from negative to positive in more than a half-year to full-year time.

8.7 Limitations, Unresolved Issues, and Future Research

The net economic impacts of the gasoline savings are favorable, large in absolute magnitude, and dominate the long-run results of the REMI modeling. Therefore, besides the sensitivity analyses already presented, it is useful to consider how accurately the model can estimate the effects of fuel savings and how future research can refine our understanding of how gasoline savings affect the U.S. economy. In this section, we consider whether the REMI results are consistent with the impacts of diminished U.S. fuel prices in 2014-16, recent evidence concerning how U.S. consumers are reacting to the savings in fuel expenditures, and how the impacts of gasoline savings on oil imports and U.S. production can be refined in future research.

8.71 Insights from the Recent Collapse of Oil and Gasoline Prices

There is a significant literature in macroeconomics on how abrupt changes in the price of oil and gas have impacted the U.S. and global economies (e.g., see P. Edelstein and Kilian 2009; Hamilton 2011). One of the positive aspects of lower energy prices is a boost to consumer spending on other goods and services. Due to the decline in fuel prices from a peak of roughly $4.00 per gallon (national average in May 2011) to $2.20 per gallon (national average in 2016), the average American motorist has been saving roughly $1,080 per year on gasoline expenses (assuming 15,000 miles per year at 25 miles per gallon) (Blake 2011; Cox 2015; Appelbaum 2016; Soper, Olson, and Townsend 2015; Arora 2015; Skowronski 2015). These savings are of the same order

Figure 8.23. Difference in Employment Between Baseline and Combined Regulatory Scenarios with Low and High Gasoline Prices.

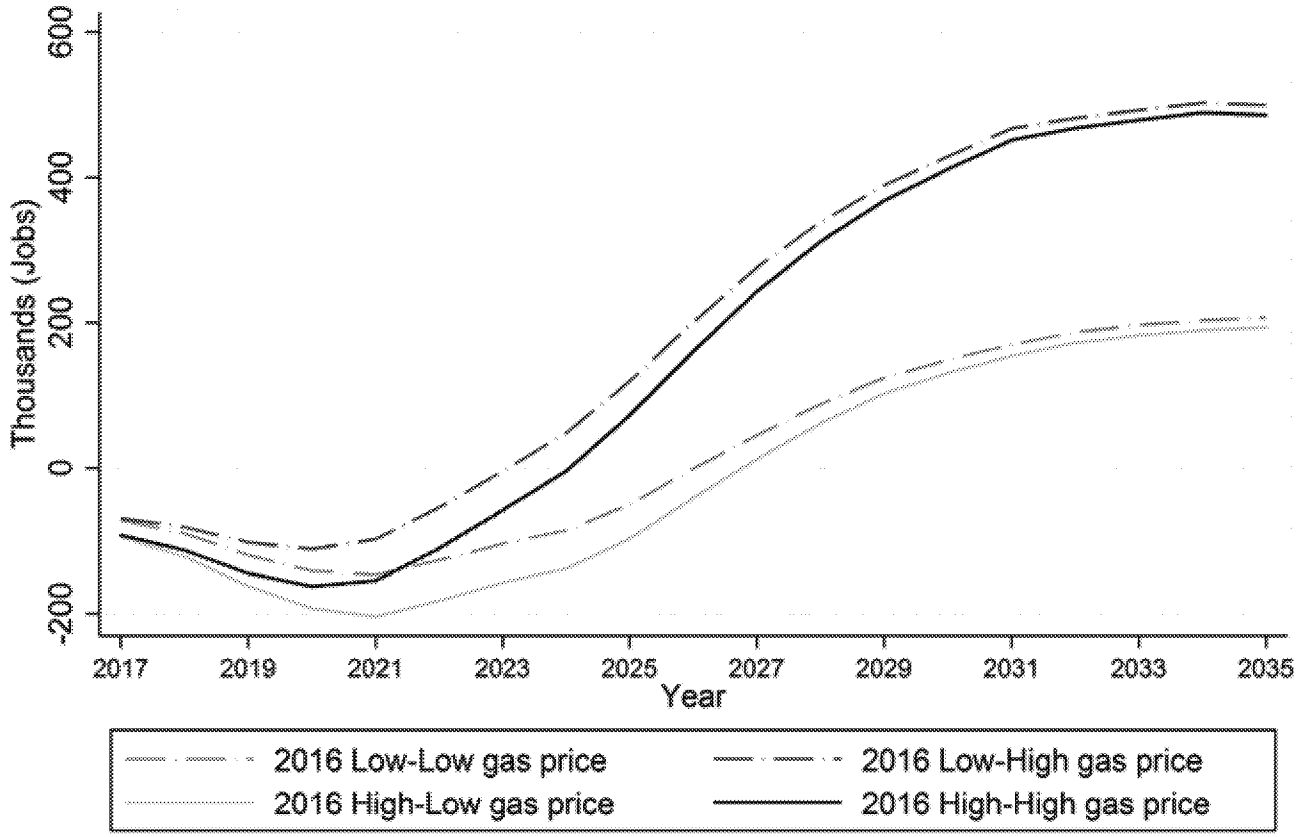


Figure 8.24. Difference in GDP Between Baseline and Combined Regulatory Scenarios with Low and High Gasoline Prices.

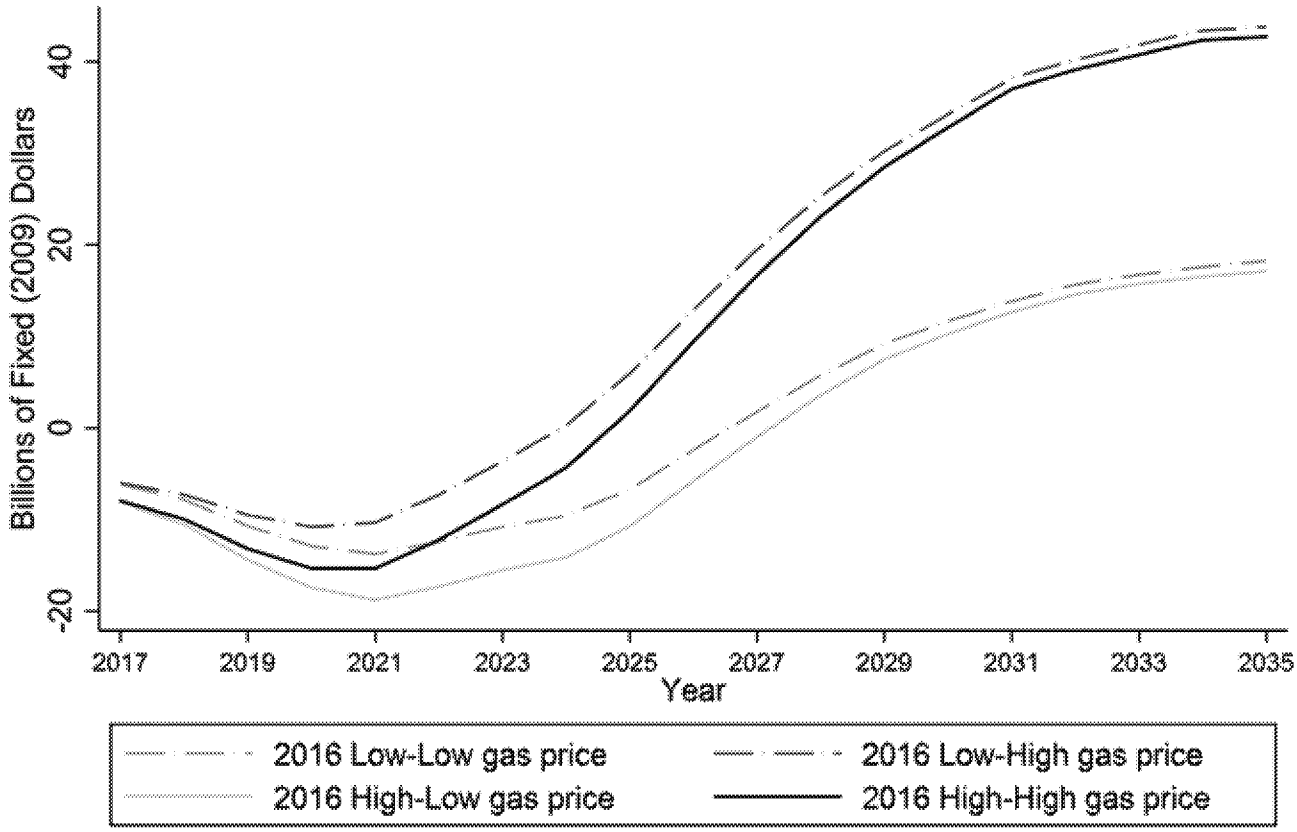
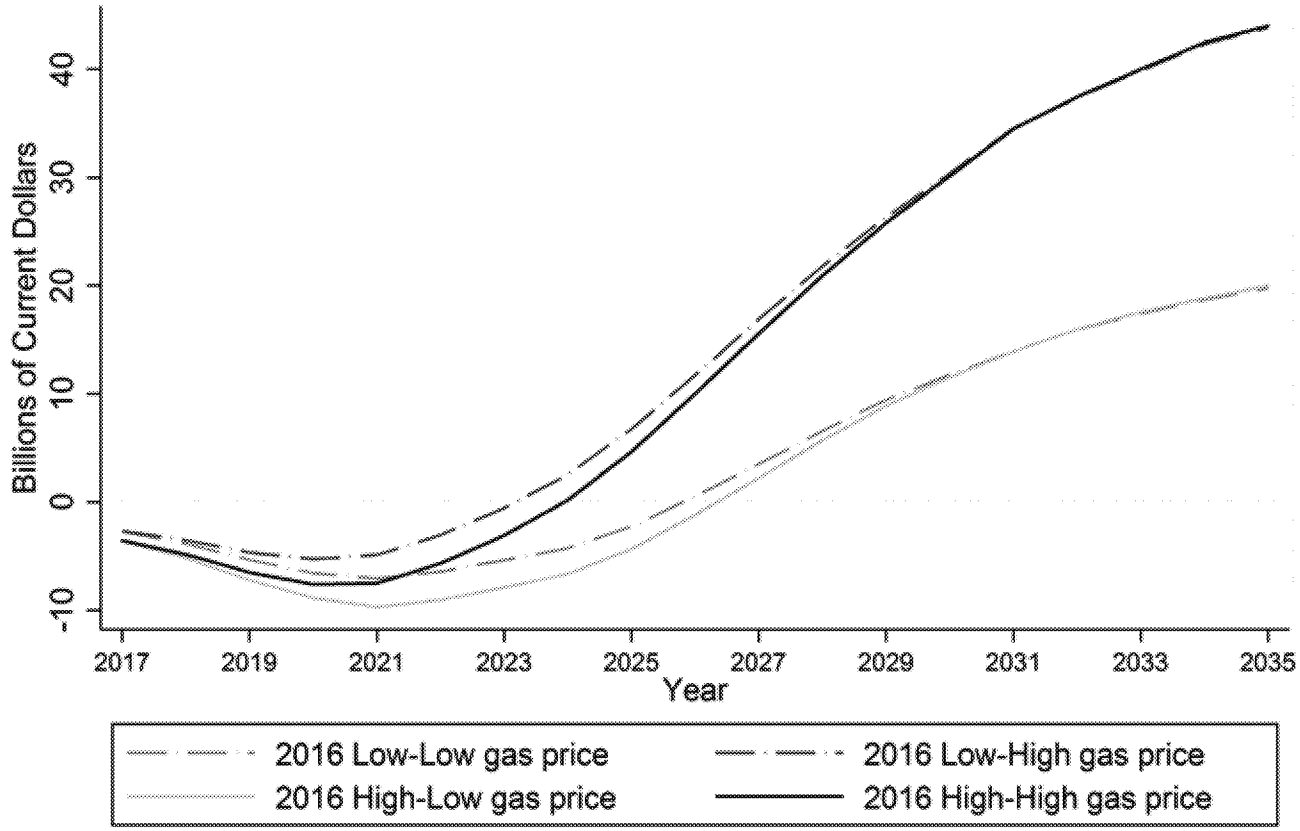


Figure 8.25. Difference in Disposable Personal Income Between Baseline and Combined Regulatory Scenarios with Low and High Gasoline Prices.



of magnitude as the present value of fuel savings for the model year 2025 federal standards, but they are much more immediate in their occurrence.

Economists from Goldman Sachs were widely quoted as characterizing the consumer savings on fuel as the equivalent of a $100-125 billion tax cut in 2014 (Morath 2014). However, a year later, a Goldman Sachs economist was quoted as saying that the spending boost from lower gasoline prices has "fallen short of expectations" (Cox 2015). Another year later, an economist confessed to the New York Times that the economy-wide benefits of the lower oil and gasoline prices "failed to deliver the usual economic benefits" (Appelbaum 2016). More generally, the question has been raised as to why the sharp decline in oil and fuel prices in 2014-16 has not spurred a stronger U.S. recovery. The U.S. economic recovery since the Great Recession of 2007-9 has been quite slow by historical standards, indeed the slowest of any of the modern recessions studied by the National Bureau of Economic Research (Graham 2016; Seefeldt et al. 2013).

The major explanation that has been offered is that consumers are not behaving in the ways that economic models such as REMI assume. First, when consumers save money on gasoline due to lower fuel prices, they may respond by paying off their credit card debts and boosting their savings and investments. Consumer debt payments as a share of disposable income rose from 2012-2015 (Arora 2015). Since low-income consumers spend a higher fraction of their income on gasoline than high-income consumers, the behavior of low-income consumers needs to be studied carefully (Murphy, Plante, and Yücel 2015).

On the other hand, the REMI model assumption that consumers spent 100% of the savings is not far off from the standard estimate that Americans save only about 5% of every dollar that they earn (Soper, Olson, and Townsend 2015; Skowronski 2015). Additionally, recent studies of credit and debit card holders find that consumers are spending between 80% and 100% of the gasoline savings induced by lower fuel prices (Farrell and Greig 2015;

Gelman et al. 2016). Some consumers may not yet be convinced that the savings are permanent and thus some of the transitory income is used to pay down debts. For application to the regulations we are studying, there is no particular reason for consumers to expect the savings to be temporary, though the magnitude may be seen as uncertain.

There is another body of literature suggesting that motorists are plowing a substantial amount of the savings back into gasoline by purchasing premium gasoline (higher-octane, higher-priced blends) (Hastings and Shapiro 2013; Appelbaum 2015). The surge in sales of premium gasoline is considered ill-informed by many experts, as most vehicles designed to run on regular gasoline will not perform any better—or have lower maintenance costs or burn more cleanly—when operated with premium gasoline (Stepp 2016). About 70% of passenger vehicles on the road were designed to run on regular gasoline (Friedman 2016). AAA has undertaken a public education program to discourage consumers from spending money on purchases of premium gasoline (Blumenthal 2016). From a macroeconomic perspective, it seems unlikely that a shift from regular to premium gasoline will have much of a favorable economic effect. Once again, this consumer response may also be a short-term effect, but it needs to be studied further.

While it is tempting to draw parallels between the recent savings in gasoline expenses due to lower oil and gasoline prices and the long-term accumulated savings in fuel expenses that federal agencies predict will result from federal CAFE and GHG standards, the two scenarios have some strong differences when compared. The recent savings in gasoline expenses are occurring in an economy that is also experiencing a rapid decline in oil prices and a sluggish recovery from the Great Recession. The federal regulations under study are not expected to have a large effect on the global price of oil, primarily because the U.S. has a much diminished share of the global oil market than it did several decades ago. In addition, gasoline savings from the federal standards will accumulate slowly and gradually over many years of vehicle use, with no connection to the Great Recession. Thus, a dollar of gasoline savings may have a different impact on the U.S. economy in 2014-15 than it will from 2017-2035.

8.72 Unresolved Issues Related to Effects of Gasoline Savings on Oil Imports and U.S. Production of Oil

The structure of REMI and some of its key inputs were designed prior to the fundamental changes in energy markets that caused the sharp decline in oil and gasoline prices. For example, the default settings in REMI assume that the U.S. economy imports about 52% of its oil (in 2015 EIA put the U.S. oil-import share at 24%). Moreover, the geographic origin of U.S. oil imports has changed, as Canada and Mexico—both economies that are integrated with the U.S. economy—now account for a majority of U.S. oil imports (EIA 2016; Wilson 2011; Fergusson 2011). In fact, some of the "oil imports" that remain are simply foreign users of U.S. oil refineries, since the product of the refiners (e.g., diesel fuel) is then exported to Europe or elsewhere in the world. Those "imports" to U.S. refiners would not be affected by the regulations under study. The U.S. is already a net exporter of natural gas and some forecasts suggest that the U.S. could become a net exporter of oil prior to 2025. In other words, the magnitude and nature of "oil imports" is changing in the U.S., and thus the structure of REMI needs to be modernized to reflect these changes.

Another key assumption of REMI is that a substantial share of the supply chain for U.S. oil and gas production is imported (e.g., some of the steel and chemicals used by U.S. oil producers are imported). However, REMI's supply chain for oil and gas has not yet been updated to reflect the unconventional development practices that were pioneered in the U.S. and have become widespread in the U.S. industry in the last five years, such as horizontal drilling and multi-stage hydraulic fracturing with large quantities of water, sand, and chemicals.

We performed two sensitivity analyses to determine how sensitive the REMI results might be to changes in the analytic treatment of oil imports. When we compared two extremes—all of the gasoline savings lead to oil-import reductions vs. all the gasoline savings lead to U.S. oil production cuts—our results did change significantly (results not reported here). Thus, we recommend future research to modernize the structure of REMI to reflect new energy production practices in the U.S., including forecasts of how they are expected to evolve in the years ahead.

8.73 The Need to Incorporate Revenue Recycling from Imports

A basic feature of most economic input-output models of entire economies is that cash outlays for imported goods and services permanently leave the economy under study. Sectors with large import shares in their supply chains, other things equal, have smaller multipliers than sectors whose supply chains draw entirely from producers in the domestic economy. This is certainly not a unique feature of REMI but it is likely to have influenced the results of our modeling significantly.

We confronted the issue twice, once in the case of oil imports and again in the case of the stimulus of the automotive supply chain. In the case of oil imports, it is well known that much of the money paid for foreign oil is recycled back into the U.S. economy—directly or indirectly—when foreigners purchase U.S. goods and services or invest in U.S. financial assets such as Treasury securities, stocks, and mutual funds (M. Higgins, Klitgaard, and Lerman 2006). Today, the largest sources of U.S. oil imports are Mexico and Canada, yet those two economies are highly integrated with the U.S. economy.

In the case of automotive supply chains, cash is paid to German, Korean, and Japanese suppliers of parts, but REMI assumes that none of it is recycled back into the U.S. economy. In reality, a share of the revenues paid to foreign parts suppliers are reinvested back into the U.S. economy, for the same reasons described in the case of oil imports. Of particular concern are the important roles that Mexico and Canada play in the U.S. automotive industry (Swiecki and Menk 2016). REMI treats Mexico and Canada as foreign economies when, in fact, the U.S., Mexican, and Canadian economies are highly integrated. That was of course the entire point of the North American Free Trade Agreement (NAFTA) (Dziczek et al. 2017).

We performed some preliminary exploration to determine whether oil-revenue recycling into U.S. capital markets would significantly change our results. REMI has a capital-market sector with developed links to employment, GDP, and income. When we allowed petrodollars from U.S. imports to recycle back into U.S. capital markets, the results of our REMI model changed noticeably, and pushed the long-term macroeconomic benefits of the regulation many years out into the future (results not reported here). This result is due to the expectation that the federal regulations of fuel economy and GHG emissions will reduce the volume of recycled petrodollars entering the U.S. economy. For future research, we suggest a more in-depth analysis of global capital markets and the manner in which petrodollars circulate within these markets.

Recycling of the auto-import dollars raises some similar and distinct issues. The roles of Canada and Mexico as integrated economies are again important, like it was with oil imports. However, car exporters in Germany, Korea, and Japan are quite different than the main oil-exporting countries (e.g., Saudi Arabia, Venezuela, and Nigeria). Although the issues are analytically challenging, we encourage future research to capture more realism about the U.S. economy by building in some recycling of dollars paid for imported goods and services.

An alternative analytic approach is to work with an input-output model of the global economy, one that has sufficient regional differentiation and interactions to shed light on these issues. We believe that the global approach is also worthwhile to pursue.

9. VEHICLE SALES ANALYSIS

While the REMI model is able to predict macroeconomic effects based on a complex set of economic and demographic interactions, it is limited in its ability to predict real world market dynamics. We discussed several of these shortcomings in section 8. An additional limitation is its inability to model consumer perceptions and behavior. In the REMI model, consumers respond to an increase in the price of a vehicle by simply demanding less of that commodity, as calculated via an elasticity of demand. Yet, as the energy economics literature reveals (see section 4), consumers tend to have more complex decision making processes than a simple elasticity can capture, especially within markets for energy efficient commodities. Thus, for estimates of new vehicle demand we elected to build a detailed set of procedures that can more fully and accurately account for consumer perceptions and behavior, not only in relation to the price of vehicles but also as it pertains to the price of gasoline, perceptions of resale value, and other important considerations. We describe these procedures and discuss the implications of our results in this section.

The volume of new vehicle sales is a commonly reported macroeconomic indicator but, as we explained earlier in the report, it is also a crucial input to environmental, safety, and cost-benefit analyses. Changes in the volume of new vehicle sales impact the pace of penetration of cleaner and safer vehicles into the fleet; they are also central to gauging the magnitude of regulatory costs and benefits from a societal perspective. Thus, our analytic work should assist agencies performing societal cost-benefit analyses as well as offer a supplemental macroeconomic perspective.

9.1 Baseline and Time Horizon

As in the REMI modeling, results of the TCO modeling are reported for the 2017-2035 period, using the 2016 federal standards and the 2017 ZEV requirements as the baseline. However, the estimated impacts on new vehicle sales are meaningful only through 2025, since we assume that the federal and state regulations are unchanged after 2025 and since we assume no lag between when a vehicle price increase occurs and when effects on new vehicle sales occur. However, the TCO results account for consumer perceptions over the entire lifetime of each model year. For example, for consumers considering a new vehicle in 2025, the TCO accounts for consumer perceptions of fuel prices, fuel savings, and resale value throughout the entire vehicle lifetime (maximum of 30 years for cars and 37 years for trucks).

9.2 The Total Cost-Of-Ownership (TCO) Model

In order to capture the effects of the regulations on the volume of new vehicle sales, we need a modeling structure that accounts for both changes in new vehicle price and changes in vehicle operating costs and resale values due to new technology. We elected to use the same modeling structure that NHTSA has used in its RIAs for more than a decade, as that structure has been reviewed by the Office of Management and Budget and the Council of Economic Advisors and is familiar to the stakeholders and congressional staff interested in the regulatory issues. The structure is a total cost-of-ownership (TCO) model, looking at the total cost for consumers over the anticipated life of the vehicle.

Specifically, we assume that the percentage change in new vehicle sales, due to regulation, is triggered by a change in the "net" price premium and the price elasticity of demand for new vehicles. The "gross" price premium is the initial price increase attributable to the incremental costs of producing vehicles with fuel-saving technology. The "net" price premium is a complex construct: it is the gross price premium minus the present discounted value of a stream of cash flows related to vehicle purchase costs (sales taxes, insurance premiums, and loan financing fees/payments), vehicle operating costs (energy expenditures), and the resale value of the vehicle (since a vehicle is typically resold at least once over its lifetime). See Appendix VIII for the specific algebraic expressions and a detailed discussion of how the TCO is built.

9.3 An Illustration of the TCO Model

The TCO model combines changes in the net price premium with the price elasticity of new vehicles to determine the impact of the regulations on volume of vehicle sales. The price elasticity of demand relates a percent change in price to the corresponding percent change in new vehicle demand (volume of new vehicle sales). While the literature typically defines price elasticity of demand in terms of gross vehicle price, we—like NHTSA—make the assumption that consumers care (at least to some extent) about the "net" price premium, since consumers will also be impacted by less immediate factors such as loan payments, energy costs (gasoline and electricity), and resale values when vehicle ownership changes. Thus, if regulation causes a gross vehicle price premium of $1,000 (e.g., for a mild hybrid system that saves fuel during vehicle operation), and if less immediate factors (e.g., diminished gasoline consumption) save the consumer $700 in present discounted value over the consumer's time horizon, then the net price premium in the eyes of the consumer is $300.

If the average price of the vehicle was $30,000, the net premium of $300 will enlarge that price to $30,300, which is a 1% increase. If the price elasticity of demand is -1.0 (a standard estimate used by NHTSA and also used in our TCO modeling), that means that each 1% increase in vehicle price is associated with a 1% decline in the volume of new vehicle sales. The decline in new vehicle sales means that either (1) some consumers without a car delay purchasing their first car, and/or (2) consumers hold their existing car longer, and/or (3) consumers buy a used car instead of a new car. On a national basis, if about 17 million passenger vehicles are sold each year, a 1% decline in new vehicle sales corresponds to 170,000 fewer sales of new vehicles.

Notice that the impact of regulation on new vehicle sales can be positive or negative. If the net price premium is positive, the sales impact will be negative. But, if the net price premium is negative, the impact of regulation on new vehicle sales will be positive. This is not simply a mathematical nicety, since the federal agencies determined in 2012 that the present value of fuel savings due to regulation will be more than adequate to pay for the gross price premium associated with the 2017-2025 standards.

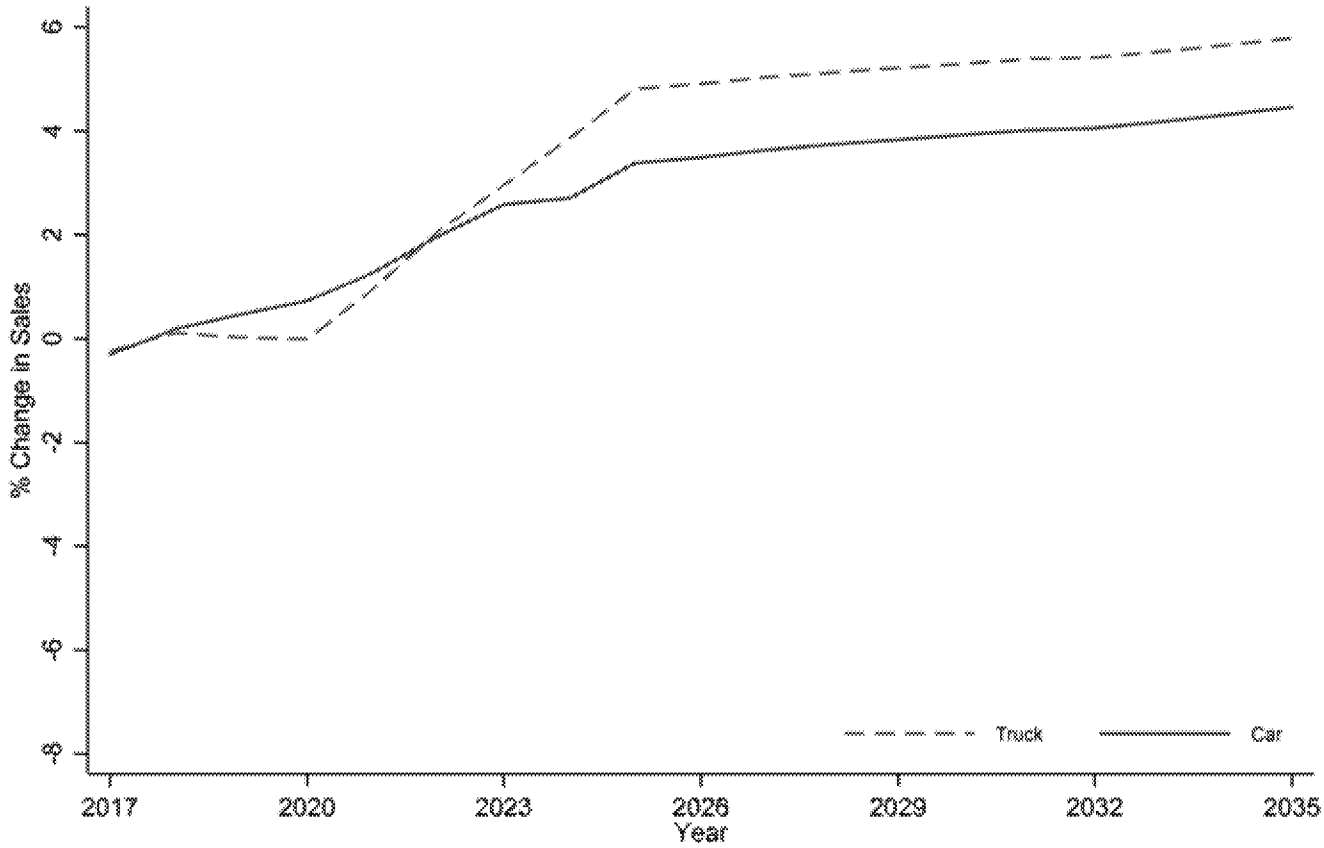
Our approach to consumer demand is conservative in the sense that we assume higher vehicle prices influence only the volume of new vehicle sales. Another form of consumer response, which we do not model, is an adjustment in the type of vehicle sold. For example, higher vehicle prices may induce consumers to purchase less expensive cars or cars with fewer options or upgrades (CAR 2015; 2016). The latter responses would impact the automotive supply chain even though the number of assembled vehicles is not altered. Additionally, the TCO analysis is based on the response of an average consumer to the changes in the price of an average car and an average light duty truck. The implication of this approach is that the only source of heterogeneity in the analysis is between cars and trucks. We do not account for heterogeneity across regions, manufacturers, make-model, or consumers. We discuss some additional assumptions in the sections that follow.

9.4 Results for the 2012 Perspective NHTSA

Figure 9.1 reports the percentage change in vehicle sales by model year (compared to a 2016 baseline) that can be attributed to the 2017-2025 standards using data and assumptions from what we call the 2012 NHTSA Perspective (i.e., our efforts to replicate the findings in NHTSA's 2012 RIA). We find that the 2017-2025 federal standards have a predominantly positive effect on new vehicle sales. The sales impact on MY 2025 vehicles is larger for light trucks than for cars because the gross price premiums are approximately the same but the fuel savings are larger for light trucks than for cars. The effect is slightly negative in 2017, since one year of fuel savings is not enough to outweigh the gross price premium in 2017. For all of the other years through 2035, the effect of the 2017-2025 standards on new vehicle sales is positive. The positive effect slows its growth after 2025 because we assume no tightening of the federal standards in model years after 2025 and, therefore, no additional increase in the vehicle price premium. The weighted average change in vehicle sales over the period 2017-2025 is +1.5%, which is modestly smaller than the NHTSA estimate of +2.3%.

The magnitude of the positive effects for MY 2025 is +3.4% for cars and +4.8% for trucks for a combined 3.8% increase in total vehicle sales. This is not a trivial effect; a +4% increase in new vehicle sales on a base of 17

Figure 9.1. Percentage Change in Vehicle Sales due to Regulation by Model Year: 2012 Perspective NHTSA.



Notes: Reported is the percentage change in vehicle sales due to the 2017-2025 federal standards, using the total cost of ownership approach used by NHTSA in its 2012 RIA. Total cost accounts for purchase price, fuel savings, resale value, loan financing, auto insurance, and sales tax.

million vehicles corresponds to 680,000 additional vehicles. That is equivalent to the annual production volume of one of the larger U.S. automotive assembly plants.

9.5 Results for the 2016 Perspective, One Change at a Time

We now present results from the 2016 perspective, showing individually how various changes used in the 2016 perspective impact the results reported for the 2012 perspective.

9.51 Adjusted Gross Vehicle Price Premiums

Using results from NRC (2015a), we show how a small and large increase in the gross vehicle price premiums for cars and trucks impact new vehicle sales. The small increase is +11%; the large increase is +56% (both relative to NHTSA's 2012 input). Those adjustments represent "most likely" scenarios of different groups of experts within the NRC Committee. Those increases reflect the joint impact of new estimates of the fuel-saving effectiveness and resource costs for technological refinements to vehicles with an internal combustion engine. Section 8 provides a detailed discussion of the price premium. Also see Appendix VIII for a more detailed discussion of how we implemented the premium changes in the TCO.

Figures 9.2a and 9.2b show the effect of the premium increase on vehicle sales for cars and trucks, respectively; the 2012 perspective is shown in order to highlight the relative sales impact of the NRC adjustments. The pattern of results is intuitive. Relative to the 2012 perspective, the small premium increase has a small effect on car and truck sales while the large premium increase is sufficient to move the car-sales impact into the negative region up

Figure 9.2a. mpact of NRC Price Premium Adjustments on Car Sales by Model Year.

