Evaluation of Innovative Methane Detection Technologies

Innovative ways to detect loss of product

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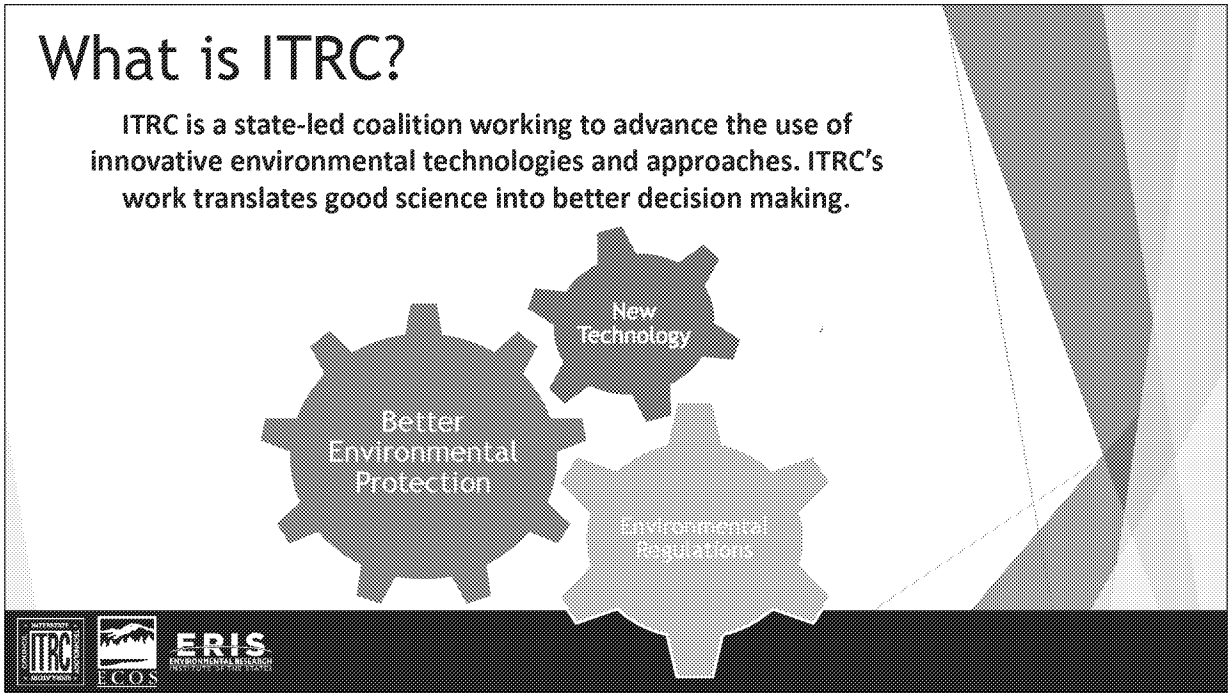
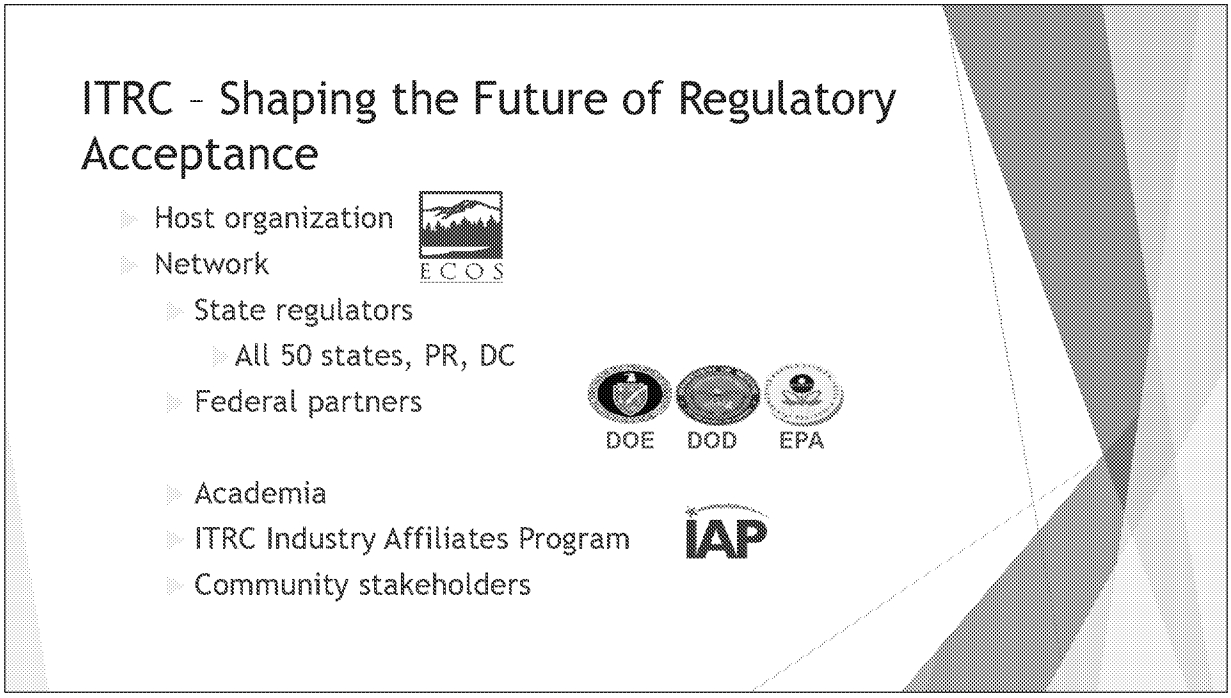
Outline



