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October 14, 2014

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17120

Re: Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2015 Update
Docket No. M-2012-2313373

Dear Secretary Chiavetta:

Pursuant to the September 11, 2014 Tentative Order in the above-referenced docket, enclosed please find **PECO Energy Company's Comments on the Proposed Update to the 2015 Technical Reference Manual**. The Comments have also been electronically mailed in word format to Megan G. Good (megagood@pa.gov) and Kriss Brown (kribrown@pa.gov).

Please do not hesitate to contact me should you have any questions regarding this filing.

Very truly yours,

Jack R. Garfinkle
Assistant General Counsel

JRG/adz

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards For the Participation of Demand Side Management Resources – Technical Reference Manual 2015 Update	: : : : :	Docket No. M-2012-2313373

COMMENTS OF PECO ENERGY COMPANY ON THE
PROPOSED UPDATE TO THE TECHNICAL REFERENCE MANUAL

Pursuant to the September 11, 2014 Tentative Order entered by the Pennsylvania Public Utility Commission (the "Commission") in the above-referenced dockets, PECO Energy Company ("PECO" or "the Company") hereby submits comments on the Commission's proposed 2015 update to its Technical Reference Manual ("TRM").

PECO appreciates the Commission's continued efforts to update the TRM and ensure that it serves as an effective tool for validating savings. The Company agrees that data provided by Pennsylvania electric distribution companies ("EDCs") are an appropriate basis for identifying TRM improvements. PECO's comments are attached to this document as Exhibit 1. Overall, PECO believes that great progress has been made through the TRM update process.

PECO appreciates the opportunity to comment on this important matter and believes that the Company's recommended revisions can improve the effectiveness of the Technical Reference Manual.

Respectfully Submitted,

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Dated: October 14, 2014

For PECO Energy Company

EXHIBIT I

PECO ENERGY COMPANY
COMMENTS ON THE PROPOSED UPDATE TO THE 2015 TECHNICAL REFERENCE MANUAL

Contents

Cross Cutting Comments

Comments:

- A key change in the 2015 draft TRM is the reorganization of measures within each chapter so they're grouped by End-Use category. This reorganization makes for a much more user-friendly TRM. New protocols added to future TRMs should be added to the section that groups other protocols of the same End-Use, instead of adding the new protocols to the end of the TRM as was done in previous years. This will help ensure that the organization by End-Use continues to be used going forward.

- Another key change in the 2015 draft TRM is the organization of the information contained within the measure protocols themselves. The protocols are now organized with section headings. Common section headings include *Eligibility, Algorithms, Definition of Terms, Evaluation Protocols,* and *Sources.* Additional section headings are included in protocols where necessary, such as *Definition of Heating Zone* in Section 2.2.3 Ductless Mini-Split Heat Pumps.

- Several protocols continue to have a *Measure Life* subsection, even though Measure Life was added to the introductory tables for every protocol. There is also a complete table in the updated TRM Appendix A: Measure Lives section. We recommend the *Measure Life* subsections be removed from each protocol and any supporting information to justify the measure life in the subsection should be moved to TRM Appendix A to reduce the chance for errors if the measure life gets updated in one location and not the other.

Section Specific Comments to the Draft Pennsylvania PUC June 2015 Technical Reference Manual

Section 1: Introduction

Section 1.7 Baseline Estimates

Comments:

- Replace the use of "retrofit on burnout" with "replace on burnout" throughout as a retrofit is by definition not the same as a replacement.

Section 1.12 Adjustments to Energy and Resource Savings

Section 1.15 Measure Lives

Comments:

- Add the word "protocol" to the first sentence so it reads "Measure lives are provided at the beginning of each measure *protocol*…"

Section 1.17 Impact of Weather

Comments:

- Replace the comma separating the last two sentences of the second paragraph with a period.

Section 2: Residential Measures

Section 2.1 Lighting

2.1.1 ENERGY STAR Lighting

<u>*Comments:*</u>

- Footnote reference 28 should include a source that includes an explanation of the baseline shift. In addition, the word "on" should be replaced with "onwards."
- The measure life for LEDs is listed at 14.7 years with the justification that, "All LED bulbs listed on the qualified ENERGY STAR product list have a lifetime of at least 15,000 hours. Assuming 2.8 hours per day usage, this equates to 14.7 years." This is therefore likely the minimum lifetime of LEDs and the average lifetime is somewhere higher. Given the limits on measure lives of a maximum of 15 years for TRC calculations, we suggest just revising this measure life to the maximum of 15 years rather than 14.7 years, understanding the average measure life is likely somewhere higher than this.

Algorithms

<u>*Comments:*</u>

- The algorithm for ENERGY STAR LED Bulbs (screw-in) includes an ISR_{CFL} factor. While we support the inclusion of the ISR factor, we recommend using an ISR_{LED} factor rather than an ISR_{CFL} factor. It is confusing to use ISR_{CFL} for LEDs and it also makes it inconsistent with the other measures that have their own ISR. Even if the values are similar, having only one variable would preclude updating one without the other if evaluation findings showed a difference.
- The energy algorithm for "ENERGY STAR Indoor LED Fixture (hard-wired, pin-based):" uses the IE_{kWh} rather than the $IE_{kWh\text{-}LED}$. This is inconsistent with the demand equation which uses the $IE_{kW\text{-}LED}$. This should be corrected to use the LED interactive effects factor.

Definition of Terms

<u>*Comments:*</u>

- We recommend adding a separate $ISR_{CFL,DI}$ and $ISR_{LED,DI}$ for direct install programs. There is a fundamental difference in concept between an ISR from a retail/time of sale/giveaway program where a customer may be purchasing/receiving CFLs for which they do not currently have an available socket, but which they will eventually install when an existing bulb burns out, and a direct install program in which all CFLs are initially installed and evaluation finds some to be subsequently removed by the customer with no plans to re-install. Navigant's evaluation of PECO's PY4 Low-Income Energy Efficiency Program (LEEP) did site visits to verify the appropriate ISR for direct install CFLs. The findings from the program yielded an ISR_{CFL} of 97.3%. We recommend the protocol include this as an open variable with a default of 97.3% which can be verified by evaluation. Although it is similar to the current upstream ISR, we recommend having separate ISR's based on this understanding of fundamental differences and the potential for significantly different findings from different direct install programs which may show lower ISR values than the defaults.
- Similarly, we recommend either adding an LED_{hours} variable or changing the CFL_{hours} variable to something more generic. It is confusing for implementers to use variables identified as being for CFLs for LED measures. It would be more intuitive to see all of the residential

lighting variables for hours of use to be labeled as HOU and the subscript identify the type of application, for example: HOU_{CFL}, HOU_{LED}, and HOU_{Torch}. This would be more consistent with all of the other variables in the lighting protocol.

- We recommend either allowing EDC data gathering or evaluation adjusted values for ISR values for bulbs included in efficiency kits and as giveaways. PY5 evaluations of PECO's energy kit program for schools showed a much lower first year in service rate than other program types. While research has not yet been completed to confirm second and third year installation rates it may be lower than for other programs given the bulbs were not purchased through a retailer. Similar to direct install bulbs, it may be appropriate to allow adjustment for these other program designs.
- The CF has been updated to 9.1% based on an EMPower MD report. It is unclear whether this CF represents the new peak demand period or the old peak 100 hour period. This should be clarified. We recommend the language "or EDC Data Gathering" be added to Table 2-1 in the "CF" row, "Value" column of to allow EDC-specific CF's to be developed. Navigant has determined a PECO specific CF for the Phase II peak demand period of 11.6% based on an analysis of various residential lighting load shapes from different studies. The review compared loadshapes from a NMR 2009 NE study, the EMPower MD referenced by the TRM, DEER 2008, and a KEMA 2005/2010 profile (merged by ADM). After comparison of the various load shapes and underlying data, it was determined the NMR 2009 NE load shape was the most reliable for PA. The CF = 11.6% was calculated using the Act 129 Phase II peak demand period and the residential lighting load shape developed through the 2009 Northeast residential lighting logger study conducted by Nexus Market Research, RLW Analytics, and GDS Associates, as part of PECO's Act 129 Phase I, PY4 evaluation.[1]

Variable Input Values

<u>Comments:</u>

- It may be worth adding 1-2 sentences saying leakage of program bulbs out of utility service territory should be assumed to be zero based on UMP and the notion that leakage out is likely approximately offset by leakage in.
- As currently written, Table 2-4 is not comprehensive and does not include a larger percentage of lamp wattages and lumen ranges. We suggest including a more comprehensive table similar to that provided below instead of the current Table 2-4 to avoid continued confusion among the ICSPs. The modified Table 2-4 below is long, but it is much more complete than the current version of Table 2-4 provided in the draft TRM and covers all lamp types and lumen ranges included in the ENERGY STAR Lamps Specification whereas the current TRM table does not. If the PA Statewide Evaluator believes there are missing or incorrect values in this table we suggest that they correct them and still include a more comprehensive table than that currently in the TRM.

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[1] Nexus Market Research, Inc., RLW Analytics, Inc., and GDS Associates, 2009. Residential Lighting Markdown Impact Evaluation. Prepared for Markdown and Buydown Program Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont. January 20, 2009.