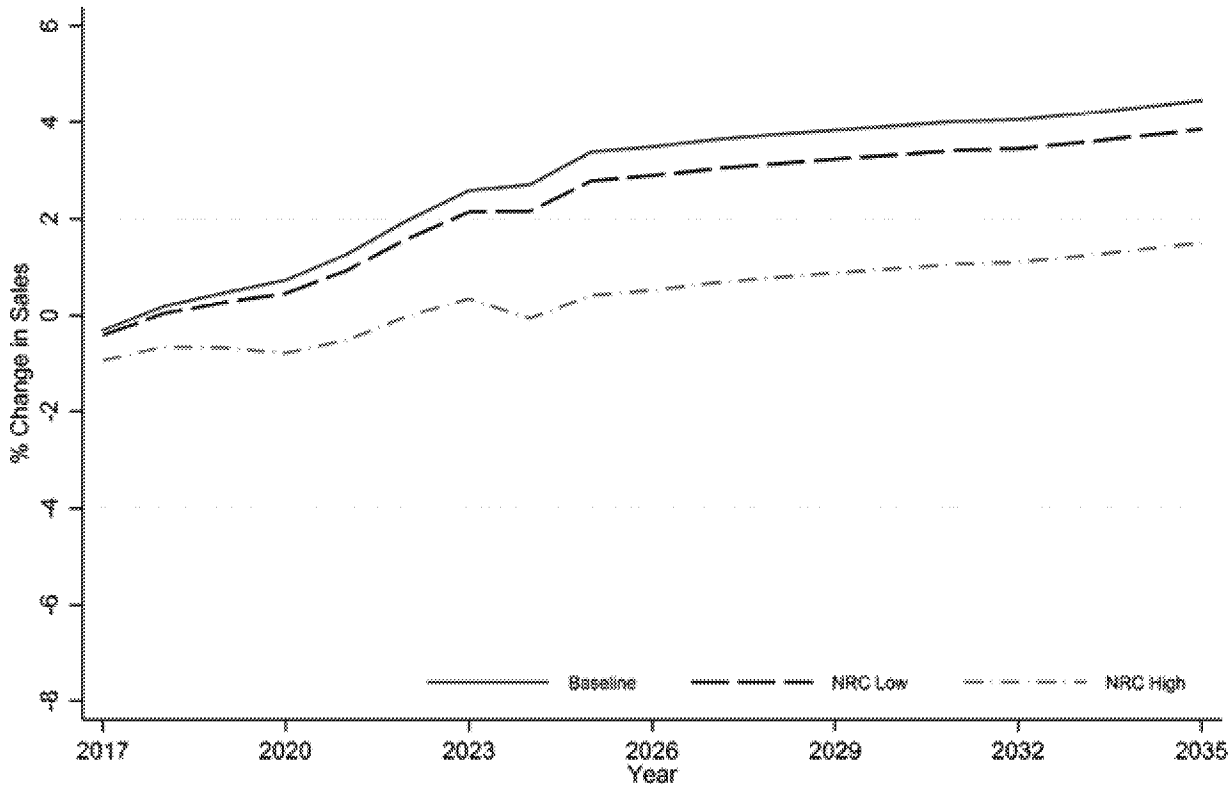
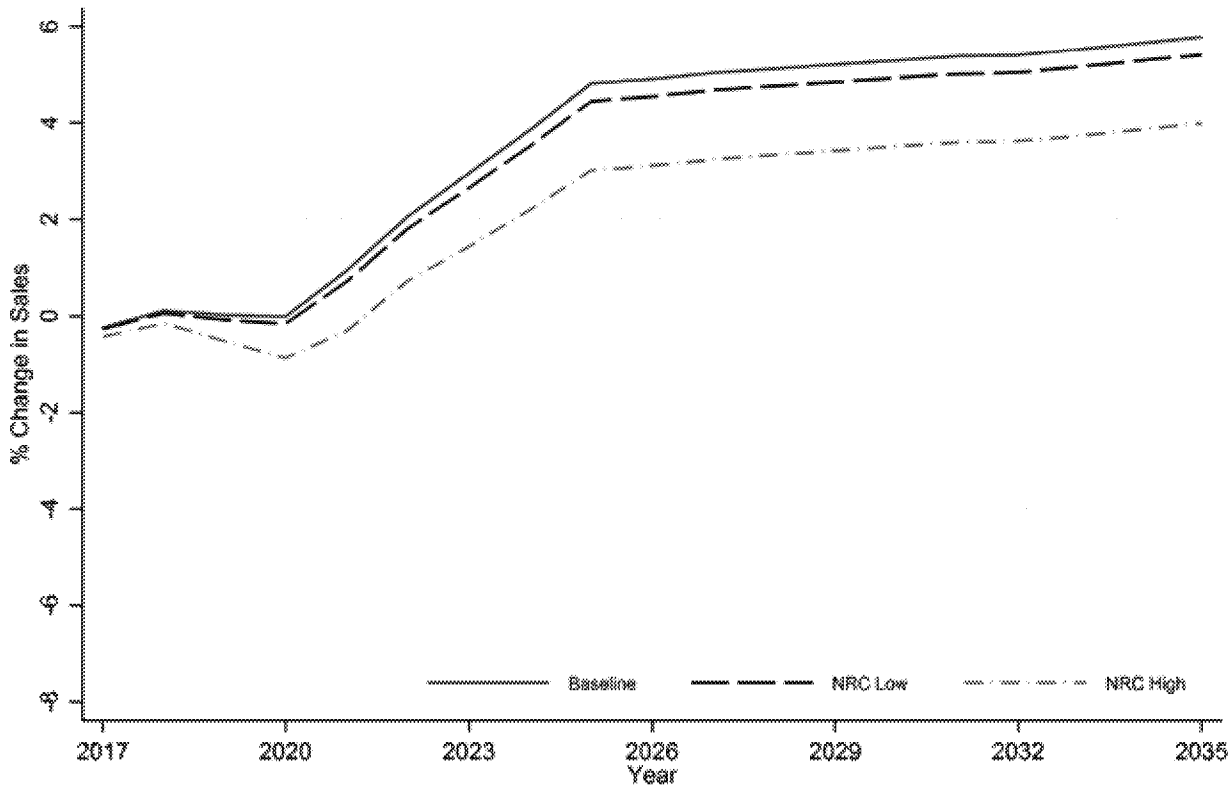


Figure 9.2b. Impact of NRC Price Premium Adjustments on Truck Sales by Model Year.



Note: Reported in both Figures 9.2a and 9.2b is the percentage change in vehicle sales due to the 2017-2025 federal standards based on various assumptions about vehicle price premiums. *Baseline* is vehicle price premium under the 2012 perspective using NHTSA's data. *NRC high* and *NRC low* represent the price premiums after accounting for the National Research Council's (NRC) 'high most likely' and 'low most likely' scenarios, respectively.

until about 2022. The car-sales impact remains positive for the remainder of the study period, but substantially less positive than in the 2012 perspective. For trucks, the large premium increase causes sales to decline through 2021, but the impact turns positive thereafter.

9.52 Add the Cost of the ZEV Requirements to the Federal Requirements

The ZEV requirements, which are applied in 10 states representing 30% of the new U.S. vehicle fleet, are modeled in several ways, each assuming different types of BEVs or different mixes of PHEVs and BEVs and thus somewhat different streams of technology costs. The ZEV premium is calculated in two ways: with a simulation approach (see section 7.3) and with the software COMET (see section 7.4). The simulation approach assumes the cost of the ZEV regulation will be allocated to cars nationally instead of being concentrated on the prices of cars sold in each of the ZEV states. We also assume that the ZEV compliance requirements do not affect manufacturers' strategy for complying with the federal programs. While this assumption simplifies the analysis, it results in over-compliance with the federal program and thus overestimates the incremental costs of the combined federal-ZEV regulations. The COMET approach addresses this latter problem and also allows for the ZEV premium to apply, separately, to both cars and trucks. The COMET approach maintains the assumption that ZEV costs are distributed nationally through vehicle prices.

Figures 9.3a and 9.3b report results for cars and trucks, respectively. The pattern of results reported in Figure 9.3a shows that the addition of the ZEV requirements to the 2012 perspective does not cause the overall impact on new car sales to become negative. However, inspection of Figure 9.3a reveals that accounting for the interdependence between the ZEV and CAFE mandates is important. Relative to the 2012 perspective (line denoted by "Baseline" in Figure 9.3a), the magnitude of the positive sales effects is dampened when we ignore the interdependence between ZEV and CAFE; from +3.4% for car sales to just over +2% in MY 2025. The COMET results show an increase in sales between 2017 and 2022, relative to the 2012 perspective, and a dampening of sales comparable to the simulation approach between 2026 and 2035.

The dampening effect is relatively large because the ZEVs (while they individually save large amounts of fuel) do not affect fuel consumption in the average new vehicle sold in the U.S. The corporate averaging features of the federal CAFE and GHG programs are such that each PEV produced due to the ZEV regulation allows vehicle manufacturers to produce one or more less fuel-efficient vehicles than they would have produced without the presence of the ZEV regulation.

The ZEV program also reduces truck sales relative to the 2012 perspective over the entire period under analysis (see Figure 9.3b). More importantly, sales are projected to decline over the 2017-2022 period before picking up again over the remainder of the study period. By 2025, truck sales are projected to be about +2% compared to approximately +4% in the 2012 perspective.

9.53 Consumer Valuation of Fuel Savings

In its 2012 analysis, NHTSA assumed that new-vehicle purchasers (1) project future fuel prices based on EIA forecasts, (2) value five years of fuel savings after purchase, which corresponds to NHTSA's assumption of the length of a car-loan agreement, and (3) perceive that they will capture 35% of the gross price premium for fuel-saving technology when the vehicle is resold after five years. The resale value is assumed to be unaffected by fuel price.

The 2016 perspective makes several changes. The consumer assumes flat fuel prices over the ownership period at the level projected at the time of vehicle purchase. The consumer's horizon on fuel savings is reduced from five years to three years or one year in alternative analyses. Resale value of fuel saving technology is equal to 55% of the present value of fuel savings (7% discount rate) from years six to 30 of the vehicle life, and varies based on fuel price scenario. All other inputs are the same as the 2012 perspective. The rationales and evidence supporting these changes are discussed in section 4.

Figure 9.3a. Impact of ZEV Regulation on Car Sales by Model Year.

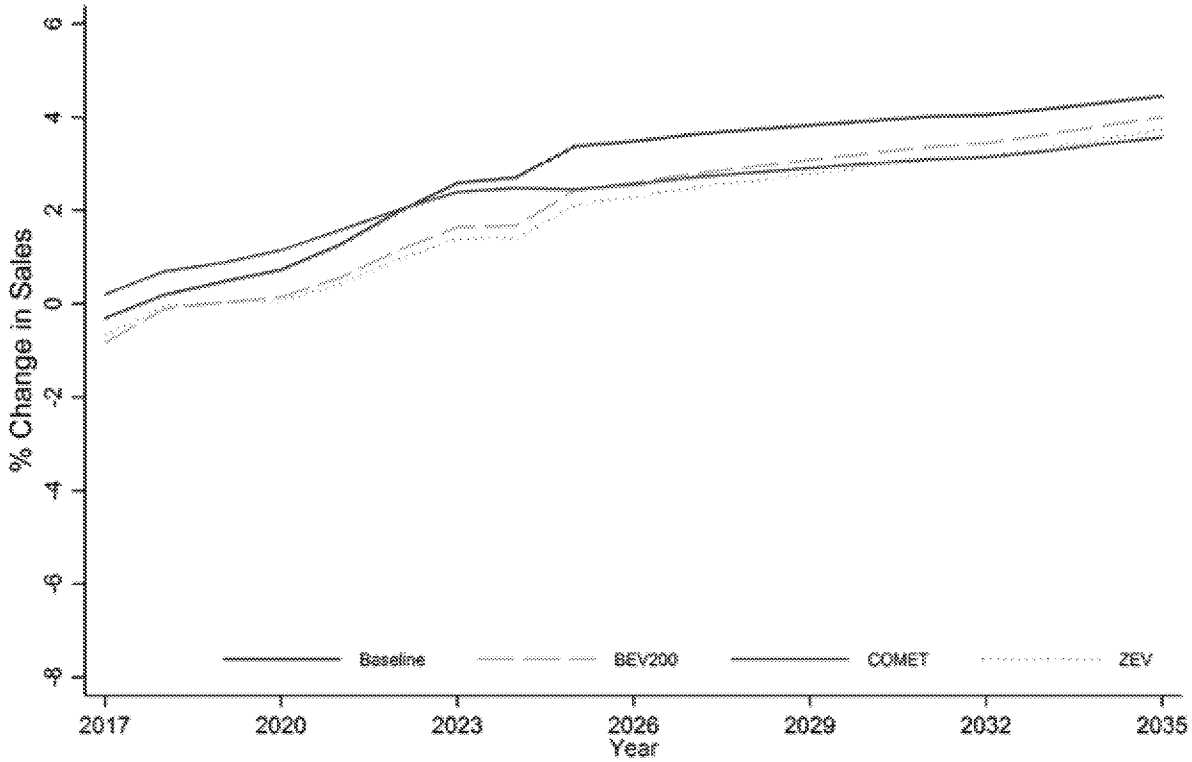
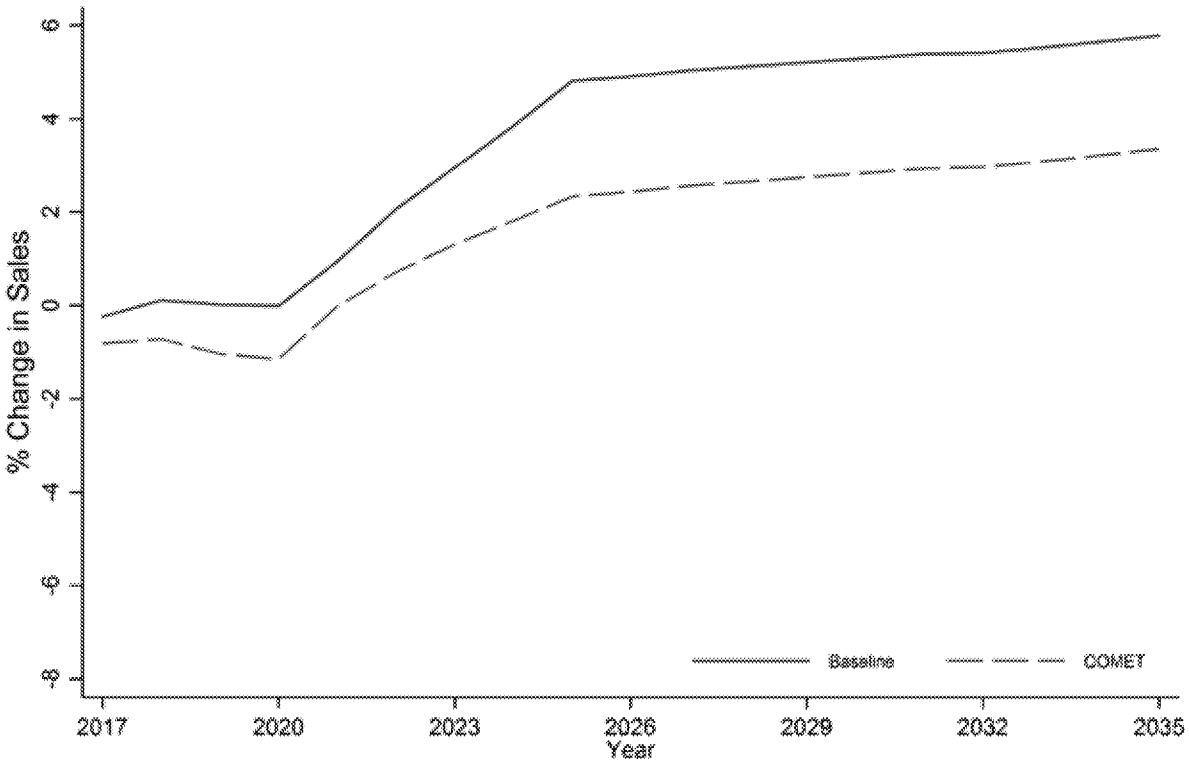


Figure 9.3b. Impact of ZEV Regulation on Truck Sales by Model Year.



Note: Reported in both Figures 9.3a and 9.3b is the percentage change in truck sales due to the regulatory programs under various assumptions about how the ZEV regulation is met. Baseline uses the price premium under the 2012 perspective using NHTSA's data, and omits the ZEV regulation. The other line shows the effect of the CAFE plus ZEV on truck sales using price premiums obtained from the *COMET* model. *COMET* assumes ZEV is satisfied with BEV75s. Notice also that the *COMET* premiums include some NRC adjustments.

The results in Figure 9.4a for cars show that the consumer's perception of fuel price change does not have a meaningful effect on the results, relative to the 2012 perspective. Reducing the valuation period for fuel savings has a large impact on the results, basically eliminating the positive sales effects (when the consumer values three years' worth of fuel) or producing a -3% sales effect in 2025 (if the consumer values only one year of fuel savings). The change in resale value works in the opposite direction: if the new-vehicle consumer perceives a higher resale value for the vehicle with superior fuel-saving technology, then the positive effects on new car sales climb by 2025 from under +3.4% to +6.4%. Note that these results all assume the 2012 fuel-price forecast, before the global change in energy markets.

The qualitative pattern of changes is the same for trucks; see Figure 9.4b. Changing the discount rate applied to future fuel savings has a smaller effect on the results than changing the number of years of fuel savings valued by the consumer. See Figure VIII.1 in Appendix VIII for vehicle sales impacts based on discount rates of 5%, 7% and 13% (the latter representing interest rates on credit card debt). We do not present results at 3% because, while 3% is an appropriate social discount rate for some applications of cost-benefit analysis, it is not relevant to modeling impacts of regulation on new vehicle sales in the automotive industry.

9.54 Lower Fuel Prices

Fundamental changes in global energy markets, including the "fracking" revolution in North America, have caused a sharp decline in oil and gasoline prices since 2012. Energy experts believe that lower oil and gasoline prices may persist for a long period of time. For example, EIA projected, in the reference case from 2012, that national gasoline prices in 2025 would be $3.90 per gallon (2010 $). In 2016, EIA's reference case forecast was $2.74 per gallon (2010 $).

The lower fuel prices impact the TCO model by reducing the savings in fuel expenditures experienced by motorists. When a consumer considers whether to purchase a hybrid or plug-in vehicle, the investment looks more attractive when fuel prices are $4 per gallon than when they are under $3 per gallon.

Figures 9.5a and 9.5b show that the lower fuel-price projection causes a meaningful change in the pattern of new vehicle sales. For cars and trucks, sales impacts are negative for several years before they turn positive. In 2025, instead of +3% impact on car sales, the boost is only about +1%. For truck sales, the boost of +5% in 2025 is shaved to about 3%.

Figures VIII.2 and VIII.3 in Appendix VIII report a single-variable sensitivity analysis using EIA's high, reference, and low fuel-price projections from 2016 for cars and trucks, respectively. The changes in estimated impacts on new vehicle sales are substantial.

9.55 Updated Information on Miles of Vehicle Travel

In the TAR (2016), NHTSA presents a rich new database on vehicle miles of travel by vehicle age. These data are based on actual odometer readings of a large sample of vehicles covering 16 model years (2000-2015). Consequently, the new data have a significant advantage over the previously used VMT data obtained from NHTSA's 2009 Household Travel Survey. Compared to the data used in 2012, the new VMT estimates are slightly larger in the early years of vehicle ownership but substantially lower in later years and for the entire vehicle lifespan. Use of the new VMT data, which changes fuel-savings estimates, does not have a noticeable impact by itself on the volume of vehicle sales (results not reported).

9.56 Raise the Average Rate on Car Loans

In 2012, NHTSA assumed an average interest rate on car loans of 5%. The 2016 perspective raises that rate to 7%, which is aligned with the 7% annual discount rate applied to future fuel savings. The higher interest rate is supported by the fact that the long-term historical average is about 7% (Allcott and Wozny 2014). Moreover, loan rates for the subprime borrower tend to be higher than average, and those borrowers may be particularly

Figure 9.4a. Impact of Consumer Valuation of Fuel Savings on Car Sales by Model Year.

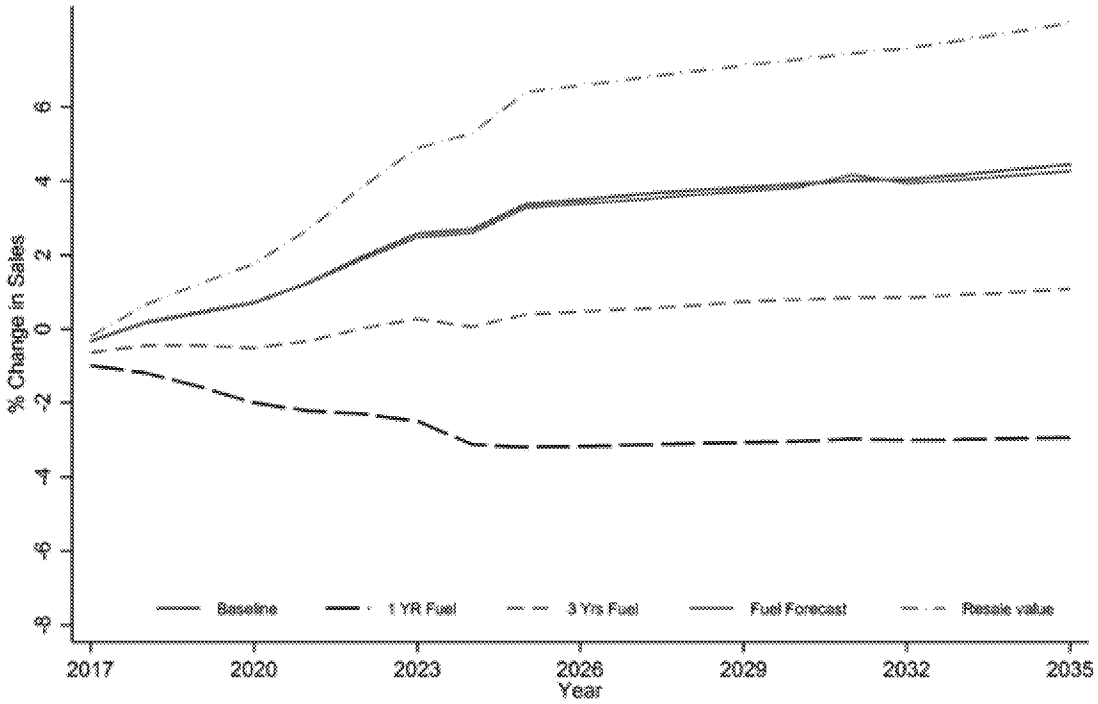
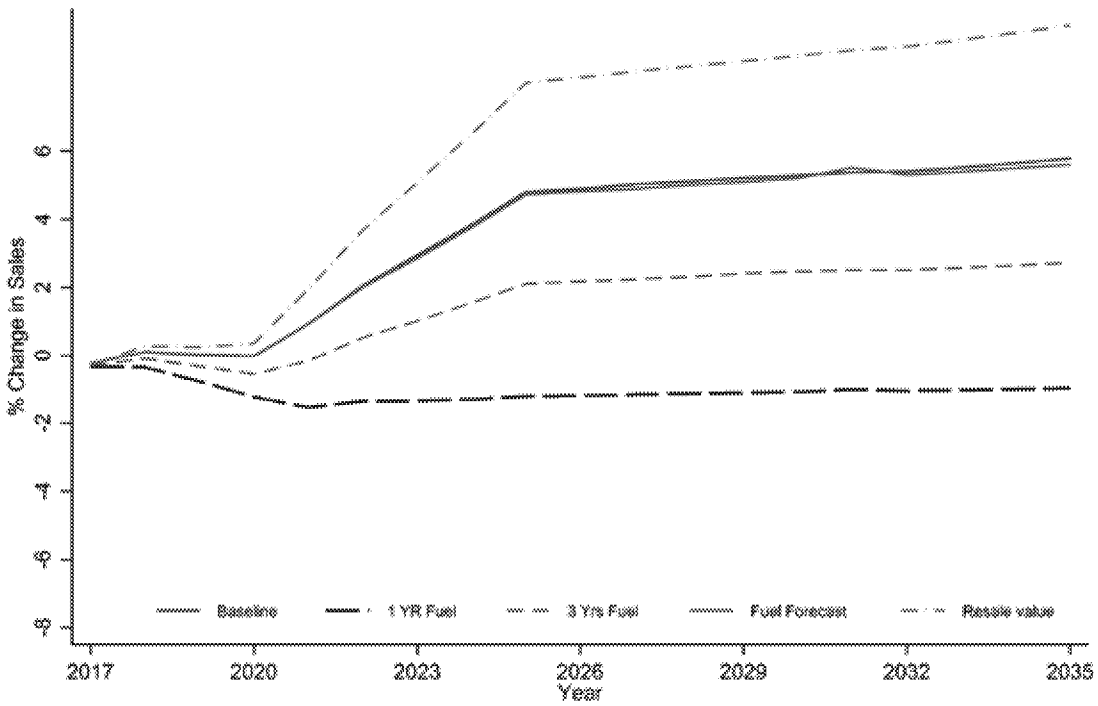


Figure 9.4b. Impact of Consumer Valuation of Fuel Savings on Truck Sales by Model Year.



Note: Reported in both Figures 9.4a and 9.4b is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about how consumers value fuel savings. *Baseline* uses NHTSA's data and thus assumes consumers value five years' worth of fuel savings, perceive resale value of fuel-saving technology to be 35% of gross price premium, and perceive future fuel prices equal to the AEO projections. *1 YR fuel* and *3 YR fuel* are the same as the baseline except that consumers only value 1 and 3 years of fuel savings, respectively. *Fuel forecast* is the same as the baseline except the consumers are assumed to take today's fuel price as the forecast of tomorrow's fuel price. *Resale* is the same as baseline except that resale value is equal to 55% of the present value of fuel savings from years 6 to 30 of the vehicle's life. Discount rate is 7%.

Figure 9.5a. Impact of Regulation on Car Sales by Model Year Under Different Fuel Prices.

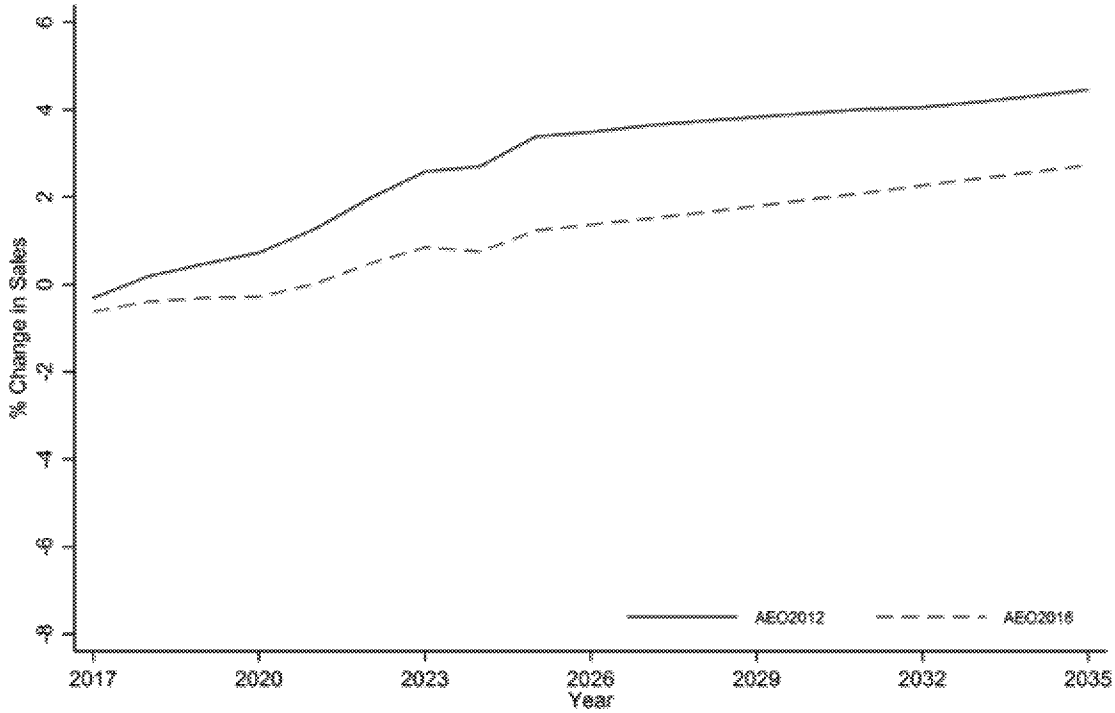
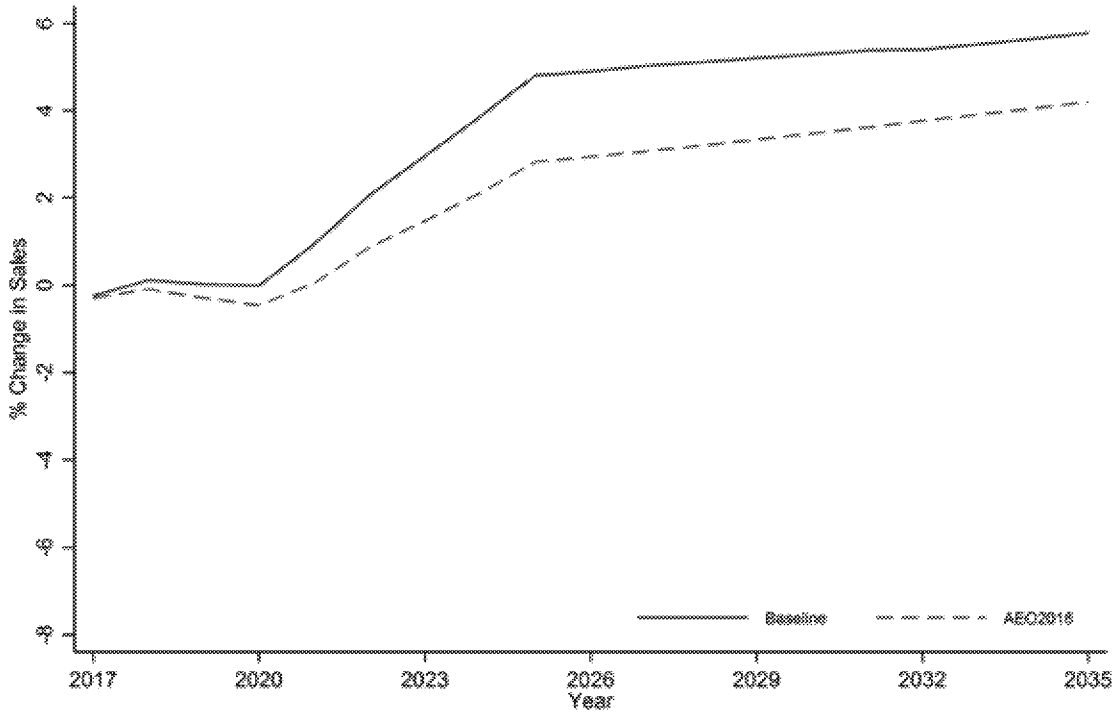


Figure 9.5b. Impact of Regulation on Truck Sales by Model Year Under Different Fuel Prices.



Note: Reported in both Figures 9.5a and 9.5b is the percentage change in vehicle sales due to the regulatory programs, using the reference fuel price published in the 2012 and 2016 annual energy outlook (AEO). *AEO2012* uses NHTSA's data and thus uses fuel price from the AEO2012. *AEO2016* is the same as AEO2012 except that fuel price projections are from the 2016 AEO.

sensitive to vehicle price increases or declines in the monetary value of fuel savings. The Federal Reserve Board has recently raised interest rates and has announced plans for additional raises in the future. Changing the loan rate from 5% to 7% does not have a meaningful effect on the sales results (results not reported).

9.6 The 2016 Perspective: Making Multiple Adjustments Simultaneously

Now that we have explored the effect of each change individually, we present the 2016 perspective with all of the analytic changes made at once. Figures 9.6a and 9.6b present the sales impacts for cars and light trucks, respectively, assuming the 2016 Low Perspective vehicle price premium. Figures 9.7a and 9.7b use the 2016 High Perspective vehicle price premium. All of the figures also include a solid curve which represents the results from the 2012 perspective. All of the results except the 2012 perspective (which serves as the baseline) include the impact of the ZEV program.

Since assumptions about consumer valuation exert a strong impact on the results, the figures are constructed for different consumer perceptions of the value of fuel savings and of the future resale value of fuel-saving technology. The most optimistic 2016 results (based on five years of fuel savings, a perceived capture of 100% of future discounted fuel savings through resale value, and a 2016 Perspective Low price premium) put the 2025 impact on sales at +1% for cars and +5% for trucks (the latter result is similar to the 2012 perspective); see Figures 9.6a and 9.6b. In contrast, the most pessimistic 2016 results (based on one year of fuel savings, a perceived 0% capture of the value of technology at resale, and a 2016 High Perspective price premium), put the 2025 impact on sales at -11% for cars and -5% for trucks; see Figures 9.7a and 9.7b.

The most plausible results may be those represented by the lines labeled "2016 high," "2016 medium," and "2016 low." At the 2016 Perspective Low price premium (Figure 9.6a), the 2025 impact on new car sales is estimated at roughly -3%, and -5%, depending on how fuel savings are valued by the consumer. At the 2016 Perspective Low price premium (Figure 9.6b), the results for trucks vary (+1%, 0, or -1%), depending on how the fuel savings are valued by the consumer. At the 2016 Perspective High price premium (Figure 9.7a and 9.7b), the 2025 results for cars and trucks are uniformly negative; -6% and -8% for cars and -1% to -3% for trucks.

9.7 The 2016 Perspective: Relaxing Some ZEV Adjustment Assumptions

The results for cars tend to be more negative than the results for trucks for several reasons: the average buyer of a light truck has been assumed to be equally interested in a gallon of future gasoline savings compared to the average buyer of a car; the technology costs for light trucks are assumed to be only slightly larger than the technology costs for cars; the costs of the ZEV program, which will cause some trucks as well as cars to be electrified, have been allocated entirely to the car fleet; and the ZEV costs are added without accounting for the interdependence between ZEV and CAFE.

9.71 CAFE ZEV Interdependence

The validity of some of the car vs. truck assumptions are open to question, and are a fruitful topic for future research. Here we relax the last two assumptions by using COMET to account for the ZEV cost premium. Specifically, we illustrate the sales impacts on cars and trucks after accounting for the fact that ZEV compliance makes it cheaper to comply with CAFE. We account for this interdependence by relying on the price premium estimated by the COMET model. The COMET model also assumes that manufacturers will implement ZEV technology on both cars and trucks.

Figure 9.8a shows the sales impact on cars for four scenarios: 2012 perspective, high and low 2016 perspectives, and COMET 2016 perspective. While all of the 2016 perspectives show negative sales impacts, the COMET 2016 perspective shows that accounting for the interdependence between ZEV and CAFE results in a smaller sales effect on cars. The 2016 COMET results for trucks track the 2016 high perspective closely up to 2022 before diverging over the rest of the period; COMET sales effects are larger in absolute terms and negative over most of the study period (see Figure 9.8b).

Figure 9.6a. Percentage Change in Car Sales Due to Regulation by Model Year, 2016 Perspectives, Low Price Premium.