ITRC is a 501(c)3 program of the Environmental Council of the States (ECOS) and is based in Washington DC. ITRC provides information resources on technically-sound innovative solutions to environmental challenges. Part of ITRC's mission is to foster integration of new beneficial technical developments within existing regulatory frameworks.

ITRC is a state-led coalition of state regulators, industry experts, public/tribal stakeholders, academia, and federal partners that works to achieve regulatory acceptance of innovative environmental technologies and approaches. ITRC consists of 50 states (and the District of Columbia and Puerto Rico) and works to break down barriers and reduce compliance costs, making it easier to use new technologies and helping states maximize resources. ITRC resources expedite quality decision making, while protecting human health and the environment.



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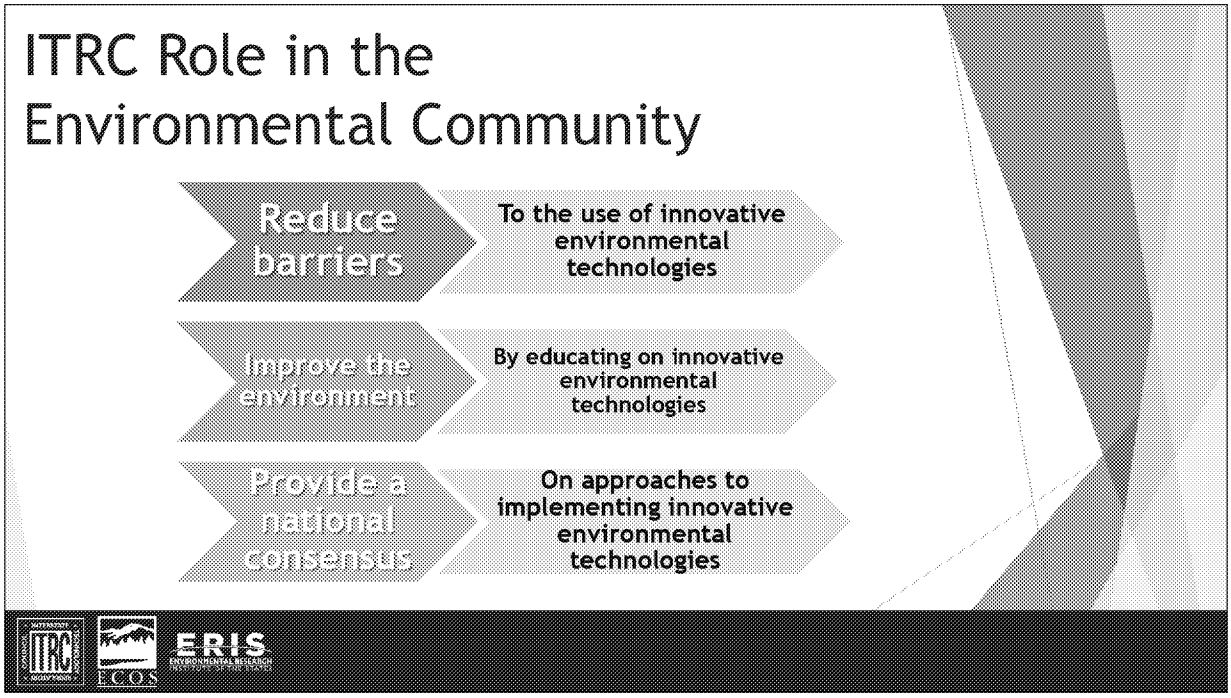