TRM Table 2-4 (updated). EISA Non-exempt General Service and Specialty Screw-in CFL and LED Baseline Wattage by Lumen Output[2,3]

Lamp Type (a)	*Rated Wattage of the Referenced Incandescent Lamp ($Watts_{base}$) (b)*	*Minimum Lower Lumen Range (c)*	*Upper Lumen Range (d)*
EISA Exempt Omnidirectional, including 3-way lamps	25	250	449
	40	450	799
	60	800	1,099
	75	1,100	1,599
	100	1,600	1,999
	125	2,000	2,549
	150	2,550	3,000
	200	3,001	3,999
	300	4,000	6,000
Covered A-Lamp[4]	25	250	449
	40	450	799
	60	800	1,099
	75	1,100	1,599
	100	1,600	1,999
	150	2,550	3,000
Decorative Globe (G) shape greater than or equal to 5" in diameter	25	250	349
	40	350	499
	60	500	574
	75	575	649
	100	650	1,099
	150	1,100	1,300
Decorative excluding Globe (includes B, BA, C, CA, DC, E12, and F)	10	70	89
	15	90	149
	25	150	299

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[2] Based ENERGY STAR Lamps V1.1 Final Specification released August 28, 2014 and effective September 30, 2014, which will replace the previous ENERGY STAR Lamps V1.0 Final Specification . https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V1%201_Specification.pdf

[3] Manufacturer ratings may differ from the list below, in which case EDCs may default to the manufacturer equivalent rating.

[4] Non-globe and non-candle type covered CFL, typically "A-shape", general purpose replacement lamps.

Lamp Type (a)	*Rated Wattage of the Referenced Incandescent Lamp (Watts$_{base}$) (b)*	*Minimum Lower Lumen Range (c)*	*Upper Lumen Range (d)*
	40	*300*	*499*
	60	*500*	*699*
All directional (R, BR and ER) lamps below lumen ranges specified below	*20*	*200*	*299*
	30	*300*	*399*
	40	*400*	*449*
Directional (R, BR and ER) lamps with medium screw bases and bulb diameter < 2.25" diameter unless otherwise listed	*45*	*450*	*499*
	50	*500*	*549*
	55	*550*	*599*
	60	*600*	*649*
	65	*650*	*749*
ER30, BR30, BR40, or ER40	*45*	*450*	*499*
	50	*500*	*649*
BR30, BR40, or ER40	*65*	*650*	*749*
R20	*45*	*450*	*719*
All other R, BR, PAR, and ER directional lamps not listed above	*40*	*420*	*524*
	50	*525*	*659*
	60	*660*	*937*
	75	*938*	*1,259*
	90	*1,260*	*1,399*
	100	*1,400*	*1,739*
	120	*1,740*	*2,174*
	150	*2,175*	*2,537*
	175	*2,538*	*2,899*
	200	*2,900*	*3,300*

We recommend Tables 2-5 and 2-6 be updated with PECO specific IE values based on a robust analysis completed by Navigant for PECO's PY4 evaluation. Navigant has completed analysis using the BEopt computer simulation program coupled with the EnergyPlus simulation engine to develop a PECO specific IE_{kWh} and IE_{kW} based data gathered from PECO's baseline study and billing data. This is a more robust simulation software than the REM/Rate software which was utilized by the SWE to develop the default values in the table. Given that REM/Rate is not an independently validated building simulation software program according to the US DOE EERE website[5], we consider the results of the BEopt and EnergyPlus simulations done by Navigant to be more reliable. A memo describing this analysis is included in Appendix A

- PECO Residential CFL/LED Interactive Effects/Waste Heat Factor Analysis Memo. We recommend that the PECO entry in Table 2-6 be updated as follows:

TRM Table 2-5 (updated). CFL Energy and Demand HVAC Interactive Effects by EDC (PECO row only)

EDC	IE_{kWh}	IE_{kW}
PECO[6]	~~9%~~**1%**	~~14%~~**22.8%**

TRM Table 2-6 (updated). LED Energy and Demand HVAC Interactive Effects by EDC (PECO row only)

EDC	IE_{kWh}	IE_{kW}
PECO[7]	~~9%~~**1%**	~~14%~~**22.8%**

Sources

Comments:

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[5] The US DOE EERE website lists hundreds of simulation software and provides a validation summary. The REM/Rate summary is listed here: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=287/pagename_menu=pc/pagename=platforms
The EnergyPlus summary is listed here: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=287/pagename_menu=pc/pagename=platforms

[6] Per PECO's PY4 Evaluation Research Report findings based on BEopt with EnergyPlus computer simulations calibrated to PECO's baseline study findings and PECO residential monthly average consumption data.

[7] Per PECO's PY4 Evaluation Research Report findings based on BEopt with EnergyPlus computer simulations calibrated to PECO's baseline study findings and PECO residential monthly average consumption data.

- Source 2 explains the ISR of 97% is based on discounting future savings back to the current program year. Please add the discount rate that is underlying this calculation.

2.1.2 Residential Occupancy Sensors

Algorithms

Comments:

- The algorithm for this measure should be updated to include the interactive effects factor IE_{kWh} similar to sections 2.1.1 ENERGY STAR Lighting. Therefore, we recommend the follow update to the algorithm:

$$\frac{Watts_{controlled}}{1000\frac{W}{kW}} \times (RH_{old} - RH_{new}) \times 365\frac{days}{yr} X\,(1 + IE_{kWh})$$

Definition of Terms

Comments:

- The unit for $Watts_{controlled}$ should be watts, not kilowatts.

2.1.3 Electroluminescent Nightlight

Definition of Terms

Comments:

- The ISR_{NL} has been updated to match the ISR for CFLs which has been increased to 97%. There is no indication that the ISR for nightlights is as high as the ISR for CFLs. In the absence of better data, we recommend a default ISR of between 60% and 85% using professional judgment to make such an estimate. For example, Navigant's PY5 evaluation of PECO's Smart Energy Saver program which included LED nightlights in energy efficiency kits given to students found an ISR of 75%. We further recommend the ISR be an open variable subject to the EDC data gathering as this may vary from program type to program type. This is particularly important given that nightlights are often included in efficiency kits which may have a lower ISR than those purchased at retail locations.

2.1.4 LED Nightlight

Definition of Terms

Comments:

- The unit for $Watts_{base}$ and W_{NL} should be watts, not "None."
- The ISR_{NL} has been updated to match the ISR for CFLs which has been increased to 97%. There is no indication that the ISR for nightlights is as high as the ISR for CFLs. In the absence of better data, we recommend a default ISR of between 60% and 85% using professional judgment to make such an estimate. For example, Navigant's PY5 evaluation of PECO's Smart Energy Saver program which included LED nightlights in energy efficiency kits given to students found an ISR of 75%. We further recommend the ISR be an open variable subject to the EDC data gathering as this may vary from program type to program type. This is particularly important given that nightlights are often included in efficiency kits which may have a lower ISR than those purchased at retail locations.

2.1.5 Holiday Lights

Comments:

- In the first sentence, invert the order of "up" and "by" so the sentence says "(...) consumption *by up* to (...)."

Algorithms

Comments:

- In the first sentence of the key assumptions, multiple unpaired parentheses and periods make the sentence confusing. Update as follows:
    - "All estimated values reflect the use of residential *(25ct. per strand)* bulb LED holiday lighting."
- The wording convention for the lamps is inconsistent. Specifically, sometimes quotes are used and other times they are not, such as with "C7" in this section and unquoted C7 in the Deemed Savings section. We recommend that one convention be selected and used consistently throughout.

Definition of Terms

Comments:

- W_{mini}, W_{C7} and W_{C9} are explained as key assumptions, but they do not appear in the algorithms. Update the algorithms to make the proper use of these weighting factors clear or remove them if not used. As currently written it is not clear how those values should be used.
- For the "#Bulbs" variable, using the "bulbs/strand" unit as written in the protocol leaves "bulbs" as a unit in the final result. We recommend the units on all of the wattage variables be changed to "Watts/bulb." This will make the units of the algorithm come out as kWh or kW savings per package rather than "kWh or kW savings*Bulb/package."
- For the "#Strands" variable, using the "strands/package" unit as written in the protocol leaves "package" as a unit in the final result. There is no other reference to "packages" in the protocol. The protocol should clarify that the algorithm is used to calculate savings per package.

Sources

Comments:

- The assumptions listed as Source 3 are key to the savings algorithms and are a duplicate of the "Key assumptions" listed in the "Algorithms" section. The assumptions are listed in Sources, but they do not cite a source. Please add the source and remove the duplication.

Section 2.2 HVAC

2.2.1 Electric HVAC

Definition of Terms

Comments:

- Include the units for $CAPY_{cool}$ and $CAPY_{heat}$ would be better expressed as $\frac{Btu}{h}$ in the "Unit" column. They are currently listed as Btuh in the "Component" column and should be deleted from that column.
- Include the Seasonal Energy Efficiency Ratio values for baseline unit ($SEER_b$) for both split system and single package central A/C and ASHP.
- The value for coincidence factor should not include the percentage sign as it's already defined as a percentage in the "Units" column. The use of the percentage sign in both columns is redundant.
- According to Source 18, the value of assumed peak-demand savings per furnace high efficiency fan, PDFS should be 0.1625 * 0.647 = 0.105 instead of 0.114

Alternate Equivalent Full Load Hour (EFLH) Tables

Comments:

- Tale 2-12 should have a source.

Sources

Comments:

- In reference 59, we recommend adding the hyperlink to *Central Air Conditioning in Wisconsin, a compilation of recent field research.* Energy Center of Wisconsin. May 2008, amended December 15, 2010, http://ecw.org/sites/default/files/241-1_0.pdf.
- In reference 60, we recommend correcting the hyperlink for ACCA, "Verifying ACCA Manual S Procedures", from http://www.acca.org/Files/?id=67 to http://www.acca.org/wp-content/uploads/2014/01/Manual_S_verification.pdf.

2.2.2 Fuel Switching: Electric Heat to Gas/Propane/Oil Heat

Algorithms

Comments:

- We recommend changing the subtraction sign in the "Heating savings with electric air source heat pump" equation from "-" to "–" as it is easy to miss and is inconsistent with the algorithm for electric baseboards.

Definition of Terms

Comments:

- The values for $AFUE_{fuel\ heat}$ and η_{motor} should not include the percentage sign as they're already defined as percentages in the "Units" column. The use of the percentage sign in both columns is redundant.

