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October 14, 2013

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 2014 Update
Docket No. M-2012-2313373 and M-00051865

Dear Secretary Chiavetta:

Pursuant to the August 29, 2013 Tentative Order in the above-referenced dockets, enclosed please find **PECO Energy Company's Comments on the Proposed Update to the 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).

Kindly return a time-stamped copy of this letter in the self-addressed envelope that is enclosed.

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

Very truly yours,

Jack R. Garfinkle
Assistant General Counsel

JRG/adz
enclosures

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 2014 Update	: : : : :	Docket Nos. M-2012-2313373 M-00051865

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

Pursuant to the August 29, 2013 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 2014 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 and that the 2014 TRM Update could serve as an appropriate tool for the entire Phase II period (program years 2013-2015). Additional updates during Phase II period would be unlikely to significantly improve the TRM, but could impact EDC savings forecasts and potentially EDC compliance with Phase II savings targets.

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, 2013

For PECO Energy Company

EXHIBIT I

PECO ENERGY COMPANY
COMMENTS ON THE PROPOSED UPDATE TO THE 2014 TECHNICAL REFERENCE MANUAL

General Comments to the 2014 TRM

Section 1 Introduction

Comments:

- One of the key changes to the 2014 TRM is the switch from the peak 100 hour proxy period of 12pm to 8pm, weekdays, June through September to a peak demand period that matches the PJM peak period of 2pm to 6pm, non-holiday weekdays, June through August. This is a significant change and improvement over the confusing peak 100 hour requirement, however, there are still many coincidence factors (CF) throughout the 2014 Draft TRM that have not yet been updated to the new peak demand period. Where observed these are noted, but it is likely that some old CF's were missed in these comments. We recommend the CF for all measures be reviewed and updated to be consistent with the new peak demand period. We strongly recommend that hourly load profiles be developed for all measures which can then be used to derive a CF for any peak demand period. This will provide for more reliability of demand savings estimates and transparency in the values.
- Another key change to this draft TRM is the inclusion of energy savings thresholds for C&I measures, above which customer specific data will be required for all open variables. While it appears to be clearly laid out in the TRM, we anticipate that each EDC, their ICSPs, and ECs that challenges will arise and advise the Commission to plan to revise these requirements as necessary in the event that they become an undue burden on the program participants.
- In Section 1.2.3, the TRM provides a table of End-Use categories that groups related protocols together. We recommend that future versions of the TRM be organized based on these end-use categories rather than the current structure which adds new measures one after the other regardless of relation. In the current format it is quite cumbersome to review and compare inputs to related measures to ensure consistency between protocols. Such a re-organization would provide for a much more useable TRM.
- Although there is currently a Definitions section, it is quite limited in scope. We recommend expansion of the list of definitions to include all major measure implementation types, and other major concepts that without proper definition may lead to confusion. This section could also be used to define common abbreviations.
- Several sections continue to have a Measure Life subsection, even though there is a complete table in the updated Appendix A: Measure Lives section. These should be removed from each section and if there is supporting information to justify the measure life in the sub-sections, it should be moved to the appendix.

Section Specific Comments to the Draft Pennsylvania PUC June 2014 Technical Reference Manual

Section 1: Introduction

1.2 Using the TRM

1.2.1 Measure Categories

Comments:

- Grammar: revise the first sentence to read:
    - "The TRM characterizes all ~~prescriptive~~ non--custom measures into two categories: deemed measures and partially deemed measures."
- Grammar: revise the second bulleted paragraph to the following:
    - "Partially deemed measure protocols have algorithms with stipulated and "open variables", that require ~~measurement~~ customer specific input of certain parameters to calculate the energy in demand savings."

1.2.3 End-Use Categories & Thresholds for Using Default Values

Comments:

- The first sentence in this section appears to contradict the first sentence of section 1.2.2 which encourages EDC's to collect and apply customer specific information in the ex-ante and/or ex post savings calculations for as many open variables as possible, to reflect most accurate savings values. The intent of these two sections should be clarified.
    - Section 1.2.2: "The EDC's and their contractors (ICSPs and ECs) are encouraged to collect and apply customer specific for program specific data in the ex-ante and/or ex post savings calculations for as many open variables as possible to reflect most accurate savings values."
    - Section 1.2.3: "The determination of when to use default values for open variables provided in the TRM in the ex-ante and/or ex post savings calculations is a function of the savings impact and uncertainty associated with measure."
- We recommend the following modifications to the second paragraph of section 1.2.3:
    - *The TRM puts all measures into various end-use categories (e.g. lighting, HVAC, motors & VFDs). ~~The~~ kWh savings thresholds are established at the end-use category level and should be used to determine whether customer specific information is ~~necessary~~ required for estimating ex ante and or ex post savings.*
- Subscripts 7 and 8:
    - In subscript 7 "procedure" is misspelled
    - The definitions of "measure" and "end-use" are very broad. There is also no differentiation between measure and technology type. This can lead to confusion due to using the term "measure" to mean different things. Using more specific definitions of "measure," "technology type," and "end-use" will reduce potential confusion among parties. We recommend including the following definitions (or something similar) to provide additional clarity:
        - Measure: a new installation, the replacement of an existing installation, or the retrofitting/modification of an existing installation of a building, of a system or process component, or of an energy using device in order to

reduce energy consumption. E.g., the installation of a 14W CFL is one measure, and the installation of a 21W CFL is a separate measure; the installation of wall insulation, or the modification of an existing building to reduce air infiltration are two other measures.

   - Technology type: the grouping of related measures in order to differentiate one type of measure from another. Each technology type may consist of multiple measures. E.g., CFLs, LEDs, and VFDs are all different technology types. A 14W CFL and a 21W CFL are different measures within the CFL technology type.
   - End-Use: grouping of related technology types all associated with a similar application or primary function. E.g., CFLs, LEDs, fluorescent lamps, and lighting controls are all within the lighting end-use category; efficient water heaters, water heater blankets, water heater setback, and faucet aerators are all within the domestic hot water end-use category.

- The second sentence in subscript 12 should be modified to read as follows:
  - *If evaluation contractors determine that data collected by the CSP's are not reasonably valid, then the evaluator must perform measurements consistent with IPMVP options to collect post retrofit information for projects that have estimated* ***end-use*** *savings above a threshold kWh/year level.*
- Table 1-1
  - This table is a useful organizational tool. We recommend the TRM be organized by end-use category rather than the current method which does not group related measures. For example, it would be useful if all of the HVAC sections were adjacent to each other in the TRM.
  - We recommend the agricultural equipment be added as a separate sector in the table, rather than repeating section numbers in both the residential market sector and commercial & industrial sectors.
  - To avoid confusion, we recommend the "Hot Water" end-use category for both the residential and C&I sectors be changed to read, "Domestic Hot Water" to differentiate it from hot water systems used in HVAC or industrial process water loops.
  - We recommend renaming the "Office Equipment" end-use category to an "Electronics" end-use category as it more accurately represents the technology types included in the end-use.
  - There are a few TRM sections missing in the table as follows:
    - sections 2.6 and 2.38 should be included in the Residential Domestic Hot Water end-use category
    - section 2.11 should be removed from the HVAC end-use category and included in the Residential Appliances end-use category
    - section 2.33 should be removed from the Residential Appliances end-use category and included in the Residential Electronics (Office Equipment) end-use category
    - section 2.20 should be included in the Residential Building Shell end-use category
- The paragraph following Table 1-1 states that, "End-use metering is the preferred method of data collection projects above the threshold, but trend data from BMS or panel data are acceptable substitutes." In some cases end-use metering, trend data, or logging are not viable options, however, billing analysis may be the best option available. It should be made clear

that billing analysis is an acceptable method of verification when customer specific data is required.

- Grammar Correction: the sixth sentence in the paragraph following Table 1-1 should be corrected as follows:
    - *The EDC's are encouraged to meter projects with savings below the threshold that have high uncertainty, but are not required ~~i.e.~~ where data is unknown, variable, or difficult to verify.*
- Table 1-2
    - We recommend adding a threshold for the Agricultural Equipment end-use category at ≥ 250,000 kWh

1.2.4 Applicability of the TRM for estimating ex ante (claimed) savings

Comments:

- The last sentence of this section may leed to confusion as to how the savings are counted. Although savings for the customer begin to accrue the project's ISD, EDC's are allowed to claimed savings for the entire program year in which the measure was installed and partially operable. This sentence should be clarified to reduce confusion.
- In regards to which TRM should be applied to claimed savings for any given measure, we recommend adding language which allows EDC's to use the most current version of the TRM if they so choose for all installations regardless of ISD. Given that the latest TRM should be the most reliable version, this option should be available to the EDC's.