Why are innovative environmental technologies/approaches important? Innovative environmental technologies/approaches are (1) typically more cost-effective and efficient than traditional approaches and (2) can provide a solution for a problem where no solution previously existed. Barriers exist to using innovative environmental technologies, including (1) lack of understanding or trust in the benefits of the innovative technology; (2) different sets of procedures and/or data requirements among states; (3) institutional resistance to change; and
(4) regulatory inflexibility or pre-specified approaches.

ITRC works to break down barriers by (1) increasing state regulators' understanding and confidence in innovative technologies/approaches; (2) producing guidance documents and training that are used by environmental professionals across the country to increase regulatory consistency from state-to-state; (3) fostering integration of new technical developments within existing regulations; (4) creating networks of technical experts for use by states when making decisions on innovative environmental technologies/approaches; (5) showing the cost and time savings that can be achieved with innovative environmental technologies/approaches.

What Does ITRC Achieve?

Accomplishments

- Educates state regulators on the use of innovative technologies
- Encourages a common language for complex topics
- Replaces adversarial relationships with collaboration
- Achieves national paradigm shifts for using new technology

Benefits

- Harmonized state approaches to environmental issues across the nation
- Consistent approach to using innovative technology
- Faster decision-making
- Reduced permitting time
- Decreased costs
- Leveraging of partnerships
- Increased efficiencies

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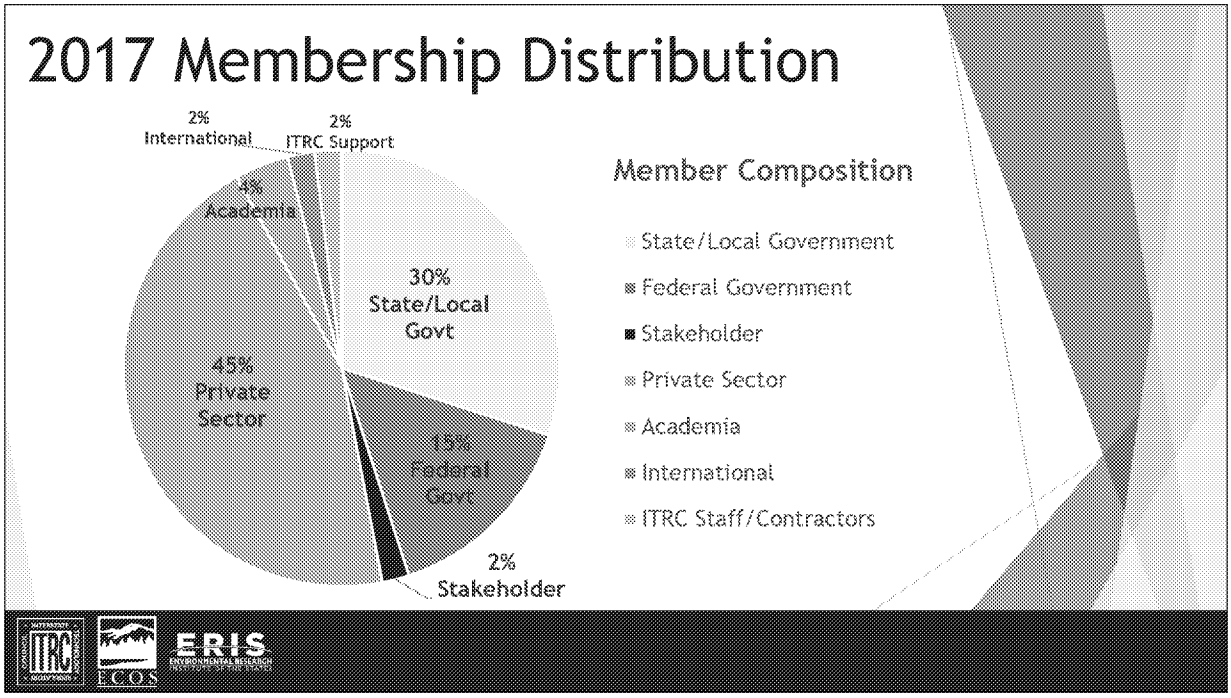