2.2.3 Ductless Mini-Split Heat Pumps

Comments:

- We recommend correcting the hyperlink in footnote reference 64 from http://www.deeresources.com/deer0911planning/downloads/EUL_Summary_10-1-08.xls to http://www.deeresources.com/files/deer0911planning/downloads/EUL_Summary_10-1-08.xls.

Definition of Terms

Comments:

- The Source for Duct Leakage Factor (DLF) is missing and needs to be added.
- The value for coincidence factor should not include the percentage sign as it's already defined as a percentage in the "Units" column. The use of the percentage sign in both columns is redundant.

Sources

Comments:

- The text in Source 4 is incomplete and can be confusing. We recommend it be more detailed to make it clearer. We also recommend updating the algorithms so they include all relevant mathematical functions (for example, update the algorithm relating COP and HSPF so it reads "HSPF = 3.413 * COP").

2.2.4 ENERGY STAR Room Air Conditioners

Definition of Terms

Comments:

- The value for coincidence factor should not include the percentage sign as it's already defined as a percentage in the "Units" column. The use of the percentage sign in both columns is redundant.

Sources

Comments:

- In footnote reference 72, we recommend correcting the hyperlink for ACCA, "Verifying ACCA Manual S Procedures", from http://www.acca.org/Files/?id=67 to http://www.acca.org/wp-content/uploads/2014/01/Manual_S_verification.pdf.

2.2.5 Room AC (RAC) Retirement

Definition of Terms

Comments:

- The unit of rated cooling capacity (size) of the RAC unit, *CAPY*, would be better expressed as $\frac{Btu}{h}$ instead of Btuh.
- $CEER_{base}$ and $CEER_{ee}$ should be correctly renamed as "Combined Energy Efficiency Ratio" instead of "Energy Efficiency Ratio". The word "Combined" is missing.
- The values for demand coincidence factor and RAC time period allocation factor should not include the percentage sign as it's already defined as a percentage in the "Units" column. The use of the percentage sign in both columns is redundant.

2.2.6 Duct Sealing

Definition of Terms

Comments:

- The value for coincidence factor should not include the percentage sign as it's already defined as a percentage in the "Units" column. The use of the percentage sign in both columns is redundant.
- The units of Cap_{cool} and Cap_{heat} would be better expressed as $\frac{Btu}{h}$ instead of Btuh.
- Error in naming DE_{after} and DE_{before}. These parameters are "Distribution Efficiency" and not "Distribution Energy". Replace "Energy" with "Efficiency".

2.2.7 Furnace Whistle

Definition of Terms

Comments:

- The values for Efficiency Improvement (EI), In-Service Rate (ISR) and Coincidence Factor (CF) should not include the percentage sign as they're already defined as percentages in the "Units" column. The use of the percentage sign in both columns is redundant.

2.2.8 Programmable Thermostat

Comments:

- As this is a residential measure, we recommend changing the source for measure life of 11 years. The description of source in footnote reference 84 should be changed from *"New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs, September 1, 2009, based on DEER"* to *"DEER: http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx"*.

Definition of Terms

Comments:

- The units of $CAPY_{cool}$ and $CAPY_{heat}$ would be better expressed as $\frac{Btu}{h}$ instead of Btuh.

Section 2.3 Domestic Hot Water

2.3.1 Efficient Electric Water Heaters

Comments:

- The web address in footnote reference 91 needs to be updated, it does not work as it's written.

2.3.2 Heat Pump Water Heaters

Default Savings

Comments:

- We recommend that units be included for the constants in the algorithm to avoid ambiguity (such as adding the unit for "3080").

2.3.3 Solar Water Heaters

Algorithms

Comments:

- The correct for footnote reference 100 appears to be "http://www.solar-rating.org/ratings/index.html" instead of "http://www.solar-rating.org/ratings/ratings.htm." Please verify and, if so, add more details about the specific source for the information within this website. Listing the website on its own makes the source ambiguous.

Sources

Comments:

- For Source 1, the correct source appears to be "http://www.solar-rating.org/ratings/index.html" instead of "http://www.solar-rating.org/ratings/ratings.htm." Please verify and, if so, add more details about the specific source for the information within this website. Listing the website on its own makes the source ambiguous.

2.3.4 Fuel Switching: Electric Resistance to Fossil Fuel Water Heater

Comments:

- The web address in footnote reference 102 needs to be updated, it does not work as it's written.

2.3.5 Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater

Heat Pump Water Heater Energy Factor

Comments:

- The paragraph is missing punctuation and may be confusing. We recommend that it be reworded for clarity, or at a minimum updated with punctuation as indicated in *underlined italics* below:
  - The Energy Factors are determined from a DOE testing procedure that is carried out at 67.5°F dry bulb and 56 °F wet bulb temperatures. However, the average dry and wet bulb temperatures in PA are in the range of 50-56°F DB and 45-50 °F WB. The heat pump performance is temperature and humidity dependent, therefor*e* the location and type of installation is significant*.* To account for this, an EF de-rating factor (F_{derate}) has been adapted from a 2013 NEEA HPWH field study, Figure 15 (Source 8). The results used are for "Heating Zone 1", which is comprised of Olympia, WA and Portland, OR*,* and have average dry and wet bulb temperatures (51°F DB, 47°F WB and 55°F DB, 49°F WB, respectively) comparable to Pennsylvania.

Sources

Comments:

- The web address in footnote reference 115 needs to be updated, it does not work as it's written.

2.3.7 Water Heater Temperature Setback

Sources

Comments:

- The web address for Source 10 needs to be updated, it does not work as it's written.

2.3.11 Thermostatic Shower Restriction Valve

Algorithms

Comments:

- The ΔkW_{peak} algorithm needs to be realigned to match the alignment for the Δ kWh/yr algorithm.

Section 2.4 Appliances

2.4.1 ENERGY STAR Refrigerators

Definition of Terms

Comments:

- The numbers used to list models in column "Refrigerator Category" of Table 2-70 may be confusing. We recommend they be deleted, or that a clarifying note be added before the table saying that those numbers correspond to the models listed in the ENERGYSTAR standard. This should be done for all similar tables in this section.

Deemed Savings

Comments:

- The title of this sub-section leads to confusion as to whether the savings given are defaults or deemed values. Given that many of the variables in the algorithm are actual "Open" it appears the intent is for this section to include "default" savings rather than "deemed." The title of this section should be revised from "Deemed Savings" to "Default Savings."

2.4.2 ENERGY STAR Freezers

Definition of Terms

Comments:

- The numbers used to list models in column "Freezer Category" of Table 2-74 may be confusing. We recommend they be deleted, or that a clarifying note be added before the table saying that those numbers correspond to the models listed in the ENERGYSTAR standard. This should be done for all similar tables in this section.

2.4.3 Refrigerator/Freezer Recycling with and without Replacement

Comments:

- The comments below are based on this measure protocol as currently written, however, overall, this protocol should be revised to refer to the DOE Uniform Methods Project (UMP) protocol for refrigerator recycling as was previously discussed and agreed to during the PEG meetings. It is reasonable for the TRM protocol to refer to the UMP protocol while including a PA specific regression algorithm with deemed regression coefficients, however, as currently written it is confusing as it partially refers to the UMP protocol with some significant revisions included. By including the PA specific regression while allowing the EDCs to follow the UMP in full, this will allow the EDCs to use a common approach to calculate savings based on the actual recycled units for each EDC and reduce confusion as to how to apply the UMP protocol. It is also reasonable for the protocol to include default energy consumption per existing refrigerator by EDC and a default energy consumption for new non-ENERGY STAR and new ENERGY STAR refrigerators which will allow EDCs to use the default for program planning and tracking until the regressions can be used.

Partially Deemed Savings Algorithms

Comments:

- This subsection should be retitled from "Partially Deemed Savings Algorithms" to "Algorithms" to be consistent with all other protocols. This entire subsection should be revised to be more consistent with the "Algorithms" subsection of other measure protocols.
- The variable "DEEMED_kWhsaved Per Unit" should be corrected to read "GROSS_kWhsaved Per Unit" to be more consistent the Uniform Methods Protocol (UMP) and other protocols in the TRM. This should be changed throughout the protocol.
- Although the variable "Net_kWhsaved Per Unit" is consistent with the UMP for this measure, it is inconsistent with how savings are being defined in PA. The algorithm for this variable is actually being used to calculate the "gross" savings for a refrigerator/freezer with replacement rather than viewing this as "net" savings. This variable should be renamed to clarify that it represents the gross savings for a unit that was recycled and replaced.

Default Savings Calculations

Comments:

- Most of the algorithms in this section should be moved to the "Algorithms" section of this protocol to be consistent with other measure protocols.
- The tables "Refrigerator Unit Energy Consumption Equation" and "Freezer Unit Energy Consumption Equation" are really definition tables of variables and should be moved to the "Definitions" section of this protocol to be consistent with other measure protocols. The tables are not numbered. These tables should be numbered for consistency with other measure protocols.

2.4.4 ENERGY STAR Clothes Washers

Sources

Comments:

- Source 6 lists the Illinois and Mid-Atlantic TRMs. Those are not in themselves the sources of the information used in this protocol. Please update so that the original source is cited instead of the TRMs.

2.4.7 ENERGY STAR Dishwashers

Sources

<u>*Comments:*</u>

- Source 4 lists the Illinois TRM. The TRM is not in itself the source of the information used in this protocol. Please update so that the original source is cited instead of the TRM.

2.4.8 ENERGY STAR Dehumidifiers

Definition of Terms

<u>*Comments:*</u>

- The first table in this section is not numbered. Tables used in this section of other protocols are numbered, so we recommend that this table be numbered for consistency.
- In the third line in the first table, under column "Value," the "Federal Standard" portion of Table 2-91 is referenced. Other protocols do not reference specific values within a table, as this one does. We recommend that the words "Federal Standard" be deleted for consistency. The same comment applies to the fourth row of the table where the words "ENERGY STAR" should be deleted for consistency.