1.3 Definitions

Comments:

- There are several definitions that reference the custom measure protocol (CMP) method. All definitions should be modified to remove all references to the CMP method.
- The definition for EDC Reported Gross Savings should be modified to read, "Also known as "EDC Claimed Savings" or "Ex Ante Savings." EDC estimated savings for projects and programs…"
- We recommend changing "Retrofit on Burnout (ROB)" to "Replace on Burnout (ROB)" to be more consistent with standard industry language. We further recommend modifying the definition for "Retrofit on Burnout (ROB)" as follows:
    - … *The baseline used for calculating energy savings for ~~retrofit~~ replace on burnout measures is the applicable code, standard or industry standard practice in the absence of applicable code or standards. The incremental costs for ~~retrofit~~ replacement on burnout measures is the difference between the cost of baseline and more efficient equipment. Examples of projects which fit in this category include replacement due to existing equipment failure, or imminent failure, as judged by a competent service specialist, as well as replacement of existing equipment which may still be in functional condition, but which is operationally obsolete due to industry advances and is no longer cost-effective to keep.*
- We recommend the following edits be included in definitions of New Construction Measure, Retrofit Measure, and Substantial Renovation Measure.
    - … *The baseline used for calculating energy savings for ~~retrofit~~ replacement on burnout measures is the applicable code, standard or industry standard practice in the absence of applicable code or standards*…

- We recommend splitting the definition for Retrofit measures and Early Replacement measures as follows:
    - *Retrofit Measure (RET) –measures which modify or add on to existing equipment with technology to make the system more energy efficient. Retrofit measures have a dual baseline: for the estimated remaining useful life of the existing equipment the baseline is the existing equipment; afterwards the baseline is the applicable code, standard, or industry standard practice expected to be in place at the time the unit would have been naturally replaced or retrofit. If there are no known or expected changes to the baseline standards, the standard in effect at the time of the retrofit is to be used. Incremental cost is the full cost of equipment retrofit. In practice, in order to avoid the uncertainty surrounding the determination of "remaining useful life" retrofit measure savings and costs sometimes follow replace on burnout baseline and incremental cost definitions. Examples of projects which fit this category include installation of a VFD on an existing HVAC system, or installation of wall or ceiling insulation.*
    - *Early Replacement Measure (EREP) –replacement of existing equipment, which is functioning as intended and is not operationally obsolete, with a more efficient model primarily for purposes of increased efficiency. Early replacement measures have a dual baseline: for the estimated remaining useful life of the existing equipment the baseline is the existing equipment; afterwards the baseline is the applicable code, standard, or industry standard practice expected to be in place at the time the unit would have been naturally replaced. If there are no known or expected changes to the baseline standards, the standard in effect at the time of the early replacement is to be used. Incremental cost is the full cost of equipment replacement. In practice, in order to avoid the uncertainty surrounding the determination of "remaining useful life" early replacement measure savings and costs sometimes follow replace on burnout baseline and incremental cost definitions. Examples of projects which fit this category include upgrade of an existing production line to gain efficiency, upgrade an existing, but functional, lighting or HVAC system that is not part of a renovation/remodeling project, or replacement of an operational chiller with a more efficient unit.*
- We recommend combining the substantial renovation measure definition into the new construction measure definition.
- To properly represent the different types of measures being offered in Act 129 programs, we recommend adding definitions for the following measure types:
    - Direct Install (DI) measures
    - Efficiency Kits (KIT)
    - Time of Sale (TOS) measures
    - Early Retirement (ERET) measures
- We recommend adding definitions for Measure Life / Effective Useful Life (EUL) and Remaining Useful Life (RUL)

1.5 Algorithms

<u>Comments:</u>

- The definition of CF should be updated to represent the PJM definition per section 1.10.

1.7 Baseline Estimates

<u>Comments:</u>

- Replace the use of "retrofit on burnout" with "replace on burnout"
- This section should be modified to include baselines for not just replacement on burnout, new construction, and early replacement, but also for retrofit, direct install, efficiency kits, and early retirement measures.

1.10 Electric Resource Savings

Comments:

- Table 1-3 should clarify whether the peak demand hours are on daylight savings time or standard time.

1.12 Adjustments to Energy and Resource Savings

1.12.2 Measure Retention and Persistence Savings

Comments:

- This section refers to "measure life" and "useful life", however, these terms have not been properly defined. Per our previous recommendation to add definitions for "effective useful life" and "remaining useful life", this section should be modified to reflect the use of those terms for consistency.