Over 900 members total, 45% private sector, 45% government

Team intro…

Innovative ways to detect loss of product

Evaluation of Innovative Methane Detection Technologies

Context

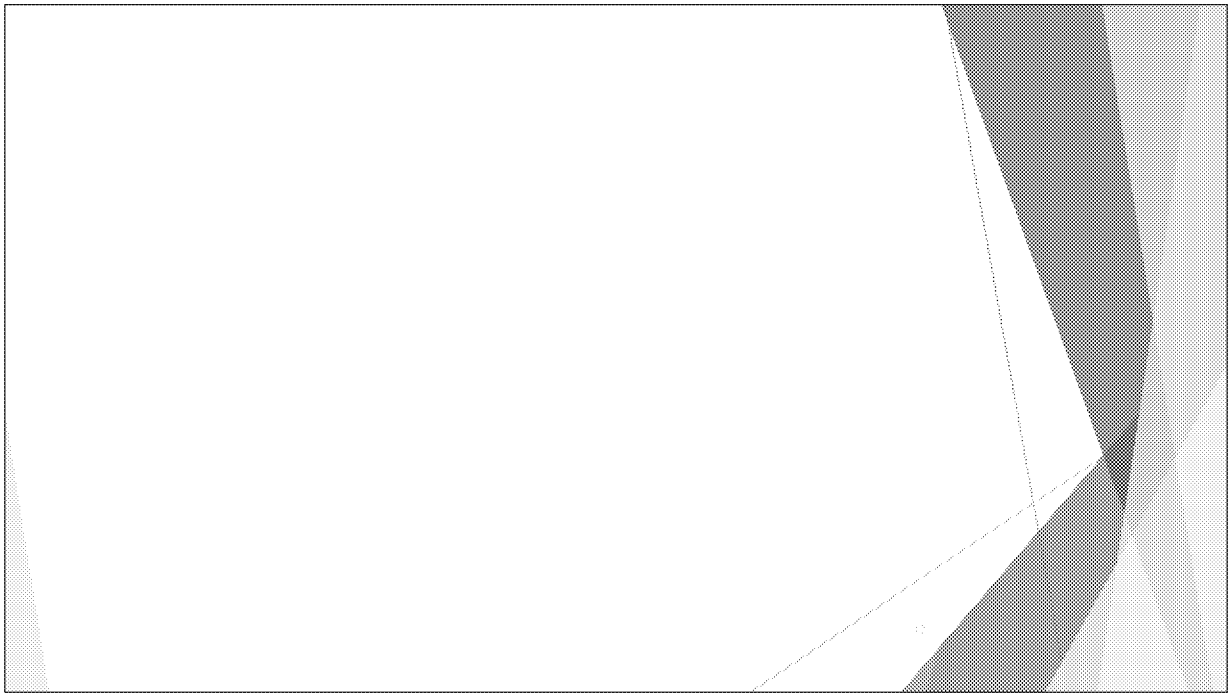
- US power production shifting away from oil-, coal-, and nuclear-powered toward natural-gas; US on verge of being net exporter
- States adopting regulations of methane emissions related to natural gas production and distribution
- EPA and DOI released proposed Regs for methane leaks at new sources and on Bureau of Land Management (BLM) lands
- New detection technology introduced into the market at a fast rate
- No standard methodology for state or federal lawmakers to evaluate equivalency or superiority of new methane detection technologies compared with those approved.