2.4.9 ENERGY STAR Water Coolers

Eligibility

<u>*Comments:*</u>

- "Cold Only & Cook & Cold Units" should be updated to read "Cold Only *or* Cook *and* Cold Units" to more correctly reflect the categories used in the ENERGY STAR standard.

Definition of Terms

<u>*Comments:*</u>

- In Table 2-93, units are included in the first two rows of column "Component." This is redundant, we recommend that they be deleted from this column.
- In Table 2-93, the name of column "Type" should be replaced with "Unit." This will make the column name better identify the information contained, and it will make it consistent with the column headers used in other protocols.

Sources

<u>*Comments:*</u>

- Source 3 refers to assumptions stated in a separate TRM protocol. We recommend that more details be added to Source 3 so all of the relevant information is contained within this protocol.

Section 2.5 Consumer Electronics

2.5.1 ENERGY STAR Televisions

Deemed Savings

<u>*Comments:*</u>

- The title of Table 2-100 can be deleted from the text under the table for simplicity. We recommend that the text "Coincident demand savings are given in the Table 2 100: Deemed coincident demand savings for ENERGY STAR Version 6.0 and ENERGY STAR Most Efficient TVs." be updated to "Coincident demand savings are given in Table 2-100."

`2.5.2 ENERGY STAR Office Equipment

Sources

Comments:

- Source 1 says that information "Referenced latest version released in May," but it does not specify a year. Please add the year for clarity.

2.5.3 Smart Strip Plug Outlets

Comments:

- The reference for Measure Life, ""Smart Strip Electrical Savings and Usability", David Rogers, Power Smart Engineering, October 2008" is not easily found. Consider adding a hyperlink to the source, or adding more detail to the reference to ease access.

Definition of Terms

Comments:

- Footnote reference 188 refers to the Efficiency Vermont TRM. The TRM is not in itself the source of the information used in this protocol. Please update so that the original source is cited instead of the TRM. This recommendation also applies to the text used in Source 3.

Section 2.6 Building Shell

2.6.1 Ceiling/Attic and Wall Insulation

Comments:

- Update the measure life to "15 years", and update footnote reference 189 to as follows:
    - "Massachusetts Statewide Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, Version 1.0, accessed August 2010 at http://www.ma-eeac.org/docs/091023-MA-TRMdraft.pdf. Note *that measure life is defined as 25 years; however,* PA Act 129 savings can be claimed for no more than 15 years."
- Update the unit energy savings and the unit peak demand reduction from "Varies" to "Variable" to be consistent with other measures.

Definitions of Terms

Comments:

- Update the last paragraph as follows:
    - "Alternate EFLH values from Table 2-12 and Table 2-13 in Section 2.1 may also be used for central ~~aire conditioners~~ *air conditioners* and air source heat pumps."

2.6.4 Residential New Construction

Definitions of Terms

Comments:

- Revise the definitions in the "Components" column so they do not contain the units, such as, "Heating kWhbase, Annual heating energy consumption of the baseline home ~~in kWh~~, from software," as units are defined in the "Unit" column. The use of the units in both columns is redundant.

Section 3: Commercial and Industrial Measures

Section 3.1 Lighting

3.1.2 New Construction Lighting

Algorithms

Comments:

- Table 3-11 list hours of use for new construction that are reduced by 24% to account for the savings associated with installing required controls in new construction buildings (except for Dusk-to-Dawn Lighting and 4/7 Facilities or Spaces). We recommend that the hours of use not be adjusted by 24%, and that instead the savings algorithm be adjusted to have a base case of SVG = 24% for all cases. By adjusting the HOU by 24% and reducing the savings factors for all controls types by 24%, the savings are underestimated. The more correct method is to leave the HOU the same as the retrofit lighting measure and calculating the savings by subtracting the total efficient energy consumption from the base case consumption. Consider the following example:

  $(kW_{base} - kW_{ee}) \times [(HOU\ (1 - 0.24)) \times (1 - 0.10) \times (1 + IF_{energy})] \neq \{[kW_{base} \times HOU\ (1 - 0.24) \times (1 + IF_{energy})] - [kW_{ee} \times HOU\ (1 - 0.34) \times (1 + IF_{energy})]$

  Where the first algorithm to the left of the not equal sign is equivalent to the TRM as currently written. The reduced hours of use in the new construction protocol are equivalent to $(HOU\ (1 - 0.24))$ in the algorithm. Use of controls in new construction lighting does not in itself mean that the lighting hours are less, they mean that the controls are mandated and the base case has reduced consumption due to the base case controls. Adjusting the algorithm to account for the change in SVG from base case to efficient case is therefore a better representation of the true savings. We recommend the savings algorithm be modified to:

  $$\Delta kWh = [(kW_{base} \times (1 - SVG_{base})) - (kW_{ee} \times (1 - SVG_{ee}))] \times HOU \times (1 + IF_{energy})$$

  Where SVG_{ee} is based on the savings factors as shown in table 3-4 and SVG_{base} is equal to 24%.
- The algorithm for demand savings does not include the savings factor for controls, but it should. The demand equation should be updated as follows:

  $$\Delta kW_{peak} = [(kW_{base} \times (1 - SVG_{base})) - (kW_{ee} \times (1 - SVG_{ee}))] \times CF \times (1 + IF_{demand})$$

- Where SVG_{ee} is based on the savings factors as shown in table 3-4 and SVG_{base} is equal to 24%.
- The algorithm for demand savings for the space by space method does not include the savings factor for controls, but it should. The demand equation should be updated as follows:

  $$\Delta kW_{p1} = [(kW_{base,1} \times (1 - SVG_{base})) - (kW_{ee,1} \times (1 - SVG_{ee,1}))] \times CF \times (1 + IF_{demand,1})$$

  Where $SVG_{ee,1}$ is based on the savings factors as shown in table 3-4 and SVG_{base} is equal to 24%.

Definition of Terms

Comments:

- Table 3-11 list hours of use for new construction that are reduced by 24% to account for the savings associated with installing required controls in new construction buildings (except for Dusk-to-Dawn Lighting and 4/7 Facilities or Spaces). We recommend that the hours of use not be adjusted by 24%, and that instead the savings algorithm be adjusted as described above under the Algorithms section. We recommend table 3-13 be made the same as table 3-4.

3.1.3 Lighting Controls

Definition of Terms

Comments:

- Default controlled kW values are listed in Table 3-14 for three lighting control types. The values listed do not match the values in the source, the 2013 Efficiency Vermont TRM. The kW values should be updated to:
  - Wall mounted occupancy sensor: 0.294
  - Remote mounted occupancy sensor: 0.456
  - Fixture mounted occupancy sensor: 0.173

  Further, we do not recommend these three defaults be included at all given that all lighting projects are required to fill out the Appendix C tables. There should be no need to default to an unreliable assumption.

Sources

Comments:

- The date in Source 3 should be updated to say "2013" instead of "2011."

3.1.6 LED Channel Signage

Comments:

- The description of LED channel signage colors is unclear. It currently states "Red, green, blue, yellow, and white LEDs are available, but at a higher cost than red LEDs." Please update so that the role of red LEDs is clear.

Section 3.2 HVAC

3.2.1 HVAC Systems

Definition of Terms

Comments:

- We recommend including measure vintage (Replacements or New Construction) for Packaged Terminal Systems as shown in Table 503.2.3(3) on Page 45 of IECC 2009.

3.2.2 Electric Chillers

Definition of Terms

Comments:

- Grammatical revision: The sentence concerning EFLH in Table 3-26 has a grammatical error. The word "from' should be removed from the sentence "The most appropriate EFLH from shall be utilized in the calculation".

3.2.5 Fuel Switching: Small Commercial Electric Heat to Natural Gas/Propane/Oil Heat

Comments:

- Measure Unit name correction: It should be changed to "Gas, Propane or Oil Heater" from "Water Heater"

Definition of Terms

Comments:

- In Table 3-39, reference number 300 should be superscripted.
- We recommend including heating baseline for Packaged Terminal Systems (New Construction).

3.2.6 Small C/I HVAC Refrigerant Charge Correction

Algorithms

Comments:

- Equivalent Full-Load Hours for Heating should be abbreviated as $EFLH_h$ instead of $EFLH_{mh}$ to be consistent with the way it is abbreviated in section "Definition of Terms".

3.2.7 ENERGY STAR Room Air Conditioner

Definition of Terms

Comments:

- In Table 3-42, the word "heater" should be removed from the definition of $CEER_{ee}$ and EER_{ee}.

Section 3.4 Domestic Hot Water

3.4.1 Electric Resistance Water Heaters

Eligibility

Comments:

- We recommend considering expanding this measure (with appropriate sources for annual water use) to include larger commercial units in food service building types such as restaurants which often use large quantities of hot water.

Algorithms

Comments:

- The units in the algorithm for average annual gallons of water are not balanced. Term $1.0\ \frac{Btu}{lb \cdot °F}$ is missing in the denominator. The correct algorithm is:

$$\text{HW (Gallons)} = \frac{Load \times EF_{ng,base} \times 1{,}000\ \frac{\text{Btu}}{\text{kBtu}} \times Typical\ SF}{1.0\ \frac{\text{Btu}}{\text{lb} \cdot °\text{F}} \times 8.3\ \frac{\text{lb}}{\text{gal}} \times (T_{hot} - T_{cold}) \times 1{,}000\ SF}$$

Definition of Terms

<u>*Comments:*</u>

- There is no explanation about the significance of resistive discount factor, RDF. We recommend including a brief one.

3.4.2 Heat Pump Water Heaters

Eligibility

<u>*Comments:*</u>

- We recommend considering expanding this measure (with appropriate sources for annual water use) to include larger commercial units in food service building types such as restaurants which often use large quantities of hot water.

