New Retail Model: Phase 1
Direction for SRA
August 2, 2007

Minor Changes from the July 31 document, based on our August 2 meeting are in red and bold.

Objective:
The following document provides information on the benchmarking methodology for retail buildings; i.e. buildings that are primarily used for retail sales of consumer products. The target public release date of this model is **September 28, 2007.** EPA has been actively working with 10 organizations during the development of this model. These organizations are likely to upload several hundred buildings when the new retail model is released. Please note, coordination and use of the automated data exchange feature will be critical for the retail audience.

Timeline:

Final draft of technical direction and model to SRA	**07/31**
Sample building data to SRA for testing	**One week from receipt of import templates**
Sample building test result from SRA back to EPA	**08/31**
Final Release Date into PM	**09/28**

Items:

I. Attributes, definitions and default values
II. Model format and coefficients
III. Procedure for calculating a rating
- Scoring a building with one retail space only
- Scoring a building with two or more retail spaces
- Scoring a building with a retail space and another primary space
- Scoring a building with a retail space and a secondary space

IV. Source energy conversion factors
V. Weather normalization
VI. Automated data exchange
VII. Criteria for receiving a rating
VIII. Label eligibility flags
IX. Model Testing
X. Retail lookup table

I. Attributes, definitions, and default values:

There were ten attributes identified as being key explanatory variables that can be used to estimate the expected average source energy use intensity (kBtu/sqft) in a retail store. The following list describes each of these attributes. Information on each variable will need to

be collected from each retail store in Portfolio Manager for final calculation of an energy performance rating. Additionally this information will need to be added to PM Help.

Retail Space type definition:

Retail Store: Applies to stores of at least 5,000 square feet in gross floor area used to conduct the retail sale of consumer products goods. The total gross floor area should include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, etc. Stores must be free standing or located in strip centers. Stores located in enclosed malls are not eligible, with the exception of mall anchors. Retail segments typically eligible for benchmarking include: Department Store, Discount Store, Supercenter, Warehouse Club, Drug Store, Dollar Store, Home Center/Hardware, and Apparel/Hard Line Specialty (i.e. books, clothing, office products, toys, home goods). Retail segments not eligible for benchmarking include Electronics Stores.

Attributes for the Retail space type:

Please note that the following attribute definitions are intended to address information on "retail space" located in space use information part of PM Help.

1. **Gross square foot**:
   - **Identical to** the new definition of gross square foot that was recently requested for update in PM FAQs. However, specific terminology as it applies to retail stores is included in the following definition.
   - **Definition:** Gross floor area is defined as the total number of square feet used to conduct the retail sale of consumer products goods. The total gross floor area is measured between the principal exterior surfaces of the enclosing fixed walls and includes all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc.

     Also note the following:
     - Existing atriums should only include the base floor area that it occupies.
     - Interstitial (plenum) space between floors should <u>not</u> be included in total.
     - Gross floor area is not the same as leasable space.
   - **In the model**, this attribute will be expressed as ln(square feet)
2. **Operating Hours per week:**
   - **Identical to** the supermarket model attribute except some noted changes in language.
   - **Definition:** The total number of hours per week that the retail store is open for business, excluding hours when the building is occupied only by maintenance, security, or other support personnel. For buildings with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.
   - **NOTE:** ***<u>Please replace the current Supermarket operating hours per week definition with this new definition (please note that the definition</u>***

for supermarket will read "the total number of hours per week that the SUPERMARKET is open for business….")

3. **Workers on Main Shift**:
   - **Identical to** the new office model attribute definition except some noted changes in language
   - **Definition:** Indicates the number of employees who are present during the main shift. This is *not* the total number of employees or visitors who are in a building during an entire 24 hour period but rather represents typical peak staffing level during the main shift. For example, in a retail store if there are two daily 8 hour shifts of 15 workers each, the Workers on Main Shift value is 15.
   - **In the model,** Workers on Main shift will be expressed as worker density; i.e. Number of Workers on Main Shift per 1,000 sqft.
4. **Number of PCs:**
   - **Identical to** number of PCs collected in office model except some noted changes in language
   - **Definition:** Indicates the total number of personal computers and data servers in the retail store. Personal computers are not used to check out customers and are generally located in manager offices, break rooms, and/or storage and inventory areas.
   - **In the model**, number of PCs will be expressed as a PC density; i.e. Number of PCs per 1,000 sqft.
5. **Number of Cash Registers:**
   - **Definition:** Indicates the total number of cash registers in the retail store. Cash registers are defined as business machines that are used primarily for conducting transactions and indicating to customers the amounts of individual sales; they record and total receipts, may automatically calculate the change due, and often include a money drawer from which to make change.
   - **In the model,** number of cash registers will be expressed as a register density; i.e. number of cash registers per 1,000 sqft.
6. **Number of Walk-in Refrigeration/freezer units:**
   - **Definition:** Indicates the total number of large walk-in refrigeration or freezer units in use within the retail store. This typically includes large refrigeration units located in the back of a retail store in storage and receiving areas and used to store refrigerated goods.
   - **In the model,** number of walk-in refrigeration units will be expressed as a the number of walk-in refrigeration units per 1,000 sqft.
   - ***PLEASE NOTE: This definition should also replace the current supermarket definition for walk-in refrigeration units (please note that the definition for supermarket will read "…located in the back of a SUPERMARKET store in storage and receiving areas…".***
7. **Number of Open and closed refrigeration/freezer cases:**
   - **Definition:** The number of commercial refrigeration units (cases) used for the sale or storage of perishable goods. This includes display type refrigerated open or closed cases and cabinets as well as display type