The Challenge

- Loss of product
- Regulatory compliance
- Increased safety
- The challenge is to create a framework to choose the appropriate tool

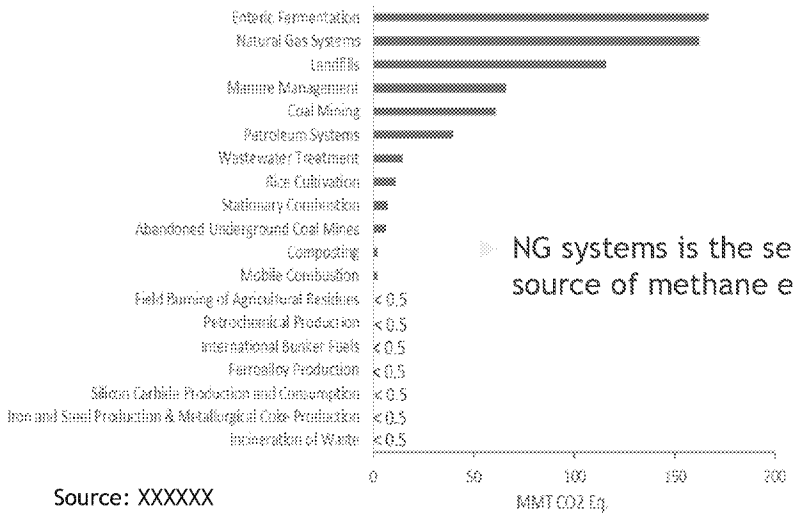
A Solution:
Evaluation of Innovative Methane Detection Technology (Tech Reg Document)

- Provides an overview of existing and emerging methane detection technologies
- Guidance regarding performance characteristics and parameters to consider in technology evaluation
- Identify regulatory barriers to the use of innovative technologies
- **Enable users to evaluate, compare, and select suitable technologies to detect/quantify methane emissions from segments of oil and gas (O&G) supply chain to:**
  - Comply with existing (forthcoming) leak regulations
  - Monitor inventories, and
  - Enhance safety



Characterization

Sources of U.S. Methane Emissions 2015



- NG systems is the second largest source of methane emissions

Source: XXXXXX

Characterization

Production & Processing

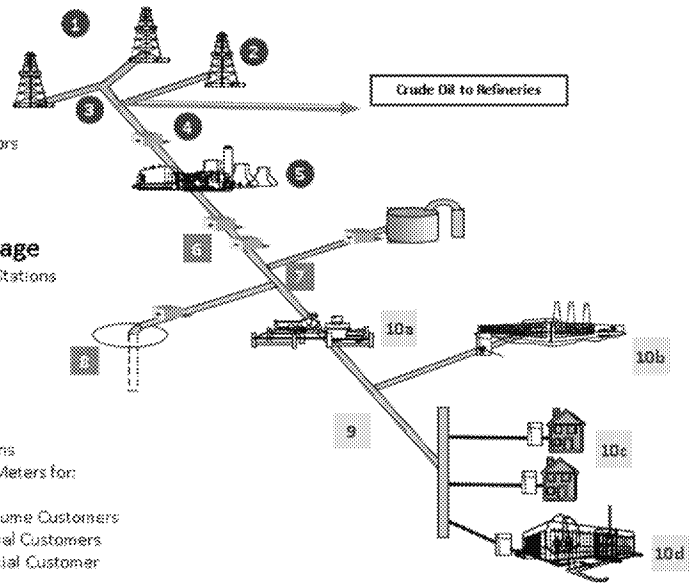
1. Drilling and Well Completion
2. Producing Wells
3. Gathering Lines
4. Gathering and Boosting Compressors
5. Gas Processing Plant