Algorithms

<u>*Comments:*</u>

- The units in the algorithm for average annual gallons of water are not balanced. Term $1.0\ \frac{Btu}{lb \cdot °F}$ is missing in the denominator. The correct algorithm is:

$$\text{HW (Gallons)} = \frac{Load \times EF_{ng,base} \times 1{,}000\ \frac{\text{Btu}}{\text{kBtu}} \times Typical\ SF}{1.0\ \frac{\text{Btu}}{\text{lb} \cdot °\text{F}} \times 8.3\ \frac{\text{lb}}{\text{gal}} \times (T_{hot} - T_{cold}) \times 1{,}000\ SF}$$

- The temperature of hot water in the description of "Resistive Heating Discount Factor" should be changed to 119 °F from 123 °F to be consistent with the value mentioned in "Definition of Terms" section.

Definition of Terms

<u>*Comments:*</u>

- We recommend writing the units of temperature for hot and cold water as "°F" instead of "Degrees Fahrenheit." The "°F" from the "Value" column should be removed, the use of the unit in both columns is redundant.

3.4.3 Low Flow Pre-Rinse Sprayers for Retrofit Programs

Definition of Terms

<u>*Comments:*</u>

- For parameters U_{bng} and U_{png}, the term $\frac{min}{day}$ should be removed from the "Values" column as it is already mentioned in "Unit" column. The use of the unit in both columns is redundant.
- For T_{hng}, T_c and T_{hg}, the term °F should be removed from the "Values" column as it is already mentioned in "Unit" column. The use of the unit in both columns is redundant.

3.4.4 Low Flow Pre-Rinse Sprayers for Time of Sale/Retail Programs

Definition of Terms

Comments:

- Unit revision: The unit for the conversion factor of 3,413 should be corrected to $\frac{Btu}{kWh}$ instead of $\frac{Btul}{kWh}$.

Default Savings

Comments:

- We request the commission to include a detailed explanation, and mention the sources used, that lists the values of the parameters used to calculate the default savings.

3.4.5 Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane

Comments:

- Section numbering revision: This section should be correctly numbered as 3.4.5 instead of 3.4.6. This numbering update applies to all measures in Section 3 going forward.

Eligibility

Comments:

- It's unclear why there is a restriction on efficiency of replaced electric unit. If assuming replace-on-burnout, baseline consumption can be calculated based on an EF of 0.904 regardless of actual old unit efficiency.

Definition of Terms

Comments:

- We recommend writing the units of temperature of hot and cold water as "°F" instead of "Degrees Fahrenheit". Also, "°F" should be removed from the "Value" column, the use of the unit in both columns is redundant.

3.4.6 Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane

Definition of Terms

Comments:

- We recommend writing the units of temperature of hot and cold water as "°F" instead of "Degrees Fahrenheit". And "°F" from the "Value" column should be removed, the use of the unit in both columns is redundant.

Section 3.5 Refrigeration

3.5.1 High-Efficiency Refrigeration/Freezer Cases

Sources

Comments:

- The correct website link for Source 2 is: http://www.energystar.gov/sites/default/files/specs//private/Commercial_Refrigerator_and_Freezer_Program_Requirements%20v2_1.pdf
- The correct website link for Source 3 is: http://issuu.com/neepenergy/docs/trm_march2013version/286?e=12509042/8424791

3.5.3 High-Efficiency Evaporator Fan Motors for Walk-in Refrigerated Cases

Definition of Terms

Comments:

- Footnotes 376 and 377 provide links to the RTF general website. We recommend the links be specific as there are active and inactive protocols in this website.

3.5.5 Controls: Floating Head Pressure Controls

Comments:

- The link sourced for measure life leads to the RTF website and the version numbers for the protocols have been updated. Please update the web link to avoid ambiguity.

3.5.7 Controls: Evaporator Coil Defrost Control

Definition of Terms

Comments:

- In the fourth row of Table 3-109, under the "Values" column, the text for "Table 3-110" has been included twice. Please delete one instance of "Table 3-110."

3.5.10 Night Covers for Display Cases

Comments:

- The correct website link for footnote reference 400 is: http://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights%26HVACGDS_1Jun2007.pdf

3.5.11 Auto Closers

Algorithms

Comments:

- Footnote references 3 and 4 do not follow the numbering scheme for footnotes used in the rest of the TRM. Their correct numbers should be 407 and 408, respectively. Please renumber those footnotes and make sure that the numbering update is carried throughout the rest of the TRM.
- The correct website link for footnote reference 4 (which should be footnote 408, as stated above) is: http://dx.doi.org/10.4236/ojee.2014.31003

Section 3.8 Building Shell

3.8.1 Wall and Ceiling Insulation

Algorithms

Comments:

- In addition, the algorithm should be updated to match with defined terms as follows:

$$\Delta kwh_{cool} = \left(\frac{CDD\ x\ 24}{Eff\ X\ 1000}\right) * \left[A_{ceiling}\left(\frac{1}{Ceiling\ Ri} - \frac{1}{Ceiling\ Rf}\right) + A_{Wall}\left(\frac{1}{Wall\ Ri} - \frac{1}{Wall\ Rf}\right)\right]$$

$$\Delta kwh_{heat} = \left(\frac{HDD\ x\ 24}{COP\ X\ 3412}\right) * \left[A_{ceiling}\left(\frac{1}{Ceiling\ Ri} - \frac{1}{Ceiling\ Rf}\right) + A_{Wall}\left(\frac{1}{Wall\ Ri} - \frac{1}{Wall\ Rf}\right)\right]$$

- In addition, expand the definition of the area of insulation installed by defining the variables $A_{ceiling}$ and A_{wall}.

Definition of Terms

Comments:

- Expand the definition of the area of insulation installed by defining the variables $A_{ceiling}$ and A_{wall}. That's consistent with the definitions of Ceiling R_i and Wall R_i.
- For consistency with the residential measure, revise units for HDD and CDD from "°D" "°F · Days"
- Update R-value units from "None" to $\frac{°F-ft^2 \cdot hr}{Btu}$
- Update the unit for EFLH from "None" to $\frac{Hours}{Year}$
- The EER and COP have a high impact on the savings for this measure, and the defaults are minimally code compliant. Particularly for new construction and for heat pumps, the EERs available from manufacturers is often substantially higher than the minimally code compliant HVAC system efficiencies in the codes and standards, and higher EER options can be selected by engineering designers as standard practice. Consider emphasizing that site specific design values should be used in the calculation wherever possible, to avoid overestimating the savings using the default minimally compliant EERs.

Section 4 Agricultural Measures

Section 4.1 Agricultural

4.1.1 Automatic Milker Takeoffs

Algorithm

Comments:

- Further explanation is needed for the annual energy savings algorithm: Please elaborate, either in a source note or in the definition of terms, why the number of milkings per day per cow (MPD) is being divided by two times the average milkings per day. Is this an approach that more accurately reflects the annual amount of times a cow is milked?
    - It appears that the energy savings factor (ESC) for this measure is in terms of kWh savings per cow; and that this factor was derived using the assumption that there are two milkings per day. Is it not possible to derive the energy savings for this measure by multiplying the number of cows by the energy savings factor? What is the purpose of including the milkings per day per cow and two times the average milkings per day into the energy savings algorithm? If there is a valid reason, it would add value to include it in this section.
- The peak demand reduction algorithm is incorrect: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. As the energy savings algorithm is using an energy savings factor per cow, it may be beneficial to identify and use an equivalent factor for peak demand reduction. Another method would be to divide the energy savings by the annual vacuum pump run hours and then multiply by the coincidence factor. (ΔkW = ΔkWh / **HRS** x CF)

Definition of Terms

Comments:

- Problems with the definition and description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.00014. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.
    - The current demand coincidence factor in this section is referenced from the demand coincident factor used in the Variable Speed Drive (VSD) Controller on Dairy Vacuum Pumps measure, where it is defined as the estimated result of dividing the average peak coincident demand kW reduction by the ΔkWh savings for a 1 horsepower motor. In actuality, what this is describing is a conversion factor that can be used to estimate peak coincident demand savings if ΔkWh savings are known. If this approach is desired, we recommend stopping the use of the terminology of coincidence factor because that is not what this savings/conversion factor is, and it is not consistent with the other sections of the

TRM. Admittedly, a coincidence factor is defined as the result of dividing the peak coincidence demand kW reduction by the average demand kW savings, not the ΔkWh savings. Or rather, as defined in section 1.3 – Definitions of the TRM, a coincidence factor; "The ratio of the (1) sum of every unit's average kW load during the PJM peak load period (June through August, non-holiday weekdays, 2 pm to 6 pm) to the (2) sum of the non-coincident maximum kW connected load for every unit."

4.1.2 Dairy Scroll Compressors

Algorithms

<u>*Comments:*</u>

- The peak demand reduction algorithm is incorrect: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. It may be beneficial to incorporate the equivalent full load hours of the compressor into the equation. The correct formula would have the kWh savings divided by the compressor run hours and then multiplied by the coincidence factor. (ΔkW = ΔkWh / <u>**HRS**</u> x CF)

Definition of Terms

<u>*Comments:*</u>

- Definition of the Compressor Operating Hours: The operating hours per day of the milking parlor is used in the algorithms, but this does not accurately reflect the operating hours of the compressor. The "HRS" component used in the algorithm should be the equivalent full load hours of the compressor, and defined as such. This means a different default value for hours should be used, and the source/explanation would need to be revised as well. The compressor will cycle on and off, assuring that it will have an alternative run time in comparison to the milking parlor.
- Value of the Installed Compressors Efficiency: The EER of the installed compressor is recommended to be collected from the compressor's nameplate in order to calculate energy savings. Nameplates will not typically provide EER information. In order to collect valid EER information for compressors, EER data must be collected from compressor manufacturer information at a given operating condition. These operating conditions are compressor head and suction set point. The suction set point should be defined to match delivered temperature set points for the milk cooling process. The condenser set point should be related to condenser minimum set point limitations. This is typically defined as 90 degrees Fahrenheit. It may be worth mentioning the receipt of compressor manufacturer data in either the eligibility or the evaluation protocols section.
- Problems with the Definition and Description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.00014. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.