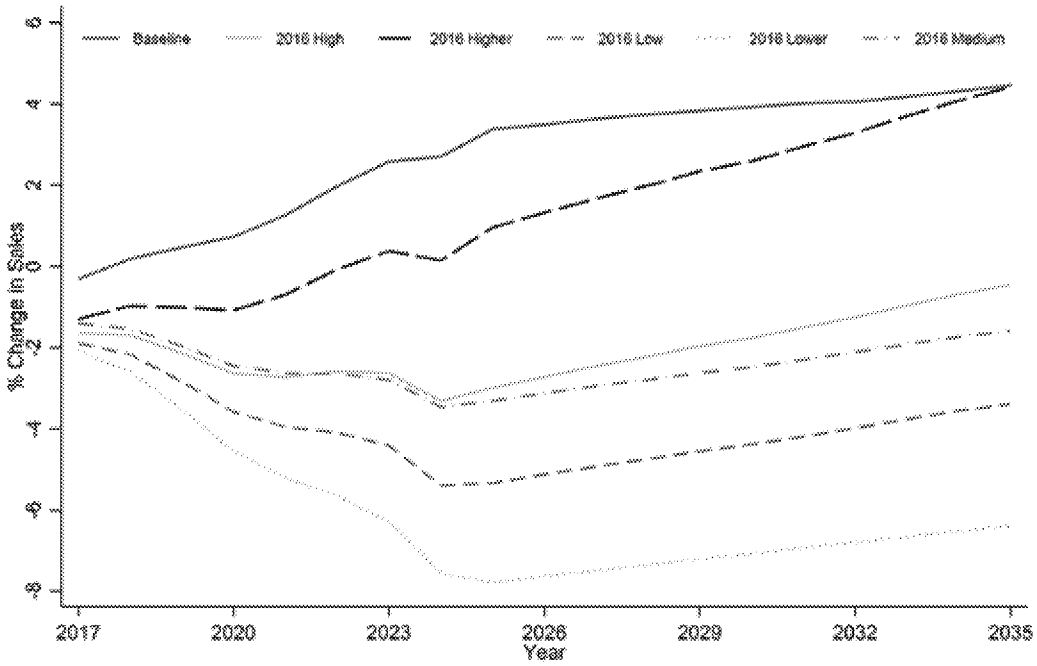
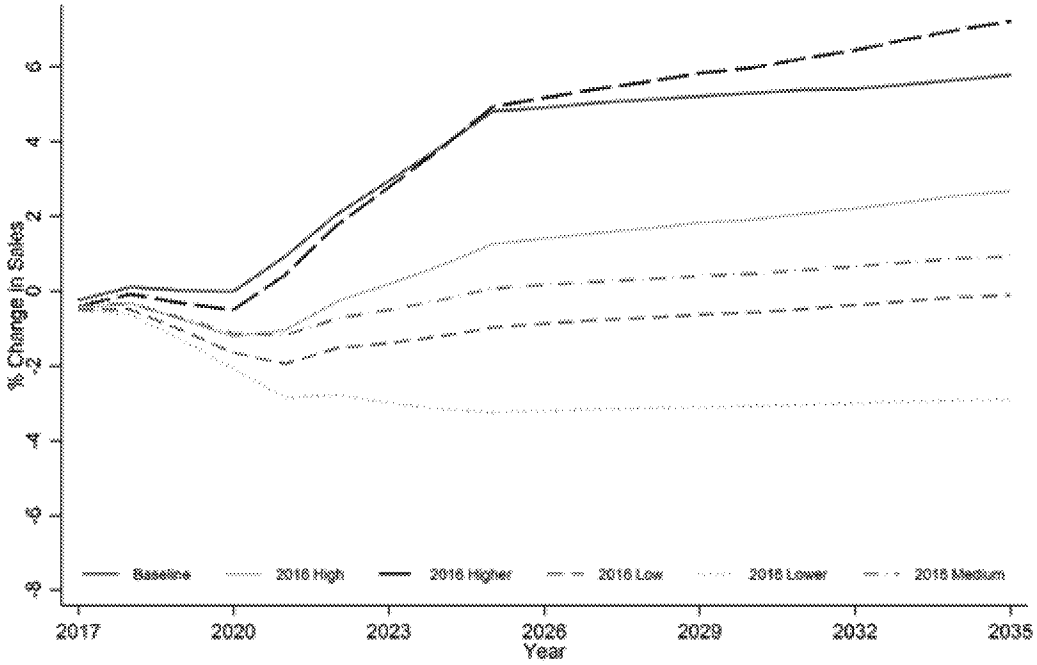


Figure 9.6b. Percentage Change in Truck Sales Due to Regulation by Model Year, 2016 Perspectives, Low Price Premium.



Note: Reported in both Figures 9.6a and 9.6b is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about how consumers value fuel savings. *Baseline* is based on NHTSA's 2012 data; it assumes that consumers value five years' worth of fuel savings, perceive resale value equal to 35% of gross price premium, and perceive future fuel price equal to the AEO projections. The remaining lines are based on 2016 data, but vary consumer valuation of fuel savings. *Lower, Low, Medium, High,* and *Higher* assume the consumer values one, three, three, three and five years of fuel savings, respectively. *Low* and *Lower* sets perceived incremental resale value to zero. *High* and *Higher* sets perceived resale value equal to 55% and 100% of the present value of fuel savings from years 6 to 30 of the vehicle's life, respectively. *Medium* sets the incremental resale value to 35% of the gross premium. Gross price premium is equal to the NHTSA 2012 projections in the baseline. All other lines are based on the low price premium scenario; i.e., NHTSA 2012 plus DOE estimate of ZEV plus NRC 'low most likely' adjustment for Figure 9.6a, NHTSA 2012 plus NRC 'low most likely' for Figure 9.6b.

Figure 9.7a. Percentage Change in Car Sales Due to Regulation by Model Year, 2016 Perspectives, High Price Premium.

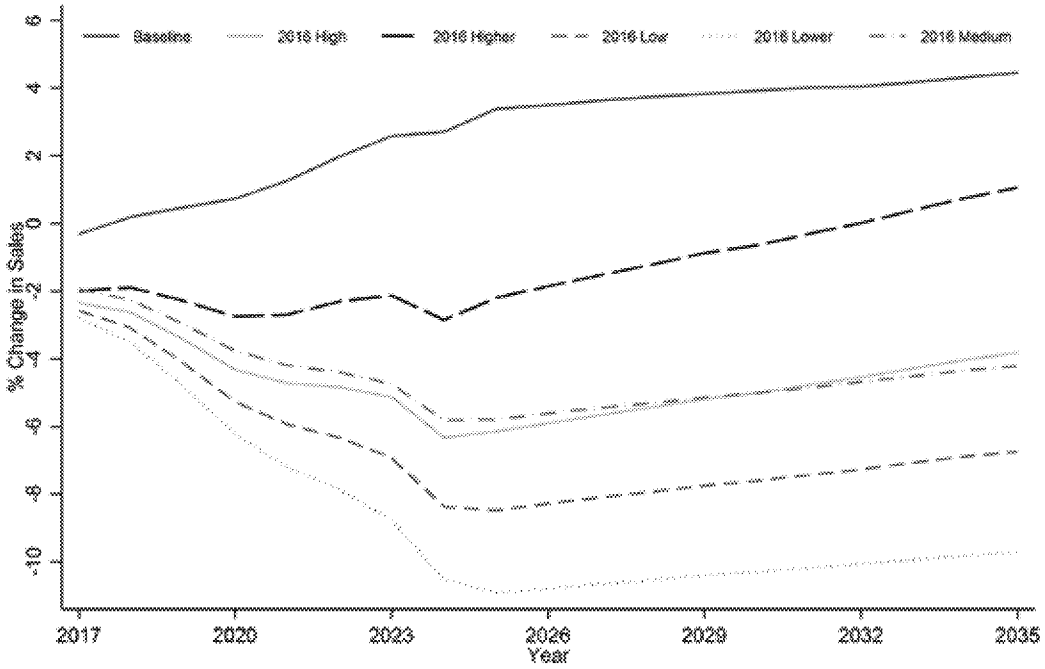
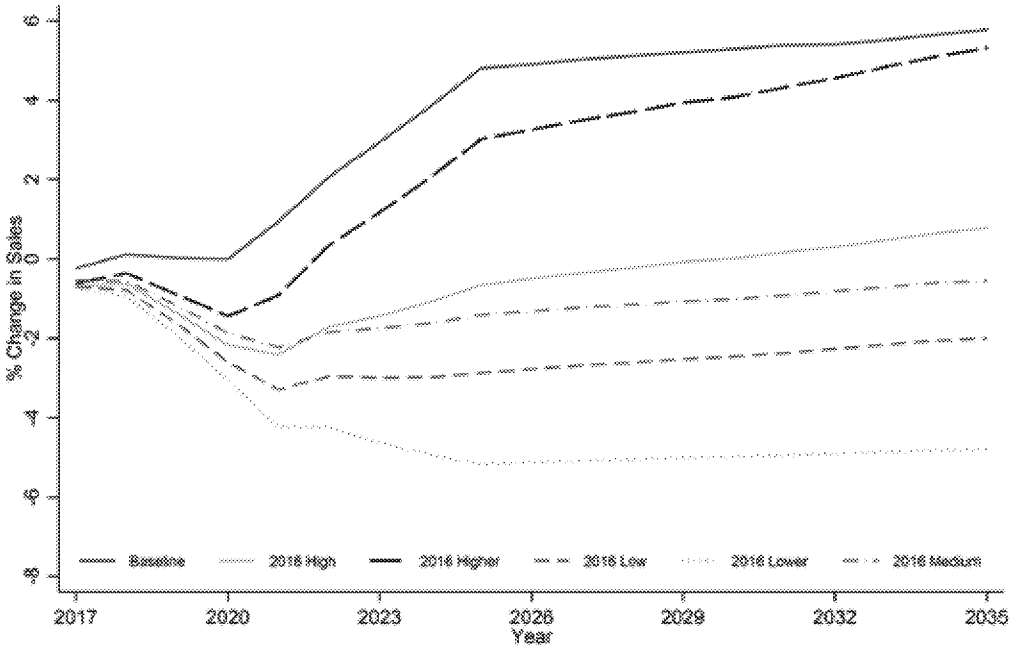


Figure 9.7b. Percentage Change in Truck Sales Due to Regulation by Model Year, 2016 Perspectives, High Price Premium.



Note: Reported in both Figures 9.7a and 9.7b is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about how consumers value fuel savings. *Baseline* is based on NHTSA's 2012 data; it assumes that consumers value five years' worth of fuel savings, perceive resale value equal to 35% of gross price premium, and perceive future fuel price equal to the AEO projections. The remaining lines are based on 2016 data, but vary consumer valuation of fuel savings. *Lower, Low, Medium, High,* and *Higher* assume the consumer values one, three, three, three and five years of fuel savings, respectively. *Low* and *Lower* sets perceived incremental resale value to zero. *High* and *Higher* sets perceived resale value equal to 55% and 100% of the present value of fuel savings from years 6 to 30 of the vehicle's life, respectively. *Medium* sets the incremental resale value to 35% of the gross premium. Gross price premium is equal to the NHTSA 2012 projections in the baseline. All other lines are based on the low price premium scenario; i.e., NHTSA 2012 plus DOE estimate of ZEV plus NRC 'high most likely' adjustment for Figure 9.7a, NHTSA 2012 plus NRC 'low most likely' for Figure 9.7b.

Figure 9.8a. Percentage Change in Car Sales by Model Year; Illustration of CAFE/ZEV Interdependence.

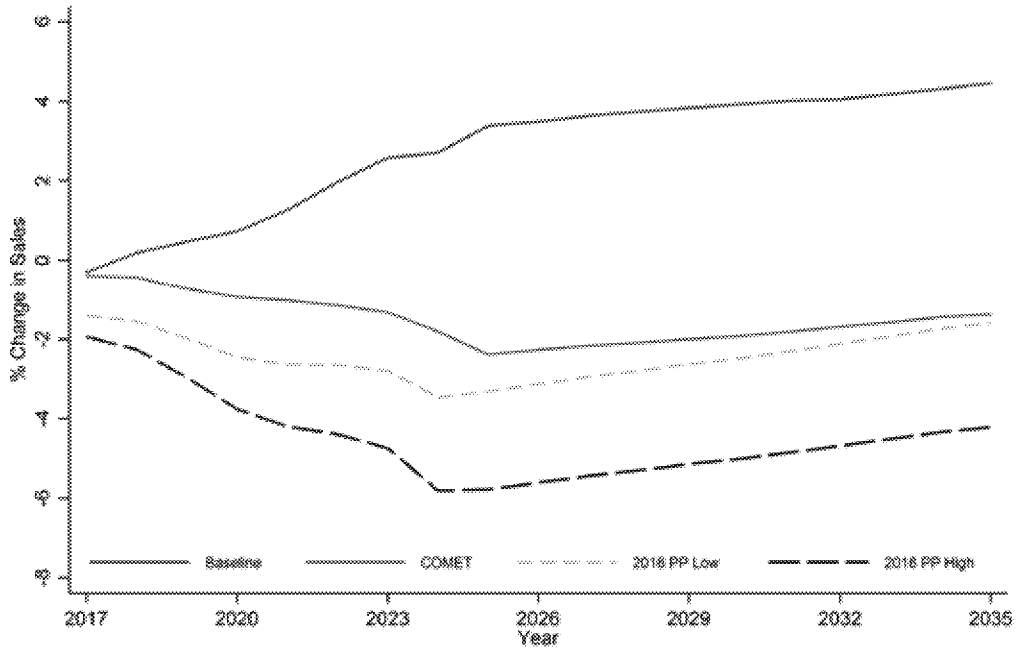
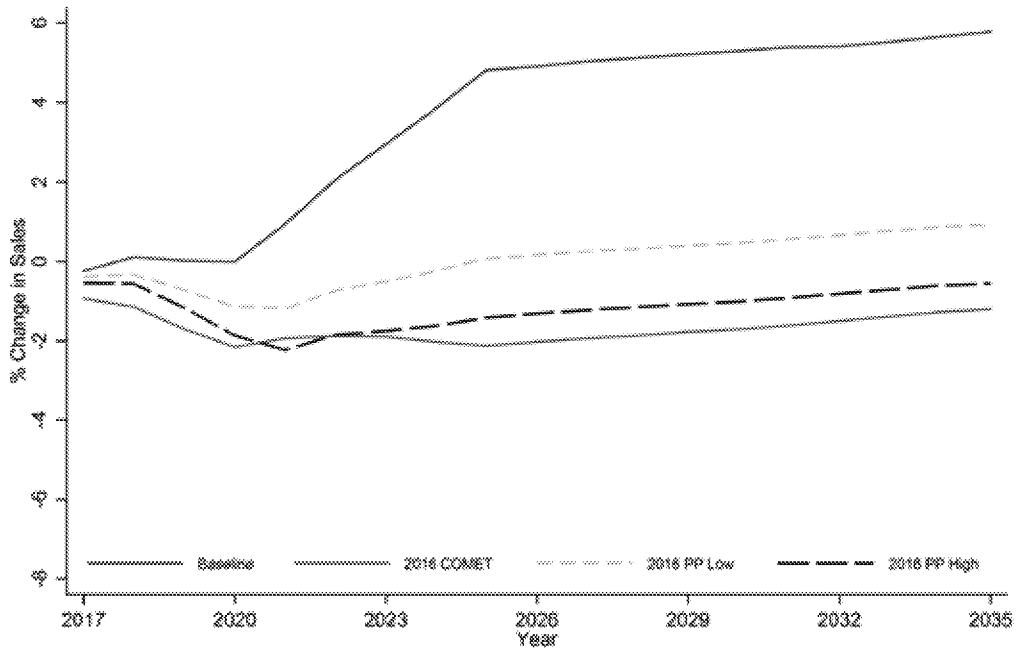


Figure 9.8b. Percentage Change in Truck Sales by Model Year; Illustration of CAFE/ZEV Interdependence.



Note: Reported in both Figures 9.8a and 9.8b is the percentage change in vehicle sales due to the regulatory programs based on our four perspectives. *Baseline* is based on NHTSA's 2012 data, and represents the 2012 perspective. The remaining lines represent the alternative 2016 perspectives. COMET accounts for the interdependence between CAFE and ZEV while the other 2016 perspectives do not account for this interdependence. Consumer valuation of fuel savings differs between the 2012 and 2016 perspectives: *Baseline* assumes that consumers value five years' worth of fuel savings, perceive resale value equal to 35% of gross price premium, and perceive future fuel price equal to the AEO projections. The 2016 perspectives assume the consumer values three years of fuel savings, perceive future fuel price equal to fuel price at time of vehicle purchase, and perceive the incremental resale value to equal 35% of the gross premium. Gross price premium is equal to the NHTSA 2012 projections in the *baseline*; NHTSA 2012 plus DOE estimate of ZEV plus NRC 'low most likely' adjustment in *2016 PP Low*; and NHTSA 2012 plus TAR estimate of ZEV plus NRC 'high most likely' adjustment in *2016 PP High*. The gross premiums in COMET are obtained directly from the COMET model account for ZEV and some NRC adjustments. The premium for trucks does not account for ZEV.

There are important caveats to these findings. First, COMET is based on EPA data in the TAR (2016) while the other 2016 perspectives are based on NHTSA data. This suggests that one must be careful when interpreting the differences in sales impacts between the respective lines in Figures 9.8a and 9.8b. Second, the COMET results allow for manufacturers to comply with ZEV using both cars and trucks, whereas the other 2016 perspectives presume there will be no ZEV trucks prior to 2025.

9.72 Allocation of ZEV Costs Across Prices of Both Cars and Trucks

One of the key simplifying assumptions of our TCO analysis is that manufacturers comply with the ZEV mandate by adding technology to cars alone and pass those costs on to car buyers with a price premium. While it might be reasonable to assume that ZEV technology will only be applied to cars prior to 2025, the assumption that the costs will only be passed on to car buyers is questionable. A more likely outcome is for manufacturers to allocate the ZEV compliance costs across all trucks as well as cars. Allocating the ZEV costs across cars and trucks lowers the price premium on cars and increases the price premium on trucks. This should reduce the negative sales impacts on cars and increase the negative sales impacts on trucks.

We illustrate this effect by assuming that manufacturers satisfy the ZEV mandate with only cars, but allocate those costs equally over cars and trucks. This is done using the simulation approach mentioned above, and the results are presented in Figures 9.9a and 9.9b for cars and trucks, respectively. As expected, allocating the costs of complying with the ZEV regulation between cars and trucks reduces the negative impact on cars while increasing the negative impacts on trucks, relative to the scenarios where the costs are applied only to prices of cars.

9.8 Modeling Comparisons, Unresolved Issues, and Future Research

We conclude by highlighting some intriguing differences between the REMI and TCO models and some unresolved issues, including promising topics for future research.

The TCO model focuses on impacts on new vehicle sales, and does not provide information about other economic indicators such as employment, GDP, and real disposable income. Nonetheless, there are some interesting similarities and differences between the TCO and REMI modeling exercises.

The two models are similar in that they both treat the vehicle price premium and fuel savings as main effects. The results of both modeling systems are also influenced by the trajectory of oil and gasoline prices: when fuel prices are low, the TCO model dampens consumer interest in fuel-efficient vehicles, and the automobile industry is more susceptible to a decline in new vehicle sales due to regulation; REMI also dampens the size of the fuel-savings effect when fuel prices are low, and thus lower fuel prices attenuate the macroeconomic benefits of the regulations.

There are also important differences. The TCO model does not have an equivalent of the supply chain innovation effect that is important in REMI, and, consequently, offsets at least half of the employment losses due to the vehicle price effect. REMI is designed with a larger price elasticity of demand (-1.65) than the TCO model (-1.0), so the adverse effects on motor vehicle demand are larger in REMI than in the TCO model. However, the price elasticity of demand in REMI applies only to retail consumers (as vehicle demand by government and businesses is assumed to be inelastic). Moreover, REMI has built-in adjustment mechanisms that attenuate the impacts of external price shocks, which means the adverse effects of a price increase attenuate over time (e.g., recall from Figure 8.7 how the employment losses from the vehicle price increase fall steadily from 2025-2035).

REMI does not incorporate any consumer demand for fuel economy, and thus the vehicle price effects operate through the gross price premium, as is typical of macroeconomic models. In the specialized TCO model, consumer demand for new vehicles operates through the net vehicle price premium, and thus fuel savings (directly and through resale value) have a substantial influence on demand for new vehicles. REMI is not equipped to model impacts from changes in the net vehicle price premium.

Figure 9.9a. Percentage Change in Car Sales by Model Year; 50-50 Allocation of ZEV Costs Between Cars and Trucks.

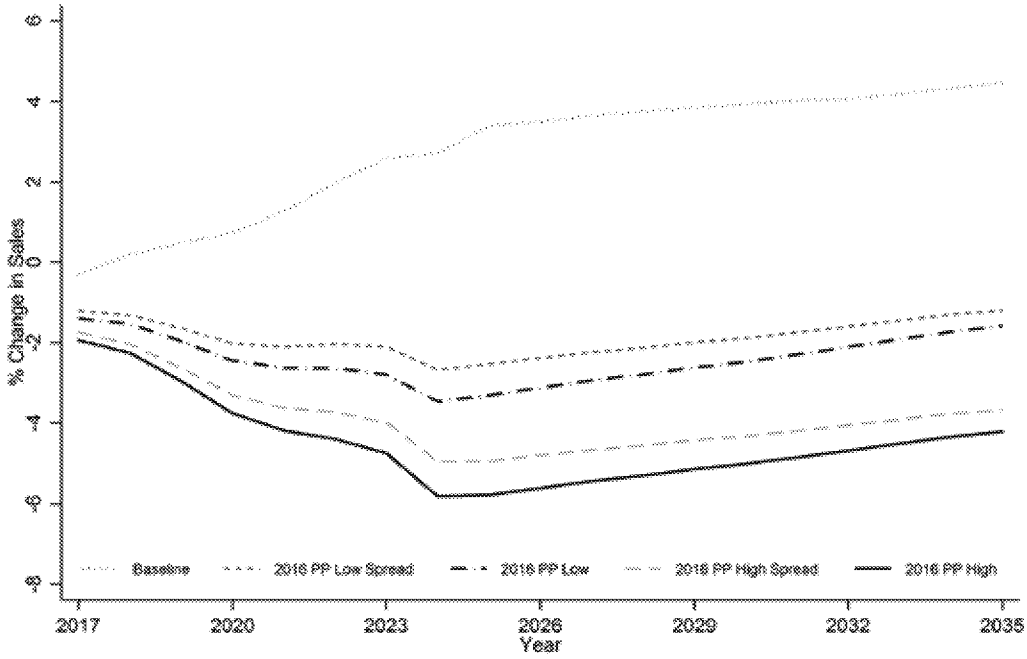
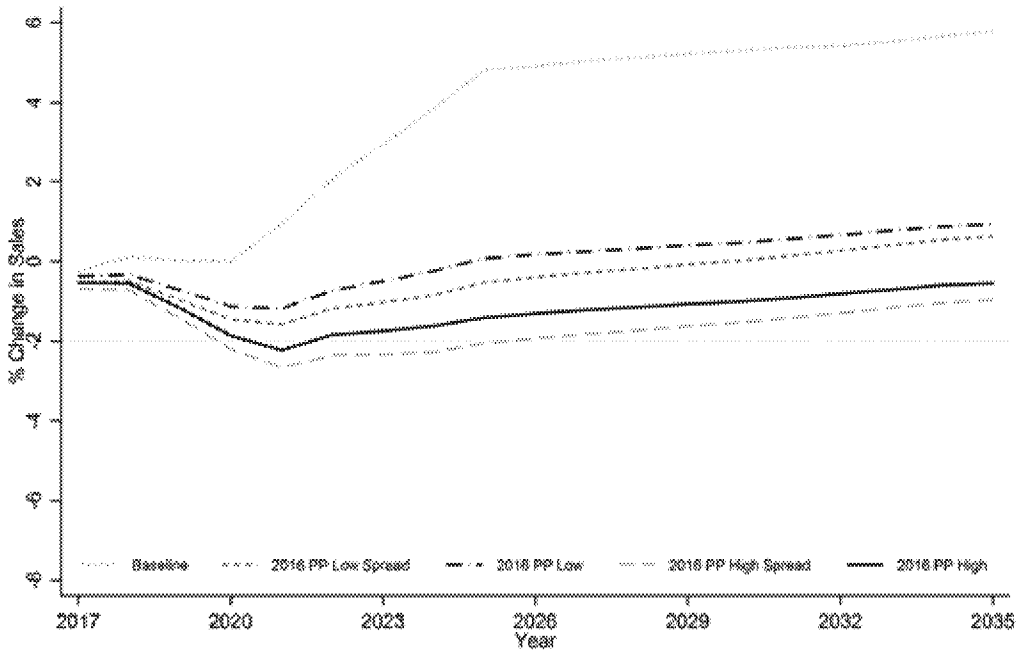


Figure 9.9b. Percentage Change in Truck Sales by Model Year; 50-50 Allocation of ZEV Costs Between Cars and Trucks.



Note: Reported in both Figures 9.9a and 9.9b is the percentage change in vehicle sales due to the regulatory programs based on our four perspectives. Baseline is based on NHTSA's 2012 data, and represents the 2012 perspective. The remaining lines represent the alternative 2016 perspective. Consumer valuation of fuel savings differs between the 2012 and 2016 perspectives: *Baseline* assumes that consumers value five years' worth of fuel savings, perceive resale value to equal to 35% of gross price premium, and perceive future fuel price equal to the AEO projections. The 2016 perspectives assume the consumer values three years of fuel savings, perceive future fuel price equal to fuel price at time of vehicle purchase, and perceive the incremental resale value to equal 35% of the gross premium. Gross price premium is equal to the NHTSA 2012 projections in the *baseline*; NHTSA 2012 plus DOE estimate of ZEV plus NRC 'low most likely' adjustment in the *Low* scenarios; and NHTSA 2012 plus TAR estimate of ZEV plus NRC 'high most likely' adjustment in *High* scenarios. We assume throughout that ZEV is satisfied only with cars. Lines labeled by the word *Spread* indicates that the ZEV premium is allocated 50-50 between cars and trucks; otherwise, the ZEV cost is allocated fully to cars.

Finally, the fuel savings in REMI are not attenuated by any consumer perceptions, undervaluation, or temporal preferences. The fuel savings for consumers in REMI exert their full effect when they are experienced in an actuarial and temporal sense. REMI does not adjust economic outcomes based on expectations.

10. QUALITATIVE POLICY ANALYSIS OF THE FEDERAL AND STATE REGULATORY PROGRAMS AND RELATED FISCAL POLICIES

Our macroeconomic analyses of the regulatory programs portray a future of some near-term decline in the health of the U.S. economy in exchange for even greater long-term improvements in the U.S. economy. Use of the 2016 inputs instead of the 2012 inputs accentuates the near-term negatives and dampens the long-term positives. Nonetheless, even with the 2016 inputs, the macroeconomic analyses do not provide any analytic basis for rescission of the federal programs. Under both sets of inputs, the long-term outcomes for the U.S. economy appear favorable.

In this section, we explore regulatory reforms that might preserve most or all of the long-term gains from the federal and California programs while limiting the near-term losses in the U.S. economy. We begin with the federal programs, and then examine the California ZEV program, as we express more fundamental concerns about the latter. Since we provide only a qualitative analysis of the reforms here, each reform should be subjected to its own cost-benefit analysis before it is enacted, as would typically be required under presidential executive order requirements. We then consider the case for harmonization of the divergent federal and state fiscal policies toward AFVs, until it is time for fiscal policy makers to take a neutral posture toward AFVs and the internal combustion engine. We conclude with the consideration of higher gasoline taxes or a national carbon tax.

10.1 Reform of the Federal Programs

Here we examine possible reforms of the federal programs (NHTSA 2012a; EPA 2012a). We do not analyze the California GHG program separately, since it seems to make sense to treat compliance with the federal programs as adequate demonstration of compliance with the California GHG program. In the long run (post-2025), this issue may need to be revisited.

10.11 Stretch out the Federal Compliance Schedule

As currently designed, the stringency of the CAFE and EPA requirements ramp up significantly from model years 2022-2025, especially for light trucks. The consumer payback from those ramp-ups is unlikely to be attractive (in part, due to relatively low fuel prices that were not apparent when the schedule was designed), suggesting that adverse impacts on new vehicle sales are plausible. The TAR (2016) reports payback periods of 5 to 6 ½ years for the 2022-2025 federal standards using AEO2015 fuel prices and a 3% discount rate.

One option would be to retain the current CAFE and GHG targets, but stretch out those ramp-ups from 2025 to 2030 or 2035. The stretch out would allow additional time for the cost of fuel-saving technologies to decline, as NRC (2015a; 2015b) predicts will occur, and for fuel prices to rise, as EIA projects will occur from 2025-2030 and thereafter.

A disadvantage of the scheduling extension is that it will slow the rate of decline in gasoline consumption and GHG emissions from new vehicles compared to the current schedule. To offset this disadvantage, an equivalent or greater magnitude of benefit is obtainable by enacting policies that accelerate the rate of retirement of older vehicles from the light-duty fleet. If "cash-for-clunkers" programs are the policy instrument of choice, they need to be designed carefully in order to ensure reductions in gasoline consumption and GHG emissions (see Appendix II). Legislative action would likely be necessary to accelerate the retirement of older vehicles from the fleet. A corollary advantage of this approach is that it balances the focus on GHG emissions from new vs. old vehicles, as virtually all of the current policy focus is on new vehicles.

10.12 Automatic Reform Triggers

Another reform option is to include an automatic reform trigger based on compliance cost: if the cost of CAFE compliance is shown to exceed a certain level, then the regulatory compliance schedule would be stretched out,

or noncompliance penalties would be reduced, or manufacturers would be given the option of providing funds for public education about AFVs. Automatic reform triggers are commonly used in cap-and-trade programs and in state renewable portfolio standards (i.e., alternative compliance payments).

Designing the reform trigger around compliance costs would be difficult because cost information is proprietary and cost varies across manufacturers. The average price of credits in the trading programs could be used to design a reform trigger, since the price of compliance credits will be influenced by the marginal cost of compliance. But, the price of credit trades is not currently disclosed publicly. Public disclosure of the transaction prices for credits might be an improvement in its own right, as we discuss below.

It is questionable whether high-volume automakers will use credit trading as a primary compliance strategy, since it runs a risk of triggering shareholder protests and harm to a company's public image. Moreover, regulatory agencies have a known tendency to devalue accumulated credits (e.g., see EPA's May 2010 decision to restrict credits earned in the 2009-2011 optional GHG credit program in EPA 2016c), so it would be quite risky for a high-volume vehicle manufacturer to rely on accumulated or purchased credits as a primary compliance strategy. Thus, the price of credits may not be a reliable source of information about compliance costs.

A more limited version of the reform trigger, which focuses on consumer payback, could link the pace of the regulatory ramp-up to EIA forecasts of fuel prices for model years 2022-2025. EIA makes annual adjustments to long-term fuel-price forecasts based on the best available information about world oil markets and other factors that impact fuel prices in the U.S. The rationale for focusing on fuel price is that it strongly influences consumer payback, as we demonstrated in Appendix I.

A complication with the fuel-price trigger is how to give vehicle manufacturers enough lead-time to adjust their product designs and volumes. If EIA lowers fuel-price forecasts in 2022, it is too late for automakers to adjust their products for model year 2022. A better approach would be for EPA and NHTSA, in the midterm review process, to commit to a planned linkage between EIA fuel forecasts and the stringency of the performance standards four years later. Thus, EIA's 2018 forecast would influence the final standard for model year 2022; the 2019 forecast would influence the final standard for model year 2023; and so forth through model year 2025.

Here we present an alternative illustration of how fuel-price forecasts might be linked to regulatory requirements. If EIA's 2020 fuel-price forecasts for 2025 rise significantly above $4 per gallon, then the federal requirements for model years 2022-2025 could remain as currently scheduled, as that was the fuel-price forecast when the schedule was developed. If the 2020 fuel-price forecasts for 2025 are less than $3 per gallon, then the ramp-up could be slowed considerably, possibly stretched out to 2035. If the 2020 fuel-price forecasts for 2025 land between $3 and $4 per gallon, then a stretch-out to 2030 might be appropriate.

EPA and NHTSA should consider carefully the merits of an automatic cost or fuel-price trigger. It might even be possible to change the penalty for noncompliance so that the penalty is low (high) when the cost of compliance is high (low) or when the projected fuel price is low (high). If the fuel-price trigger is preferred, it can be discrete or continuous in nature: a continuous approach would remove rigidities near a fuel-price cut-point while a discrete approach would be easier to explain to policy makers and the public. From a legal perspective, some reform triggers could be implemented with executive power; others would require legislative changes by the Congress.

10.13 Off-Cycle Measures

Compliance is currently measured by laboratory (dynamometer) tests that focus on engine operations and air emissions (Roland 2009). However, there are many valid ways for vehicle manufacturers to enhance vehicle fuel economy and reduce GHG emissions that are not measured in the specified laboratory compliance tests. Examples include better air conditioners, active grille shutters to modify airflow and improve aerodynamics, vehicle stop/start systems, electric heat pumps, solar panels, high-efficiency external lighting, solar reflective glass/glazing, solar reflective paint, active seat ventilation, and active transmission warm-up (Nelson 2013b).

EPA and NHTSA should develop a more systematic, consistent, and timely approach to off-cycle measures that automakers can use to reduce vehicle fuel consumption and GHG emissions.

Under current law, NHTSA is apparently not permitted to consider some off-cycle measures (e.g., air conditioners) under the CAFE program while EPA is permitted to consider them. In the midterm review, NHTSA and DOT could recommend legislative language to permit systematic, consistent, and timely use of off-cycle measures by both NHTSA and DOT. Such legislation might also authorize updating test procedures to represent current driving styles and road conditions.

The current EPA process has permitted some off-cycle measures (EPA 2015). EPA has a predetermined list of permissible off-cycle measures, but the list is limited and is associated with conservative (i.e., low) credit values. Measures that are not on EPA's list—or measures that deserve values larger than EPA's conservative default values—must be validated in 5-cycle testing that includes high speeds, hard acceleration, and cold temperatures. From 2012-2015, only one vehicle manufacturer had received off-cycle testing credits based on 5-cycle testing (EPA 2016c). Alternative methodologies are permitted if manufacturers believe 5-cycle testing is not appropriate, but the multiple criteria applied to alternative methodologies are perceived as formidable. In only a few cases, alternative methodologies have resulted in the granting of off-cycle credits (EPA 2016c). The pace of decision making under the current program has been quite variable (Auto Alliance and Global Automakers 2016).

EPA and NHTSA should work together annually to update a comprehensive list of permissible off-cycle measures, each with a best-estimate value (rather than a low conservative value). Manufacturers and the public could be offered an opportunity to participate in the creation and validation of the annual list of off-cycle measures and credit values. Manufacturers should also be permitted to propose measures—or compliance credit values—based on alternative methodologies that are evidence-based and have been approved by an expert third-party review process. Those proposals should have a presumption of validity in a public comment and agency deliberative process. This more flexible approach to off-cycle measures, implemented jointly by NHTSA and EPA, might stimulate innovation in the industry and foster more cost-effective compliance with federal regulatory requirements.

10.14 Credit Trading: Harmonize and Modernize

As the federal performance standards become more stringent, the workability of the credit-trading programs may take on more significance. There are inconsistencies in the design of the credit trading programs at NHTSA and EPA that have no apparent rationale. They should be harmonized because each inconsistency reduces the potential cost-effectiveness of the two programs, since vehicle manufacturers must comply with both programs (Leard and McConnell 2015).

Here are some illustrations of the inconsistencies: the banking periods for credits are not aligned in the EPA and NHTSA programs; NHTSA places restrictions on trading between the light-truck and passenger-car fleets while EPA does not place such restrictions; and NHTSA has a separate standard for imported and domestic car fleets whereas EPA has one program for a manufacturer's entire car fleet. Harmonization to the more flexible approach can improve cost-effectiveness of the program, without compromising any gasoline savings or GHG benefits.

The credit-trading programs should also be modernized to reflect best practices. The prices of trades are not disclosed publicly, which weakens the ability of the marketplace to find the most cost-effective responses to the federal standards. A good case can also be made that the two credit-trading programs should be merged into one program (Leard and McConnell 2015).