freezer units typically found on the sales floor. Each case or cabinet section, typically 4 to 12 feet in length, should be considered 1 unit. Include those cases located inside and immediately adjacent to the facility. This should *not* include any refrigerated vending (soda) machines.

- **In the model,** number of open and closed refrigeration /freezer cases will be expressed as the total number of open and closed refrigeration cases per 1,000 sqft.
- ***PLEASE NOTE: This definition should also replace the current supermarket definition for walk-in refrigeration units***

8. **Percent Heated:**
   - **Identical to** % heated attribute collected for k-12 schools and medical office buildings.
   - **Definition:** Portion of the retail building that is heated. [Similar to k-12 schools and medical offices, this information will be collected by a dropdown menu with options ranging from 0 to 100 in bins of 10.].
   - **In the model,** % heated will be multiplied by HDD to create the variable "HDDxPHeated"
9. **Percent Cooled:**
   - **Identical to** % cooled attribute collected for k-12 schools and medical office buildings.
   - **Definition:** Portion of the retail building that is cooled. [Similar to k-12 schools and medical offices, this information will be collected by a dropdown menu with options ranging from 0 to 100 in bins of 10.].
   - **In the model,** % cooled will be multiplied by CDD to create the variable "CDDxPCooled"
10. **Default Values:**

If the user cannot provide a value for any of the attributes, the following default values can be applied. Default values for each attribute are based on the average values in the CBECS population, as well as the average values observed during EPA's beta-test of the model. They are summarized in the following table.

Parameter	Default Value
Square Foot	No default available
Hours	65 hours per week
Workers	1 per 1,000 square feet
PCs	0.2 per 1,000 square feet
Registers	0.3 per 1,000 square feet
Open/Closed Refrigeration	0 units
Walk in Refrigeration	0 units
Percent Heated	100 %
Percent Cooled	100 %

II. Model format:

The new retail model will rely on the following equation:

Source EUI = 153.099
+ 20.187* [Ln(square foot) - 9.370678]
+ 1.373* [operating hrs - 63.74061]
+ 61.755* [worker density - 0.627964]
+ 70.601* [pc density - 0.314887]
+ .01127* [HDDxPH - 3810.862]
+ .01255* [CDDxPC - 972.0578]
+ 249.058* [register density - 0.190495]
+ 720.212* [walk-in refrig density - 0.003779]
+ 81.903* [open/closed refrig density - 0.045045]

Where:

Source EUI = Source Energy (kBtu) per square foot
Ln square foot = natural log of the total floor area of retail space
Operating hours = total hours the store is open each week
Worker density = number of workers per 1000 ft^2 (=1000*worker number/ft^2)
PC Density = number of PCs per 1000 ft^2 (=1000*PC number/ft^2)
HDDxPH = HDD value*percent heated
(=Experienced HDD * bin for % heated selected by user)
CDDxPC = CDD value*percent cooled
(=Experienced CDD * bin for % cooled selected by user)
Register density = number of cash registers per 1000 ft^2
(=1000*cash register number/ft^2)
Walk-in refrig density = number of walk in refrigeration units per 1000 ft^2
(=1000*walk-in refrig number/ft^2)
Open/closed refrig density = number of open & closed refrigeration units per 1000 ft^2 (=1000*open&closed refrig number/ft^2)

The retail lookup table is in a ratio format, like the new office model. Section X. contains the retail lookup table including instructions.