- The current demand coincidence factor in this section is referenced from the demand coincident factor used in the Variable Speed Drive (VSD) Controller on Dairy Vacuum Pumps measure, where it is defined as the estimated result of dividing the average peak coincident demand kW reduction by the ΔkWh savings for a 1 horsepower motor. In actuality, what this is describing is a conversion factor that can be used to estimate peak coincident demand savings if ΔkWh savings are known. If this approach is desired, we recommend stopping the use of the terminology of coincidence factor because that is not what this savings/conversion factor is, and it is not consistent with the other sections of the TRM. Admittedly, a coincidence factor is defined as the result of dividing the peak coincidence demand kW reduction by the average demand kW savings, not the ΔkWh savings. Or rather, as defined in section 1.3 – Definitions of the TRM, a coincidence factor; "The ratio of the (1) sum of every unit's average kW load during the PJM peak load period (June through August, non-holiday weekdays, 2 pm to 6 pm) to the (2) sum of the non-coincident maximum kW connected load for every unit."

4.1.3 High Efficiency Ventilation Fans with and without Thermostats

Eligibility

<u>*Comments:*</u>

- Measure Description Recommendation: It is important to include a warning that farmers should not exceed or fall short of the recommended airflow ratings for their animals. It may also be important to include a warning on replacing pit fans for swine facilities and that maintaining airflow recommendations with these fans are critical for the health of the hogs.

Algorithms

<u>*Comments:*</u>

- The peak demand reduction algorithm is incorrect: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. It may be beneficial to incorporate the run hours of the fans into the equation. The correct formula would have the kWh savings divided by the fan run hours and then multiplied by the coincidence factor. (ΔkW = ΔkWh / <u>**HRS**</u> x CF)

Definition of Terms

<u>*Comments:*</u>

- Problems with the Definition and Description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.000197. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.
    - A more accurate approximation of the fan load shape and coincidence factor would depend on whether or not the farm is utilizing thermostats. If the farm is, the load

shape would resemble that of a residential cooling load with a set temperature of 70 degrees Fahrenheit. If the fans do not have a thermostat, the load shape would be 1. Either because a typical farm will keep their fans running continuously through the summer months, or the internal temperature of an animal barn will be above 70 degrees Fahrenheit during the summer peak period.

  - TMY3 data could also be utilized to find a more precise fan load shape given the following fan breakdown from the TRM: For a stall barn, it was assumed 33% of fans are on 8,760 hours per year, 67% of fans are on when the temperature is above 50 degrees Fahrenheit, and 100% of the fans are on when the temperature is above 70 degrees Fahrenheit. For a cross-ventilated or free-stall barn, it was assumed 10% of fans are on 8,760 hours per year, 40% of fans are on when the temperature is above 50 degrees Fahrenheit, and 100% of the fans are on when the temperature is above 70 degrees Fahrenheit.

4.1.4 Heat Reclaimers

Algorithms

<u>*Comments:*</u>

- The peak demand reduction algorithm is incorrect: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. It may be beneficial to incorporate the run hours of the water heater into the equation. The correct formula would have the kWh savings divided by the water heater operation hours and then multiplied by the coincidence factor. (ΔkW = ΔkWh / **<u>HRS</u>** x CF). The energy and demand savings of a heat reclaimer come from the reduction in use of the existing/traditional water heater.

Definition of Terms

<u>*Comments:*</u>

- Problems with the Definition and Description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.00014. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.
  - The current demand coincidence factor in this section is referenced from the demand coincident factor used in the Variable Speed Drive (VSD) Controller on Dairy Vacuum Pumps measure, where it is defined as the estimated result of dividing the average peak coincident demand kW reduction by the ΔkWh savings for a 1 horsepower motor. In actuality, what this is describing is a conversion factor that can be used to estimate peak coincident demand savings if ΔkWh savings are known. If this approach is desired, we recommend stopping the use of the terminology of coincidence factor because that is not what this savings/conversion factor is, and it is not consistent with the other sections of the TRM. Admittedly, a coincidence factor is defined as the result of dividing the peak coincidence demand kW reduction by the

average demand kW savings, not the ΔkWh savings. Or rather, as defined in section 1.3 – Definitions of the TRM, a coincidence factor; "The ratio of the (1) sum of every unit's average kW load during the PJM peak load period (June through August, non-holiday weekdays, 2 pm to 6 pm) to the (2) sum of the non-coincident maximum kW connected load for every unit."

4.1.5 High Volume Low Speed Fans

Definition of Terms

Comments:

- Incorrect Value Note for the Wattage of the Installed HVLS Fan: The default value is referencing the wrong table. Please update this value note to reference Table 4-9 and not Table 4-4.

4.1.6 Livestock Waterer

Eligibility

Comments:

- Edit / Grammar: Make the changes to the following sentence; "In freezing climates ~~no~~ **energy free** or low energy livestock waterers are used to prevent livestock water from freezing. These waterers are closed watering containers that typically use super insulation, relatively warmer ground water temperatures, and the livestock's use of the waterer to keep water from freezing." Energy-free livestock waterers is a more common term for stock waterers than no-energy livestock waterers.

Algorithms

Comments:

- Adjustments to the Energy Savings Algorithm: Allows users to input base wattages and efficient wattages of the existing and proposed units, instead of a default/deemed ESW factor (energy demand savings per waterer). [$ESW = W_{base} - W_{eff}$] If the base and efficient wattages are unknown, use the existing default value of 0.5 kW. This lets the user be more flexible with the size of the units being assessed, as well as increasing the energy savings if energy-free units are to be evaluated ($W_{eff} = 0$).

4.1.7 Variable Speed Drive (VSD) Controller on Dairy Vacuum Pumps

Eligibility

Comments:

- Additions to the Eligibility Requirements: Vacuum pump VSDs can only be utilized by blower or lobe style pumps; for example, VSDs cannot be utilized on water ring pumps. This is an important eligibility requirement to add as it may require the participant to replace their existing pump.
    - Additionally, variable speed drives require three-phase power to operate. If a farm is using single-phase power, which is often the case in residential agricultural settings, then the VSD requires the installation of a phase convertor. VSDs on farms with poor power quality have been known to cause harmonic distortion so it may be important

to include verbiage on the importance of controlling harmonic distortion by limiting the current pulses with filters.

Algorithms

Comments:

- Problems with the Definition and Description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.00014. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.
    - The demand coincidence factor in this section is defined as the estimated result of dividing the average peak coincident demand kW reduction by the ΔkWh savings for a 1 horsepower motor. Rather, what this is describing is a conversion factor that can be used to estimate peak coincident demand savings if ΔkWh savings are known. If this approach is desired, we recommend stopping the use of the terminology of coincidence factor because that is not what this savings/conversion factor is, and it is not consistent with the other sections of the TRM. Admittedly, a coincidence factor is defined as the result of dividing the peak coincidence demand kW reduction by the average demand kW savings, not the ΔkWh savings. Or rather, as defined in section 1.3 – Definitions of the TRM, a coincidence factor; "The ratio of the (1) sum of every unit's average kW load during the PJM peak load period (June through August, non-holiday weekdays, 2 pm to 6 pm) to the (2) sum of the non-coincident maximum kW connected load for every unit."
- The peak demand reduction algorithm is incorrect: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. It may be beneficial to incorporate the run hours of the vacuum pump into the equation. The correct formula would have the kWh savings divided by the vacuum pump run hours and then multiplied by the coincidence factor. (ΔkW = ΔkWh / **HRS** x CF)

Sources

Comments:

- Edit / Grammar: Make the change to the following sentence in the second source note; "Therefore, the DEER default value was lowered to 8 hours per day, as the average ~~heard~~ **herd** size ~~in~~ **is** 75 cows in Pennsylvania."

4.1.8 Low Pressure Irrigation System

Measure Life

Comments:

- Additional explanation or clarification is required: The 5 year measure life used in the TRM for low pressure irrigation system does not apply in this situation. The measure detailed in the TRM is for a complete conversion of a high pressure to a low-pressure irrigation system.

The pumps, piping, valves, and nozzles, which make up the system degrade over time, and these are the aspects of the irrigation system that have a measure life. It is inaccurate to say the low-pressure irrigation system, as a whole, has a measure life of 5 years.

  - Typically, the 5 years will refer to the nozzles, which do in fact need to be replaced every 5 years. For example, if it was an irrigation conversion to a drip system it would be inaccurate to say it had a measure life of 5 years. Drip irrigation systems can last upwards of 25 years, but may require routine maintenance every few years.

Algorithm

Comments:

- Unnecessary variable used in the Agriculture Application algorithm: The *ACRES* variable (number of acres irrigated) adds no value to the algorithm and should be removed. By keeping this variable in the equation, the final units are in terms of kWh-acres and this is not an accurate portrayal of energy savings. The algorithm for the golf course application is accurately represented where the acreage of irrigated land is not included and does not apply.
- The peak demand reduction algorithm is incorrect for the Agriculture Application algorithm: Currently, the algorithm is employing an incorrect method for peak demand reduction by multiplying the energy savings by the coincidence factor. It may be beneficial to incorporate the run hours of the irrigation pump into the equation. The correct formula would have the kWh savings divided by the vacuum pump run hours and then multiplied by the coincidence factor. (ΔkW = ΔkWh / **HRS** x CF)

Definition of Terms

Comments:

- Problems with the Definition and Description of the Coincidence Factor: This is not the same definition of the coincidence factor used in other parts of the TRM. We recommend being consistent and using the TRMs definition of coincidence factor for all agricultural measures. This means revising the default value and source definitions for all coincidence factors for all the agricultural measures. Currently, the TRM states a coincidence factor of 0.0026. A closer approximation would be the load shape for dairy farms utilized in the Vermont TRM (0.341). This value is an aggregate for all dairy farm equipment during the summer peak period and is more accurate than what is currently used. The source notes will need to be rewritten accordingly.