10.15 Compliance Incentives for AFVs: Harmonize and Update

The compliance multipliers EPA offers to manufacturers for the sale of AFVs such as PEVs and FCVs are currently set to expire at the end of model year 2021. There may not be sufficient notice to eliminate them now, as the regulated companies have anticipated them in their product plans. However, if the multipliers are to be extended

beyond model year 2021, an analysis should be conducted to justify them, as no such analysis was ever provided. They reduce the GHG and gasoline-savings benefits of the federal programs from 2017-2021 (Jenn, Azevedo, and Michalek 2016).

The schedule for the compliance multipliers may also need to be reconsidered and updated, in light of new data from the marketplace. The EPA multipliers were added when the Obama administration was working to put 1 million PEVs on the road by 2015 (Rascoe and Seetharaman 2013). As a result, the compliance incentives for PEVs that start in model year 2017 are phased down, and disappear in model year 2022, since it was expected that the viability of PEV commercialization would have been demonstrated before 2022.

It has proven much more difficult to commercialize PEVs in the U.S. than regulators or industry envisioned (NRC 2015b; Graham et al. 2014; Shepardson 2016). As such, instead of expiring in 2022, the incentives for PEVs in the federal program might need to be extended until 2025, if the federal government is serious about a national transportation electrification strategy. The federal decision on this issue should be made in collaboration with CARB, as it refines the ZEV program. A joint analysis from CARB, EPA, and NHTSA should be prepared to determine whether the compliance incentives should be retained and extended.

If the compliance incentives are extended, the crediting preference for BEVs over PHEVs should be reconsidered. In 2012, EPA did not supply an analysis to support the preference for BEVs over PHEVs. Evidence suggests that PHEVs can be more cost effective than BEVs, depending on how they are designed and used (Michalek et al. 2011). Moreover, mainstream consumer interest in PHEVs may be easier to muster, largely because their driving range is typically comparable in length to a gasoline vehicle (Graham et al. 2014). Furthermore, PHEVs may serve as a practical bridge to BEVs, much like HEVs have served as a useful bridge to PEVs (Axsen and Kurani 2008; Colias 2015). In some countries in the world, public policies are more favorable to PHEVs (relative to BEVs) than they are in the U.S. (IEA 2016).

Insofar as compliance incentives are to be used to stimulate commercialization of new technology, it may be useful to focus compliance incentives on segments of the automotive market where PEV penetration is weakest or non-existent. A consumer today has no difficulty finding a PEV offered as a small car, but PEV penetration among crossovers and light trucks is much more limited. Given that consumers are expressing growing interest in crossovers and light trucks, it might be useful to focus PEV compliance incentives in those segments (IFC 2015).

Finally, if the multipliers are to play their intended role in the compliance decisions of vehicle manufacturers, the same multipliers should be present in both federal programs. Offering compliance multipliers at one agency but not the other does not offer an incentive for PEV commercialization or compliance flexibility for manufacturers.

10.16 Provide Better Fuel-Economy Information to Consumers

If the concern of regulators is that some consumers undervalue the private benefits of fuel economy (i.e., savings in gasoline expenses), the most straightforward solution is to provide information to consumers to combat the undervaluation. There is plenty of evidence that many consumers do not make present-value calculations of fuel-saving technologies (Turrentine and Kurani 2007) and that many consumers misinterpret the information made available by EPA on fuel-economy labels (Larrick and Soll 2008).

Several years ago, EPA took a step in this direction by modifying the fuel-economy label on new vehicles to emphasize how much fuel and money will be saved over a five-year period, if a consumer chooses a vehicle with an above-average EPA rating for fuel economy. Although EPA conducted some focus groups to inform this change in labeling, the new label was not subject to a large-scale randomized trial to determine whether the revised label made any difference to consumers. The only randomized trial in the literature on this subject found no evidence that the EPA's revised label changed consumer intention to purchase an HEV, a PHEV, or a BEV (Dumortier et al. 2015). Instead, that trial found that greater use of total cost-of-ownership information impacts the stated purchasing intentions of some new car buyers. On the other hand, two recent experiments with fuel-

saving information (i.e., annual and vehicle-lifetime fuel costs tailored to the consumer's personal situation) did not find a significant impact on the purchase of fuel-efficient vehicles (Allcott and Knittel 2017).

A priority for the federal government is a serious commitment to behavioral research that clarifies which consumers undervalue fuel economy and how information programs should be designed to meet their needs. Targeting an information solution at the proper subgroup of consumers is generally a superior strategy to raising CAFE standards for all new vehicles, since some consumers may not be undervaluing fuel economy and would prefer not to pay for the more expensive mandated technologies (Allcott and Greenstone 2012; Allcott, Mullainathan, and Taubinsky 2014).

10.2 Reform of the California ZEV Program

The ZEV regulation was not incorporated into the 2012 Joint National Program designed by the Obama administration from 2009-2012. We have not been able to find any explicit justification for the exclusion of ZEV regulation from the design of the JNP. The simultaneous presence of two federal programs and the California ZEV program creates the potential for regulatory interaction and unintended consequences (Goulder and Stavins 2012; Roth 2014).

Both EPA and CARB are taking the position that they lack the legal authority to subject the ZEV program to a national cost-benefit or cost-effectiveness test (EPA 2013). CARB's 2011 RIA was undertaken as if the federal programs for model years 2017-2025 did not exist. In addition, the 2012 EPA and NHTSA RIAs were conducted as if the ZEV program did not exist. EPA does not examine the cost-benefit case for the ZEV regulation during waiver requests under the Clean Air Act (as it defers to California's determinations) and EPA does not review the decisions of other states to join the ZEV program (EPA 2013).

Proponents of the 2012 ZEV regulation can rightly argue that EPA and NHTSA did not finalize their 2017-2025 standards until nearly a year after CARB approved its ZEV standards for model years 2018-2025, so CARB could not possibly have incorporated the final 2017-2025 federal standards into its baseline. However, on May 21, 2010, President Obama issued a "Presidential Memorandum Regarding Fuel Efficiency Standards" that directed EPA and NHTSA to develop stricter fuel economy and GHG standards for model years 2017-2025. He also called for those stricter standards to be "harmonized" with "applicable" state standards.

Since CARB knew where the federal government was headed, they could have performed some scenario or sensitivity analyses showing how the case for the 2018-2025 ZEV standards might be impacted by stricter federal CAFE and GHG standards. Such analyses may have suggested that some delay in the CARB standards would have been desirable from a harmonization perspective. More importantly, the proposed federal standards were announced for public comment by the White House on July 29, 2011, a full five months before the ZEV standards were finalized by CARB. The White House announcement refers explicitly to federal performance standards equivalent to 54.5 miles per gallon in model year 2025. From an analytical perspective, CARB had ample time to incorporate the federal proposal into its baseline, as the CARB analysis was not released until December 2011.

The lack of coordination is an invitation to perverse consequences since the federal and ZEV regulations have similar objectives and cover the same industry. In the course of studying the complex provisions of the ZEV regulation and the federal programs, we uncovered some potentially important interaction issues that are begging for careful analysis, as we have discussed in several places in this report.

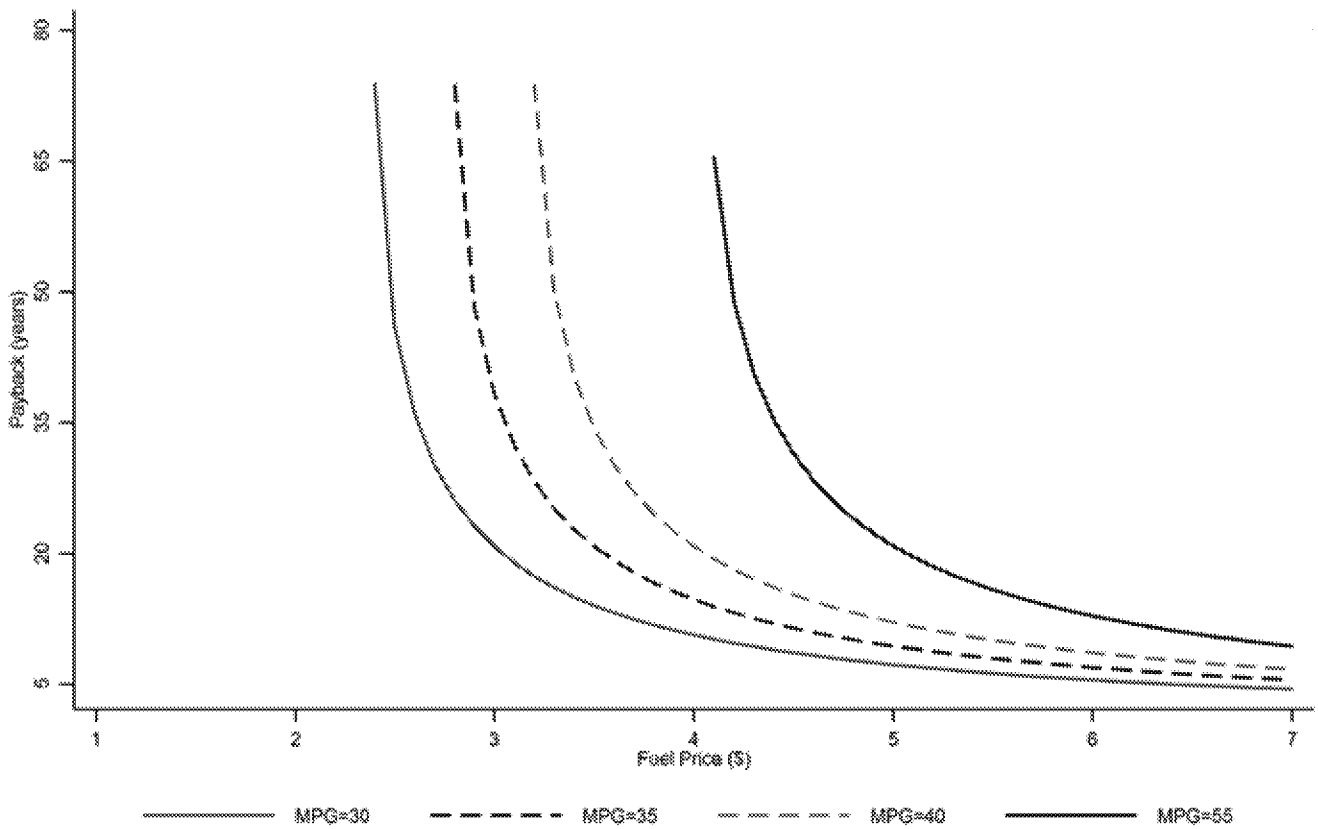
10.21 PEVs Have a Longer Consumer Payback Period When the Federal Programs Serve as the Baseline

We prepared a consumer payback analysis for a BEV at an interest rate of 5% (CARB's assumption) with alternative assumptions about fuel price and fuel economy of a gasoline-powered car. Based on industry experience and recent survey evidence, a consumer payback period longer than three years is considered unattractive by the typical retail car purchaser (Small 2010; Greene, Evans, and Hiestand 2013; CAR 2011; NRC 2015a).

The results in Figure 10.1 show that the attractiveness of the consumer payback from a BEV purchase declines as gasoline-powered cars become more fuel-efficient. This conclusion is evident in the upward and rightward shift of the payback curves as the average fuel economy of gasoline vehicles increases from 30 MPG to 55 MPG in Figure 10.1. In other words, for a given interest rate and fuel price, the consumer payback period for a BEV becomes longer as the average fuel economy of gasoline cars increase, all else equal. This insight suggests that the increased fuel economy mandated by the federal standards is likely to undermine the commercial success of BEVs, complicating implementation of the ZEV program and threatening a loss of new vehicle sales due to the ZEV requirements.

The fact that the ZEV payback periods extend beyond three years does not mean that, from a societal perspective, the ZEV regulation is inefficient. That kind of conclusion requires findings from a full cost-benefit analysis, including financial impacts beyond the third year of ownership as well as environmental impacts. The simple point made here is that vehicles produced under the ZEV standards will be more attractive to consumers without the 2017-2025 federal standards than with the 2017-2025 standards and thus there is a serious interaction that needs to be considered when analyzing consumer response.

Figure 10.1. Payback Analysis (in Years) for a BEV with a 100-Mile Range Compared to Four Gasoline Vehicles.



Note: Reported is the payback period (in years) required to recoup the incremental cost of buying a battery-electric vehicle (BEV) at an interest rate of 5% and under various assumptions about fuel price. The BEV is compared to a traditional gasoline powered vehicle that gets 30, 35, 40, and 55 MPG, respectively. We assume that the consumer drives 12,500 miles per year, that the BEV has a range of 100 miles on a full charge of 35 KWh, and that electricity costs $0.15/KWh. We assume that the price premium is $11,551 for each of the gasoline cars except for the car that achieves 55 MPG where we assume a price premium of $9,751. The difference in resale value between the BEV and traditional vehicle is assumed to be zero. The analysis assumes that all parameter values are constant over the life of the vehicle, which implies that fuel savings are constant across time.

10.22 The ZEV Regulation is Unlikely to Reduce GHG Emissions Due to the Corporate Averaging Provisions in the Federal Programs

CARB (2012b) has already acknowledged that the rationale for the ZEV program has shifted to GHG control as well as local air quality management. CARB argues that it is already apparent, based on the best available climate science, that California must achieve 40% penetration of ZEVs by 2030 and 100% penetration of ZEVs by 2050. Otherwise, the State's climate-policy goals will not be met (CARB 2011a; CARB 2016). For the ZEV regulation to make a meaningful contribution to GHG control, it needs to be coordinated with federal GHG regulation.

Manufacturer compliance with the ZEV regulation moves each affected company closer to meeting federal CAFE and GHG targets. That means each affected manufacturer can adjust their product designs for gasoline vehicles, invest fewer resources in fuel economy and GHG control, and allocate more resources to other fuel-expending attributes such as performance, comfort, and trunk space (NRC 2015b, 354). Thus, although each ZEV sold will emit less pollution than the average gasoline vehicle, the weighted average rate of GHG emissions from all new vehicles is not likely to be affected by the presence of the ZEV regulation (NRC 2015b; Jenn, Azevedo, and Michalek 2016; ICCT 2012).

This interaction with federal programs has already been acknowledged by CARB, though in a somewhat different context: "fleet average requirements ensure that air quality benefits do not suffer as a result of an automaker producing fewer ZEVs" (CARB 2014, 17). This comment was made in reference to the positioning of the ZEV program within California's Advanced Clean Car Program, which sets fleet average emission standards commensurate with EPA standards, and CARB's proposed modifications to the ZEV program that would relax some requirements for intermediate-volume manufacturers. As long as the federal program is binding on a vehicle manufacturer, each ZEV produced for California will permit the manufacturer to produce one or more less fuel-efficient cars elsewhere in the country.

In a similar vein, CARB's 2006 GHG standards (pursuant to AB 1493, 2002) for new passenger vehicles have been shown to have only limited environmental benefits when they are implemented in the context of a national EPA GHG performance standard that contains fleet-wide averaging provisions (Goulder, Jacobsen, and van Benthem 2012). Fortunately, the CARB GHG standards were carefully integrated into the One National Program, so the environmental benefits of CARB's GHG standards are captured by the federal programs, with no incremental cost imposed on vehicle manufacturers or consumers. No such integration was undertaken for the ZEV program.

Notice that this line of argument is different from the commonly-made claim that PEVs do not reduce pollution because a PEV draws its electricity from an electric power plant that emits pollution. Lifecycle comparisons of PEVs that count pollution from the power plant as well as from the tailpipe suggest that they have significant GHG advantages over gasoline vehicles, as long as the carbon-intensity of power production is sufficiently low (NRC 2015b; Tessum, Hill, and Marshall 2014). The ZEV states—especially California—depend more on natural gas and renewables than coal as a source of energy for electric power production, which helps explain why the lifecycle analysis of a PEV is generally favorable in ZEV states. The problem with the ZEV regulation is not the induced emissions at the powerplant but the lack of coordination with the federal programs.

10.23 The ZEV Regulation May Not Reduce Local Smog Levels in Polluted California Cities Due to Unexplored Regulatory Interactions

Because GHGs are a global pollutant, it does not matter whether the emissions occur in California or in another state or country. The impact on climate change is the same, regardless of emission location. Pollutants such as smog and soot need to be analyzed differently because they have localized effects where human exposure is elevated.

In fact, the original rationale for enactment of the ZEV program in 1990 was to control local smog in the congested cities of ZEV states. The Los Angeles region and San Joaquin Valley are both classified as "extreme nonattainment areas" by EPA due to excessive smog levels (CARB 2012a). The volume of PEVs required in California to achieve

attainment with health-based air quality standards may be greater than the volume of PEVs required to achieve the State's GHG-control goals (E3 2014). But, the ZEV regulation does not necessarily affect smog levels due to unanalyzed interactions of the ZEV program with other CARB and EPA regulatory programs.

CARB and EPA standards for controlling smog- and soot-forming pollutants from new vehicles have become so stringent that the environmental advantages of a ZEV are not nearly as large today as they were when the ZEV program was authorized by Congress in 1990 (EPA 2014; IFC 2015). Moreover, some degree of local pollution will also occur at the electric power plant when the ZEV is plugged into the electrical grid. For example, nitrogen dioxide (NO2) emissions from a power plant fueled by natural gas will contribute to urban smog in many cities, depending on the chemistry of the downwind ambient environment. The net effect of PEVs on local pollution will depend on how the electricity sector is regulated for emissions (Holland et al. 2016; Linn and McConnell 2013).

The corporate averaging provisions in the CARB and EPA tailpipe standards for smog- and soot-forming pollutants also need to be considered. When a ZEV is produced, the manufacturer can count that vehicle's zero NO2 emissions toward their compliance with CARB's 2012 tailpipe standards and EPA's 2014 tailpipe standards for NO2. The manufacturer is then free to sell other vehicles that have somewhat larger emissions of NO2. Even if the NO2 emissions averted by a PEV are at a different location than the NO2 emissions induced by corporate averaging, there may not be any net improvement in public health due to the pollution transfer. Detailed air quality modeling, coupled with dose-response modeling of health impacts in each affected locality, is required to determine whether pollution transfers cause a net gain for public health.

10.24 The Technology-Innovation Argument for the ZEV Regulation Should Be Analyzed in the Context of Alternative Approaches to Spurring Innovation

Some proponents of the ZEV regulation defend it as a policy tool to stimulate the development and commercialization of new technologies that will enable stricter federal standards after model year 2025. Without the ZEV regulation, automakers are likely to focus R&D on refinements to the internal combustion engine, since those refinements are more cost effective than a PEV or FCV (NRC 2015a). Automakers and their suppliers might delay development and commercialization of PEVs and FCVs for many years. According to this view, the ZEV regulation has long-term environmental value that is complementary to the federal programs.

There is also an international variant of the technology-innovation argument. ZEV technologies demonstrated in California will make it easier for other countries, such as China and India, to control GHG emissions in the decades ahead (Lippert 2015; Fischer, Harrington, and Parry 2007). Given that global imperative, ZEV regulation may be seen as necessary or useful to help prepare automakers, suppliers, dealers, motorists, utilities, and communities for an accelerated transition to ZEVs.

Although the technological-innovation argument has merit, it needs to be evaluated in the context of plausible R&D alternatives to the ZEV regulation. The U.S. Department of Energy (DOE) has a significant research, development, and demonstration program aimed at stimulating the commercialization of clean engines and fuels, including ZEV-like technologies (Roth 2014). The DOE program could be expanded to include community demonstrations of PEVs and FCVs in several regions of the country. Norway and the Netherlands have used incentive-based policies to accomplish a faster rate of PEV penetration than California has achieved with the ZEV standards (IEA 2016; Figenbaum and Kolbenstvedt 2015). Moreover, since other countries are already demonstrating PEV technologies (IEA 2016), California is not making a unique international contribution by forcing commercialization of PEVs. Thus, it does not appear to be necessary to implement a ZEV regulation in order to provide PEVs a viable opportunity for significant commercialization.

10.3 Reconsidering the EPA Waiver

Insofar as the ZEV program does not provide significant environmental benefits or has costs greater than benefits, stemming in part from interaction with federal regulatory programs and consideration of alternative policies, then EPA should use its waiver authority to work with CARB to improve and coordinate the ZEV program. Since

removal of ZEV's waiver would be unprecedented, it would likely face years of complex litigation with uncertain outcomes. Thus, a cooperative approach between EPA and CARB, using the waiver as the context, may prove to be a productive approach.

Historically, when granting a ZEV waiver, EPA has not even considered whether the incremental air quality benefits of the ZEV program justify the costs of the ZEV program (EPA 2013, 2155). CARB has prepared a cost-benefit analysis of the ZEV regulation from California's perspective (CARB 2011a), but a demonstration that the ZEV program is in California's interest does not necessarily mean that the ZEV program is in the interest of the U.S.

Consider a recent study that compared the costs and benefits of a PEV from California's perspective. The costs included incremental costs of producing the vehicle, charging infrastructure costs, and the costs of delivered electricity. The benefits included the federal tax credit (up to $7,500 per vehicle) for the consumer, gasoline savings, and reduced greenhouse gas emissions. They found that the benefits to California of each PEV were about $20,000 per vehicle, which was almost $5,000 greater than the estimated costs per vehicle. The authors note that the federal tax credit is important to the favorable benefit-cost result, though the importance of the credit declines as the projected cost of producing a PEV declines due to innovation in battery technology (Cutter 2015; 2016; IFC 2015).

Evaluation of the same PEV from the U.S. perspective would be quite different. The federal tax credit would represent a transfer and thus would be excluded from the cost benefit analysis. The gasoline savings and environmental benefits would be much smaller (and possibly close to zero) due to the corporate averaging provisions in the EPA GHG and smog/soot control programs. Moreover, the extra costs of the PEV are unlikely to be charged to the PEV buyer in California because the large price premium would make it difficult for manufacturers and dealers to sell the vehicle. If the extra cost is instead spread among all U.S. vehicle purchasers, as CARB and EPA have suggested (2013), then more than a majority of the price burden would be felt outside of California and the 10 ZEV states. This conclusion does not even consider the distribution of the economic development impacts: California gains employment at PEV start-up and recharging companies while gasoline engine producers in the South and Midwest lose production volume to battery-back producers.

The federal government should take a careful look at whether the costs and benefits of the ZEV program differ from a California vs. national perspective. An independent body such as the Congressional Budget Office or the National Research Council should be commissioned to undertake the evaluation. A similar comparison should be done for the 10 ZEV states vs. the nation as a whole, since EPA does not review the decisions of other states to adopt the California standards. This matter has some urgency because both EPA and CARB are taking the legal position that neither has the authority to evaluate the costs and benefits of the ZEV program from a national perspective (EPA 2013). A more definitive solution would be for the Congress to amend the Clean Air Act and require ZEV waiver decisions to be supported by a national cost-benefit analysis.

10.4 National ZEV Program

If it is determined that continuation of a ZEV regulation is appropriate, then the inquiry should shift to whether the mandate should apply only to California and the other nine ZEV states or whether a national ZEV regulation under EPA or NHTSA authority would be preferable. A uniform national ZEV program could provide equivalent or greater GHG control while providing more compliance flexibility to vehicle manufacturers.

Under the current ZEV mandate, vehicle manufacturers earn no compliance credit for ZEVs sold outside of California and the other nine ZEV states (except for bonus EPA credits that expire after model year 2021). In a national ZEV scheme, a ZEV sale in Atlanta would have equal value to a ZEV sale in San Francisco. If a national ZEV program is considered, the precise levels of stringency need to be determined based on careful technology assessments, environmental modeling, and cost-benefit analysis. If a long-term commitment is made to a national ZEV regulation, then continuation of the NHTSA-CAFE, EPA-GHG, and CARB-GHG performance

standards may not be necessary. A simplification of the number of regulatory programs and agencies would be a step in the right direction.

When considering a national ZEV program (or an extension of the California ZEV program), there should also be some analysis of the federal incentives for PEVs and FCVs that are already in place (e.g., the $7,500 federal income tax credit for qualified PEVs, the larger federal credit for FCVs, and the compliance incentives for BEVs, PHEVs, and FCVs in the 2012 EPA GHG rule). The array of state-level incentives for ZEVs also needs to be considered. The interaction between federal and state incentives for ZEVs and the state and federal regulatory requirements have not yet been analyzed by EPA, NHTSA, or CARB, despite repeated calls for such analyses (CBO 2012; McConnell and Turrentine 2010; Linn and McConnell 2013).

A possible argument against a national ZEV program is that the environmental damages from use of gasoline and electricity are not uniform across the country. One study found that the average rate of environmental damage from electricity use is much lower in California (e.g., where coal is rarely used in power production) than in the nation as a whole (Holland et al. 2016). Moreover, gasoline use in California is more environmentally damaging than it is in the rest of the country, in part because the seven counties in the country with the most severe particle pollution are all in California (EPA 2013). A complete version of this analysis needs to project the pathway for gasoline and electricity prices in each of the 50 states, and determine how much interstate difference there is in the financial case for ZEVs as consumers may be strongly influenced by the financial considerations. If the net benefits of PEVs are positive in all 50 states, the policy direction should be different than if the net benefits are highly variable across states.

10.5 Reforms of the ZEV Program

If it is determined that a California ZEV regulation should be pursued instead of a national ZEV program, there are some reforms of the ZEV regulation that are worthy of consideration. We mention a variety of reforms here, recognizing that the State of California should prepare a careful supporting analysis before adopting any of them. Although we focus on California, most of the reforms are relevant to all 10 ZEV states.

10.51 Stretch out the Schedule for ZEV Requirements

One option would be to retain the current ZEV requirements but stretch out those ramp-ups from 2025 to 2030 or 2035. The stretch out would allow additional time for the cost of PEVs and FCVs to decline, as NRC (2015a; 2015b) predicts will occur, and for fuel prices to rise, as EIA projects will occur from 2025-2030 and thereafter. Communities in ZEV states (especially those located outside of California) also need more time to become ready for rapid market penetration of PEVs and FCVs. CARB has taken similar steps in the past, when it was apparent that market conditions could not support rapid commercialization of PEVs. EPA has stated, in the context of ZEV waiver decisions, that cost of compliance is a lawful consideration if the cost is related to the appropriate timing/schedule of the standards (EPA 2013, 2134). EPA views that type of cost consideration different than a cost-benefit or cost-effectiveness analysis, which they defer to California (EPA 2013, 2134).

The argument made here is not for rescission of the ZEV regulation. Since lithium ion battery prices appear to be declining rapidly, any relaxation of the ZEV compliance schedule should be undertaken with care, since the compliance pressure on automakers and their suppliers may be contributing to innovations such as cost-effective improvements in battery design and production methods. Without some compliance pressure, cost reductions may slow down or come to a halt, though global demand for PEVs may sustain the incentive for innovation.

10.52 Extend the Travel and Regional-Pooling Provisions

The travel provision, which allows manufacturers to apply compliance credits earned for BEVs in one ZEV state to all other ZEV states, expires at the end of model year 2017. The elimination of the travel provision will essentially mean that manufacturers will be compelled to rapidly increase their production and sale of BEVs in each of the 10 states. However, as we explain below, many states—including some ZEV states—are not yet ready

to accommodate electrification of their passenger vehicles. Thus, it may be prudent to extend the travel provision for several years until communities are prepared.

CARB's regional credit pooling arrangement is a useful innovation and would be even more useful in burden reduction if it were designed with fewer restrictions. For example, instead of requiring manufacturers to comply with ZEV requirements in each of the nine ZEV states, variable percentage requirements in the western and eastern regions could be based on the extent of regional progress in community readiness for PEVs and FCVs. The western region might have a more ambitious requirement than the eastern region until eastern states make progress on readiness.

Insofar as GHG control is the primary rationale for future ZEV requirements, more flexibility should be provided in the regional pooling arrangements, since it does not matter where GHG emissions occur. CARB currently does not permit over-compliance in California to be used by a manufacturer to compensate for shortfalls in the eastern or western regions. Counting California in the western region would add some more flexibility. Reducing the penalty for transferring credits across regions is also worthy of consideration. Some of the additional flexibility mentioned here can be provided by CARB; other forms of flexibility may require legislation.

10.53 Give PHEVs a Larger Role in the Future of the ZEV Program

PHEVs, even those with a short all-electric range, are a more promising and cost-effective strategy for GHG emissions control and oil savings than BEVs, at least in the near term (Michalek et al. 2011). Moreover, PHEVs may be a useful bridge to BEVs, like HEVs have helped pave the way to PEVs.

Over time, though, BEVs may compete more favorably with PHEVs, at least in some applications. PHEVs have an inherent long-term cost disadvantage because two powertrains are required rather than one (NRC 2015b). Indeed, the federal agencies, in the draft TAR (2016), are projecting that the cost of producing BEVs will fall faster than the cost of producing PHEVs, eventually creating a cost advantage for BEVs over PHEVs. It may take a long period of time for long-range BEVs to achieve that cost advantage, so PHEVs are promising in the years ahead (TAR 2016).

Supporting this reform is the depressed condition of the PEV market, where consumer demand for BEVs, with the possible exception of Tesla's products, is not approaching the supply mandated under the ZEV regulation (Shelton 2015). Manufacturers already report incurring losses on BEV sales, stemming from high production costs and price discounts offered to encourage their sale. In 2013, the Chrysler Group conceded publicly a loss of $10,000 on each sale of a new Fiat 500e (Woodyard 2013b).

The simplest approach would be to increase the number of credits awarded for PHEVs (classified as TZEVs under the ZEV program) or increase the fraction of PHEVs that large manufacturers can count toward compliance with ZEV requirements. An alternative reform is to reset ZEV regulatory requirements according to electricity miles over a vehicle's life, instead of according to production quotas by vehicle type. For example, when operating a BEV, a 25-mile reserve is typically required while a PHEV can use 100% of its electric range (given that the gasoline engine is available as a backup) (Bienenfeld 2016). GM cites data showing that, for the updated Volt (which has 53 miles of all-electric range), 90% of trips and 65% of vehicle miles of travel are in e-mode only (Mims 2016). BEVs are used 30% less than gasoline vehicles because of their range limitation (TAR 2016). Electricity miles may be a reasonable alternative to the current system, as it would credit vehicles based on their actual real-world performance (Nelson 2015). Our understanding is that additional data on this issue will be collected and considered in CARB's midterm review process.

More generally, California's policy preferences for BEVs over PHEVs should be reconsidered (Michalek et al. 2011; Peterson and Michalek 2013). The cash rebate in California for a BEV ($2,500) is larger than for a PHEV ($1,500). Other states tend to have a similar BEV preference. Internationally, the pattern is more complex, as some countries have adopted public policies that put the PHEV on a more even footing with the BEV (IEA 2016).

Until recently, California's HOV-lane access was designed to favor BEVs over PHEVs. An unlimited number of carpool lane stickers were made available to owners of BEVs or FCVs; only 40,000 (recently increased to 85,000) stickers were made available to PHEV owners (Berman 2012; CARB 2016). The stickers for PHEVs reached the limit, which discouraged sales of PHEVs. Recently, California changed its position and decided to allow an unlimited number of stickers for PHEVs as well as for BEVs (Kane 2016).

Since the U.S. market shares of BEVs and PHEVs were roughly 48% and 42% (of total PEVs), respectively, in 2016, one is tempted to conclude that the PHEV is not more attractive to consumers, even though it has a large advantage in driving range (Cobb 2017). However, as explained above, federal and state subsidy policies tend to be biased toward BEVs, and vehicle manufacturers have received a clear message that CARB and federal regulators prefer BEVs to PHEVs. Thus, the market competition between BEVs and PHEVs has not occurred on a level-playing field—a bias that should reconsidered. The experience in Norway is that PHEVs and BEVs appeal to different subsets of consumers: BEV owners are more likely to live in urban centers and own multiple vehicles; PHEV owners are more spread out geographically and are more likely to be single-vehicle households (Figenbaum and Kolbenstvedt 2016).

10.54 Enhance Community Readiness for PEVs

The success of the ZEV regulation can be enhanced by implementing measures that improve the readiness of communities for PEVs and FCVs (Clinton et al. 2015; Sierzchula et al. 2014; Graham et al. 2014; Lutsey et al. 2015). Currently, some states and cities are much better prepared for PEVs than other cities (Carley et al. 2013), however, better-prepared cities are not necessarily located in ZEV states (Clark-Sutton et al. 2016). Atlanta, Georgia, for example, has highly progressive PEV policies and one of the highest penetration rates of PEVs among U.S. cities, primarily due to sales of the Nissan Leaf, but Georgia is not a ZEV state (Ramsey 2014). A systematic analysis of PEV readiness in the 31 largest U.S. cities found no strong evidence that PEV-ready cities are more likely to be located in a ZEV state (Clark-Sutton et al. 2016).

Making home charging of PEVs convenient and inexpensive is key to community readiness. Utility data from California show that 74-80% of charging occurs at home (E3 2014). But some public charging stations are also required for optimal community readiness, especially where short-range BEVs dominate the PEV fleet.

Even the best prepared states and cities have a long road ahead to achieve a high degree of PEV readiness. One indicator of PEV readiness is availability of public charging stations. The rate of PEV sales in California (3%) is much higher than the national average (0.9%), in part reflecting the extensive efforts made in California to pave the way for PEVs (IEA 2016). A 2014 study presents different charging infrastructure scenarios in relation to California's PEV goal of having 1 million PEVs on the road by 2020. Under one scenario, 50,150 public charging outlets would be needed to accommodate expected growth in PEVs (Melaina and Helwig 2014). A different study in California estimated that, if the State meets its goal of having 1.5 million PEVs on the road by 2025, 230,000-410,000 PEV recharging sessions will be needed daily—an 18-fold increase over what was available in 2014 (E3 2014). As of September 2016, a total of 11,855 charging outlets were available for public use in California (California Energy Commission 2016; DOE 2017a). New England states are only beginning to work on readiness and, not surprisingly, PEV sales rates in New England are only slightly above the national average. Surveys show that car shoppers in the Northeast are much less aware of PEVs than car shoppers on the West coast (Kurani, Caperello, and Tyreehageman, 2016).

A wide range of federal, state, and local policies could be implemented in order to enhance community readiness for PEVs (NRC 2015b; Lutsey et al. 2015). Uniform standards, certification, and training throughout the industry are considered crucial to large-scale uptake of PEVs (S. Brown, Pyke, and Steenhof 2010). NRC (2015b) found that progress on each of these fronts is inadequate. If public subsidies are expanded, subsidies of batteries—and especially sustained R&D for enhanced batteries—are more cost-effective than subsidies of public charging stations (NRC 2015b; Roth 2014; Peterson and Michalek 2013).

Policy makers should use the NRC (2015b) report as a PEV blueprint about community readiness, and commission a similar report from NRC on readiness for FCVs.

10.55 Provide Support for FCVs as a Compliance Alternative

Critics have argued that the ZEV program is a "de facto industrial policy" that favors BEVs to the exclusion of other promising technological innovations (Knittel 2014). In theory, the ZEV regulation is structured as a performance standard; any technology that accomplishes zero emissions is acceptable. The most promising alternative to the PEV is the hydrogen FCV, but questions have been raised as to whether the State of California and other ZEV states are serious about FCVs.