Important Note

With this methodology of predicting EUI it ***is*** possible to receive a negative prediction of EUI. This is not expected. However, when attribute values fall well below average ranges, this can occur (i.e. a building that is only open 30 hours a week, with 1 employee and zero percent heated/cooled). In these cases, the program should default a negative prediction to a value of 1 and in this case, the building should receive an NA as its rating (NA Message: "The combination of space attributes falls below the expected range for retail stores and cannot be assessed with the EPA rating model") *(does SRA have a better suggestion for this message?)*. Ideally, SRA will be able to note any occurrence of negative values and inform EPA.

III. Procedure for Calculating a Rating:

[Note the procedures for calculating a rating for retail space are identical to that of the new office model.]

To score a building that consists of one retail space only:

1. Calculate the predicted Source EUI
2. Calculate the predicted Source Energy Use (=Predicted EUI*Square foot)
3. Calculate the efficiency Ratio (=Actual Source Energy (non W/N) / Prediction in Step 2.
4. Lookup the ratio in the lookup table
5. Return Rating

To score a building that consists of two or more retail spaces:

[Note this procedure is identical to combining two or more office spaces using the new office model.]

1. The attributes will be combined for all retail spaces within a single building.
    a. Square foot = add the square foot for all retail spaces
    b. PCs = add the PCs for all retail spaces
    c. Workers on Main Shift = add the workers for all retail spaces
    d. Operating Hours = compute the average operating hours *weighted by floor space*
    e. Number of cash registers = add all registers for all spaces
    f. Number of walk-in refrigerators = add all the walk-in refrigerators for all spaces
    g. Number of open/closed refrigerators = add all the open/closed refrigerators for all spaces
    h. Percent Heated: Calculate the average percent heated using the bin value (0,10,20,30…100) for each space. (*average is weighted by floor area)*

        For example if there are two retail spaces, one that is 100 percent heated and one that is 30 percent cooled, the two values (100 and 30) are averaged together, weighted by the floor space of the two spaces.

    i. Percent Cooled: Calculate the average percent cooled using the bin value (0, 10, 20, 30…100) for each space. (*average weighted by floor area).*
    j. Values needed for the predicting equation (such as worker density) are then computed with these aggregate figures.
2. Compute the predicted EUI using the combined values obtained from Step 1
3. Calculate the predicted Source Energy Use (=Predicted EUI*total square foot of building)
4. Calculate the efficiency ratio (=Actual Source Energy (non W/N) / Prediction from Step 3)
5. Lookup the ratio in the lookup table
6. Return rating

To score a building that includes a retail space with another primary space:

[Note this procedure is identical to scoring an office space with another primary space.]

1. Create a combined lookup table
    a. As with the current models, this will be completed by "adding across" the two lookup tables.
    b. For each space with an old model (i.e. school) there is a unique look up table in units of source energy
    c. For each space with a new model (i.e. retail or office) there is a lookup table in units of the energy efficiency ratio – This can be converted into units of source energy by multiplying each ratio by the predicted energy intensity and the floor space value. The following example table works through this calculation at 3 scores.

Score	Energy Intensity Ratio	Source Energy Value
99	0.2	1,600,000
75	0.4	3,200,000
30	2.1	16,800,000
Note: this assumes a building with a predicted EUI of 80 and a floor space of 100,000		

    d. The combined lookup table adds across the source energy at each score. The following table illustrates an example of this for an office and retail.

Score	Retail Source Energy	K-12 Source Energy	Combined Source Energy
99	1,600,000	1,000,000	2,600,000
75	3,200,000	2,500,000	5,700,000
50	8,000,000	5,000,000	13,000,000
30	16,800,000	8,000,000	24,800,000

    e. The actual source energy use (the total summed across all meters with ***no*** weather normalization) can be directly looked up in the combined source energy column.

2. It is important to note that the proposed method, when applied to a combination of two new spaces can also be computed directly in ratio units, where the ratios are added across and ***weighted according to the relative predicted source energy use***. This method is mathematically identical. It is described in the following table.

    a. As the two methods are mathematically identical, SRA should select the methodology that minimizes programming time and works best within the tool. It may be useful to try to plan for a future in which all models will have a ratio lookup table, in that case this second method may reduce overall time spent.

Rating	Retail Lookup Ratio Value	Office Lookup Ratio Value	Combined Lookup Ratio Value
100	0.2	0.15	0.185
75	0.36	0.29	0.339
50	1.0	1.0	1.0
25	2.9	3.5	3.08
Note: *These number are sample figures, and assume a building that is 70% retail* ***(i.e the retail predicted energy accounts for 70% of the total predicted energy)***			

To score a building with a retail space and secondary space:

[Note this procedure is identical to the new office + secondary space scenario.]