Transmission & Storage

6. Transmission Compressor Stations
7. Transmission Pipeline
8. Underground Storage

Distribution

9. Distribution Mains
10. Regulators and Meters for:
    a. City Gate
    b. Large Volume Customers
    c. Residential Customers
    d. Commercial Customer



Source: Adapted from American Gas Association and EPA Natural Gas STAR Program

Regulation of Methane Emissions

- Federal agencies overseeing fugitive emissions (for enviro issues) or equipment leaks from O&G include:
  - Environmental Protection Agency (EPA),
  - Bureau of Land Management (BLM) of the Department of Interior,
- With oversight for the up to (?) production and processing segments of the sector
  - And the Pipeline and Hazardous Materials Safety Administration (PHMSA), of the Department of Transportation
- With oversight of transmission and distribution (pipelines) (edit - Pam Lacey comment) distribution through gathering (LNG)

Safety vs environmental

Regulation of Methane Emissions

- Authority is given to states to implement;
  - typically through environmental or air quality department for production and processing and
  - through the public utility commission (PUC) for transmission and distribution
- Main objective for air quality regs - to reduce emissions to maximum extent feasible while considering impacts such as cost, enforceability, and community concerns
- Regulators need significant levels of information on the technology or method being evaluated
- Regs including alternative compliance methods have challenge of establishing equivalent compliance criteria for evaluating and approving a new method or technology
- Document summaries current state and federal regs (surveyed state POCs)

Regulation of Methane Emissions

- Currently only two main methodology for methane emissions technologies for leak detection (0000a vs Subpart W? See Tb 3 in Regs Section):
  - EPA's Method 21 and
  - Optical gas imaging (OGI)
- Method 21 is EPA procedure to detect VOC leaks from process equipment using a portable detecting instrument
  - Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.
  - Easily enforceable concentration standards, but can be time- and labor-intensive
- Commercial enterprises have produced new detection techniques, such as the OGI handheld cameras
  - Make detection possible by display on a screen, allowing visualization of a gas plume that is otherwise invisible to the naked eye
  - OGI offers a quicker, more efficient approach to monitor hard-to-reach or unsafe equipment, but has higher detection limit and lacks a written monitoring protocol

Rapidly Evolving Technologies - Summarized

- Describe technologies existing or under development and provide a template against which future developments can be evaluated
- Uses classification scheme including:
  - primary data type (i.e., qualitative vs. quantitative);
  - result type (e.g., yes/no vs. numerical value),
  - deployment platform utilized;
  - measurement temporal resolution (i.e., sampling rate);
  - Size (handheld to car-based);
  - deployment method (e.g., walking, vehicle, fixed);

Confirm this list is correct and comprehensive

Rapidly Evolving Technologies - Summarized

- Uses classification scheme (Cont.):
  - specificity/speciation (i.e., methane only or also other hydrocarbons);
  - working distance;
  - environmental limitations (e.g., air temperature, wind speed or direction);
  - calibration procedures; and
  - maturity

Confirm this list is correct and comprehensive

Rapidly Evolving Technologies - Summarized

- Technologies currently available or under development fall into the following general categories:
  - Forward Looking Infrared Camera (FLIR)
  - Flame Ionization Detector (FID)
  - Tunable Diode Laser
  - High Flow Dilution Sampler
  - Catalytic Combustion
  - Metal Oxide
  - Gas Chromatography (GC)
  - Mass Spectrometry (MS)
  - Printed Nanotubes
  - Tunable Laser (Closed Path)
  - Etalon
  - Optical Gas Imaging (OGI)
  - Fourier Transform Infrared (FTIR)

Confirm this list is correct and comprehensive – Soap Solutions?? Get image from Pam Lacey. For laughs!