The challenges for FCVs are much greater than for PEVs because very few hydrogen filling stations are available and the pace of infrastructure buildup is slow, even in California (Undercoffler 2016b). It appears that some automakers may choose to offer FCVs instead of PEVs to meet the ZEV mandate prior to 2025, but the infrastructure requirements for FCVs are significant (CARB 2016; Fleming 2015; Undercoffler 2016c). Some loans and grants for hydrogen stations are now available from the California Energy Commission, Toyota, and Honda (Undercoffler 2016b).

Toyota, Honda, Hyundai, GM, and some other automakers have worked diligently to bring down the costs of FCVs and demonstrate the technology to regulators and the public. In the fall of 2015, Toyota launched the Mirai sedan as a FCV for limited public use. The U.S. Congress has renewed the $8,000 federal income tax credit for purchases of a FCV. While CARB continues to encourage FCVs through its ZEV credit system and the FCV travel provision, the big missing ingredient is the development of a network of hydrogen refueling stations.

CARB pledged to play a leadership role in this area but the agency has acknowledged that progress has been slower than the agency expected (CARB 2016). Toyota's reluctant decision in late 2016 to launch a PEV program may be an implicit acknowledgement that the State of California is not a reliable partner on FCVs (McLain 2016b; McLain 2016c). Insofar as CARB is serious that the ZEV program is not simply a BEV mandate, accelerated progress on FCV infrastructure would be a constructive development.

10.6 Coordinate Federal and State Fiscal Policies toward PEVs

In a competitive market economy, a new technology, in order to be sustainable, must be appealing to consumers without tax advantages and subsidies (Sallee 2010). A case can be made that a promising technology with environmental advantages should receive some limited, time-restricted tax advantages and/or subsidies in order to determine whether the technology has long-term promise.

Fiscal policies toward PEVs should not be made in isolation. Policy makers need to consider how to establish a level playing field for PEVs relative to other promising technologies such as mild hybrids, HEVs, advanced diesel technology, cellulosic ethanol, and hydrogen fuel cells. Congress has recently made the following decisions: (1) did not extend the $3,400 tax credit for HEVs, which expired in 2010, but EPA is providing some special GHG compliance credits for hybrid trucks; (2) allowed subsidies and tax credits for ethanol to expire, but EPA is gradually expanding ethanol blending requirements; and (3) most recently authorized the $8,000 federal tax credit for FCVs.

Fiscal policy makers at the federal and state levels are making tax and subsidy policies toward PEVs without coordination of their efforts and without a shared understanding of the proper magnitude, duration, and instrument of support. As a result, it is possible that tax dollars are not being used efficiently (Sallee 2010).

Given the current state of PEV technology, consensus building is needed regarding three questions. (1) Should fiscal policy be encouraging, neutral, or discouraging to a consumer's decision as to whether to purchase a PEV? (2) If a favorable fiscal stance is selected, what is the most cost-effective way for fiscal policy makers to stimulate commercialization of PEVs? (3) If consumer purchases of PEVs are to be subsidized, how long should the subsidies

last? In the context of answering those questions, fiscal policy makers need to appreciate how expensive PEVs are currently, how much those costs may decline between now and 2025, and what can be learned from the experience with fiscal policies in the U.S. and abroad.

10.61 Even with Forecasted Declines in Battery Prices, BEVs are not likely to be Cost Competitive in 2025

It is critical to consider consumer receptivity to PEVs in light of their costs (Dumortier et al. 2015; Siddiki et al. 2015; Helveston et al. 2015). If vehicle manufacturers price PEVs using standard costing and retail markup procedures, then the cost of a PEV to the consumer is likely to be substantial—much more than a conventional hybrid, an advanced diesel, or a more fuel-efficient version of the internal combustion engine. Exactly how much more costly it will be is uncertain because (1) lithium ion battery packs are the single largest source of cost, (2) the cost of manufacturing those battery packs is closely-held, proprietary information, and (3) the cost of battery packs is declining and is projected to decline significantly over the next decade (Baker, Chon, and Keisler 2010; Weiss et al. 2012; Orcutt 2015).

Nonetheless, we start with some cost figures from the NHTSA 2012 RIA that are similar to figures in (CARB 2011a, ES–4). We then offer additional insight based on NRC (2015b). We focus on PEVs rather than FCVs because, despite recent technical breakthroughs, FCVs are significantly more expensive than PEVs. We focus on BEVs rather than PHEVs because BEVs receive full credit under the ZEV program.

NHTSA (2012a) estimated that a small BEV would cost $14,581 more than a baseline 2010 gasoline powered car. NRC (2010) warned that steep drops in the cost of producing lithium ion batteries are not likely. Nonetheless, more recent data has shown significant cost reductions and by 2025 the additional cost was projected by NHTSA (2012) to decline to $7,899.

An additional consumer cost of $1,000—equipment plus installation—should be added for a 240 volt home charger, since it reduces the time for a full charge from 12-18 hours with a standard 110 volt outlet to 4-6 hours (NRC 2015b; E3 2014). That technology allows the BEV owner to obtain a full charge overnight and then drive up to 70-100 miles the next day without recharging (NRC 2015b).

Not much has been released publicly in the U.S. about the degree to which the cost of producing lithium ion batteries has declined recently. One international study reviewed all of the publicly available information and concluded that the costs of battery packs have been declining by 14% per year from 2007-2014 and thus the BEV may already be approaching cost competitiveness with the gasoline engine (Nykvist and Nilsson 2015). More recently, IEA (2016) reported that the rapid decline in battery prices appears to have slowed in 2015-16. NRC (2015b) concluded that the BEV cost projections in NHTSA's 2012 RIA remain valid today. The TAR (2016) also suggests that a cost premium for BEVs will remain in 2025, a claim also asserted through independent analysis by energy economists in the U.S. (Covert, Greenstone, and Knittel 2016).

10.62 Federal Tax Credits for PEVs Have a Scheduled Phase Out

NRC (2015b) emphasizes that the decline of battery production costs is occurring only gradually and probably not fast enough, given the planned phase out of the federal income tax credits for PEVs. The federal tax credit for the cost of the 240-volt charger has already expired (2011) and was not renewed. The $7,500 tax credit for the PEV purchaser begins to phase out after a manufacturer produces 200,000 PEVs.

Nissan, Tesla, and General Motors are likely to be the first manufacturers to reach the 200,000-unit threshold, and probably will do so before 2025 (Cole 2017). In 2015 and 2016, Tesla was the largest seller of PEVs in the U.S. and the company's new Model X is only in its first full year of availability. Although more than 400,000 consumers have put $1,000 down toward a purchase of the forthcoming Tesla Model 3 (scheduled for 2018), those consumers may not realize that the federal tax credit may no longer exist when they make their purchase (Cole 2017).

Proponents of PEVs are disappointed that the U.S. Congress did not adopt the Obama administration's repeated request to liberalize the federal tax credit (i.e., enlarge it to $10,000 and require the dealers to make the rebate at the point of sale). NRC (2015b) recommends that Congress consider an enlargement of the manufacturer quotas or some extension of the federal income tax credit. A drawback to this approach is the equity concern: about 90% of the PEV credits go to taxpayers in the top income quartile (greater than $75,000 per year) (Sparshott 2015). Meanwhile, IEA (2016) reports that several countries are planning phase outs of the subsidies for PEVs, typically prior to 2025, arguing that the PEV technology is now available and should sink or swim on its own.

10.63 State Fiscal Policies toward PEVs Are Fragmented and Inconsistent

State fiscal policies toward PEVs are quite fragmented and inconsistent (Graham et al. 2014). In many cases, state policies are not coordinated with federal regulatory or fiscal policy.

Some state legislatures are enlarging cash incentives for PEVs, some are reducing or rescinding them, and some are beginning to tax PEVs on the grounds that they do not contribute to road-repair funding. With regard to encouraging PEVs through electricity-pricing reforms (e.g., time of use pricing), progress is slow. Thus, the future outlook for state-level support for transportation electrification is murky.

California has the longest history of a significant cash rebate for PEVs, but the available funding has been constrained; the maximum size of the rebate for BEVs has been reduced from $5,000 to $2,500, and the rebate is no longer provided to some high-income households that are likely to consider a PEV (CVRP 2012; S. Edelstein 2015; Hirsch 2011). California once gave out free Level-2 chargers to owners of Leafs and Volts, including up to $2,250 toward the cost of charger implementation, but the federal funds for those giveaways are no longer available. The California legislature recently awarded CARB only half of its $230 million request for PEV subsidies under the Clean Vehicle Rebate Project (Mulkern 2016).

Massachusetts and Connecticut recently enacted new cash rebates for EVs, but Illinois and Georgia have eliminated their cash rebates (DeMorro 2015a; DeMorro 2015b; Sawyers 2015; LaReau 2015). Colorado now has the most generous state-level PEV rebate ($5,000) and it is offered at the point of sale rather than at the end of the tax year (Von Kaenel 2016).

Meanwhile, 10 states have passed new legislation to impose fees on the registration of alternatively fueled vehicles (PEVs and HEVs). Fees for PEVs specifically range from $50- $200. In nine of the states, these are annual fees added to regular vehicle registration fees. Other states are considering similar legislation (Atiyeh 2015).

The registration fees applied to PEVs are unlikely to contribute significantly to government funding of road construction and repairs (Dumortier, Kent, and Payton 2016). But, those fees may complicate the social marketing of PEVs and therefore work at cross purposes with a national policy of transport electrification. Thus, there is a clear need for stronger consensus building about PEVs at the national and state levels of government.

The financial case for a PEV purchase is enhanced if electricity prices are low and/or if time-of-use (TOU) rate structures are employed, with low rates at night when many PEVs would be recharged (Ryan and Lavin 2015). But, some ZEV states (e.g., Massachusetts) have relatively high electricity prices and, more generally, states have been slow to adopt TOU rate structures due to public and business opposition. A recent study of a TOU rate scenario in California found lower net revenues for the utility and its ratepayers but lowered costs for delivered energy and higher net benefits for PEV owners, which encourages PEV adoption (IFC 2015).

State utility agencies could also help the electrification effort by allowing power producers to charge ratepayers for the cost of installing an initial network of public charging stations. While Oregon has passed legislation that directs state government to move in this direction, other states, such as Kansas and Missouri, have denied requests to charge ratepayers for the cost of public recharging infrastructure (Uhlenhuth 2016; Tomich 2016).

An unexpected boost for PEV recharging infrastructure came with Volkswagen's recent settlement of the diesel-emissions scandal. VW agreed, as part of the settlement, to spend $80 million in California and $1.2 billion in the rest of the U.S. on ZEV infrastructure and public education about ZEVs over the next 10 years (von Kaenel 2016). The details as to how VW will implement this part of the settlement are not yet known, and coordination issues with other federal and state policies are unresolved.

10.64 International Experience Suggests That, if Fiscal Incentives Are Large Enough, Consumers Will Purchase and Use PEVs

The country of Norway has demonstrated that incentive-based policies can achieve a PEV penetration rate of 25%, without any ZEV-like regulation (Hovland 2015; Kane 2015). U.S. policy makers can learn from the Norwegian experience, even if the specifics of Norway's policies are judged to be inapplicable or inappropriate for the U.S.

The Norwegian subsidy policy for PEVs is actually a complex combination of policies that evolved over the last 10-15 years (Jolly 2015). Elements of the policy include an exemption from the Value Added Tax (VAT) and other taxes on vehicle sales, free public parking spaces in the city, free use of toll roads and ferry connections, free access to bus and HOV lanes, a 50% lower tax on company cars, a 50% lower annual motor vehicle tax, and free recharging of batteries at publicly-funded charging stations.

Although the Norwegian policy has succeeded in promoting PEV sales, a recent evaluation points to some perverse effects (e.g., encouragement of families to purchase a second car and to refrain from walking, biking, and using public transit). Moreover, the subsidy package costs roughly $13,500 per ton of CO avoided, a figure that is cost ineffective compared to other feasible investments in carbon control (Holtsmark and Skonhoft 2014). There are also some reports that policymakers in Norway are planning to phase out PEV subsidies, in part because they are not fiscally sustainable (Hovland 2015; Kane 2015).

Norway is not the only country to stimulate substantial commercialization of ZEVs. The Netherlands has achieved a 10% PEV penetration rate, again with incentive-based policies. For a recent survey of international policies toward PEVs, see IEA (2016).

10.65 The Large Tax Credit or Consumer Rebate May Not be the Most Cost-Effective Method of Stimulating Consumer Interest in PEVs

The U.S. Congressional Budget Office (CBO) has examined the consequences of the $7,500 federal tax credit for PEV purchases and noted some concerning ramifications (CBO 2012). Households claiming the credit often have high incomes, and many would have purchased the PEV even without a credit. A disproportionate share of the credits are awarded to residents of California, in part due to the preferences of California consumers but also due to the ZEV regulation, the HOV lane access for PEVs on congested California freeways, and the relatively high fuel prices in California (often $1.00 gallon or more greater than the U.S. average). The credits typically change purchasing behavior in the most fuel-efficient segment of the new vehicle market (subcompact and compact cars), but the segment with the highest rate of GHG emissions is in the growing consumer market for light trucks. Additionally, PEV sales stimulated by the federal credit allow automakers to sell more fuel-inefficient vehicles and still comply with federal performance standards. Thus, it is not apparent that the $7,500 credit makes a near-term contribution to GHG control or fleet-wide fuel economy.

An alternative approach to public subsidies is to rapidly increase the number of U.S. motorists who have an affordable opportunity to test drive a PEV and, if intrigued, use the vehicle for a week (Bühler et al. 2014). A large body of evidence suggests that test drives and hands-on experience with a PEV is a potent way to increase PEV awareness, generate positive attitudes, and proliferate the word-of-mouth talk about transport electrification (Plug In America 2016; Graham-Rowe et al. 2012). In other words, instead of investing $7,500 in foregone federal revenue on a tax credit for a high-income PEV purchaser, the same amount of money might be better spent providing 75 consumers with a $100 subsidy to rent a PEV for a week.

Another flaw in the $7,500 federal credit is that it has the practical effect of encouraging a small car owner or Prius owner to trade in their vehicle for a small PEV. That does not save much gasoline. Encouraging a pickup truck buyer to purchase a hybrid or diesel truck would save much more gasoline. The hybrid truck credit might save four gallons of gasoline per dollar of subsidy; helping the Prius buyer might save 1.1 gallons per dollar of subsidy (Sallee 2010). Thus, the efficiency of federal tax policy in achieving energy and environmental objectives needs to be reconsidered.

10.66 Fiscal Policies toward PEVs Should be Coordinated with Regulatory Policies

Fiscal policies and regulatory requirements tend to be designed by different policy makers at the federal and state levels. Regulators reside in different offices than budget directors.

Greater collaborative efforts need to be made to facilitate coordination of the two types of policies (Roth 2014; McConnell and Turrentine 2010; Jenn, Azevedo, and Michalek 2016). Current fiscal policies tend to favor BEVs and FCVs over PHEVs and HEVs, which is arguably consistent with the current design of the ZEV regulation. However, PHEVs and HEVs are currently a more cost-effective path to GHG control than BEVs (Bandivadekar et al. 2008; Michalek et al. 2011; Traut et al. 2012; Kromer and Heywood 2008; Samaras and Meisterling 2008; Kammen et al. 2008). The current federal and state fiscal policies do nothing to help implementation of the footprint-based federal programs, since they offer no encouragement to consumers who are considering a high-mileage hybrid crossover or a high-mileage diesel-powered sedan or pickup truck (Sallee 2010). Making more of the fiscal policies footprint-based, like current federal regulations, might be a promising and innovative approach to coordination.

10.67 Bipartisan Commission on Fiscal Policy toward AFVs

Given that current fiscal policies toward AFVs are fragmented and inconsistent, we recommend that a bipartisan commission be created to seek more harmonization of fiscal policies. Members of the commission should include legislators (at the federal and state levels), budget officers (at the federal and state levels), regulators, and a wide range of stakeholders including industry, environmental and consumer groups, and fiscal hawks.

10.7 Higher Gasoline Taxes or a National Carbon Tax

A substantial body of economic and policy literature dating back to the 1980s has highlighted the virtues of a carbon tax or higher gasoline tax, either as a substitute or complement to federal CAFE requirements and/or to ZEV requirements (Austin and Dinan 2005; Jacobsen 2013; L. J. White 1981; Crandall et al. 1986; Crandall 1992; Nivola and Crandall 1995; Gerard and Lave 2003; Kleit 2004; Karplus et al. 2013; Knittel 2012). Some analysts suggest that use of a gasoline tax alone is more efficient than any combination of CAFE standards and a gasoline tax (Anderson, Parry, et al. 2011), while others seek to combine CAFE standards with a higher gasoline tax or carbon tax (McConnell 2013).

An important advantage of such price instruments is that they work to reduce gasoline consumption and GHG emissions in the entire 250-million fleet of vehicles on the road while simultaneously encouraging consumers to purchase a more fuel-efficient vehicle. Higher gasoline taxes also help sales of PEVs, since the spread between electricity prices and gasoline prices is widened, thereby underscoring the financial advantage of a PEV compared to a gasoline-powered vehicle.

Another potential advantage of the price instruments is that they could ultimately replace the complex combination of federal and state regulations. The need for favorable fiscal policies toward AFVs would also be lessened, since the tax instruments would create the desired economic incentives for AFVs.

The political feasibility of a higher federal gasoline tax is questionable. Since it would take a large increase in the fuel tax ($1.00 per gallon or more) to have a significant impact on gasoline consumption and GHG emissions, it is hard to imagine a higher fuel tax replacing the federal standards for the foreseeable future (Klier and Linn

2010). The recent multi-year highway funding package passed by Congress was enacted without any serious consideration of a higher gasoline tax. Some states have enacted increases in gasoline taxes for revenue purposes but the small size of those increases is not relevant for the present aims.

Globally, national carbon taxes pegged to the social cost of carbon emissions have been blocked by political opposition (Jenkins and Karplus 2016). A national U.S. carbon tax seems more remote in terms of political feasibility, since the idea has received little attention in Congress since the Obama administration's "cap and trade" proposal was blocked in the Senate in 2009-10.

The range of carbon taxes that are commonly suggested ($10-60 per ton of CO_2) would not have a large impact on gasoline prices or investment in alternative fuels (Burtraw 2016; Morrow et al. 2010). A gallon of gasoline burned produces 8,887 grams of carbon dioxide (CO_2) (NRC 2015a, 98). By means of a back-of-the-envelope calculation, a carbon tax of $10/ton of CO_2 would translate into a $0.10/gallon increase in the price of gasoline. At the same time, additional considerations regarding the share of biofuels used in gasoline (which would remain untaxed in a carbon tax setting) as well as the behavioral response of consumers driving less in response to a carbon tax, pushing down retail fuel prices, might weaken the pass through of a carbon tax into fuel prices even more. In fact, the EIA (2014) estimates that a $10 carbon tax would increase motor gasoline prices by only $0.08 in 2015 (the first year the tax would be implemented). Thus, even a $60/ton carbon tax would raise gasoline prices by a maximum of $0.53 per gallon (excluding the caveats mentioned previously). The failed cap-and-trade proposal in the 2009-2010 Congress would have reached only $26 per ton in 2019 (Sallee 2010).

Such a modest impact of carbon pricing on fuel prices explains why some experts believe that a carbon tax would do little to reduce GHG emissions from the transportation sector (Morrow et al. 2010). But, that outcome may be acceptable on cost-benefit grounds. As long as the carbon tax is pegged to the external (social) cost of carbon emissions, the resulting outcomes for emission control in various sectors should represent the socially efficient results. If carbon taxes fall far short of estimates of the social cost of carbon, implementation of standards and subsidies, as described in this report, seem likely to continue.

11. RECOMMENDATIONS

We have analyzed a complex mix of federal and state regulatory programs, all with similar objectives and each covering the automotive industry. Drawing from our qualitative and quantitative analyses, this section makes a series of recommendations to guide analysts, regulators, and legislators. Some of our recommendations flow directly from our macroeconomic analyses; others flow from our qualitative analysis of the industry, the regulatory programs, and related public policies.

For Analysts

Given that the federal agencies and CARB are finalizing the Technical Assessment Report (TAR), which contains a wealth of valuable technical and cost data, our focus is on guidance for analysts who are exploring regulatory reform options, especially for model years 2022-2025.

1. Regulatory-reform options should be analyzed taking into account the unexpected drop in fuel prices that has occurred since the federal and ZEV rules were developed from 2009-2012, including the downward revision of fuel-price forecasts through 2025.

   The ramifications of lower fuel prices should be explored from a variety of perspectives, including: (1) impacts on the volume of new vehicle sales in the regulatory baseline, as low fuel prices tend to spur consumer interest in purchasing or leasing new vehicles; (2) impacts on fuel economy and GHG emissions in the baseline fleet of vehicles that would be sold if regulations are not tightened from 2022-2025, including the changing size distribution of vehicles (e.g., cars vs. SUVs and trucks) and the likely increases in consumer demand for performance and other fuel-expending vehicle attributes; (3) impacts on trends in vehicle miles of travel, both directly through the price elasticity of travel demand and indirectly due to possible changes in the "rebound effect," as fuel-economy technologies may have a different impact on travel demand in a low fuel-price environment; (4) impacts on consumer pay-back periods for investments in fuel-saving technologies, since lower fuel prices will tend to lengthen the duration of those payback periods; (5) impacts on the resale value of fuel-economy technologies and plug-in electric vehicles; and (6) impacts on consumer willingness to pay a price premium for fuel-economy technologies.

   Although fuel prices are now expected to be more than 25% lower in 2025 than experts thought in 2012, the future paths of both oil and gasoline prices are notoriously difficult to predict. Thus, we recommend that regulatory analyses include sensitivity analyses based on the low, reference, and high fuel-price scenarios published annually by the Energy Information Administration.

2. Regulatory-reform options should be evaluated based on the best available technology information, focusing on key issues that may distinguish one technology from another; realistic estimates of the impacts of multiple technologies need to be obtained.

   The draft TAR (2016) has a wealth of information on the fuel-saving effectiveness and costs of alternative fuel-saving technologies, including PEVs and other alternative-fueled vehicles. However, additional information is required to make objective comparisons of alternative regulatory reforms and technology combinations. Specifically, we urge analysts to consider the following recommendations concerning residual technology issues that have not been adequately addressed in the draft TAR (2016): (1) the fuel-saving effectiveness and costs of various combinations of technologies should be reconsidered, accounting for the fact that there may be negative and positive synergies when multiple technologies are employed in the same vehicle; (2) the assessment of lightweight materials (e.g., aluminum and lightweight steel) should go beyond consideration of production cost and fuel-saving effectiveness and include a broader and more in-depth assessment of long-term impacts on vehicle maintenance and repair expenses, occupant safety, and lifecycle GHG emissions; (3) the assessment of advanced diesel engine technology should go beyond consideration of production cost and fuel-saving effectiveness and include the value of an engine with a longer lifetime, significant performance

advantages (e.g., added torque and cargo-carrying capability), and the added cost of emissions controls that will work in real-world driving conditions; (4) the assessment of conventional hybrid technology should go beyond consideration of production cost and fuel-saving effectiveness and consider why consumer demand for conventional hybrids has not risen as much as expected, given the initial success of the Toyota Prius and the favorable results from total cost-of-ownership studies; (5) the assessment of refinements to the internal combustion engine should go beyond consideration of production cost and fuel-saving effectiveness and consider whether there are hidden amenity costs and benefits in the eyes of consumers (e.g., the largely negative reaction of American consumers to dual-clutch transmissions); and (6) the assessment of PEVs should go beyond a consideration of production cost and net energy savings, and consider why the rate of growth of consumer demand for PEVs has been lower than both the government and industry expected, especially given the extensive PEV incentives available at the federal and state levels.

3. When considering how consumers evaluate fuel-economy gains in new vehicle design, agencies should take into account new econometric studies that infer consumer valuations from short-term changes in fuel prices, decades of practical experience with fuel-saving technologies, and recent real-world experience with conventional hybrid engines.

4. Although agencies have made major steps forward in forecasting a realistic baseline set of vehicles for model years 2022-2025, refinements in the forecasted fleet are necessary in order to make valid comparisons to a regulated fleet subject to the 2022-2025 federal and ZEV standards.

   Specifically, the baseline fleet should be refined to account for the following: (1) higher consumer demands for fuel-expending features (e.g., performance, interior volume, and cargo-carrying capability) due to diminished fuel prices and income growth; and (2) higher regulatory demands for fuel-expending features to meet other environmental and safety objectives (e.g., controls on ultra-fine particles from gasoline engines, higher blends of ethanol in gasoline, and advanced airbag systems).

   After the consumer and regulatory demands for fuel-expending features are quantified, additional fuel-economy technologies should be added to the baseline fleet of vehicles to meet the anticipated consumer and regulatory demands. If agencies are uncertain as to which features will be demanded by consumers and regulators, an empirical approach can be used that defines an average annual increase in fuel-expending features (e.g., performance) based on historical data, and that annual average should be projected through model year 2025.

5. Federal agencies should conduct a careful regulatory impact analysis of the combination of the federal CAFE and GHG regulations and the ZEV program, including interactions between the programs that will influence incremental cost and benefit comparisons.

   Specific suggestions for this analysis include the following: (1) since PEVs and FCVs are currently less cost-effective technologies than the advanced gasoline-engine technologies stimulated by the federal programs, the RIA should begin with the federal programs, refined as appropriate, as the baseline; (2) the environmental benefit assessment of the ZEV regulation should take account of the existence of the federal programs, including the fleet-averaging provisions in the federal programs that may nullify any reduction in GHG emissions and gasoline consumption attributable to PEVs and FCVs; (3) the long-run environmental benefits of the technology-stimulating feature of the ZEV regulation should be adjusted to account for the technology stimulation that will occur anyway, due to ongoing advanced battery R&D programs around the world and the federal and state incentives for PEVs and FCVs; (4) the incremental cost assessment of the ZEV regulation should account for savings in expenditures on gasoline engines and related fuel-economy features that are unnecessary or can be downsized due to the presence of an electric propulsion system, and (5) the incremental cost-benefit assessment of the ZEV regulation should be undertaken from both a national and California perspective in order to inform regulators and legislators as to whether the regulation is in the interests of the citizens of both California and the nation as a whole.

6. Federal agencies should estimate the impact of the model year 2022-2025 standards on the volume of new vehicle sales. The vehicle-sales analyses are a crucial input to analyses of employment impacts, environmental and safety impacts, used-car market ramifications, and societal costs and benefits.

   We offer specific guidance on several analytic issues: (1) since there is genuine uncertainty about the vehicle-price impacts of the 2022-2025 standards, sensitivity analyses of sales volumes should be conducted for different assumptions about the size of the price premiums caused by the regulations; (2) consumers should be assumed to be sensitive to the net vehicle-price premium—where the net premium accounts for the incremental costs of complying with the standards (the gross premium)—car-loan costs, insurance charges, sales taxes, energy expenditures, and any changes in vehicle maintenance and repair costs; (3) emphasis should be given to financial impacts that occur within the first three years of vehicle ownership, even though passenger cars and light trucks may be used for up to 30 and 37 years, respectively, since there is a good deal of evidence that new vehicle consumers are short-run oriented; (4) the resale value of vehicles with enhanced fuel economy should be modeled as a function of the fuel-price environment and future miles of travel, with consumers undervaluing the residual value of fuel-saving technology relative to a rational-choice, present-value computation, and (5) NHTSA's rich new data set on miles of travel by vehicle age should be used to compute the magnitude of fuel savings due to regulations.

7. Agency analysts should estimate the macroeconomic impacts of the combinations of regulations using at least several economic indicators (e.g., total employment, GDP, and real disposable income) and some regional or state disaggregation.

   Extending the analytic work presented in this report, future work should: (1) provide updated estimates of the price elasticity of demand for new vehicles; (2) consider impacts not only on the volume of new vehicle sales but demand for add-on features such as powerful engines, leather seats, and advanced navigation systems; (3) examine alternative scenarios of economic impact where automakers are not able to pass on to consumers the higher incremental cost of producing new vehicles, and how the diminished margins of automakers would affect the industry and the U.S. economy; (4) pursue a quantitative assessment of the employment consequences in the U.S. of a significant shift from gasoline engines to PEVs, with emphasis on labor impacts in the supply chains for the two propulsion systems, including gasoline and recharging stations; (5) collect new data on how consumers are choosing to adjust their household budgets (spending and saving patterns) due to savings in gasoline expenses from lower prices and fuel-saving technologies; (6) prepare economic-impact assessments for each of the 50 states rather than the aggregated nine Census regions used in this report; and (7) estimate impacts on average earnings of workers as well as total levels of employment.

For Regulators

In the near future, federal and state regulators need to consider which regulatory-reform options are worthy of more in-depth analysis from the perspective of benefit and cost. Based on this report, we believe the following options are worthy of consideration for further regulatory assessment.

1. CARB and EPA should reconsider the design of the ZEV program, emphasizing ways to enhance the cost-effectiveness of the program and coordinate its requirements with the federal programs. If EPA determines that a ZEV-like program is in the national interest, EPA should consider expanding the California ZEV program into a national ZEV program that replaces or complements the federal CAFE and GHG performance standards.

   Specific reforms worthy of consideration include: (1) stretching out the schedule for meeting ZEV requirements in conjunction with the federal requirements, recognizing how difficult it is to sell the current generation of PEVs and allowing more time for the costs of FCVs to decline and the next generation of improved PEVs to be widely available to consumers; (2) extending the travel or regional-pooling provisions until community readiness in the 10 ZEV states approximates the conditions recommended by NRC (2015c);

and (3) reconsidering the role of PHEVs in ZEV compliance formulas given their superior driving range, greater utility to consumers, and superior cost-effectiveness from the perspective of GHG control.

2. Federal agencies should reconsider the schedule and explore a variety of refinements to the 2022-2025 performance standards to enhance cost-effectiveness.

   Specifically, federally agencies should: (1) consider a fuel-price threshold that would automatically trigger relaxation, continuation, or tightening of the 2022-2025 standards, depending upon how energy markets change and EIA adjusts its fuel-price forecasts in 2020 for the years 2022-2025; (2) consider a stretch out of the timetable for CAFE and GHG compliance to allow more time for the cost of innovative technologies to decline and gasoline prices to rise; (3) clarify and streamline the process for ruling on off-cycle credit applications, thereby enhancing the cost-effectiveness of the federal programs; (4) consider emphasizing total cost-of-ownership information in consumer-facing educational programs about fuel-economy technologies and ZEVs; (5) harmonize the credit-trading programs and other compliance flexibilities, and (6) reconsider the role and schedule for compliance incentives for PEVs and FCVs, depending on whether the ZEV program is retained or how it is refined.

For Legislators

The federal and state regulatory programs will not work optimally unless legislators take steps to coordinate the regulatory statutes and authorize cost-effective incentives for consumer use of advanced technologies. Some of the necessary legislation must be enacted at the federal level while other components require action by state legislators.

We do not focus here on promising alternatives to the federal and state regulations (e.g., a national carbon tax, higher gasoline taxes) because, despite a large literature on the superior economic case for such alternatives, politicians in the U.S. have been reluctant to enact those alternatives. The legislative suggestions below are highlighted for further consideration and dialogue among stakeholders and should not be considered immediate policy recommendations.

1. The U.S. Congress should commission an independent assessment of the national costs and benefits of the California ZEV program, given the growing stringency of the federal performance standards and fiscal policies designed to promote plug-in electric vehicles. Although the federal agencies may decide to prepare such an assessment, the U.S. Congress should seek a separate look at the issue from an independent body such as the Congressional Budget Office or the National Research Council.

2. Both EPA and CARB are taking the position that a national cost-benefit assessment of the ZEV program is not permissible under the current statutory language of the Clean Air Act. Congress should consider whether to revise the Clean Air Act and require such a national cost-benefit assessment of ZEV waiver decisions.

3. The U.S. Congress should consider new legislation to fully harmonize the federal CAFE and GHG programs, including the credit-trading programs, the penalties for non-compliance, and the compliance-flexibility provisions.

4. The U.S. Congress should commission a bipartisan commission of federal and state legislators and stakeholders to assess the future of consumer incentives for PEVs and FCVs, taking into account the recent reports from the NRC (2015a; 2015b) and new studies of the impact of consumer incentives in the U.S. and abroad. The Commission should consider how incentives should be coordinated with the federal and state performance standards and when the incentives should be scheduled for a phase out.

5. Given that older vehicles account for a disproportionate share of GHG emissions, smog-inducing pollutants, fuel consumption, and safety problems, legislatures should consider cost-effective steps to accelerate the phase-out of older vehicles, taking into account the lessons learned from the "cash-for-clunker" programs evaluated in the U.S. and Europe.

APPENDIX I:
Sensitivity Analyses of Fuel Prices

The GHG and CAFE standards for model years 2017-2025 are projected to reduce gasoline consumption by 4 billion barrels of oil over the entire lifetimes of the vehicles. Applying a 3% discount rate, this reduction results in estimated monetary savings ranging from $459 billion (2010 baseline fleet) to $471 billion (2008 baseline fleet). The monetary benefits derived from reduced fuel consumption represent 80% of the combined benefits of the federal 2017-2025 standards; environmental and energy-security benefits account for most of the remaining 20% (NHTSA 2012a).

To arrive at the estimated monetary savings, NHTSA and EPA used gasoline price projections based on the early release of the 2012 Annual Energy Outlook (AEO) of the Energy Information Administration (EIA). The projection path included the following prices per gallon of gasoline: $3.53 in 2015, $3.76 in 2020, $4.04 in 2030, and $4.57 in 2050. In its 2011 RIA, CARB made similar assumptions for gasoline prices ($4.06 for 2020, $4.02 for 2025, and $4.17 for 2030). The AEO 2012 forecasts only extended as far as 2040. The agencies, however, considered fuel savings over the entire lifetime of the vehicles and, as a result, required fuel price projections as far as 2061. The projected fuel prices for the period 2041-2061 were estimated by NHTSA using an average growth rate of 1.47%.

The monetary savings estimated by the agencies do not include federal and state fuel taxes as these taxes are viewed as income transfers. However, when considering the savings experienced by consumers, fuel taxes were incorporated in the analysis.