Appendix A

PECO Residential CFL/LED Interactive Effects/Waste Heat Factor Analysis Memo

The following memo is submitted in support of the comments for the Residential Section 2.1.1 ENERGY STAR Lighting.

To: **Nick DeDominicis, Marina Geneles; PECO**

From: **Ryan Del Balso, Justin Spencer, Jonathan Strahl; Navigant**

Cc: **Frank Stern, Dan Greenberg; Navigant**
Jeremy Eddy; Itron

Date: **September 5, 2013**

Re: **PECO – Residential CFL/LED Interactive Effects/Waste Heat Factor Analysis**

This memo details the methodology and results of Navigant's HVAC interaction effects factor (waste heat factor) study for PECO. Navigant constructed building energy computer simulation models to determine the heating, ventilation, and air conditioning (HVAC) impacts from efficient lighting installations in the PECO service territory. Navigant used these models to calculate energy and demand interactive effects factors (IEF) which are used to adjust the program lighting savings to account for the additional impacts on HVAC energy and demand. The Navigant team has not applied energy and demand interactive effects in previous evaluations of PECO's residential programs because these were not included in the TRM. However, the evaluation team believes that by not including this factor, the TRM is significantly underestimating demand savings from efficient lighting installations.

The energy and demand interactive effects factors define the secondary impacts on HVAC energy caused by the primary energy savings from reduced-wattage lighting installations. The efficient lighting equipment emits less "waste heat" to the conditioned building space, which in turn increases the need for heating from the HVAC system during winter months and decreases the need for cooling in air conditioned spaces during summer months. This modeling analysis calculated the impacts on heating and cooling energy use from installation of reduced-wattage lighting equipment, and the reduction in peak demand for the utility summer peak period.

The interactive effects are defined as the ratios between the total savings (primary lighting and secondary HVAC impacts) and the primary, lighting-only savings. Navigant used the following equations to calculate energy and demand interactive effects. The energy IEF is calculated using annual energy savings, while demand IEF is calculated using the kW savings for lighting and HVAC end uses during the PECO summer peak periods.

Energy: $$IEF_e = \frac{(kWh\ Savings_{Lighting} + kWh\ Savings_{HVAC})}{kWh\ Savings_{Lighting}}$$

Demand: $IEF_d = \frac{(kW\ Savings_{Lighting} + kW\ Savings_{HVAC})}{kW\ Savings_{Lighting}}$

Methodology

The following section describes Navigant's methodology for calculating energy and demand interactive effects for PECO. In general, Navigant performed these steps:

- Developed hourly residential building models with EnergyPlus 8.0 simulation software
  - Inputs were derived from the 2011 PECO Baseline Study conducted by Navigant
  - Models were calibrated to PECO-specific monthly billing data from EIA Form 826
  - Models used Building America Benchmark hourly lighting profiles
  - Performed simulations using weather data from Philadelphia International Airport
- Calculated IEF_d using two specifications for peak period
  - 2012 actual meterological year (AMY) weather data used to calculate a PECO specific IEF_d for PECO's actual top 100 hours for the period of June 1, 2012 through May 31, 2013 (effectively June through September, 2012)
  - 2012 typical meterological year (TMY) weather data used to calculate a IEF_d for the statewide Technical Reference Manual using PJM's definition of the peak period (2-6pm on all non-holiday weekdays between June and August)
- Calculated annual IEF_e using all 8760 hours of the year
- Results analyzed as a weighted average of home type (single family and multifamily) heating type (gas, heat pump, electric resistance) and AC type (central AC and room AC) as observed in the PECO Baseline Study

The following sections describe each process in more detail.

EnergyPlus Simulation

Navigant performed hourly building energy simulation modeling with the EnergyPlus 8.0 software package, a well-established and vetted whole building simulation software developed by the US Department of Energy. EnergyPlus allows for hourly building simulation to calculate the hourly demand for all major end uses in the building (including lighting and HVAC). Navigant chose to use hourly simulation modeling because the software calculates the complex and dynamic interactions between the building components, thermal mass, weather, and HVAC equipment. Navigant used the lighting and HVAC hourly end use demand profiles from EnergyPlus to calculate the energy and demand interactive effects for this study. More details on the calculation methodology are provided in the Calculations/Analysis section.

BEopt Model Inputs and Calibration Process

Building Energy Optimization (BEopt) software is a platform developed by NREL to use as a front-end to the EnergyPlus software engine. PECO specific models were developed in BEopt according to housing characteristics determined by the 2011 PECO baseline study conducted by Navigant. Analysis of the baseline data and segmentation by home type and heating system yielded eight specific models with their respective weightings in parentheses:

Single family – gas furnace (59%)
Single family – heat pump (11%)
Multifamily – gas furnace (2 orientations; 24%)

Multifamily – electric resistance (2 orientations; 4%)
Multifamily – heat pump (2 orientations; 2%)

Each model differed in terms of envelope inputs according to the data in the baseline study. For a complete listing of the inputs present in each model, see Appendix A. The multifamily homes were modeled as townhouses with shared walls on two sides, so two models were built for each home at perpendicular orientations to match data that indicated there is no predominant orientation of townhomes within PECO service territory.

A weighted calibration of all models was performed using the average monthly consumption of a residential PECO customer derived from EIA 826 billing data. Due to the limitations of the baseline study building attributes and billing data, it was determined that the modeling outputs would only be valid using a weighted average rather than developing IEF for each individual building model.

Certain parameters of the model were adjusted in order to match the billing data, including thermostat setpoints, natural ventilation behavior, and thermal mass of the building.[8] Area-specific Building America Benchmark defaults built into BEopt were used for lighting and domestic hot water schedules. The models were calibrated as a group to the billing data using the weighted average results, rather than calibrating each model to the billing data on an individual basis.

Calculations/Analysis

In order to calculate energy and demand interactive effects, Navigant first ran all of the models with the baseline lighting profiles and respective weather files. Next, Navigant modeled 'efficient' building models by "upgrading" 100% of screw-in fixtures in the house to compact fluorescent (CFL) bulbs. Navigant performed trial models upgrading 25%, 50%, and 75% of the fixtures to CFLs, and noted that the interaction factor results are independent of the number of lights replaced. Each of the simulations was performed a total of four times: with the baseline and efficient cases, using 2012 AMY weather data and TMY weather data.

Demand Interaction Effects Factor

Navigant used the following methodology to calculate the IEF_d during the summer and winter utility peak periods:

$$IEF_d = \frac{[(Average\ Lighting\ Demand\ Savings) + (Average\ HVAC\ Demand\ Savings)]}{Average\ Lighting\ Demand\ Savings}$$

To determine a PECO-specific IEF_d for calculating PECO's Act 129 Phase I verified demand savings in the summer of 2012, we averaged the lighting and HVAC savings over the peak 100 hours for PECO in 2012.

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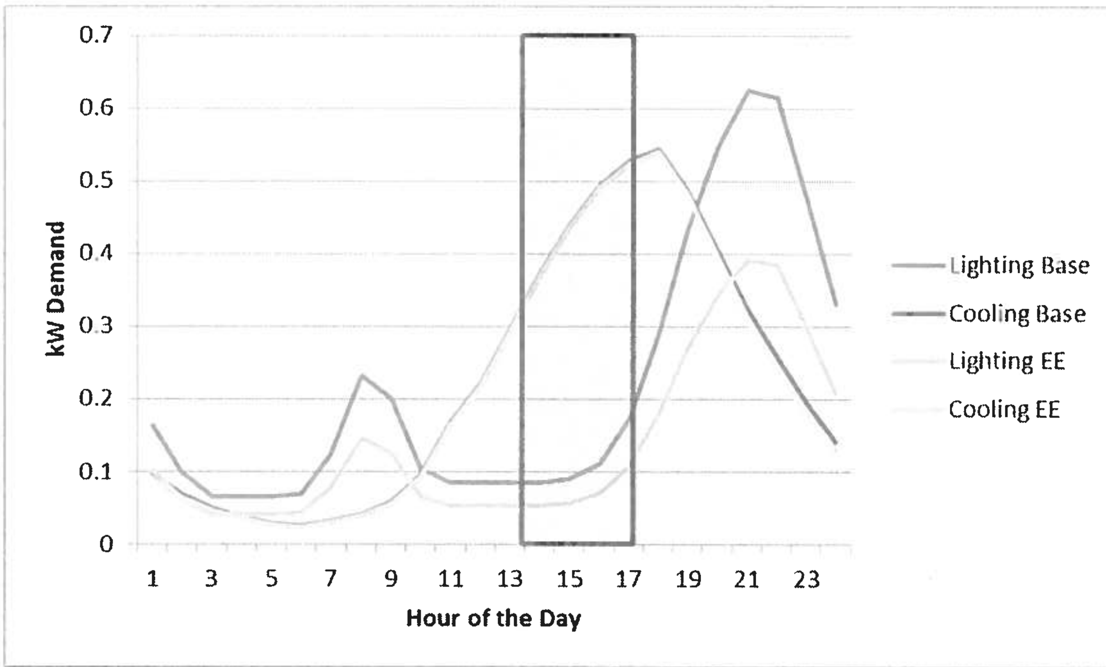
[8] These calibration parameters were chosen because they are largely independent of the physical structure of the house. Thermostat set points and natural ventilation are determined by the behavior of the house occupants, and the thermal mass of the house is affected by the amount of furniture etc. present inside the house.

To determine a PECO-specific IEF_d for the Act 129 Phase II statewide Technical Reference Manuals, we averaged the lighting and HVAC savings over the utility peak period as defined by PJM. The utility peak period is defined as:

» Summer Peak Period: weekday, non-holiday, June through August, 2:00 PM – 6:00 PM.