1.15 Measure Lives

Comments:

- This section refers to "measure life", "useful life", and "remaining life", however, these terms have not been properly defined. Per our previous recommendation to add definitions for "effective useful life" and "remaining useful life", this section should be modified to reflect the use of those terms for consistency.

1.16 Custom Measures

Comments:

- We recommend a new paragraph be started at, "While TRM measures…"
- We further recommend the following sentences be modified to read as follows:
  - *The EDC's are not required to submit savings protocols for C&I and custom measures to the Commission or the SWE for each measure/technology type prior to implementing the custom measure. The, however, the Commission recommends that these site-specific custom measure protocols be established in general conformity to the International Performance Measurement and Verification Protocol (IPMVP) or Federal Energy Management Program M&V guidelines.*

1.17 Impact of Weather

Comments:

- This section describes how the savings estimates for several protocols in the TRM were adjusted to account for differences in California weather versus Pennsylvania weather using cooling degree hours. It is not clear that the California climate zones chosen to map to the Pennsylvania cities are appropriate. California climate zone 4 represents the central coastal mountain range between LA and San Francisco, characterized as having some ocean influence which keeps temperatures from hitting or extreme highs and lows. California climate zone 15 represents the low desert characterized by extremely hot and dry summers and moderately cold winters, with over 4000 cooling degree days. California climate zone 9 represents a small Southern California inland valley climate zone with high winds that bring hot and dry air and marine air which brings cool and moist air. This area has hot summers and winters that never frost. These climates zones may have similar cooling degree hours as Pennsylvania cities, however, they are not proper mappings based on the type of climate zone that represent. The only California climate zone that is in the same ASHRAE climate zone as Pennsylvania is California climate zone 16. This climate zone has the closest heating degree days and cooling degree days to the Pennsylvania cities being mapped. Although there are still issues with using this climate zone, is probably the closest representative California climate zone to Pennsylvania weather. We recommend reconsidering the weather mapping table 1-4 and used in the various refrigeration measures.

1.18 Measure Applicability Based on Sector

Comments:

- In the last sentence in this section the word *"units"* is misspelled as *"untis."*

Section 2: Residential Measures

2.1 Electric HVAC

Comments:

- This section should have an "Eligibility" sub section as the other sections do. The baseline and retrofit condition should be clearly defined for each included measure type.

2.1.1 Algorithms

Comments:

- The Central A/C and ASHP (Duct Sealing) measure should be removed from this section since it has been replaced by measure 2.41 Duct Sealing and Insulation.
- We request the Commission add more clarifying information about what conditions must be met to be able to claim the stipulated savings for each measure, consistent with other protocols.
    - For example, for what kind of maintenance does the Central A/C and ASHP (Maintenance) measure account? This measure has been particularly confusing for ICSPs as there are many forms of maintenance and not all maintenance measures save the same amount of energy.
    - Additionally, specify if the Proper Sizing measure is specifically for new units (i.e. Quality Installation).

2.1.2 Definition of Terms

Comments:

- DuctSF appears in the list, but not in the table. Since the Duct Sealing measure should be removed from this section, PECO suggests removing DuctSF from the list of terms.
- Replace GSHPDR with GSHPDF in the table.
- Replace T_{hot} with T_h in the table.
- Replace T_{cold} with T_c in the table.
- The Energy to Demand Factor appears in the table, but needs to be added to the Definition of Terms list.
- The CF and Energy to Demand Factor are based on non-transparent sources. It is not clear whether or not the CF represents the CF for the new peak demand period, as it has not been adjusted from when the peak 100 hour proxy period was being used. This CF should be revised using an HVAC load profile in PA and the new peak period. Similarly, the Energy to Demand Factor does not appear to be updated either. This factor should also be updated.

2.1.3 Alternate Equivalent Full Load Hour (EFLH) Tables

Comments:

- Tables 2-2 and 2-3 need to have an explicitly stated source.

2.1.4 System Performance of Ground Source Heat Pumps

Comments:

- The text for Source 2 is ambiguous. More detail should be added for clarity.