Each secondary space has a predicted energy use (or energy use per square foot). According to the current routines these values are added to the energy values in the lookup table. Analysis indicates that the superior methodology is to subtract the energy use from the actual energy value instead. Therefore the predicted secondary space energy is to be subtracted directly from the actual source energy consumption.

Our analysis indicates that at this time, there is not a high risk that the prediction for the secondary space will exceed the actual energy consumption and result in a negative value after subtraction. However, we should potentially be prepared for this case, as in theory we should be prepared for a future with net-zero energy buildings. Therefore, there should be a condition that states if a negative value is obtained, then the user receives an actual energy value of 0 (which would mean a score of 100). Ideally SRA would track the occurrence of any such zero values and report them to EPA.

IV. Source Energy Conversion Factors:

Please note, the new 2007 source conversion factors will also be applied to retail space. These new source conversion factors are summarized in the following table. Because the retail space will be released with the office model revisions, these source energy values will be applied *to every building in Portfolio Manager*.

Summary of Changes to Site-Source Conversion Factors		
Fuel Type	**Current Factor**	**New Factor**
Electricity	3.013	3.340
Natural Gas	1.024	1.047
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.0	1.01
Propane & Liquid Propane	1.0	1.01
Steam	1.39	1.45
Chilled Water	1.0	1.05
Wood	1.0	1.0
Coal/Coke	1.0	1.0
Other	1.0	1.0

V. Weather Normalization:

All predictions will reference as experienced HDD and CDD values, not the 30-year average HDD and CDD values. Because the new retail model will be released with the updated office model, *all buildings in Portfolio Manager should be using as experienced HDD and CDD values not 30-year averages.*

The weather normalized source EUI (for display in PM, not part of the rating) will be computed according to the new routine developed by SRA in December 2006. Because the new retail model will be released with the updated office model, *the new weather normalization routine will be applied to all buildings in the tool*.

VI. Automated Data Exchange:

As noted above, a number of key partner retailer organizations already work directly with Avista and other third party data exchange organizations. The automated data exchange is a key feature for the success of the retail models and should be available upon the release, September 28. If there are concerns about including the PMDX development during this time, SRA should notify EPA so that we can determine together the best strategy for development

SRA will let EPA know within 1 week if there will be a problem meeting the PMDX release date of 9/28.

Please note that of the 10 organizations who participated in the beta test, some are likely to use PMDX while others are likely to use manual entry or PM import templates.

VII.Criteria for Receiving a Rating:

In order to be eligible to receive a national energy performance rating, retail space must have the following operating characteristics. This information will also be added to the new Portfolio Manager web pages and new Criteria Summary Table.

1. Gross floor area of the building (excluding parking) must be at least 5,000 square feet.
2. All retail spaces must be in operation at least 30 hours per week, but not more than **168** hrs/wk.
3. **~~The retail space must be in operation at least 10 months per year.~~ (No longer a rule for receiving a rating.)**
4. All retail buildings must contain at least 1 register.
5. Each retail space must contain at least 1 worker during the main shift.
6. The user must enter at least 11 consecutive months of data for all the operating characteristics.
7. There must be at least 11 full consecutive calendar months of energy data for all active meters. If there are multiple meters, there must be 11 consecutive months and overlapping months. No individual electrical meter entry can be for a period longer than 65 days.

VIII. Label Eligibility Flags:

As for all other spaces in the tool, if a Retail building is applying for the label, the application should be flagged if the source EUI is outside the established lower or upper EUI bounds. The analysis that was conducted at the beginning of the summer addressing the need for appropriate label eligibility flags for all ratable space types also applies to retail space. Lower bounds were determined by multiplying the average source EUI[1] by 0.15 and the upper bound was determined by multiplying the average source EUI by 1.5. The Source EUI bounds for label eligibility flags are as follows:

1. lower source EUI bound = 26 kbtu/sqft
2. upper source EUI bound = 259 kbtu/sqft

In addition, the attributes of the retail model should be screened during the label application process. For those attributes that fall outside of the typical range for retail stores, the applicant will be required to provide an explanation before the label application can be approved. The eligibility flags are determined relative to the 5th and 95th percentile values for the attributes in the CBECS 2003 data set.

1. gross square foot ≥ 1,000,000 sqft
2. worker hours < 40 hrs/wk or > 100 hrs/wk
3. register density > 0.66 registers per 1,000 sqft
4. worker density <.12 workers per 1,000 sqft or >1.59 workers per 1,000 sqft

The PE will be required to verify on the SEP that the retail store is open 10 months of the year or more. The applicant will not be offered an opportunity to "justify" fewer months of operation.