We used the hourly simulation output from EnergyPlus to calculate the average hourly demand during both peak periods. Figure 1 shows the weighted average summer hourly demand profiles for the baseline and reduced-wattage models. The shaded box indicates the peak period as defined by PJM.

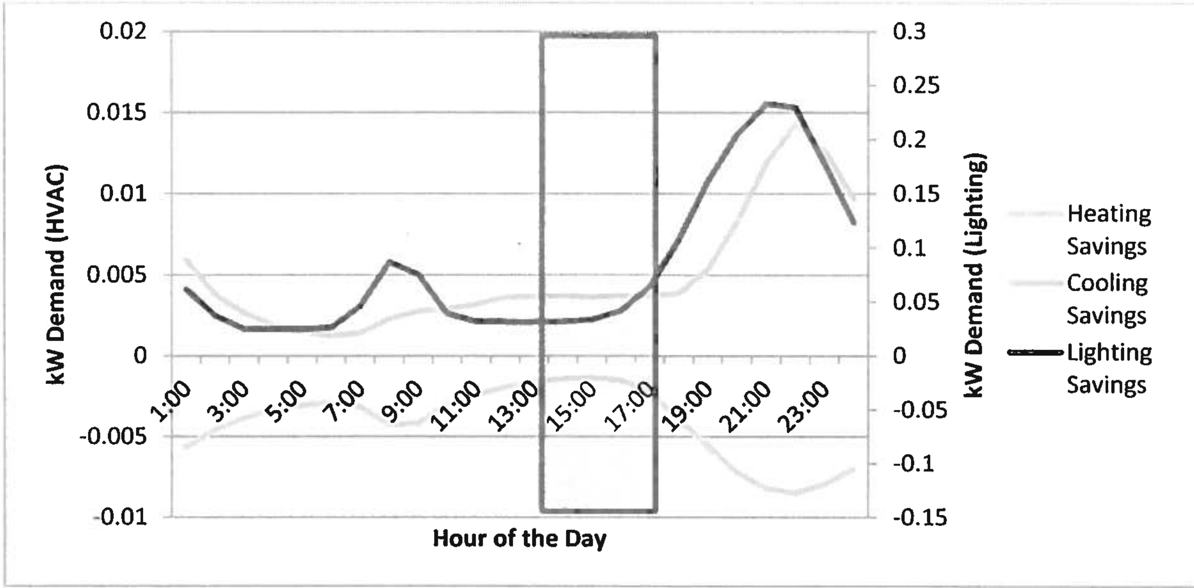
Figure 1. Weighted Average Lighting and Cooling Demand for Baseline and EE Models



Source: Navigant Analysis

Figure 2 displays the hourly demand savings from the baseline for lighting and HVAC end-uses for the weighted average of all models. The IEF_d quantifies the additional reduction in HVAC demand due to lighting demand savings during the utility peak period indicated by the shaded box. Heating savings are negative, reflecting an increase in heating demand between the incandescent (Baseline) and CFL (EE) cases. This increase in heating demand is a result of lower heat emissions from lighting fixtures in the EE case.

Figure 2. Weighted Average Lighting and HVAC Demand Savings between Baseline and EE Models



Source: Navigant Analysis

The following is an example IEF_d calculation using the modeling results shown in Figure 2. Lighting and HVAC demand savings are averaged during the summer peak period.

$$IEF_d = \frac{[(0.0239\ kW) + (0.0055\ kW)]}{0.0239\ kW} = 1.228$$

We calculated IEF_d for all building models for both the summer peak periods as defined by PJM and PECO's actual 2012 top 100 demand hours.

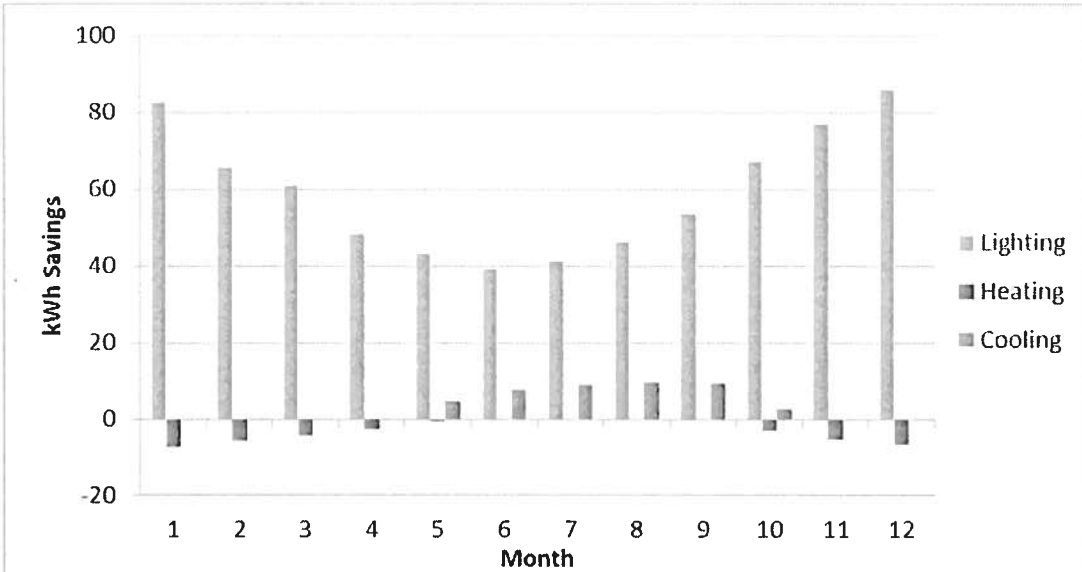
Energy Interaction Effects Factor

We used the following methodology to calculate the IEF_e:

$$IEF_e = \frac{[(Annual\ Lighting\ Energy\ Savings) + (Annual\ HVAC\ Energy\ Savings)]}{Annual\ Lighting\ Energy\ Savings}$$

Figure 3 shows the monthly kWh savings for lighting and HVAC equipment for the weighted average of all building models. HVAC savings are negative during the winter and positive during the summer because of the increased need for heating from the HVAC system during winter months and the decreased need for cooling in the summer months to maintain temperature setpoints.

Figure 3. Monthly Lighting and HVAC Energy Savings for a Weighted Average of All Models (TMY)



Source: Navigant Analysis

The following is an example IEF_e calculation for the weighted average of all models using the results shown in Figure 4.

$$IEF_e = \frac{[(710.2\ kWh) + (7.0\ kWh)]}{710.2\ kWh} = 1.010$$

Results

Table 1 through Table 3 shows the results of energy and demand interactive effects factor study. The results of this study are shown for each individual HVAC type, and then weighted appropriately using weightings from the PECO Baseline Study. Each result is reported as an Act 129 Phase I 2012-specific value using AMY weather data from 2012, and a general Act 129 Phase II value using TMY weather data.

We calculated an IEF_e above 1.0 for gas heated homes, and an IEF_e below 1.0 for electrically heated homes. This is due to the fact that the HVAC heating penalty is higher than the cooling benefit provided in electrically heated homes with efficient lighting installations. We weighted these results based on HVAC type, for a weighted an IEF_e of 1.010 (TMY) and 1.020 (2012 AMY), shown in Table 1.

Table 1. Energy Interactive Effects Factor Results

HVAC and Home Type	IEF_e (TMY)	IEF_e (2012 AMY)	Weighting %
Single Family - Gas	1.046	1.058	59%
Single Family – Heat Pump	0.865	0.903	11%
Multifamily - Gas	1.042	1.053	24%
Multifamily – Electric Resistance	0.620	0.660	4%
Multifamily – Heat Pump	0.868	0.904	1%
Weighted Average	**1.010**	**1.020**	100%

Source: Navigant Analysis

We calculated a weighted average summer IEF_d for all homes. The presence of central and room AC was determined from the baseline study data shown in Table 2.

Table 2. PECO Baseline Study Air Conditioning Prevalence Weightings

Air Conditioning Prevalence	Single Family % AC	Multifamily % AC
Central AC	76%	45%
Room AC	13%	41%
Unknown	11%	14%

Source: Navigant Analysis

Because BEopt is unable to accurately model the presence of room AC units, all homes were modeled with central AC. To account for the presence of room AC, one-third of the model output was used as a conservative estimate of the consumption of a room AC unit relative to a central unit. The model outputs were therefore adjusted according to the following formula:

$$Adjusted\ Output = Modeled\ AC - (\%\ of\ each\ model\ that\ is\ room\ AC * Modeled\ AC) * (2/3)$$

Application of this adjustment yielded a weighted summer IEF_d of 1.228 (TMY) and 1.194 (2012 AMY), as shown in Table 3.

Table 3. Summer Demand Interactive Effects Factor Results

HVAC and Home Type	IEF_d (TMY)	IEF_d (2012 AMY)	Weighting %
Single Family - Gas	1.239	1.205	59%
Single Family – Heat Pump	1.241	1.202	11%
Multifamily - Gas	1.176	1.169	24%
Multifamily – Electric Resistance	1.170	1.168	4%
Multifamily – Heat Pump	1.171	1.167	1%
Weighted	**1.228**	**1.194**	**100%**

Source: Navigant Analysis

Recommendations

Based on the results of this analysis of the PECO residential CFL/LED lighting HVAC interactive effects factors, the evaluation team recommends use of the following interactive effects factors when determining PECO's verified savings for Act 129 compliance for Phase I and Phase II.

Table 4. PECO Verified Residential CFL/LED Lighting HVAC Interactive Effects Factors

PECO's Act 129 Phase	IEF_e	IEF_d
Phase I (June 1, 2012 – May 31, 2013) (Based on 2012 AMY weather file)	**1.020**	**1.194**
Phase II (June 1, 2015 – May 31, 2016) (Based on TMY weather file)	**1.010**	**1.228**

Source: Navigant Analysis

PECO also recommends the next version of the PA TRM be updated to use the above listed Phase II IEF_e and IEF_d values for PECO.