Evaluation of Methodologies

- With growing innovation technology, there is concurrent development of approaches for evaluating performance
- Provides examples of past and ongoing programs for assessing innovative leak detection systems
- Evaluation of systems should be based on an objective assessment of technology-neutral, quantitative metrics directly related to stakeholder goals
- Illustrates and defines initial system objectives and metrics

Technology vs Methodology - discuss here? Ask David Lyon this section (or Others) - for gut check (makes sense?)

Evaluation of Methodologies

- Numerous sensor technologies and applications used to detect, locate, and/or quantify methane emissions, including:
  - stationary arrays or point sensors,
  - moving point or line sensors,
  - box flux estimation,
  - plume imaging,
  - long path sensing, and
  - tiered approaches integrating multiple systems
- Depending on target sites and stakeholder goals, several approaches may meet primary performance criteria though differ in other metrics (i.e., methane concentration detection limits)

Evaluation of Methodologies

- What is the ultimate objective of the leak detection system?
  - Detect methane concentration above a specific concentration limit or difference from baseline concentration
  - Detect the presence of emission sources above a specific emission rate
  - Quantify the emission rate of a site and/or individual sources
  - Locate fugitive emission sources at a site/sub-site level to increase the efficiency of follow-up, component-level surveys such as OGI
  - Locate fugitive emission sources at a spatial resolution allowing direct identification of the leaking component
  - Assess if emission reductions achieve a percentage target
  - Assess if emission reductions are equivalent to another technology
  - Achieve compliance with a specific regulation or voluntary program

Evaluation of Methodologies

- What is the typical size and complexity of target sites?
  - New, multi-well production sites
  - Well pads of any size or age
  - Gathering compressor stations
  - Processing plants
  - A field of upstream and midstream oil and gas sites
  - Gathering pipelines
- What is the spatial distribution of target sites?
  - Single facility
  - Cluster of closely-spaced sites
  - Widespread, loosely distributed sites
  - Linear (e.g., pipeline leaks)

Evaluation of Methodologies

- What environmental and meteorological challenges apply?
  - Minimum and maximum temperature
  - Typical wind speed and direction
  - Topography
  - Vegetation structure (e.g., forested or grassland)
  - Extreme weather (e.g., blizzards, dust storms)
  - Other local methane sources (e.g., landfills, cattle)
- Who will maintain the equipment and how often are site visits required?
  - Will the site operator, regulator, or a third party maintain the equipment?
  - For systems located permanently at a site, do system objectives include a maximum frequency of site visits for maintenance or related activities such as instrument calibration?

Evaluation of Methodologies

- Who will receive data from the system and what are their requirements?
  - Will the site operator, regulator, or a third party receive data from the systems?
  - How frequently does data need to be received?
  - What communication infrastructure is required to transmit data?
  - What is the tolerance towards false positives, false negatives, or other inaccurate data?
- Does the system need to be specific to methane and/or measure other compounds?
  - Natural gas; Methane only; Isotopically-distinct methane (13C:12C or 2H:1H ratio); Total hydrocarbons; Volatile Organic Compounds; or Speciated individual compounds
- What secondary objectives are mandatory for successful system performance?
- Are there any regulatory requirements or barriers?

Evaluation of Methodologies

- Express system objectives as quantifiable, testable statement that describes the primary goals, target sites, and acceptable limitations of the system.
- Should include sufficient detail so any system that agrees with the full statement is considered compliant with the objectives.
- Three example objective statements are listed below:
  - **Concentration.** The system will signal when fence line methane concentrations exceed 10 ppm CH4. The system must have a 95% probability of signaling within 4 hours of elevated concentration during precipitation-free conditions of -20 to 120 ºF and <10 mph wind speed.

Evaluation of Methodologies

- Three example objective statements (cont.):
  - **Emission source.** The system will detect, locate, and quantify emission sources at well pads in North Dakota. Emission sources ≥ 6 scfh must be located within 1 meter spatial accuracy and their emission rate quantified to ±30% within 24 hours. Sources should be identified as intentional, unintentional, or offsite with less than a 5% error of misclassifying intentional or offsite sources as onsite, unintentional. The system must perform successfully 80% of the annual hours with a maximum of 1 week to detect emissions.
  - ***Emission reductions.*** The system will achieve equivalent or better emission reductions at gathering stations than quarterly OGI following NSPS OOOOa work practices. Equivalency is defined as percent of annual emission mitigated at the company/basin-level. In addition to the system's ability to detect leaks, it must be evaluated as part of a work practice that includes the emissions threshold and time to repair detected leaks.