IX. Model Testing:

EPA will provide (via excel spreadsheet) attribute and energy data for 600 sample buildings. SRA should use the new scripts (i.e. not by hand in excel) to generate scores of these 600 buildings, in order to verify that new methods are functioning properly. SRA should submit to EPA the list of each of these facilities with its rating. EPA will verify these ratings against ratings obtained internally for these facilities. Additionally EPA will also enter also enter some of these buildings (obviously not all 600) into staging, to ensure that everything is working correctly.

Timeline:

- EPA will send the test buildings over **1 week after receipt of import template**
- SRA will provide EPA with a result report that states each building's ID and its score by **August 31**
- EPA will compare SRA's result to an independent scoring of the same 600 buildings and share results with SRA by August 25 *(If there are discrepancies,*

[1] Averages were calculated as a weighted average from CBECS 2003 data and new source conversion factors

then we will request greater detail in order to reconcile differences and assure proper modeling).

X. Retail Lookup Table:

Please note that if the ratio (actual divided by predicted energy consumption) is between two ratios listed in the table, the system should round down and choose the rating that corresponds with the lower of the two ratios. This rounding process is detailed in the following examples:

- If the ratio is less than 0.2243 the rating for that building should be 100
- If the ratio is greater than or equal to 0.2243 and less than 0.2743, the rating for the building should be 99
- If the ratio is greater than or equal to 0.9543 and less than 0.9662, the rating for the building should be 49
- If the ratio is greater than or equal to 2.2721 and less than 2.5066, the rating for the building should be 2
- If the ratio is greater than or equal to 2.5066, the rating for the building should be 1

Lookup Table for Retail Rating						
Rating	**Cumulative Percent**	**Ratio**		**Rating**	**Cumulative Percent**	**Ratio**
100	0	<0.2243		50	0.5	0.9543
99	0.01	0.2743		49	0.51	0.9662
98	0.02	0.3100		48	0.52	0.9783
97	0.03	0.3390		47	0.53	0.9906
96	0.04	0.3640		46	0.54	1.0029
95	0.05	0.3864		45	0.55	1.0154
94	0.06	0.4067		44	0.56	1.0281
93	0.07	0.4256		43	0.57	1.0409
92	0.08	0.4434		42	0.58	1.0539
91	0.09	0.4602		41	0.59	1.0671
90	0.1	0.4762		40	0.6	1.0804
89	0.11	0.4915		39	0.61	1.0940
88	0.12	0.5063		38	0.62	1.1078
87	0.13	0.5206		37	0.63	1.1219
86	0.14	0.5345		36	0.64	1.1362
85	0.15	0.5480		35	0.65	1.1507
84	0.16	0.5612		34	0.66	1.1656
83	0.17	0.5742		33	0.67	1.1808
82	0.18	0.5868		32	0.68	1.1963
81	0.19	0.5993		31	0.69	1.2121
80	0.2	0.6116		30	0.7	1.2284
79	0.21	0.6237		29	0.71	1.2450
78	0.22	0.6356		28	0.72	1.2621
77	0.23	0.6474		27	0.73	1.2797
76	0.24	0.6591		26	0.74	1.2978
75	0.25	0.6707		25	0.75	1.3164
74	0.26	0.6822		24	0.76	1.3357
73	0.27	0.6936		23	0.77	1.3556
72	0.28	0.7050		22	0.78	1.3762
71	0.29	0.7162		21	0.79	1.3977
70	0.3	0.7275		20	0.8	1.4200
69	0.31	0.7387		19	0.81	1.4433
68	0.32	0.7499		18	0.82	1.4677
67	0.33	0.7610		17	0.83	1.4933
66	0.34	0.7721		16	0.84	1.5202
65	0.35	0.7833		15	0.85	1.5488
64	0.36	0.7944		14	0.86	1.5791
63	0.37	0.8055		13	0.87	1.6115
62	0.38	0.8167		12	0.88	1.6463
61	0.39	0.8279		11	0.89	1.6841
60	0.4	0.8391		10	0.9	1.7252
59	0.41	0.8503		9	0.91	1.7707
58	0.42	0.8616		8	0.92	1.8216
57	0.43	0.8729		7	0.93	1.8795
56	0.44	0.8843		6	0.94	1.9469
55	0.45	0.8958		5	0.95	2.0280
54	0.46	0.9073		4	0.96	2.1307
53	0.47	0.9189		3	0.97	2.2721
52	0.48	0.9306		2	0.98	2.5066
51	0.49	0.9424		1	0.99	>2.5066