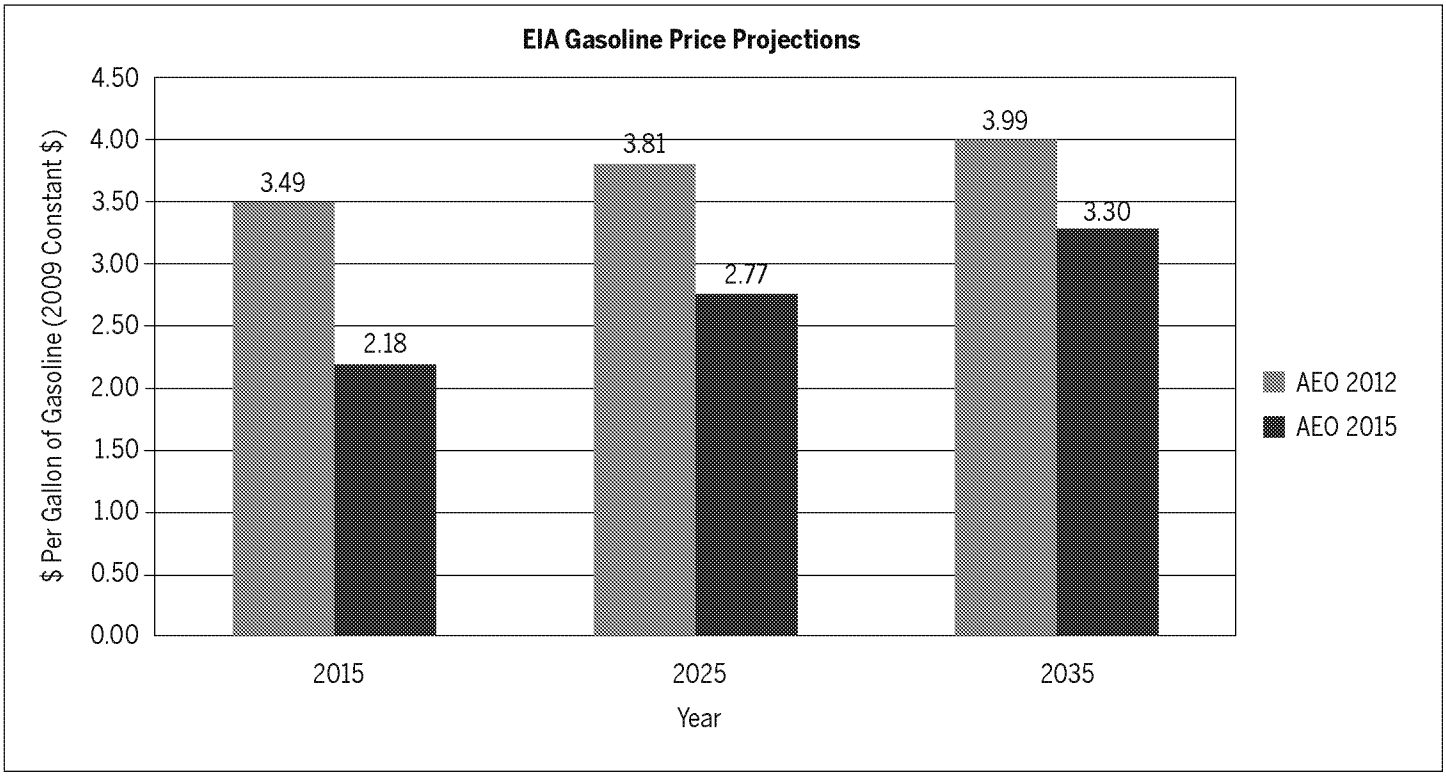
Since the development of the final 2017-2025 federal and ZEV rules, the world oil market has undergone significant changes. The rate of growth in global demand for oil has tapered as the growth of the Chinese economy has slowed and as economic difficulties have plagued the economies of the EU and other regions. On the supply side, the success of unconventional technologies has boosted U.S. and Canadian oil production (Luskin and Warren 2015). Iraq has resumed its production, Iran may expand production, and both Russia and Saudi Arabia have chosen to defend market share rather than reduce production (IEA 2015; Gold 2015; Faucon and Said 2015; Kantchev and Said 2015; Sheppard and Raval 2015).

The subsequent drop in gasoline prices in the U.S. has been significant, with the national average price in 2015 being $2.31 (EIA 2015b). EIA forecasts the average national price of fuel at $2.74 in 2020 and $3.20 in 2030. Figure I.1 illustrates gasoline price projections from AEO 2012—which are the projections used by the agencies in setting the regulations—and AEO 2015 (calculated in constant 2009 dollars). The difference between the AEO 2012 forecast for 2015 and the observed price was $1.31 per gallon. Differences of similar magnitudes are estimated for 2025 ($1.04) and to a lesser extent for 2035 ($0.69). The price path based on the AEO 2015 projections deviates substantially from the 2012 AEO reference case projections and, if applied to the analysis conducted by the agencies, would result in a downward revision of the estimated benefits of the rules.

The large degree of uncertainty regarding long-run oil and gasoline prices is acknowledged by EIA (EIA 2015b; 2015a). Each year, EIA reports both a reference case and low and high gas-price scenarios. For 2020, those projections are $2.56, $2.18, and $3.88, in 2009 constant dollars, respectively. We encourage agency analysts to compute consumer payback periods based on all three scenarios for gasoline prices in 2020-2025, using the most recent EIA forecasts.

With regard to the commercial future of PEVs, the difference between fuel prices and electricity prices also needs to be considered. DOE's eGallon tool was developed to make this comparison easy for consumers (Leistikow 2013). The tool uses the most recent data on gasoline and electricity prices to compare how much money consumers will pay for energy during a trip of the same length. On January 18, 2016, DOE reported the average cost of gasoline in the U.S. as $2.00 per gallon; the price of electricity, in DOE's eGallon format, was $1.16 per gallon. The advantage for electricity was much larger in California ($2.84 per gallon of gasoline vs. $1.36 per

Figure I.1. Gasoline Price Forecasts Based on AEO 2012 and AEO 2015.



Note: The 2015 figure of $2.18 is obtained from the 2015 Short Term Energy Forecast (not the 2015 Annual Energy Outlook). All prices are calculated in 2009 constant dollars.

Source: EIA, 2012; EIA, 2015b; calculations made by the authors.

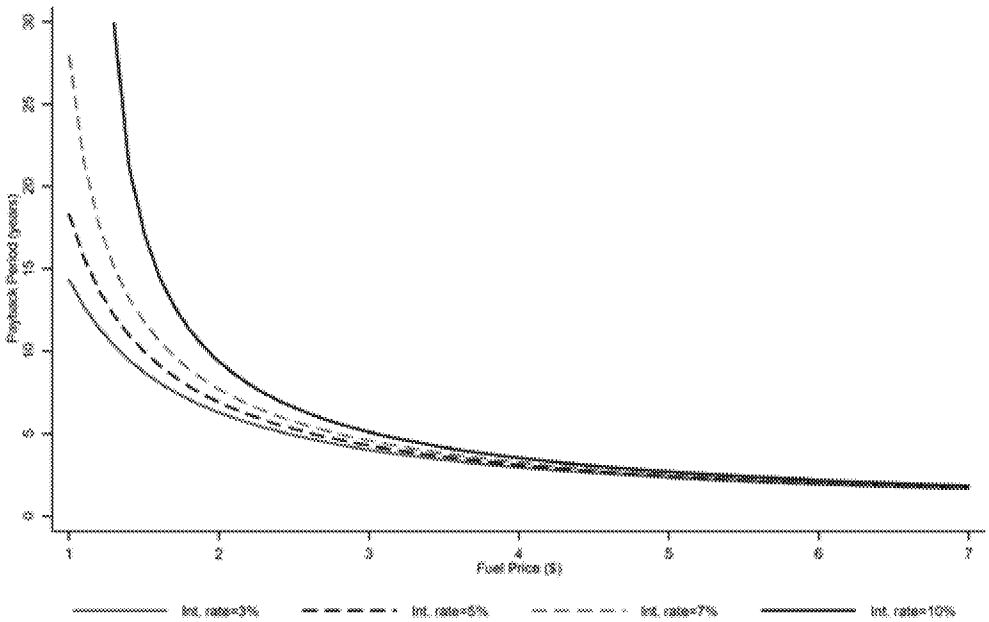
eGallon) than it was in Massachusetts ($1.97 per gallon for gasoline vs. $1.67 per eGallon). Looking forward, agencies need to consider the projected pathways for both electricity and gasoline prices, especially in the ZEV states.

In order to illustrate the powerful impact of lower fuel prices on the appeal of fuel-efficient vehicles and PEVs, we calculate consumer payback periods for a range of fuel prices and four discount rates. The results from this analysis are presented in Figures 2, 3, and 4 for incremental price impacts of $2,000, $5,000, and $10,000, respectively. The lower price corresponds roughly to extensive modification of a gasoline-powered vehicle, the mid-range prices correspond roughly to an HEV or an advanced diesel engine, and the higher price corresponds roughly to a future PEV. In assessing the consumer payback periods, it may be useful to consider the rough rule of thumb that a typical new vehicle purchaser expects payback for a fuel-economy investment in three years (NRC 2015a; CAR 2011; Greene, Evans, and Hiestand 2013).

The results show that consumer payback periods are lengthened substantially at low fuel prices. For example, Figure I.2 shows that a $2,000 investment in fuel economy is defensible at $4 per gallon; the payback period is less than five years regardless of the discount rate. The investment is far less attractive when fuel price is $2 per gallon, especially at higher interest rates. Similarly, Figure I.3 shows that the payback period for a price premium of $5,000 is not attractive at fuel prices under $7 per gallon. Finally, Figure I.4 shows that, at a price premium of $10,000, a PEV might pay for itself after 12 years of driving, assuming gasoline costs $4 per gallon and a 5% discount rate. At $2 per gallon, it takes almost 40 years of driving for the investment to pay off.

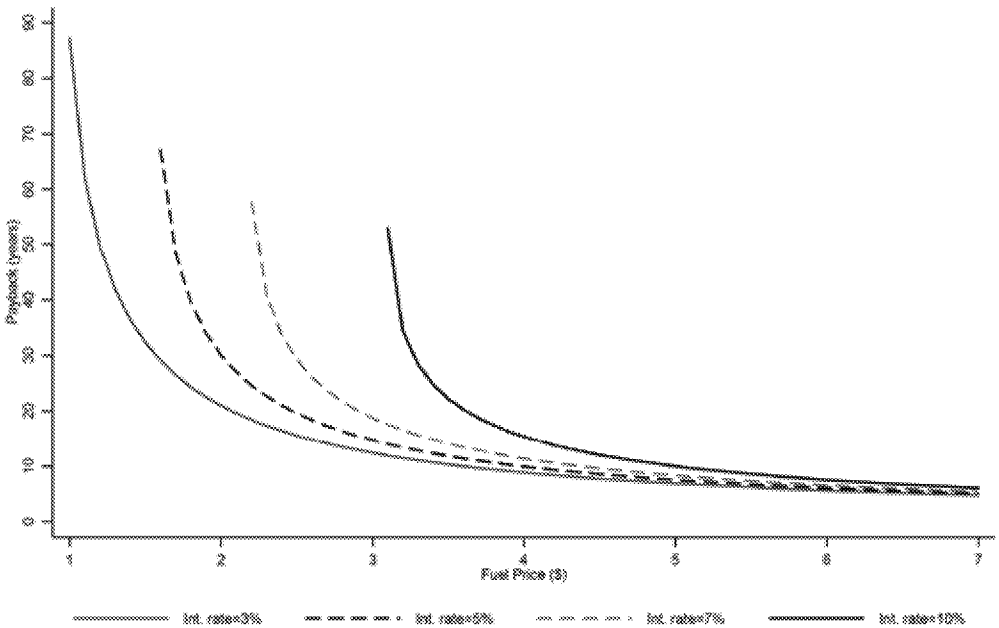
An independent assessment of the consumer's perspective found that the three most important variables to the consumer are the price of the fuel-saving technology, the fuel price, and the expected number of miles driven.

Figure I.2. Consumer Payback (in Years) Analysis for a 55 MPG Vehicle with an Incremental Price of $2,000.



Note: Reported is the payback period (in years) required to recoup the $2,000 incremental cost of buying a fuel efficient vehicle under various assumptions about interest rates and fuel price. We assume the consumer drives 12,500 miles per year, that the inefficient car gets 35 MPG, and that the efficient vehicle gets 55 MPG. We further assume that on-road fuel economy is 80% of the stated fuel economy and that the incremental resale value of the efficient vehicle is 10% of the incremental cost. The analysis assumes that all parameter values are constant over the life of the vehicle, which implies that fuel savings are constant across time.

Figure I.3. Consumer Payback (in Years) Analysis for a 55 MPG Vehicle with an Incremental Price of $5,000.



Note: Reported is the payback period (in years) required to recoup the $5,000 incremental cost of buying a fuel efficient vehicle under various assumptions about interest rates and fuel price. We assume the consumer drives 12,500 miles per year, that the inefficient car gets 35 MPG, and that the efficient vehicle gets 55 MPG. We further assume that on-road fuel economy is 80% of the stated fuel economy and that both vehicles have the same resale value. The analysis assumes that all parameter values are constant over the life of the vehicle, which implies that fuel savings are constant across time.

The authors conclude that "the reality is that higher fuel economy levels currently envisioned in CAFE are not expected to be economically viable at current fuel prices" (Simmons et al. 2015). Below, we explore recent evidence about how consumers weigh these factors when purchasing a new car or light truck.

Lower fuel prices may also influence a series of other analytical parameters in the RIAs (see Appendix III). Here we offer another example of a variable—the rebound effect—that needs to be reconsidered in a low fuel-price environment.

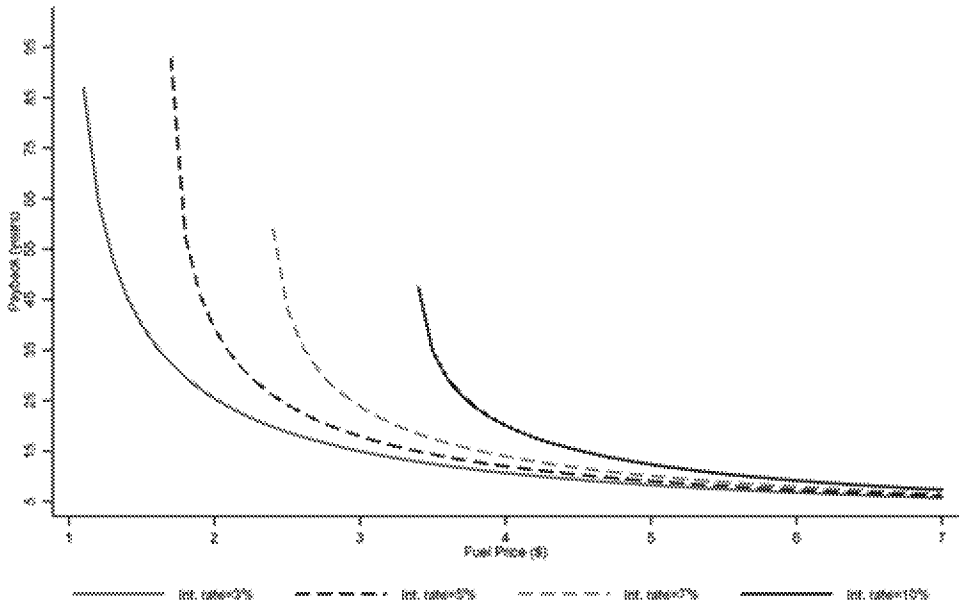
A significant literature has addressed the "rebound effect," that is, the behavioral phenomenon whereby drivers of fuel efficient vehicles tend to increase their vehicle miles traveled due to the lower fuel cost per mile of travel.

The federal agencies conducted a thorough review of the literature and assumed a rebound rate of 10% which, at the time the RIAs were published (2012), captured the consensus among the peer reviewed literature. However, recent work has found a declining rebound effect over time.

Hymel and Small (2015) use data from 1966-2009 and find that consumers respond more to fuel price increases than decreases. As a result, they report a greater rebound effect in years when fuel prices are rising. Furthermore, they find that the rebound effect declines in magnitude as household income rises. This income effect can be justified based on the fact that, as income levels increase, the driver's time plays a predominant role in the variable cost of travel, and decreases the role of fuel prices. In another recent study, Gillingham, Jenn, and Azevedo (2015) report a short run gasoline price elasticity of driving of 10% for drivers in Pennsylvania, with substantial heterogeneity demonstrated among drivers. Drivers of low fuel economy vehicles exhibit high rates of gasoline price elasticities of driving, while drivers of fuel efficient vehicles demonstrate inelastic behaviors.

During the midterm reviews, analysts should examine carefully how lower fuel prices could influence each of the variables in the consumer payback analyses. Emphasis should be given to how low fuel prices influence, directly and indirectly, consumer payback periods and new vehicle sales.

Figure I.4. Consumer Payback (in Years) Analysis for a PEV with an Incremental Price of $10,000.



Note: Reported is the payback period (in years) required to recoup the $10,000 incremental cost of buying a PEV under various assumptions about interest rates and fuel price. We assume the consumer drives 12,500 miles per year, that the inefficient car gets 35 MPG, and that the efficient vehicle gets 105 MPG (the equivalent of a BEV100 [35kWh]). We further assume that on-road fuel economy is 80% of the stated fuel economy and the incremental resale value of the efficient vehicle is -10% of the incremental cost. The analysis assumes that all parameter values are constant over the life of the vehicle, which implies that fuel savings are constant across time.

APPENDIX II: Review of European and American Experiences with Cash-for-Clunkers Program

The cash-for-clunkers idea originated in France in the 1980s, as the government sought to reduce pollution and boost the fortunes of the French-owned automotive companies and their workers (Wald 2009). The idea spread rapidly to Germany, Italy, Spain, the UK, and Ireland (Dial 2011; Schoenfeld and Walker 2009). Both the U.S. and selected European countries experimented with cash-for-clunker programs in the 2005-2010 period, primarily to stimulate the depressed levels of new vehicle sales. Many U.S. states currently have such programs, though they vary in their design. Some of the state programs have no focus on environmental gain, while others focus on removing older vehicles with poor environmental performance.

Evaluations of cash-for-clunker programs have yielded mixed results, both with respect to stimulus effects and environmental impacts. The programs increase new vehicle sales temporarily, but sales are much lower when the incentive is removed (Gayer and Parker 2013; Knittel 2009). It appears that the cash incentive influences precisely when the owner of an old vehicle decides to purchase a new one, but the earlier purchase may be less than a year ahead of when it would have been otherwise (Mian and Sufi 2012).

The stimulus effect is minimal or negative if new vehicle purchases are restricted to greener vehicles, since overall spending on vehicles may fall or not increase (Hoekstra, Puller, and West 2014). Programs that do not regulate the environmental profile of the new vehicle may have adverse effects on the environment, as the cash incentive may cause the consumer to buy a larger and more polluting vehicle than they would have acquired without the cash incentive, as that was the perverse experience in Germany (Kloßner and Pfeifer 2015). The programs do not necessarily benefit low-income households, as higher-income households are more likely to take advantage of the cash incentive, and the programs may raise prices on older used cars—those often purchased by income-constrained households (Gayer and Parker 2013; Sawyers 2009, April 7; Sawyers 2009; Woodyard 2009).

Programs that require cash rebates to be used for green vehicles, such as the U.S. Cars Allowance Program (CAP), do report environmentally positive results (NHTSA 2009). The CAP, which triggered the replacement of 680,000 old vehicles with new vehicles, induced the consumer to accelerate their new vehicle purchase by an average of 2.87 years. Those vehicles were typically driven 10,000-12,500 miles per year. The average EPA mileage rating of the new vehicles was 9.2 MPG higher than the average rating of the retired vehicles (24.9 vs. 15.7 MPG). As a result, CAP was associated with significant reductions in fuel consumption, GHG emissions, and criteria pollutants that are linked to the formation of smog and soot (NHTSA 2009). Other studies find smaller but still substantial differences in the mileage ratings: 2.5-5.0 MPG higher ratings for the new vehicle compared to the retired vehicle, in part because the retirements are often SUVs and pickup trucks while the new vehicles are often small cars (Hoekstra, Puller, and West 2014; Kellogg and Mitchell 2009; Curtin 2009).

The cost-effectiveness of the pollution reductions from CAP are unattractive when compared to the social cost of carbon or carbon prices (Li, Linn, and Spiller 2013; Knittel 2009), but properly designed cash-for-clunker programs may still be more cost-effective at the margin than the ZEV regulation. The midterm reviews should explore such a comparison.

APPENDIX III:
Toward a More Realistic Baseline Fleet of Vehicles

When estimating the impact of stricter standards on new vehicle sales, agencies need a realistic baseline fleet of vehicles to use for comparison purposes (NRC 2015a). The baseline is the fleet of vehicles that would be sold to consumers if CAFE/GHG standards were frozen at their 2016 levels, or at the 2021 levels, if the focus is the model year 2022-2025 standards. The characteristics of those vehicles (price, fuel economy, and other attributes) can then be compared to the characteristics of the vehicles subject to the stricter standards (price, fuel economy, and other attributes). If the regulated vehicles are more attractive to consumers, then the volume of new vehicle sales should increase; if they are less attractive, new vehicle sales should decline.

In the final rulemaking for model years 2017-2025, EPA/DOT started with a simulated fleet of 2016 vehicles as improved by the 2011-2016 standards (i.e., fuel-economy certification data for the 2010 fleet was used as a baseline and then fuel-saving technologies were applied until the simulated 2016 fleet was in compliance with the 2016 standards). Other vehicle attributes such as performance (e.g., horsepower and acceleration capability) and safety (e.g., number of airbag systems in the vehicle) were held constant from 2010-2016.

Both NHTSA (2012a) and NRC (2015a, 320, 363) have pointed out that it is not realistic to assume that, in the absence of stricter standards for 2017-2025, fuel-expending improvements such as increased performance and enhanced safety would not have been implemented by automakers. A robust body of historical data does show that, as technological advances proceed, automakers deliver more performance, acceleration capability, and fuel economy to consumers (EPA 2015). Without pressure from regulation or high fuel prices, innovation tends to be channeled to performance and acceleration capability instead of fuel economy (Knittel 2011). Those improvements in performance and safety, if foregone by the stricter 2017-2025 standards, represent an "opportunity cost" of the stricter standards that should be analyzed (NRC 2015a, 327). However, it is difficult to know exactly what those characteristics would have been and how consumers would have valued them.

A tractable approach to addressing this issue, which we recommend for consideration, is to assign a fuel economy penalty in the baseline 2017-2025 fleet for the projected improvements in performance and safety that producers would deliver in response to consumer and regulatory demands. For example, in 2002 NRC recommended that NHTSA assign a 3.5% weight penalty in the baseline fleet for future safety and smog-related emissions requirements (NRC 2002, 66, 76, 112). NHTSA has found that some safety systems do add to the weight of the vehicle (Tarbet 2004). The extra vehicle weight can then be assigned a fuel economy penalty using standard methods. EPA has indicated that stricter regulations of vehicles may be necessary to address the ultra-fine particles emitted from gasoline-powered vehicles, and compliance with those regulations would likely entail a fuel-economy penalty.

Likewise, it would be reasonable to assume a 1% or 2% annual gain in horsepower in the baseline fleet to meet consumer demand, and an associated fuel economy penalty for the added horsepower (EPA 2015). If evidence suggests that consumers do not notice small changes in horsepower or other attributes, then this complexity does not need to be addressed. The available evidence on consumer transactions does suggest that some consumers are sensitive to marginal changes in performance (Klier and Linn 2012).

The consequence of the fuel economy penalties is that a more extensive and costly set of fuel economy technologies are necessary to bring the baseline fleet into compliance with the 2017-2025 standards. The cost of those additional technologies (with deductions for the fuel savings) are then incorporated into the analysis of vehicle prices and impacts on new vehicle sales and employment.

An advantage of this approach is that the agencies can maintain their preferred analytic assumption that safety and performance will not be affected by the regulatory requirements. All that changes are vehicle price and fuel economy, and those characteristics can readily be linked to new vehicle sales with established methods and data.

APPENDIX IV:
Regulatory Impact Analyses Model Parameters

In their RIAs, NHTSA, EPA, and CARB document several economic parameters that were used as inputs in their consumer-payback modeling efforts. The assumptions they made about those parameters affected, among other things, the estimated effects the regulations would have on consumer benefits and payback periods, new vehicles sales, and the overall benefits of the regulations. In our report, we have discussed some of those input parameters extensively (i.e., technology costs, gasoline prices, and rebound effect). In this Appendix, we present additional parameters that were used by the agencies in the RIAs.

Price Elasticity for Automobiles

The agencies assume a price elasticity of demand for automobiles equal to -1. That figure implies that a 1% increase in the price of an automobile will decrease sales by 1%, all else equal. The assumption used by the agencies is that automobile manufacturers will be able to pass on the increase in cost of production, due to implementation of fuel efficient technologies, to consumers.

Automobile Insurance Cost

NHTSA and EPA use data from the National Bureau of Economic Analysis to calculate the average price of a new passenger car in 2010 at $24,572 and that of a new light truck at $31,721. Considering those two estimates, the agencies calculated the average price of a new vehicle in 2010 to be $27,953. The latter is the figure based on which insurance costs were calculated. The agencies assumed that costs of collision and comprehensive insurance for the first five years in the life of a new vehicle, expressed in percentage terms of the price of the vehicle, decline based on the following schedule: 1.86% for year one, 1.82% for year two, 1.75% for year three, 1.64% for year four, and 1.50% for year five. In aggregate, the overall cost of insurance for the first five years of the vehicle's life is 8.5% of the original price. The CARB RIA assumes an insurance premium of 6.6%.

Automobile Loan Cost

NHTSA and EPA assumed that 70% of consumers finance their automobile purchases through a loan at an average rate of 5.16% for a period of 48 months. The relevant interest rate used by CARB was slightly higher at 5.35%. The literature on automobile purchases suggests that some consumers use their credit cards to make car payments (Busse, Knittel, and Zettelmeyer 2013). If that is the case, then the financing interest rate one would need to consider to estimate the actual cost of purchasing a new car is the interest rate consumers pay on their credit cards.

Vehicle Resale/Residual Value

NHTSA assumes that the average resale value of a vehicle five years into its lifetime is 35% of its original price. The present value of this percentage using a 3% discount rate yields an effective residual value of 30.64%. The equivalent figure used in the EPA RIA is 23% (assuming a 7% discount rate), while the CARB RIA assumes a resale value of 39% (using a 5% discount rate).

Average Period of Automobile Ownership

EPA and NHTSA considered the full lifetime of cars to be 30 years and trucks to be 37 years, while CARB considered the median lifetime of a passenger car in California to be 14 years. For vehicles of a given model year, EPA and NHTSA calculate the probability that vehicles remain in service after the year they are sold. The resulting "survival rate" is used to calculate the number of vehicles in service at a specific time period. This is the first step in estimating fuel consumption. The next step requires an estimate of Vehicle Miles Traveled (VMT). The latter is produced by using the Federal Highway Administration's 2009 National Household Travel Survey

(2011). The VMT projections made by the agencies align closely with the EIA (2012) early release projections and are illustrated in Table IV.1. From a consumer perspective, average auto ownership for new car buyers is estimated to be only 2-5 years, significantly lower than the total lifetime of a vehicle considered by the agencies.

Automobile Sales Tax

NHTSA and EPA use a national weighted average sales tax of 5.46% in their regulatory impact assessments, computed by weighting the most recent automobile sales tax by state (as of when the assessments were performed) by census population by state. Census population was used as the weighting parameter instead of new vehicle sales by state, though the latter was preferable, due to data availability limitations. As a proxy for new vehicles sales, NHTSA used new vehicle registrations by state. The tax rate resulting from the registration-based proxy of new vehicle sales was negligibly different from that produced using census population data. The California sales tax used in the CARB RIA is 7.25%.

Fuel Efficiency Rebound Rate

Both NHTSA and EPA estimate the rebound rate associated with increased fuel efficiency at 10%, though the agencies use different ranges in their sensitivity analyses. NHTSA uses a range of 5-20% for sensitivity testing, whereas EPA uses a range of 0-20%. CARB assumes a declining rebound rate based on the following schedule: 6% in 2012, 5% in 2020, and 3% in 2030.

On Road Fuel Economy Gap

Both NHTSA and EPA assume a 20% fuel economy gap for liquid fuel and a 30% gap for vehicles with an electric drivetrain.

Discount Rate Applied to Future Fuel Savings

NHTSA and EPA conduct their regulatory impact assessments assuming 3% and 7% discount rates on future fuel savings. These are the standard social discount rates federal agencies apply in their regulatory impact assessments, as recommended by the Office of Management and Budget (OMB). The OMB sets standard discount rates for regulatory impact assessments in light of substantial variation in the literature on the appropriate valuations of such, particularly across regulatory domains. The CARB uses a 5% discount rate for future fuel savings in its regulatory impact analysis.

Table IV.1. Survival Weighted Per-Vehicle Reference VMT Used in the RIAs

	MY 2021		MY 2025	
	Cars	Light Trucks	Cars	Light Trucks
EPA	204,161	218,399	209,037	223,688
NHTSA	206,768	218,812	211,795	223,865

Source: EPA and DOT, 2012

APPENDIX V:
ZEV Price Premium

In this Appendix we provided a detailed explanation of the methodology for the ZEV premium calculation. All the values for the BEV and PHEV premiums are presented in Table V.1. For each vehicle technology (PHEV20, PHEV40, BEV75, BEV100, and BEV200), we calculate the price premium for small and standard cars and then obtain the average of the two (highlighted in blue in Table V.1).

Tables V.2 and V.3 contain information on the price premium of four components of EVs, namely: (1) Car batteries, (2) Non-Battery Items, (3) In-Home Chargers, and (4) Labor Cost for In-Home Charger Installation. Each Table contains a separate panel for each of the following vehicle technologies: PHEV20, PHEV40, BEV75, BEV100, and BEV200. Table V.2 has information on the standard car class and Table V.3 on the small car class. The first five rows of each panel in Tables V.2 and V.3 contain data from the TAR (2016). All lines pertain to Total Costs (i.e. Direct Manufacturing Costs + Indirect Costs). A detailed list of the data documentation for those five line items is provided in Table V.4. The last two lines in every panel of Tables V.2 and V.3 calculate the total price premium of each vehicle technology using battery pack cost estimates from DOE (2013). To obtain those estimates we followed the methodology discussed below.

Calculation of Battery Pack Costs Using DOE Cost Estimates

DOE (2013) forecasts a target battery cost of $125/kWh by 2022, with a starting cost of $300/kWh in 2013 (NRC 2015b). We use those two data points to interpolate the battery costs for years 2017-2021. We assume that the $125/kWh cost will remain constant for year 2023 onwards. The resulting battery costs are presented in Table V.5. We use the data from the TAR (2016) regarding projected battery capacities (presented in Table V.6) and apply them to the DOE battery cost estimates of Table V.5. The final battery cost calculations based on the DOE projected are provided in Table V.7 where we incorporate the Indirect Costs assumption of the TAR (2016). The total price premium for the various vehicle technologies presented in the last line of each panel in Tables V.2 and V.3 assumes the same Non-Battery Items cost, In-Home Charger cost and Labor for In-Home Charger installation as the TAR (2016).

Equation (1) illustrates the calculations that lead to the ZEV premium:

$$\begin{aligned} ZEV\_premium_t &= Min\_ZEV\_floor_t * 30\% \\ &* \left\{ \left[PHEV\_category_{share_t} \sum_{i=1}^{2} * \left(PHEV_{share_{it}} * PHEV_{premium_{it}} \right) \right] \right. \\ &\left. + \left[(1 - PHEV\_category_{share_t}) \sum_{j=1}^{2} \left(BEV_{share_{jt}} * BEV_{premium_{jt}} \right) \right] \right\} \quad (1) \end{aligned}$$

where:

t=Model Year with t=2017,..., 2025

i is an indicator variable where 1=PHEV10 and 2=PHEV40
j is an indicator variable where 1=BEV100 and 2=BEV200

$PHEV\_category\_share_t$ is given in Table 7.5 (note that 1-PHEV_category_share = BEV_category_share)
BEV_share_{jt} and $PHEV\_share_{it}$ are given in Table 7.6
$Min\_ZEV\_floor_t$ is presented in Table 7.7
$BEV\_premium_{jt}$ and $PHEV\_premium_{it}$ are given in Table 7.11
30% captures the proportion of vehicles sold in the 10 ZEV states.

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Table V.1. Price Premiums for Different Types of PEVs and Vehicle Classes

			Model Year								
	Vehicle Class	Data Source	2017	2018	2019	2020	2021	2022	2023	2024	2025
PHEV20	Small	TAR (2016)	$10,135	$9,839	$9,142	$8,931	$8,746	$8,582	$8,436	$8,305	$7,504
	Standard		$11,115	$10,792	$10,005	$9,773	$9,570	$9,391	$9,230	$9,087	$8,214
	(Sm+St)/2		$10,625	$10,316	$9,574	$9,352	$9,158	$8,987	$8,833	$8,696	$7,859
PHEV40	Small	TAR (2016)	$12,643	$12,258	$11,391	$11,115	$10,874	$10,663	$10,472	$10,302	$9,260
	Standard		$14,728	$14,241	$13,200	$12,879	$12,599	$12,353	$12,132	$11,932	$10,726
	(Sm+St)/2		$13,686	$13,250	$12,296	$11,997	$11,737	$11,508	$11,302	$11,117	$9,993
BEV75	Small	TAR (2016)	$10,905	$10,473	$10,115	$9,812	$9,550	$9,321	$9,118	$8,939	$7,594
	Standard		$12,644	$12,155	$11,747	$11,401	$11,102	$10,840	$10,608	$10,401	$8,876
	(Sm+St)/2		$11,775	$11,314	$10,931	$10,607	$10,326	$10,081	$9,863	$9,670	$8,235
	Small	DOE (2013)	$8,027	$7,550	$7,048	$6,524	$5,979	$5,415	$5,461	$5,506	$4,836
	Standard		$10,195	$9,602	$8,980	$8,330	$7,655	$6,957	$7,006	$7,055	$6,216
	(Sm+St)/2		$9,111	$8,576	$8,014	$7,427	$6,817	$6,186	$6,233	$6,280	$5,526
BEV100	Small	TAR (2016)	$ 12,300	$ 11,807	$ 11,397	$ 11,051	$ 10,751	$ 10,490	$ 10,258	$ 10,052	$ 8,532
	Standard		$ 14,941	$ 14,353	$ 13,863	$ 13,448	$ 13,088	$ 12,774	$ 12,495	$ 12,336	$ 10,420
	(Sm+St)/2		$ 13,621	$ 13,080	$ 12,630	$ 12,250	$ 11,920	$ 11,632	$ 11,377	$ 11,194	$ 9,476
	Small	DOE (2013)	$ 10,206	$ 9,576	$ 8,911	$ 8,217	$ 7,493	$ 6,744	$ 6,806	$ 6,868	$ 6,020
	Standard		$ 12,952	$ 12,170	$ 11,346	$ 10,486	$ 9,591	$ 8,666	$ 8,736	$ 8,894	$ 7,726
	(Sm+St)/2		$ 11,579	$ 10,873	$ 10,128	$ 9,351	$ 8,542	$ 7,705	$ 7,771	$ 7,881	$ 6,873
BEV200	Small	TAR (2016)	$ 17,485	$ 16,764	$ 16,166	$ 15,658	$ 15,220	$ 14,838	$ 14,498	$ 14,197	$ 12,000
	Standard		$ 19,809	$ 19,005	$ 18,338	$ 17,770	$ 17,281	$ 16,853	$ 16,473	$ 16,134	$ 13,673
	(Sm+St)/2		$ 18,647	$ 17,885	$ 17,252	$ 16,714	$ 16,251	$ 15,846	$ 15,486	$ 15,166	$ 12,837
	Small	DOE (2013)	$ 15,860	$ 14,832	$ 13,746	$ 12,607	$ 11,421	$ 10,191	$ 10,299	$ 10,405	$ 9,080
	Standard		$ 19,886	$ 18,614	$ 17,272	$ 15,865	$ 14,401	$ 12,884	$ 13,010	$ 13,134	$ 11,473
	(Sm+St)/2		$ 17,873	$ 16,723	$ 15,509	$ 14,236	$ 12,911	$ 11,538	$ 11,655	$ 11,770	$ 10,276

Note: Values are in 2013 constant dollars.