Evaluation of Methodologies

- Develop evaluation protocols for assessing metrics. Each has a different set of approaches that can be used to evaluate systems objectives.
- *Concentration*
  - Laboratory testing
  - Field trial
- *Emission sources*
  - Laboratory testing
  - Field-based controlled releases
  - Field trial
- *Emission Reductions*
  - Field-based controlled releases and field trials
  - Modeling
  - Side-by-Side Testing
- Under controlled statistical field survey methods specific statistical data is derived

Example 1: Check for leaks on a well field

- Size of well field
- Size of leak expected

SERIES OF SCREENSHOTS OF WEB BASED DOCUMENT DRILLING DOWN…

What need to know up front. Use document to drill down

Example 2: What technology is used if I receive complaints from a local school about smells

- Scope?
- Size?
- Etc…

SERIES OF SCREENSHOTS OF WEB BASED DOCUMENT DRILLING DOWN…

If you smell – first call Gas company, then use our document.

Lessons Learned

- Methane detection technologies are moving to quantitative, continuously recorded, data-intensive systems.
- Cost-benefit analyses--that are required for USEPA rule-making—will require a replacement methane detection technology to be "equivalent" to an existing system.
- Detection technology testing or evaluation protocols may have certain environmental limitations, which in turn may mean a new technology is approved only for certain applications or geographical areas.
- There will be renewed opportunities for researchers, academics, industry, regulators, and interest groups to improve the methane detection technologies as well as the related regulations and the evaluation methodologies that link specific technologies to specific regulatory requirements.

Bring together the examples – wrap up

- outline

Stakeholder Perspectives

- Stakeholder issues Identified for Methane
  - Proximity to operating facilities with methane emissions
  - Abandoned wells and/or lines
  - Oil and Gas Extraction
  - Pipeline Safety
  - Adaptation of Detection Technologies
  - Oil Wells Without Infrastructure to Capture Natural Gas
  - Underground Storage Facilities
  - Offshore Wells (and other issues outside the scope of this document)

Thank you!

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Characterization Nomenclature

Comparison of natural gas system characterization of Subpart W, GHG Inventory and this assessment

Source (GHG Inventory)	Natural Gas Systems (Annex 3.6)										
Stage (GHG Inventory)	Field Production					Processing	Transmission & Storage			Distribution	
Natural Gas Supply Chain	Drilling	Well Completion	Producing Wells	Gathering Lines	Gathering & Boosting Stations	Gas Processing Plant	Transmission Compressor Stations	Transmission Pipeline	Underground Storage	Distribution Mains/Services	Regulators & Meters
Segment (GHGRP-Subpart W)	Onshore Production			Onshore Gathering & Boosting		Onshore Natural Gas Processing	Onshore Transmission Compression	Onshore Natural Gas Transmission Pipeline	Underground Natural Gas Storage	Distribution	

Comparison of petroleum system characterization of Subpart W, GHG Inventory and this assessment

Source (GHG Inventory)	Petroleum Systems (Annex 3.5)					
Stage (GHG Inventory)	Production Field Operations				Crude Oil Transportation	Refining
Petroleum Supply Chain	Drilling	Well Completion	Producing Wells	Gathering Lines	Crude Oil to Refineries (not addressed here)	
Segment (GHGRP-Subpart W)	Onshore Production			Onshore Gathering & Boosting		

Nomenclature used to describe the supply chain in natural gas and petroleum systems varies so first we will describe the organization provided in this chapter as compared to the US EPA Greenhouse Gas Inventory and the US EPA Greenhouse Reporting Program – subpart W. Tables 1 and 2 below show where each process falls into each of the systems of organization.