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Table V.2. Total Cost Data for Four Components of PHEV20, PHEV40, BEV75, BEV100, and BEV200 (Standard Cars)

			Model Year								
	Component (Standard Car)	**Net WR**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
PHEV 20	Car Battery	6	6,454	6,171	5,935	5,735	5,563	5,412	5,278	5,159	4,317
	Non-Battery Items	6	3,514	3,478	2,930	2,900	2,871	2,845	2,820	2,797	2,775
	In-Home Charger		72	68	65	63	61	59	57	56	47
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	PHEV 20 premium (TAR)		11,115	10,792	10,005	9,773	9,570	9,391	9,230	9,087	8,214
PHEV 40	St Car Battery	5	8,670	8,251	7,936	7,669	7,438	7,237	7,058	6,898	5,772
	Non-Battery Items	5	4,547	4,500	3,791	3,752	3,715	3,681	3,649	3,618	3,590
	In-Home Charger		436	415	398	383	371	360	350	341	289
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	PHEV 40 premium (TAR)		14,728	14,241	13,200	12,879	12,599	12,353	12,132	11,932	10,726
BEV 75	Car Battery	10	10,444	9,986	9,604	9,281	9,002	8,758	8,542	8,349	6,986
	Non-Battery Items	10	648	640	633	626	620	614	609	604	499
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 75 premium (TAR)		12,644	12,155	11,747	11,401	11,102	10,840	10,608	10,401	8,876
	Car Battery (DOE)		7,995	7,433	6,837	6,210	5,555	4,875	4,940	5,003	4,326
	BEV 75 premium (DOE)		10,195	9,602	8,980	8,330	7,655	6,957	7,006	7,055	6,216
			Model Year								
	Component (Standard Car)	**Net WR**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
BEV 100	Car Battery	7	12,660	12,104	11,642	11,250	10,911	10,615	10,353	10,119	8,468
	Non-Battery Items	7	729	720	711	704	697	691	685	769	561
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 100 premium (TAR)		14,941	14,353	13,863	13,448	13,088	12,774	12,495	12,336	10,420
	Car Battery (DOE)		10,671	9,921	9,125	8,288	7,414	6,507	6,594	6,677	5,774
	BEV 100 premium (DOE)		12,952	12,170	11,346	10,486	9,591	8,666	8,736	8,894	7,726
BEV 200	Car Battery	8	17,553	16,781	16,141	15,597	15,128	14,718	14,355	14,030	11,740
	Non-Battery Items	8	704	695	687	679	673	667	661	656	542
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 200 premium		19,809	19,005	18,338	17,770	17,281	16,853	16,473	16,134	13,673
	Car Battery (DOE)		17,630	16,390	15,075	13,692	12,248	10,749	10,892	11,030	9,540
	BEV 200 premium (DOE)		19,886	18,614	17,272	15,865	14,401	12,884	13,010	13,134	11,473

Note: All costs are in 2013 constant dollars and pertain to a standard car.

Source: TAR (2016). A detailed list of the exact source Tables in the TAR for each vehicle technology is provided in Table I.4.

Table V.3. Total Cost Data for Four Components of PHEV20, PHEV40, BEV75, BEV100, and BEV200 (Small Cars)

	Model Year										
	Component (Small Car)	**Net WR**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
PHEV 20	Car Battery	6	5,921	5,661	5,445	5,262	5,104	4,965	4,843	4,733	3,961
	Non-Battery Items	6	3,067	3,035	2,557	2,531	2,506	2,483	2,461	2,441	2,421
	In-Home Charger		72	68	65	63	61	59	57	56	47
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	PHEV 20 premium (TAR)		10,135	9,839	9,142	8,931	8,746	8,582	8,436	8,305	7,504
PHEV 40	St Car Battery	6	7,469	7,141	6,868	6,637	6,437	6,263	6,108	5,970	4,996
	Non-Battery Items	6	3,724	3,685	3,105	3,073	3,043	3,015	2,988	2,963	2,940
	In-Home Charger		375	357	343	330	319	310	301	294	249
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	PHEV 40 premium (TAR)		12,643	12,258	11,391	11,115	10,874	10,663	10,472	10,302	9,260
BEV 75	Car Battery	10	9,401	8,988	8,645	8,354	8,103	7,883	7,688	7,515	6,288
	Non-Battery Items	10	(48)	(44)	(40)	(36)	(33)	(30)	(27)	(24)	(85)
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 75 premium (TAR)		10,905	10,473	10,115	9,812	9,550	9,321	9,118	8,939	7,594
	Car Battery (DOE)		6,523	6,065	5,578	5,066	4,532	3,977	4,031	4,082	3,530
	BEV 75 premium (DOE)		8,027	7,550	7,048	6,524	5,979	5,415	5,461	5,506	4,836
	Model Year										
	Component (Small Car)	**Net WR**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
BEV 100	Car Battery	8	10,792	10,318	9,924	9,590	9,301	9,049	8,826	8,626	7,218
	Non-Battery Items	8	(44)	(40)	(37)	(33)	(30)	(27)	(25)	(22)	(77)
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 100 premium (TAR)		12,300	11,807	11,397	11,051	10,751	10,490	10,258	10,052	8,532
	Car Battery (DOE)		8,698	8,087	7,438	6,756	6,043	5,303	5,374	5,442	4,706
	BEV 100 premium (DOE)		10,206	9,576	8,911	8,217	7,493	6,744	6,806	6,868	6,020
BEV 200	Car Battery	8	15,977	15,275	14,692	14,197	13,770	13,397	13,066	12,771	10,686
	Non-Battery Items	8	(44)	(40)	(36)	(33)	(30)	(27)	(25)	(22)	(77)
	In-Home Charger		477	454	435	419	405	393	382	373	316
	Labor Cost for In-Home Charge Installation		1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075
	BEV 200 premium		17,485	16,764	16,166	15,658	15,220	14,838	14,498	14,197	12,000
	Car Battery (DOE)		14,352	13,343	12,272	11,146	9,971	8,750	8,867	8,979	7,766
	BEV 200 premium (DOE)		15,860	14,832	13,746	12,607	11,421	10,191	10,299	10,405	9,080

Note: All costs are in 2013 constant dollars and pertain to a small car.

Table V.4. Sources of Data Regarding Four Cost Components of PEVs Presented in Tables I.2 and I.3

	PHEV20	PHEV40	BEV75	BEV100	BEV200
Car Battery	Table 5.126	Table 5.127	Table 5.128	Table 5.129	Table 5.130
Non-Battery Items	Table 5.91	Table 5.92	Table 5.93	Table 5.94	Table 5.95
In-Home Charger	Table 5.96	Table 5.97	Table 5.98	Table 5.98	Table 5.98
Labor Costs for In-Home Charger Installation	Table 5.99	Table 5.99	Table 5.99	Table 5.99	Table 5.99

Note: All table numbers are from the TAR (2016).

Table V.5. Direct Manufacturing Cost of Battery Packs Based on DOE (2013) Target Cost Information

	Model Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
DMC of battery packs based on DOE target (in $2013/kWh)	222	203	183	164	144	125	125	125	125

Source: DOE 2013, NRC 2015

Table V.6. Battery Capacity in kWh for BEV75, BEV100, and BEV200 by Vehicle Class (Small and Standard Cars)

	BEV75		BEV100		BEV200	
	Small	Standards	Small	Standard	Small	Standard
Battery Capacity in kWh	19.5	23.9	26	31.9	42.9	52.7

Source: TAR 2016, Table 5.112

Table V.7. Total Cost of Batteries for BEV75, BEV100, and BEV200 by Vehicle Class (Small and Standard Cars)

			Model Year								
Vehicle Technology	**Vehicle Class**		**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
		IC/DMC ratio	0.505	0.534	0.560	0.585	0.609	0.632	0.654	0.674	0.448
BEV75	Small	DMC	4,333	3,954	3,575	3,196	2,817	2,438	2,438	2,438	2,438
		TC	6,523	6,065	5,578	5,066	4,532	3,977	4,031	4,082	3,530
	Standard	DMC	5,311	4,846	4,382	3,917	3,452	2,988	2,988	2,988	2,988
		TC	7,995	7,433	6,837	6,210	5,555	4,875	4,940	5,003	4,326
BEV100	Small	DMC	5,778	5,272	4,767	4,261	3,756	3,250	3,250	3,250	3,250
		TC	8,698	8,087	7,438	6,756	6,043	5,303	5,374	5,442	4,706
	Standard	DMC	7,089	6,469	5,848	5,228	4,608	3,988	3,988	3,988	3,988
		TC	10,671	9,921	9,125	8,288	7,414	6,507	6,594	6,677	5,774
BEV200	Small	DMC	9,533	8,699	7,865	7,031	6,197	5,363	5,363	5,363	5,363
		TC	14,352	13,343	12,272	11,146	9,971	8,750	8,867	8,979	7,766
	Standard	DMC	11,711	10,686	9,662	8,637	7,612	6,588	6,588	6,588	6,588
		TC	17,630	16,390	15,075	13,692	12,248	10,749	10,892	11,030	9,540

Note: The DMC (Direct Manufacturing Cost) is expressed in 2013 constant dollars and was calculated using the battery pack cost figures in Table A.4 and the battery capacity figures in Table A.5. The TC (Total Cost) rows were calculated by multiplying the DMC rows by 1+(IC/DMC ratio). The latter was obtained from the TAR (2016).

APPENDIX VI:
Objective Function and Constraints of COMET Model

In the COMET model, the objective function is:

$$\min_{\text{wrt } x_{ijtp}^{pack}} y^{totalCost} = \sum_{ijtpk} \frac{c_{ijk}^{sales} c_{ijk}^{packCost} x_{ijtp}^{pack}}{\left(1+c^{dr}\right)^{t}},$$

where y is total cost to the individual manufacturer, i is vehicle model, j is vehicle technology type, k is vehicle class, t is the time period, and p is the technology package. The term c represents model parameters, which are exogenous inputs from EPA input files, and x represents model variables that the optimization problem varies, all with superscript descriptors. The dr descriptor denotes a discount rate which is meant to replicate credit banking behavior.

We constructed the model to include four constraints: (1) the CAFE and GHG constraint; (2) the technology package constraint; (3) the maximum penetration of a technology package; and (4) the ZEV mandate. The notation for the constraints is as follows:

The CAFE/GHG constraint

$$\sum_{t}\left(c_{tk}^{GHG} - \frac{\sum_{i \in tok,\, jtp} c_{ijk}^{sales} c_{ij}^{emRate} x_{ijtp}^{pack}}{\sum_{i \in tok,\, j} c_{ijk}^{sales}}\right) \geq 0, \forall k;$$

technology package constraint

$$\sum_{j \in toj,\, p \in ptoj} x_{ijtp}^{pack} - 1 = 0, \forall it;$$

maximum penetration of technology package

$$c_{jp}^{packCap} - x_{ijtp}^{pack} \geq 0, \forall ijtp;$$

and the ZEV mandate

$$\frac{\sum_{ijpk} x_{ijtp}^{pack} c_{ijk}^{sales} c_{jp}^{isZEV}}{\sum_{ijk} c_{ijk}^{sales}} - c_{t}^{ZEV} \geq 0, \forall t.$$

Examples of COMET model parameters are presented in Table VI.1.

COMET accommodates a straightforward integration of regulatory requirements outside the current capability of the OMEGA model, which allows us to include the CAFE and GHG emissions standard as well as the ZEV mandate in the COMET scenarios.

The CAFE and GHG standards are harmonized and operate at a continuously more stringent rate over time. The standards are not uniform across all manufacturers; the compliance value is dependent on the fleet weighted-average footprint for each automaker.

Table VI.1. Examples of Model Parameters Used in COMET

	Description	Example
Sets		
I	Vehicle model	v1.4.1: Compact (Honda), v1.4.56: Civic (Honda)
J	Vehicle technology type	LargeAuto
K	Vehicle class	C/T (car or truck)
T	Time period	2016 (year)
P	Technology package	Indexed technology package, e.g. package 1: Auto 4VDI4+LUB+EFR1+ASL1+LDB+DCP+WR0%+6sp
Parameters		
$c_{ijk}^{\text{packCost}}$	Cost of a specific technology package	$147 for technology package 1
c^{dr}	Banking discount rate	15%
c_{tk}^{GHG}	EPA GHG standard requirement by vehicle class and year	249 grams/mi for Honda in 2014
c_{ij}^{emRate}	Base vehicle emissions rate	Vehicle index 1119 has a base emissions of 404.6 grams/mi
c_{jp}^{isEV}	Boolean denoting whether vehicle technology is an EV package	1 for EV technology, 0 for gasoline technology
c_{t}^{ZEV}	ZEV requirement	0.6% requirement for manufacturers in 2018

The calculation for determining a manufacturer's compliance pathway uses the values seen in Table VI.2 as follows:

$$f(x)=\begin{cases} a, & xc+d \le a \\ b, & xc+d \ge b \\ xc+d & \end{cases}$$

The equation above describes the rules for determining the emission rate requirement for each manufacturer. For example, suppose the sales-weighted footprint for a manufacturer in the passenger car segment is 50 sq ft. in 2016. This manufacturer's requirement in 2016 can be calculated as follows since $a<50*c+d<b$:

$$50 \times 4.72 + 12.7 = 248.7$$

If, however, the sales-weighted footprint for the manufacturer is 40 sq ft. in 2016, a>40*c+d and the manufacturer is below the floor and thus the emission rate requirement is 206 grams/mi. Likewise, if the sales-weighted footprint is 60 sq ft. in 2016, the manufacturer is above the ceiling since c<60*c+d and therefore the emission rate requirement is capped at 277 grams/mi.

Table VI.2. abcd Values for CAFE/GHG Emissions Standard Compliance

	Passenger Cars				Light Trucks			
Year	a	b	c	d	a	b	c	d
2014	228	299	4.72	34.8	275	376	4.04	109.4
2015	217	288	4.72	23.4	261	362	4.04	95.1
2016	206	277	4.72	12.7	247	348	4.04	81.1
2017	194.7	262.7	4.53	8.9	238.1	347.2	4.87	38.3
2018	184.9	250.1	4.35	6.5	226.8	341.7	4.76	31.6
2019	175.3	238	4.17	4.2	219.5	338.6	4.68	27.7
2020	166.1	226.2	4.01	1.9	211.9	336.7	4.57	24.6
2021	157.2	214.9	3.84	-0.4	195.4	334.8	4.28	19.8
2022	150.2	205.5	3.69	-1.1	185.7	320.8	4.09	17.8
2023	143.3	196.5	3.54	-1.8	176.4	305.6	3.91	16
2024	136.8	187.8	3.4	-2.5	167.6	291	3.74	14.2
2025	130.5	179.5	3.26	-3.2	159.1	277.1	3.58	12.5

The ZEV mandate requires that a percentage of vehicles distributed for sale by larger-volume manufacturers consist of ZEVs, as classified by CARB under the regulatory program. The annual requirements for zero-emissions vehicles are presented in Table VI.3. This compliance timeline is based on the annual sales of vehicles in ZEV regions and the ZEV standard over time. While the actual composition of the electric vehicle requirement is more nuanced, in COMET there is a flat requirement for all manufacturers to meet regardless of which type of electric vehicle is adopted, such as a BEV75 or a BEV200.

Table VI.3. Estimated National Zero-Emission Vehicle Requirements by Model Year

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Proportion ZEV Requirement	0.006	0.006	0.006	0.006	0.006	0.012	0.018	0.024	0.03	0.036	0.042	0.048

Since the technology input files include electrification technologies, COMET selects those particular technologies in the same preferential cost-efficient order as all other scenarios. However, due to the presence of a specific constraint on minimum EV requirements, any solutions that do not meet the ZEV mandate requirement are not legitimate solutions. The final solution from COMET is the most cost-effective method of complying with both CAFE/GHG and ZEV standards. The inclusion of the ZEV mandate results in a higher cost than if just the CAFE/GHG standards are considered. However, COMET accounts for the fact that, when manufacturers produce PEVs to comply with the ZEV regulation, they obtain compliance credits in the federal programs, which makes it somewhat easier to comply with the federal programs.

APPENDIX VII: Supply Chain Categories

NRC 2015 used the example of the midsize car pathway in order to capture the cost components of achieving the 2025 CAFE standard. The Committee utilized three major categories of technologies: (1) shift from a 2.4L NA Engine to a 1.6L TRBDS, (2) shift from a 6 speed AT transmissions to an 8 Speed AT, and (3) shift to a Lightweight Vehicle Body Structure. Table VII.1 presents the Direct Manufacturing Cost (DMC) information for each of those three technologies, broken down by DMC categories.

Table VII.1. DMC Categories for Midsize Car Compliance with 2025 CAFE Standards

		Labor	Burden	End Item Scrap	Selling, General and	Profit	Engineering, Design & Testing (ED&T)/ Research & Development (R&D)	Total Packaging Cost	Net Cost to OEM
1.6L TRBDS vs 2.4L NA Engine	$218.82	$72.58	$154.24	$11.72	$33.96	$33.12	$12.36	$0.90	$537.70
8 Speed AT vs. 6 Speed AT	$8.49	$15.11	$28.20	$0.69	$4.27	$3.74	$1.34		$61.84
Lightweight Vehicle Body Structure	$580.00	$110.00	$443.00						$1,133.00
TOTAL	$807.31	$197.69	$625.44	$12.41	$38.23	$36.86	$13.70	$0.90	$1732.54

Source: EPA, 2009; EPA, 2011; NHTSA, 2012

In order to better align those categories with our REMI model, we have conducted the re-organization presented in Table VII.2.

The difference between Table VII.1 and Table VII.2 is that in the latter we have merged the following DMC categories:

Table VII.2. Reorganized DMC Categories that Align with REMI Modeling Inputs

	Materials	Labor	Burden	Shareholder Income	ED&T R&D	Total
1.6L TRBDS vs. 2.4L NA Engine	$230.54	$72.58	$155.14	$67.08	$12.36	$537.70
8 Speed AT vs. 6 Speed AT	$9.18	$15.11	$28.20	$8.01	$1.34	$61.84
Lightweight Vehicle Body Structure	$580.00	$110.00	$443.00			$1133.00
TOTAL	$819.72	$197.69	$626.34	$75.09	$13.70	$1732.54
Percentage Share of DMC	47.3%	11.4%	36.2%	4.3%	0.8%	
Percentage Share of Total Cost	32.4%	7.8%	24.8%	3%	0.5%	

(a) Total packaging cost (Table VII.1) has been added to the Burden category in Table VII.2.

(b) End item scrap (Table VII.1) has been added to the Materials category in Table VII.2.

(c) SG&A and Profit (Table VII.1) have been merged into a new category which we call Shareholder income in Table VII.2.

The last two rows of Table VII.2 show the share of each DMC category as a percentage of: (a) DMC and (b) Total Cost (TC). The TC percentages incorporate the 1.46 RPE multiplier used by the EPA. That is, in order to obtain TC, the EPA applied the following adjustment to DMC: TC=DMC*1.46, where Indirect Cost (IC) is the 0.46 adjustment. Therefore, DMC represents 68.5% of TC (i.e. 68.5%=100/146) with IC representing the remaining 32.5% (i.e. 32.5%=46/146). Table VII.3 shows the various IC categories of the RPE multiplier.

Table VII.3. Indirect Cost Categories of the RPE Multiplier

RPE Multiplier Contributor	*Industry Average*
Vehicle Manufacturing	
Cost of Sales	1
Production Overhead	
Warranty	0.03
R&D (product development)	0.05
Depreciation and Amortization	0.07
Maintenance, Repair Operations Cost	0.03
Total Production Overhead	0.18
Corporate Overhead	
General and Administrative	0.07
Retirement	<0.01
Health	0.01
Total Corporate Overhead	0.08
Selling	
Transportation	0.04
Marketing	0.04
Dealers	
Dealer New Vehicle Net Profit	<0.01
Dealer New Vehicle Selling Cost	0.06
Total Selling and Dealer Contributors	0.14
Sum of Indirect Costs	
Net Income	0.06
Other Costs (not included as contributors)	0.04
RPE Multiplier	**1.46**

We have made the following assumptions in order to merge the IC categories of Table VII.3 with the DMC categories in Table VII.2:

(a) Production overhead (with the exception of R&D) and Corporate Overhead in Table VII.3 are part of the Burden DMC category of Table VII.2.

(b) Selling and Dealers categories in Table VII.3 form a new cost category labeled "Dealers."

(c) Net income in Table VII.3 is part of the Shareholders income category in Table VII.2.

Applying the adjustments discussed above results in the percentage shares illustrated in Table VII.4. Table VII.5 combines the information in Table VII.2 and Table VII.4 and shows the final percentage shares in each of the six cost categories.

Table VII.4. IC Categories and Their Shares of IC and TC

	R&D	Production and Corporate Overhead	Dealers	Shareholder
Percentage Share of IC	10.9%	45.7%	30.4%	13%
Percentage Share of TC	3.4%	14.4%	9.6%	4.1%

Table VII.5. Cost Categories as Percentage Shares of TC

Total Cost Components						
	R&D	Overhead/Burden	Materials	Labor	Shareholder Income	Dealers
Percentage Share of TC	4%	39.1%	32.4%	7.8%	7.1%	9.6%

APPENDIX VIII:
Total Cost of Ownership Model of Sales Impacts

Overview

One of our primary objectives is to calculate the sales impact of the CAFE standards. Following NHTSA (2010; 2012c) we calculate the sales impact of CAFE after accounting for the net total cost of ownership. This approach assumes that the consumer considers not only the incremental gross price of buying a new car, but also the effect of the higher price on taxes, insurance, and loan financing. These costs are then netted against any fuel savings as well as any incremental resale value. The final expression used in the calculations can be expressed as follows:

$$\%\Delta Sit=(Pitn/priceit)*\varepsilon,$$
$$Pitn=Pitg-Rit-Fit-Tit-Iit-Lit,$$

Subscript *i* indicates vehicle type (cars and light duty trucks) and subscript *t* indicates model years. %ΔSis percentage change in vehicle sales, Pnis net price premium, Pgis gross price premium, *R* is incremental resale value, *F* is fuel savings, *T* is incremental sales tax on new vehicles, *I* is incremental auto insurance costs, *L* is incremental auto-loan financing costs, ε is price elasticity of demand for new vehicles, and *price* is average vehicle price based on EIA (2012) projections.

Our estimates of percentage change in sales are calculated relative to a baseline that holds CAFE standards fixed at 2016 levels (i.e. ~38 mpg for cars and ~29 MPG for trucks).

The analysis begins with a replication of the (NHTSA 2012a) analysis for model years 2017-2025; we refer to this replication as our 2012 Perspective NHTSA. We then make several adjustments to the 2012 Perspective NHTSA approach to account for information that became available after the 2012 RIA was published. Each adjustment is made relative to the 2012 Perspective. Therefore, we are able to show how each change, separately, affects the results.

The 2012 Perspective

The 2012 Perspective represents our attempt to replicate the NHTSA results. As best as possible, we use the same data and assumptions as described in the 2012 RIA. This section describes those data and assumptions.

Price Premium

The 2012 perspective NHTSA uses price premium from the NHTSA 2012 RIA, which reports a premium that increases from $364 to $1,578 for MY 2017 to MY 2025 cars, and $147 to $1226 for MY 2017 to MY 2025 trucks. All dollar amounts are in 2010 constant dollars. See section 7.2 and Table 7.3 for more information on the NHTSA price premium.

Fuel Economy

The 2012 perspective NHTSA uses fuel economy from the NHTSA RIA, which reports MPG that increase from 39.61 to 55.32 for MY 2017 to MY 2025 cars, and 29.08 to 39.34 for MY 2017 to MY 2025 trucks.

Fuel Price Projections

We use reference fuel price data reported in the RIA (NHTSA RIA, Table VIII-5a, page 866). Prices are projected to increase from $3.64 in 2017 to $3.84 in 2025. The 2012 AEO projects fuel prices up to 2040. We extend the fuel projections to 2071 by using a growth rate of 0.7%.

Consumer Valuation of Fuel Savings
This covers several components:

1. Consumer fuel price projections: we follow NHTSA and assume that consumers use the AEO fuel price projections to forecast future fuel prices.
2. Consumer valuation period: we assume consumers value five years' worth of fuel savings.
3. Resale value: we assume the incremental resale value is equal to 35% of the gross premium.

Survival Rate
We use the survival rates published by NHTSA in the 2012 RIA.

Vehicle Miles Traveled
Vehicle miles traveled is based on 2008 data published in the 2009 National Household Travel Survey. We make three adjustments to the 2008 VMT schedule to produce VMT schedules for each model year following the RIA. For example, the VMT for a MY 2017 vehicle of age one (assuming the CAFE standards are increased) is obtained using the following adjustments.

1. Fuel price rebound effect: rebound effect due to change in fuel price between 2008 and 2017: (FuelPrice_2008 - FuelPrice_2017)/ FuelPrice_2008 times the rebound estimate of -0.1. Fuel price in 2008 is $3.37 and the fuel price for 2017 is taken from AEO2012.
2. Fuel economy rebound effect: rebound effect of change in MPG between 2008 and 2017: (MPG_2008 - MPG_2017)/MPG_2008 times the rebound estimate of -0.1. MPG_2008 is 22.66 for trucks and 29.2 for cars, and are taken from AEO 2011 (Table A7, page 130). Note that our calculations use the fleet MPG from 2008 and not the MPG for each model year vehicle that existed in 2008. The 2017 MPG is based on the assumption that the stricter CAFE standards are implemented.
3. Secular growth factor: (1+g)^(9). We follow NHTSA and assume that g=0.6%.

The VMT schedule for a MY 2017 vehicle of age 2 is obtained using the same three adjustments, but replaces the 2017 fuel price with the fuel price for 2018 in step 1, and uses 10 instead of 9 in the exponent of step 3, and so on for older MY 2017 vehicles.

Similarly, the VMT schedule for a MY 2025 vehicle of age 1 is obtained using the following adjustments:

1. Rebound effect due to change in fuel price between 2008 and 2017: (FuelPrice_2008 - FuelPrice_2025)/ FuelPrice_2008 times the rebound estimate of -0.1.
2. Rebound effect of change in MPG between 2008 and 2017: (MPG_2008 - MPG_2025)/MPG_2008 times the rebound estimate of -0.1.
3. Secular growth factor: (1+g)^(17). We follow NHTSA and assume the g=0.6%.

The VMT schedule for a MY 2025 vehicle of age 2 is obtained using the same three adjustments, but replaces the 2025 fuel price with the fuel price for 2026 in step 1, and uses 18 instead of 17 in the exponent of step 3, and so on for older MY 2025 vehicles. These adjustments imply that the VMT schedules vary both within and between MYs. To summarize:

VMT(MY t) = VMT(2008)*Fuel price rebound effect*Fuel economy rebound effect*Secular growth factor*survival rate

We also calculate VMT schedules for each model year under the assumption that CAFE standards remain fixed at their 2016 levels. The procedure is the same as above with the exception that the MPG for each MY (2017-2025) is fixed at the 2016 level.

Other Costs of Ownership
We use the data published in the RIA to model changes in auto-insurance costs, auto-loan financing costs, and sales taxes.

1. The population-weighted average sales tax rate is 5.53%.
2. The auto-loan interest rate is 5.16%, and we assume that 70% of consumers finance their purchase.
3. The auto-insurance costs are based on the assumption that insurance costs are 1.86%, 1.82%, 1.75%, 1.64%, and 1.5% of the vehicle's price over the first five years, respectively, of ownership.

Discount Rate
All dollar amounts are reported in constant 2010 dollars, and are discounted using a discount rate of 7%.

Fuel Savings
The fuel savings are calculated using AEO fuel price projections, survival rate adjusted VMT schedules, and vehicle fuel economy. The fuel economy is converted to gallons per mile (GPM) and corrected for on-road efficiency of 80%. The VMT schedule and GPM are combined to calculate gallons saved, which we define as the difference between gallons consumed under the updated CAFE standards and gallons consumed under the 2016 CAFE standards. This procedure gives us the gallons saved in each year over the life of each model year vehicle. We then multiply gallons saved by fuel price to get fuel savings. Since the consumer only values five years of savings, we find the present value of the fuel savings over the first five years.

The Adjustments
We make several adjustments to the baseline. The adjustment accounts for information that existed in 2012 but was not included in the agency's analyses, as well as information that did not exist in 2012.

ZEV Mandate
We adjust the baseline price premium to account for the fact that zero-emission vehicles (ZEVs) are more expensive than internal combustion engine vehicles. We calculate the sales impacts of three alternative ways of satisfying the ZEV mandate:

1. Use only BEV75.
2. Use only BEV200.
3. Use a mix of BEV100, BEV200, PHEV20, and PHEV40.

In each case, we assume that ZEV states control 30% of the national market, but that the costs of compliance with ZEV will be distributed across cars in the national market. The share of ZEVs that must be sold in each state depends on the type of ZEV. The required share in 2025 is 8.8% if only BEV200s are sold and 16% if a mix of BEVs and PHEVs are sold. The ZEV price premium is taken from the TAR, and also depends on the type of ZEV; the premium in 2025 is $12,153 and $9,171 for BEV200 and mix of BEV and PHEVs, respectively.

The adjusted price premium for the case where the ZEV mandate is satisfied with a mix of BEVs and PHEVs in MY2025 is calculated as follows:

$$Pg=(1-0.3*0.16)*\$1,578+(0.3*0.16)*\$9,171=\$1,942$$

A similar calculation is made for other MYs. We further assume that the ZEV mandate will be satisfied with only cars. In other words, we do not include any ZEV trucks in the analysis. This implies that the ZEV premium on cars is inflated relative to a scenario where a mix of cars and trucks are used to satisfy the ZEV mandate. We illustrate the potential bias of our chosen approach with a simple example in Table VIII.1 below. Panel A of Table VIII.1 shows the ZEV premium adjustment for MY 2025 if we assume the ZEV mandate is met proportionally by cars and trucks. The premium is $170 (=0.4*0.3*0.154*9171) for cars and $285 (=0.6*0.3*0.154*9171) for trucks. The weighted average premium in this case is $455 (=170+285), which is comparable to the figure projected by the agencies.

Table VIII.1. Illustration of ZEV Premium Calculation for MY 2025

Type	MKT Share	ZEV Mandate	Mkt Share of ZEV States	Premium	ZEV Premium
Panel A: ZEV Regulation Met Proportionally by Cars and Trucks					
Cars	40.00%	15.40%	30.00%	$9,171.00	$169.48
Trucks	60.00%	15.40%	30.00%	$10,286.55	$285.14
Weighted average premium					$454.62
Panel B: ZEV Regulation Met with Cars Only					
Cars	40.00%	38.50%	30.00%	$9,171.00	$423.70
Trucks	60.00%	0.00%	30.00%	$10,286.55	$0.00
Weighted average premium					$423.70

Note: Reported in the last column is the incremental cost of a vehicle due to the ZEV regulation. Calculations are based on the assumption that the ZEV regulation is met by a combination of BEVs and PHEVs.

Panel B of Table VIII.1 shows the effect of assuming ZEV is met with only cars. In this case, we have to increase the share of ZEV cars to 38.5% (=15.4%/40%) to account for the fact that all ZEVs will be cars. The average premium for cars is now $424 (=0.4*0.3*0.385*9171). This calculation explicitly accounts for the number of cars that must be sold in order to satisfy ZEV (38.5% of 40% of 30%) without overestimating the number of ZEV vehicles. Similarly, the premium for trucks is $0 (=0.6*0.3*0.0*10287). Importantly, the weighted average ZEV premium for the national fleet is now $424, which is modestly lower than the premium if we assumed both cars and trucks would be used to satisfy ZEV.

Notice that our illustration made the simplifying assumption that the ZEV mandate will be met proportionally by cars and trucks. This is a bold assumption that most surely will not be realized. We believe the actual distribution of ZEV vehicles will be much closer to the assumption in panel B of Table VIII.1; most ZEVs will be cars. Therefore, the bias in our chosen approach should be approximately zero. A more plausible assumption is that automakers satisfy ZEV with cars, but allocate the costs to both cars and trucks. We present results based on this assumption as we assume manufacturers split the ZEV costs equally between cars and trucks.

The method used to account for ZEV costs so far does not account for the interdependence between ZEV and CAFE. Since manufacturers are required to produce ZEVs, and because ZEVs have higher MPG, it is reasonable to assume that compliance with ZEV will reduce the ICE technological requirements needed to satisfy CAFE. The lower technological need implies a lower price premium for ICEs. Failure to account for this interdependence implies that manufacturers will over-comply with CAFE. We relax this assumption by using the COMET model to account for the ZEV premium. The COMET approach also allows for the ZEV premium to apply, separately, to both cars and trucks, but maintains the assumption that ZEV costs are distributed nationally.

Besides accounting for the interdependence between ZEV and CAFE, the COMET approach differs from the back-of-the-envelope approach used above in that the COMET is based solely on BEV75. Additionally, the COMET modeling of ZEV also incorporates the NRC adjustments (discussed below). See section 7.4 for a more detailed discussion of COMET.

NRC Price Premium

The National Research Council (2015a) report on technology costs and fuel-saving effectiveness highlighted two alternative cost scenarios: "high most likely" and "low most likely." The high most likely case suggests that costs

are 56% higher than the NHTSA estimates while the low most likely case suggests costs are 11% higher than the NHTSA estimates. We present results using these two adjustments. In each case we adjust the NHTSA estimates by the amount recommended by NRC. See section 7.2 for a detailed discussion of the NRC adjustments.

Consumer Valuation of Fuel Savings and Resale Value

We consider four adjustments to the way fuel is valued by consumers.

1. Consumers value one year of fuel savings.
2. Consumers value three years of fuel savings.
3. Consumers' forecast of fuel price is myopic; fuel price at time of purchase remains fixed over time.
4. Resale value is equal to 55% of the present value of fuel savings from years six to 30 of the vehicle's life.

Each of these changes is made separately. The resale value calculation is based on the assumption that the first owner believes the value of the fuel saving technology is capitalized in the price of the vehicle. She expects that the vehicle can trade for a premium on the secondary market, and that the premium is based on the present value of fuel savings over the remaining life of the vehicle. If consumers fully valued fuel savings then the premium would be equal to the present value of fuel savings. However, existing evidence is ambiguous on this issue. For this reason, we present results with full and undervaluation. In the current context, we assume the secondary market only values 55% of the fuel savings.

Other Adjustments

We make several other adjustments to capture changes that have taken place since the 2012 RIA.

1. NHTSA published updated VMT estimates in the TAR. We use these VMT estimates in place of the 2008 VMT from the 2012 RIA. The new VMT estimates are for the 2015 fleet. We use the same procedure described above to adjust the 2015 schedule for each model year from 2017-2025.
2. Auto-loan rate and discount rate are set at different values in the baseline model. We adjust this assumption and instead set the auto-loan rate equal to the discount rate.
3. The baseline model is based on fuel price projections from EIA (2012). Fuel prices have fallen significantly since then. For example, the fuel price in 2025 falls from $3.84 (EIA 2012) to $2.74 (EIA 2016). We account for this significant decline in fuel prices by presenting results based on the 2016 AEO.
4. We present results for three discount rates: 5%, 7%, and 13%.

The 2016 Perspective

Having explored the effect of each adjustment separately, we then combine them to determine the joint effect on vehicle sales. The 2016 perspective uses the following data/assumptions that are different from the baseline:

1. ZEV Mandate: turned on
2. Price Premium: now accounts for ZEV and NRC adjustments, but varies
3. Consumer Fuel Price Projections: myopic
4. Consumer Fuel Valuation Period: varies
5. Resale Value: varies
6. Fuel Price: AEO 2016 (reference case; $2.74 in 2025)
7. VMT: NHTSA's updated data from the TAR
8. Financing: auto-loan rate set equal to discount rate (7%)

We explore two variants of price premium and five variants of consumer fuel valuation.

Price Premium

Now accounts for ZEV and NRC adjustments.

1. High price premium uses the NHTSA+NRC(56%)+TAR estimate of ZEV.
2. Low price premium uses the NHTSA+NRC(11%)+DOE estimate of ZEV.
3. Both price premiums use the "medium" consumer valuation of fuel economy described below.

DOE estimate of ZEV is lower than the TAR estimate of ZEV premium.

Consumer Valuation and Resale Value

We consider five alternative specifications for consumer fuel valuation listed in Table VIII.2. Each alternative is run with both the high and low price premium described above.

Table VIII.2. Consumer Valuation of Fuel Savings and Resale Value

Alternative	Consumer Fuel Valuation Period (Years)	Incremental Resale Value
Lower	1	0
Low	3	0
Medium	3	35% of gross premium
High	3	55% of present value of fuel savings from year 6 to 30
Higher	5	100% of present value of fuel savings from year 6 to 30

REMI vs. TCO Price Premium Definition

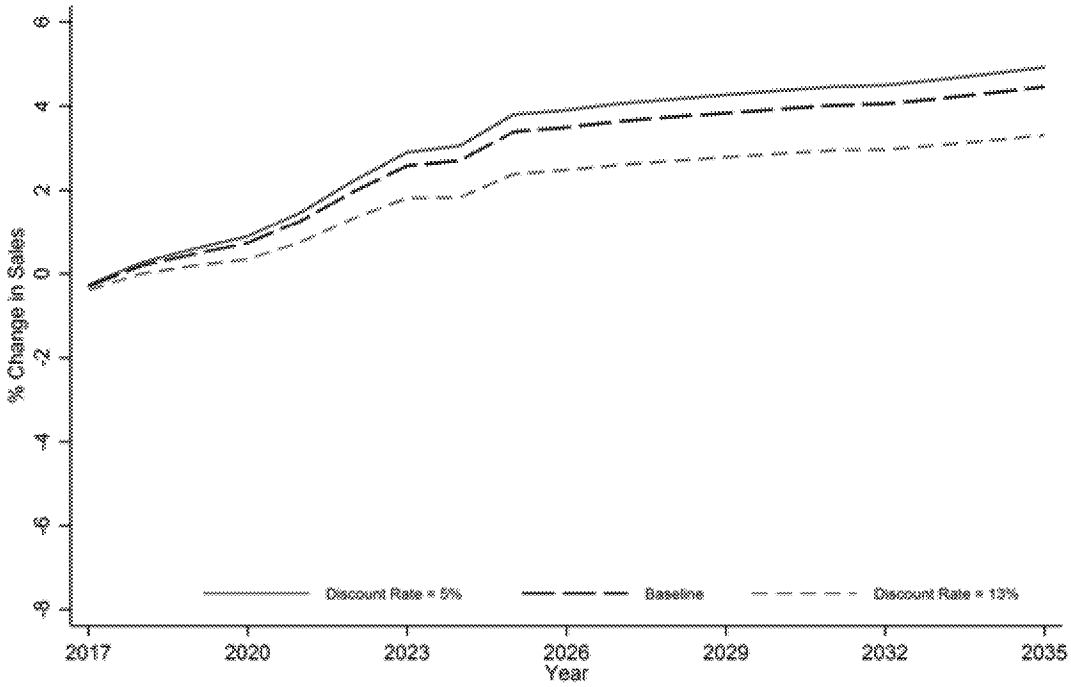
Both REMI and TCO use the terms "2016 perspective high" and "2016 perspective low." Because of differences in their modelling capabilities, each model defines these two terms differently. The differences are illustrated in Table VIII.3.

Table VIII.3. Description of 2016 Perspective Differences between REMI and TCO

	2016 Perspective High		2016 Perspective Low		2016 Perspective COMET	
	REMI	TCO	REMI	TCO	REMI	TCO
Price Premium: NHTSA	Yes	Yes	Yes	Yes	EPA - TAR	EPA - TAR
Price Premium: ZEV	Yes - TAR	Yes - TAR	Yes - DOE	Yes - DOE	Yes - TAR	Yes - TAR
Price Premium: NRC	Yes - High	Yes - High	Yes - Low	Yes - Low		
Consumer Valuation	No	Yes	No	Yes		
Fuel Price	AEO2016	AEO2016	AEO2016	AEO2016		

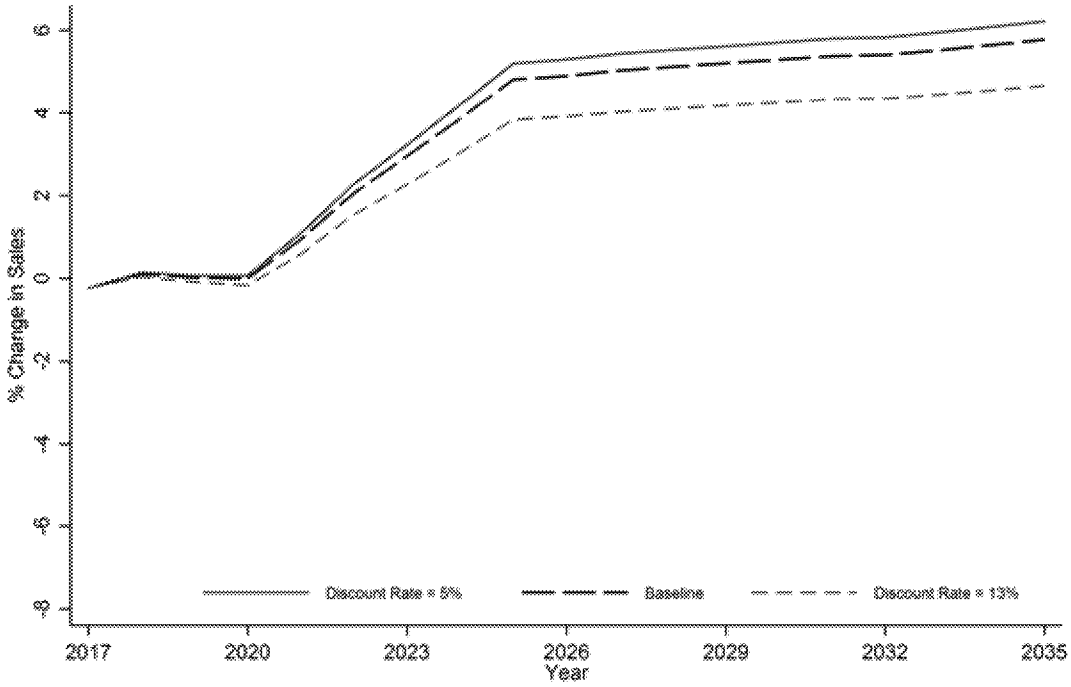
APPENDIX IX: Results

Figure IX.1. Impact of Regulation on Car Sales, Alternative Discount Rates.



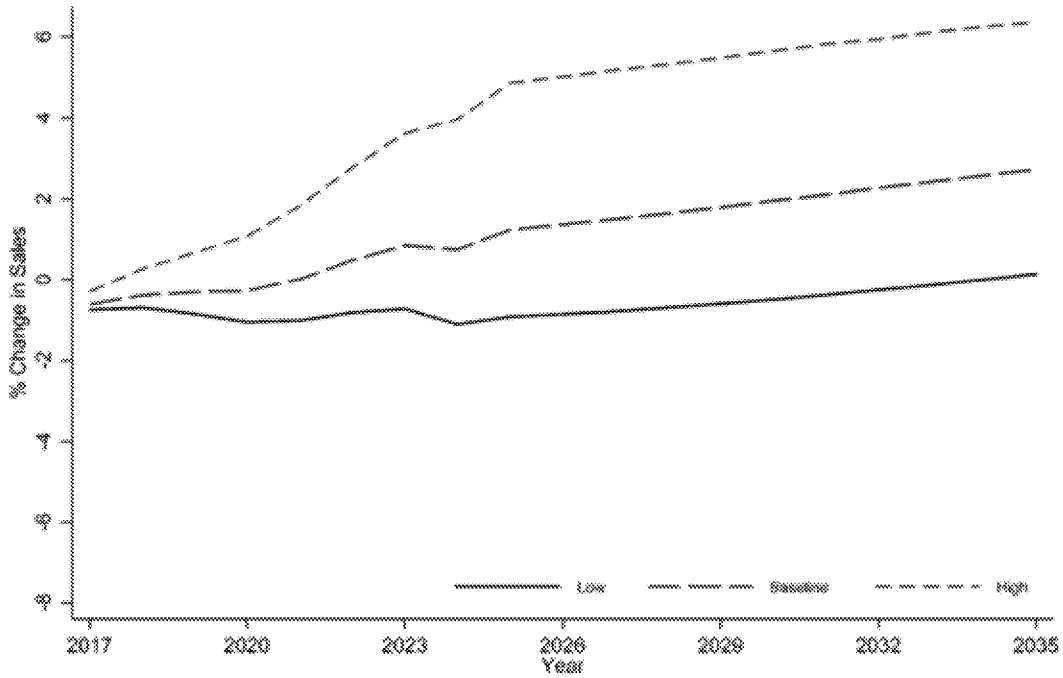
Note: Reported is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about discount rates. *Baseline* reports results using a discount rate of 7%.

Figure IX.2. Impact of Regulation on Truck Sales, Alternative Discount Rates.



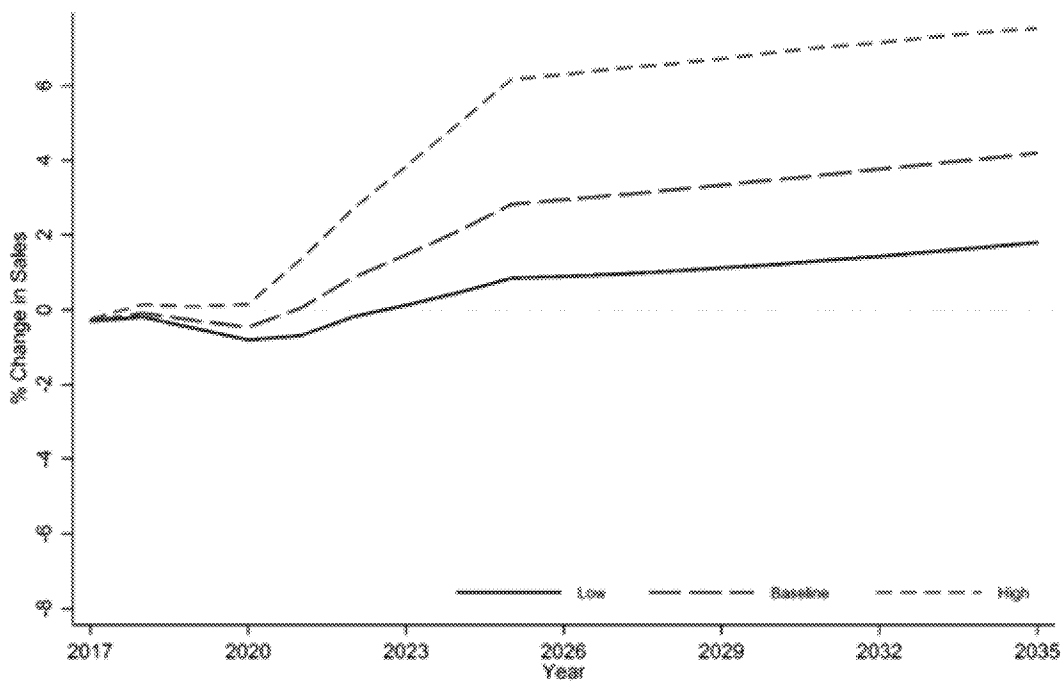
Note: Reported is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about discount rates. *Baseline* reports results using a discount rate of 7%."

Figure IX.3. Impact of Regulation on Car Sales, Alternative Fuel Prices.



Note: Reported is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about fuel prices. *Baseline* reports results using the reference fuel price published in the 2016 annual energy outlook (AEO). *Low* and *High* report the results when we use the AEO 2016 low and high fuel price projections, respectively.

Figure IX.4. Impact of Regulation on Truck Sales, Alternative Fuel Prices.



Note: Reported is the percentage change in vehicle sales due to the regulatory programs based on various assumptions about fuel prices. *Baseline* reports results using the reference fuel price published in the 2016 annual energy outlook (AEO). *Low* and *High* report the results when we use the AEO 2016 low and high fuel price projections, respectively.

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Message

From: Charmley, William [charmley.william@epa.gov]
Sent: 12/16/2016 8:34:08 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]
Subject: Re: NAIAS

Jim

I am late in getting a note back to the alliance and global, but i believe 4 people from EPA will attend:

Chris Grundler
Karl Simon
David Haugen
Bill Charmley

Thanks
Bill

Sent from my iPhone

On Dec 16, 2016, at 2:33 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:

> Hi Bill,
> NHTSA is working on finalizing the list of attendees for Monday of the NAIAS. I indicated that I would be interested in attending. As CAFE parallels GHG and criteria emissions, I wanted to reach out to see if EPA has firmed up your attendee list yet, and who expects to attend.
> Thanks.
> Jim

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 12/10/2016 9:40:27 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Yoon, Rebecca (NHTSA) [rebecca.yoon@dot.gov]
CC: Olechiw, Michael [olechiw.michael@epa.gov]; Moran, Robin [moran.robin@epa.gov]
Subject: RE: Deliberative: Harmonization Petition Coordination

Dear Jim and Rebecca,

I am sorry for not having given you feedback earlier this week. When we had the conference call on December 2, Mike and I told you we would get feedback by this past Wednesday.

Deliberative Process / Ex. 5

Best regards,
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Thursday, December 01, 2016 5:06 PM
To: Charmley, William <charmley.william@epa.gov>
Subject: Deliberative: Harmonization Petition Coordination

Hi Bill,

Deliberative Process / Ex. 5

Would you have a few minutes tomorrow to discuss EPA's thoughts on the petition and how best to coordinate NHTSA and EPA actions?
I'm available tomorrow between 9:00 – 10:00 or between 12:00 and 5:00.
Thanks.
Jim

Message

From: Charmley, William [charmley.william@epa.gov]
Sent: 5/19/2017 7:42:59 PM
To: Posten, Ryan (NHTSA) [ryan.posten@dot.gov]
CC: Tamm, James (NHTSA) [james.tamm@dot.gov]
Subject: Re: Request to Participate in Auto Industry Meetings with NHTSA

Ryan

Thank you for the response. Have a good weekend.

Bill

Sent from my iPhone

On May 19, 2017, at 2:24 PM, Posten, Ryan (NHTSA) <ryan.posten@dot.gov> wrote:

Hi Bill,

Deliberative Process / Ex. 5

We need further discussion on this end about the joint agency tech team meetings. I will get back with you soon.

Thanks again,

Ryan

R. Ryan Posten
Associate Administrator for Rulemaking
National Highway Traffic Safety Administration
U.S. Department of Transportation
202-366-1810

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Friday, May 19, 2017 12:17 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>; Posten, Ryan (NHTSA) <ryan.posten@dot.gov>
Subject: FW: Request to Participate in Auto Industry Meetings with NHTSA

Dear Ryan and Jim,

I hope all is well with both of you.

Deliberative Process / Ex. 5

Best regards,

Bill

From: Moran, Robin
Sent: Thursday, May 18, 2017 3:37 PM
To: james tamm <james.tamm@dot.gov>
Cc: Olechiw, Michael <olechiw.michael@epa.gov>; Charmley, William <charmley.william@epa.gov>
Subject: Request to Participate in Auto Industry Meetings with NHTSA

Hi Jim,

Deliberative Process / Ex. 5

Thanks, and have a nice weekend.

Best,
Robin

Robin Moran
Senior Policy Advisor
U.S. EPA, Office of Transportation and Air Quality
2000 Traverwood Dr.
Ann Arbor, MI 48105
(734) 214-4781 (phone)
(734) 214-4821 (fax)

From: Michael Hartrick [mailto:MHartrick@autoalliance.org]
Sent: Thursday, May 18, 2017 12:49 PM
To: Olechiw, Michael <olechiw.michael@epa.gov>
Cc: Bolon, Kevin <Bolon.Kevin@epa.gov>; Cherry, Jeff <Cherry.Jeff@epa.gov>; Moran, Robin <moran.robin@epa.gov>; Chris Nevers <CNevers@autoalliance.org>
Subject: Your Request to Participate in Trade Association Meeting with NHTSA

Hi Mike,

I tried to call you a few minutes ago. As follow-up to that call, thanks for reaching out to us to discuss the Midterm Evaluation. Chris Nevers asked me to respond to your request to participate in upcoming meetings that the Alliance and Global Automakers have scheduled with NHTSA next week. The materials that we have prepared for those meetings focus on technical input specific to NHTSA. Therefore, we would propose initial separate meetings with the EPA to discuss EPA specific issues.

We'd like discuss technical issues specific to EPA's modeling and analysis such as the concerns highlighted below. I suggest two meetings: (1) a briefing from Novation Analytics to discuss recent analysis of proposed determination modeling work; and (2) a broader meeting with the manufacturers to discuss technical concerns and questions. The Novation Analytics work is funded jointly by the Auto Alliance and Global Automakers and would therefore involve both light-duty automotive trade associations. Similarly, the Auto Alliance would suggest Global Automakers' participation in the second meeting so that all interested light-duty automakers have the opportunity to share their input and to engage with EPA efficiently. Such a set of meetings may also provide the opportunity for EPA to discuss on-going work and plans for the midterm evaluation.

Michael Hartrick
Director of Fuel Economy & Climate
Alliance of Automobile Manufacturers
Desk (248) 357-4717 x103
Mobile (248) 212-3590
MHartrick@autoalliance.org

Message

From: Charmley, William [charmley.william@epa.gov]
Sent: 6/29/2017 12:07:35 PM
To: Jim Tamm [james.tamm@dot.gov]
Subject: Ann Arbor today and Friday

Dear Jim

Mike Olechiw told me you and some of your staff may be in Ann Arbor today and/for a meeting with Tula.

If you or any of your staff need a conference room, phone, wifi, etc today or tomorrow just let us know.

If you have time to catch up let me know. It would be helpful to talk about the MTE and HD trailers.

Today I have an opening from 4-5, and on Friday anytime in the afternoon.

Thanks
Bill

Appointment

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 12/2/2016 5:35:46 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]

Subject: Accepted: Petition for Harmonization & Tier 3 Fuel
Location: Jim's Office and Conference Call

Start: 12/2/2016 8:30:00 PM
End: 12/2/2016 9:30:00 PM
Show Time As: Busy

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 12/2/2016 5:35:45 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]
Subject: RE: Deliberative: Harmonization Petition Coordination

Jim –

Deliberative Process / Ex. 5

Thanks
Bill

From: Charmley, William
Sent: Friday, December 02, 2016 9:08 AM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: Re: Deliberative: Harmonization Petition Coordination

Jim

Mike, David and I are available at 3:30 today.

We can use the following call in number;

Conference Line/Code / Ex. 6

I haven't heard from Steve, so he may or may it be able to join.

Thanks
Bill

Sent from my iPhone

On Dec 1, 2016, at 5:30 PM, Tamm, James (NHTSA) <james.tamm@dot.gov> wrote:

Bill,

Deliberative Process / Ex. 5

Let me know what time would work for the EPA team.
Jim

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Thursday, December 01, 2016 5:20 PM
To: Tamm, James (NHTSA)
Subject: RE: Deliberative: Harmonization Petition Coordination

Dear Jim,

I am open between 3:30 and 5pm tomorrow.

Deliberative Process / Ex. 5

If you would rather start with a one-on-one call, just let me know. Once I get your input on that, I can see what time in the 3:30-5pm block could work.

Thanks
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Thursday, December 01, 2016 5:06 PM
To: Charmley, William <charmley.william@epa.gov>
Subject: Deliberative: Harmonization Petition Coordination

Hi Bill,

Deliberative Process / Ex. 5

I'm available tomorrow between 9:00 – 10:00 or between 12:00 and 5:00.
Thanks.
Jim

Appointment

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 12/2/2016 2:19:37 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]

Subject: Accepted: Petition for Harmonization & Tier 3 Fuel
Location: Jim's Office and Conference Call

Start: 12/2/2016 8:30:00 PM
End: 12/2/2016 9:30:00 PM

Recurrence: (none)

Appointment

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 4/13/2017 1:30:59 PM
To: James Tamm (james.tamm@dot.gov) [james.tamm@dot.gov]

Subject: HD discussion
Location: I will call Jim at his desk number

Start: 4/13/2017 7:30:00 PM
End: 4/13/2017 8:00:00 PM
Show Time As: Tentative

Message

From: Charmley, William [charmley.william@epa.gov]
Sent: 1/12/2017 6:58:00 PM
To: Ryan Posten [ryan.posten@dot.gov]; Jim Tamm [james.tamm@dot.gov]
Subject: EPA Final Determination

Dear Ryan and Jim,

It was nice to see both of you in Detroit earlier this week, even though it was very brief. I hope you both had an insightful tour of the auto show.

I wanted to let you know that too the best of my knowledge EPA Administrator McCarthy will be issuing a Final Determination regarding the EPA GHG standards for light duty vehicles as detailed under the EPA regulations. The Administrators decision is the 2022-2025 GHG standards are appropriate as they are currently specified in the regulations.

Our understanding is we will be issuing the Final Determination on Friday morning, though we have been told it may occur later today.

Deliberative Process / Ex. 5

Best regards,

Bill

Sent from my iPhone

Message

From: Charmley, William [charmley.william@epa.gov]
Sent: 3/28/2017 12:32:32 PM
To: Tom Stricker (TMNA) [tom.stricker@toyota.com]; Jim Tamm [james.tamm@dot.gov]
Subject: Re: Quick Q re today

Tom

I forgot to mention, that's for the EPA team.

I have included Jim on this email, so he can figure out a game plan for the DOT/NHTSA team

Jim - please see Toms note below.

Bill

Sent from my iPhone

> On Mar 28, 2017, at 8:30 AM, Charmley, William <charmley.william@epa.gov> wrote:
>
> Tom
>
> That will be fine. Chris has a very short set of opening remarks, 2 pages with a huge font. I will ask him to intrude the EPA team, without titles.
>
> We can also give Rick or someone the business cards for all the EPA folks, and you all can just make a copy of those.
>
> The Ann Arbor team just landed. What's for breakfast if we get there early?
>
>
> Bill
>
>
> Sent from my iPhone
>
>> On Mar 28, 2017, at 6:54 AM, Tom Stricker (TMNA) <tom.stricker@toyota.com> wrote:
>>
>> Hi Bill -
>>
>> Given the large # of people, I'd like to avoid going around the room with self introductions. I plan to briefly introduce Mr. Carter and Mr. Onomura to the group before their opening remarks. Can someone (Chris/you/Jim) point out and introduce the couple of highest level senior folks on the govt side as part of your opening remarks?
>>
>> Sent from my iPad

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 11/30/2016 4:37:24 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]
Subject: RE: do you have the call in number?

Jim –

The number is 888-217-1175

Code = 29754413

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Wednesday, November 30, 2016 11:35 AM
To: Charmley, William <charmley.william@epa.gov>; Moran, Robin <moran.robin@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>
Subject: RE: do you have the call in number?

Looping in Robin and Mike.
Shoshana, Paul Hemmersbaugh, and others would like to listen to the press call. Thanks.

From: Tamm, James (NHTSA)
Sent: Wednesday, November 30, 2016 11:32 AM
To: charmley.william@epa.gov
Subject: do you have the call in number?

We don't have it and want to listen.

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 11/30/2016 4:36:07 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Moran, Robin [moran.robin@epa.gov]; Olechiw, Michael [olechiw.michael@epa.gov]
Subject: RE: do you have the call in number?

Jim – I will try to find it ASAP

Bill Charmley
Director
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

National Vehicle and Fuel Emissions Laboratory
2000 Traverwood Drive
Ann Arbor, MI 48105

desk ph. 734-214-4466
cell ph. 734-545-0333
e-mail: charmley.william@epa.gov

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Wednesday, November 30, 2016 11:35 AM
To: Charmley, William <charmley.william@epa.gov>; Moran, Robin <moran.robin@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>
Subject: RE: do you have the call in number?

Looping in Robin and Mike.
Shoshana, Paul Hemmersbaugh, and others would like to listen to the press call. Thanks.

From: Tamm, James (NHTSA)
Sent: Wednesday, November 30, 2016 11:32 AM
To: charmley.william@epa.gov
Subject: do you have the call in number?

We don't have it and want to listen.

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 6/20/2017 2:29:26 PM
To: Posten, Ryan (NHTSA) [ryan.posten@dot.gov]; Tamm, James (NHTSA) [james.tamm@dot.gov]
CC: Olechiw, Michael [olechiw.michael@epa.gov]; Robin Moran [Moran.Robin@epa.gov]
Subject: Auto Alliance and Global Automakers Meeting on Thursday of this week - possible messaging on EPA-NHTSA technical coordination

Dear Ryan and Jim –

Later this week on Thursday we have scheduled a meeting in Ann Arbor at the request of the Global Automakers and the Auto Alliance to discuss technical topics regarding the Mid-term Evaluation. My staff and managers have already invited Jim and his team to participate.

Deliberative Process / Ex. 5

I have included Mike and Robin on this email because I will be on travel Wednesday and Thursday, and they will be leading this meeting with the auto's for EPA.

Thanks
Bill

From: Charmley, William
Sent: Monday, June 12, 2017 10:53 AM
To: 'Posten, Ryan (NHTSA)' <ryan.posten@dot.gov>; Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: Follow-up regarding potential NHTSA-EPA staff technical discussions on LD CAFE/GHG assessments

Dear Ryan and Jim –

I hope you are both doing well – I heard the weather in D.C. is getting to be pretty hot again.

Deliberative Process / Ex. 5

Best regards,

Bill

From: Posten, Ryan (NHTSA) [mailto:ryan.posten@dot.gov]
Sent: Friday, May 19, 2017 2:24 PM
To: Charmley, William <charmley.william@epa.gov>
Cc: Tamm, James (NHTSA) <james.tamm@dot.gov>
Subject: RE: Request to Participate in Auto Industry Meetings with NHTSA

Hi Bill,

Deliberative Process / Ex. 5

We need further discussion on this end about the joint agency tech team meetings. I will get back with you soon.

Thanks again,

Ryan

R. Ryan Posten
Associate Administrator for Rulemaking
National Highway Traffic Safety Administration
U.S. Department of Transportation
202-366-1810

From: Charmley, William [mailto:charmley.william@epa.gov]
Sent: Friday, May 19, 2017 12:17 PM
To: Tamm, James (NHTSA) <james.tamm@dot.gov>; Posten, Ryan (NHTSA) <ryan.posten@dot.gov>
Subject: FW: Request to Participate in Auto Industry Meetings with NHTSA

Dear Ryan and Jim,

I hope all is well with both of you.

Deliberative Process / Ex. 5

Best regards,

Bill

From: Moran, Robin
Sent: Thursday, May 18, 2017 3:37 PM
To: james tamm <james.tamm@dot.gov>
Cc: Olechiw, Michael <olechiw.michael@epa.gov>; Charmley, William <charmley.william@epa.gov>
Subject: Request to Participate in Auto Industry Meetings with NHTSA

Hi Jim,

Deliberative Process / Ex. 5

Thanks, and have a nice weekend.

Best,
Robin

Robin Moran
Senior Policy Advisor
U.S. EPA, Office of Transportation and Air Quality
2000 Traverwood Dr.
Ann Arbor, MI 48105
(734) 214-4781 (phone)
(734) 214-4821 (fax)

From: Michael Hartrick [mailto:MHartrick@autoalliance.org]
Sent: Thursday, May 18, 2017 12:49 PM
To: Olechiw, Michael <olechiw.michael@epa.gov>
Cc: Bolon, Kevin <Bolon.Kevin@epa.gov>; Cherry, Jeff <Cherry.Jeff@epa.gov>; Moran, Robin <moran.robin@epa.gov>; Chris Nevers <CNevers@autoalliance.org>
Subject: Your Request to Participate in Trade Association Meeting with NHTSA

Hi Mike,

Deliberative Process / Ex. 5

Michael Hartrick
Director of Fuel Economy & Climate
Alliance of Automobile Manufacturers
Desk (248) 357-4717 x103
Mobile (248) 212-3590
MHartrick@autoalliance.org

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 1/4/2017 2:39:15 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Olechiw, Michael [olechiw.michael@epa.gov]
Subject: RE: Meetings with OEMs on the Margins of the NAIAS

Dear Jim –

Thanks for the good wishes, and the same to you – Happy New Year.

Thank you for the offer to participate in the listening session with Global/the Alliance, and the follow-up GM meeting. Next week on Tuesday both Mike and Robin are on travel, but we are going to try and have some of the staff participate, either in person or by phone, for both of these meetings.

Also, for the GM meeting that is a follow-up to the November 30 ARB/NHTSA/EPA meeting with GM. Following that meeting and the information presented by GM, the EPA technical staff have looked into the information provided by GM on:

- Future Malibu tech walk
- Future Silverado walk
- Transmission energy loss

There are several areas where we want to follow-up with GM on this topic, and we made such an offer to follow up with GM in mid-December. GM (Barbara Kiss) appreciated the offer, but wanted to wait until January.

We won't be able to do that next week with Mike out, but we will make the offer again to GM, and if they want to have a follow-up meeting later in January, we will be sure to invite NHTSA and CARB.

Thanks
Bill

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Tuesday, January 03, 2017 4:51 PM
To: Charmley, William <charmley.william@epa.gov>; Olechiw, Michael <olechiw.michael@epa.gov>
Subject: Meetings with OEMs on the Margins of the NAIAS

Happy New Year Bill and Mike,

I would like to make you aware of two meetings on the margins of the NAIAS that NHTSA will participate in. EPA is welcome to join. Please let me know someone from EPA would like to attend one or both.
Thanks.

Jim

NHTSA Harmonization Petition Listening Session with the Alliance and Global
Tuesday, January 10, 9:00 am – 11:00 am
General Motors Renaissance Center, Detroit Michigan

GM Comments on the Draft TAR
Tuesday, January 10, 11:30 am – 1:30 pm
General Motors Renaissance Center, Detroit Michigan
GM will provide feedback on the Draft TAR. The material will be similar to that present to the agencies on December 1 at EPA in Ann Arbor. NHTSA and Volpe participated via call in to the December 1 meeting, and the January 1 meeting provides opportunity for in person participation.

Message

From: Charmley, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=FB1828FB00AF42FFB68B9E0A71626D95-CHARMLEY, WILLIAM]
Sent: 12/19/2016 9:51:12 PM
To: Tamm, James (NHTSA) [james.tamm@dot.gov]; Moran, Robin [moran.robin@epa.gov]; Yoon, Rebecca (NHTSA) [rebecca.yoon@dot.gov]
CC: Wysor, Tad [wysor.tad@epa.gov]; Sutton, Tia [sutton.tia@epa.gov]
Subject: RE: A couple EPA edits on the QFR draft

Jim –

Thanks for this response.

I will send a note to Janet and Chris saying that for the staff, we think we are done.

From: Tamm, James (NHTSA) [mailto:james.tamm@dot.gov]
Sent: Monday, December 19, 2016 4:42 PM
To: Moran, Robin <moran.robin@epa.gov>; Yoon, Rebecca (NHTSA) <rebecca.yoon@dot.gov>
Cc: Charmley, William <charmley.william@epa.gov>; Wysor, Tad <wysor.tad@epa.gov>; Sutton, Tia <sutton.tia@epa.gov>
Subject: RE: A couple EPA edits on the QFR draft

Robin,

We accept this QFR draft.

Deliberative Process / Ex. 5

Jim

From: Moran, Robin [mailto:moran.robin@epa.gov]
Sent: Monday, December 19, 2016 3:32 PM
To: Yoon, Rebecca (NHTSA); Tamm, James (NHTSA)
Cc: Charmley, William; Wysor, Tad; Sutton, Tia
Subject: RE: A couple EPA edits on the QFR draft

Hi Rebecca and Jim, in case you're able to provide any feedback prior to the 5pm call, could you please "reply to all", and that way Bill and Tia (who will be on the call) can be in the loop.

Thanks!
Robin

From: Moran, Robin
Sent: Monday, December 19, 2016 2:58 PM
To: rebecca yoon <rebecca.yoon@dot.gov>; james tamm <james.tamm@dot.gov>
Subject: A couple EPA edits on the QFR draft

Hi Rebecca and Jim,

We received the draft that Paul H sent back to Janet earlier today, and have just a few suggestions. This attached draft is our comments on top of NHTSA's. In this draft, we've retained NHTSA's incoming edits, and added just 3 changes, for which we've added marginal comments to flag each:

Deliberative Process / Ex. 5

This is what we're recommending to Janet for her call w/Paul at 5pm, but if you have additional suggestion in meantime, happy to continue working that this afternoon. Thanks for all your work on this!

Robin

Robin Moran
Senior Policy Advisor
U.S. EPA, Office of Transportation and Air Quality
2000 Traverwood Dr.
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(734) 214-4781 (phone)
(734) 214-4821 (fax)