2.2 Electric Clothes Dryer with Moisture Sensor

2.2.2 *Algorithms*

Comments:

- The US EPA released a Draft 2 Version 1.0 ENERGY STAR Clothes Dryer specification on August 5, 2013. They anticipate a final Version 1.0 to be released in early 2014, or earlier depending on comments received on the Draft 2. After the final version of the ENERGY STAR specification is released, this measure should be removed from the TRM and replaced with an ENERGY STAR Clothes Dryer protocol. This will likely be available for inclusion in the 2015 TRM update. For now, it appears the savings estimates are reasonable and in line with expectations for an efficient clothes dryer.
- It is recommended revising this measure now in anticipation of the upcoming ENERGY STAR specification and rename it High Efficiency Electric Clothes Dryers.
  - It would be prudent to review the eligibility criteria of this measure, to ensure claimed savings are being achieved. PECO recommends the eligibility based on a minimum Combined Energy Factor (CEF) rather than the current requirement of just including a moisture sensor. Many dryers now include moisture sensors, but are not more efficient than others. The only way to ensure savings are achieved is to require a minimum efficiency level. PECO recommends using the draft ENERGY STAR minimum CEF values shown below.
  - For reference, Table 1 below from the US DOE EERE Appliance & Equipment Standards website shows the current minimum federal CEF standards[1].

Table 1. DOE Minimum Efficiency Standards for Clothes Dryers.

Table 1. Energy Conservation Standards for Residential Clothes Dryers

Product Class	Energy Factor (pounds/kWh)
	Manufactured On or After May 14, 1994
1. Electric, Standard [illegible]	[illegible]
2. Electric, Compact [illegible]	[illegible]
3. Electric, Compact [illegible]	[illegible]90
4. [illegible]	2[illegible]

  - Table 2 below from the US DOE EERE Appliance & Equipment Standards website shows the upcoming minimum federal CEF standards[2].

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[1] From DOE EERE website: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/36

[2] Ibid.

Table 2. DOE Minimum Efficiency Standards for Clothes Dryers after Jan 1, 2015

Table 2 Amended Energy Conservation Standards for Vented and Ventless Residential Clothes Dryers

Product Class	Energy Factor (pounds/kWh)
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

- Table 3 below from the ENERGY STAR Draft 2 Version 1.0 Specification for Clothes Dryers[3] shows the draft minimum ENERGY STAR qualification CEF standards.

Table 3. ENERGY STAR Draft 2 Version 1.0 Specification for Clothes Dryers minimum efficiencies

Table 1: Base CEF

Product Type	CEF_{BASE} (lbs/kWh)
Vented Gas	3.48
Ventless or Vented Electric, Standard (4.4 cu-ft or greater capacity)	3.93
Ventless or Vented Electric, Compact (120V) (less than 4.4 cu-ft capacity)	3.80
Vented Electric, Compact (240V) (less than 4.4 cu-ft capacity)	3.45
Ventless Electric, Compact (240 V) (less than 4.4 cu-ft capacity)	2.68

Table 2: Connected Allowance

Product Type	$CEF_{Addr\_Connected}$[1]
All Electric Dryer Types in Table 1[2]	$0.05 \times CEF_{BASE}$

[1] Calculated allowance shall be rounded down to the nearest hundredth before being applied in Equation 1.

[2] Product must be qualified using the final and validated ENERGY STAR Clothes Dryers Test Method to Validate Demand Response to use the allowance.

- It appears the CF has not been updated to reflect the new peak demand period. This should be corrected. The calculation for the CF appears to lack strong validity. A load shape for clothes dryers should be used from the Building America Benchmarks database for PA cities. These can be located here and include load shapes for several residential end-uses that can be used to update CFs in the TRM: http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip

2.3 Efficient Electric Water Heaters

2.3.2 Algorithms

Comments:

[3] From the ENERGY STAR website: http://www.energystar.gov/products/specs/sites/products/files/ENERGY%20STAR%20Draft%202%20Version%201.0%20Clothes%20Dryer%20Specification.pdf

- Revise algorithm as follows:

$$\Delta kWh = \frac{\left\{\left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed}}\right) \times \left(HW \times 365\frac{days}{year} \times 1\frac{BTU}{lb - F} \times 8.3\frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{3413\frac{Btu}{kWh}}$$

2.3.3 Definition of Terms

__Comments:__

- Table refers to Sources 3-4, which have been removed.
- The "T_{cold}, Temperature of cold water supply" variable (source 8) refers to footnote #24 of the Mid-Atlantic TRM. Assuming this is a reference to Version 2.0 (July, 2011), footnote #24 pertains to hardwired CFL fixtures. Please specify the TRM version number and check the footnote number. This comment applies to all water heater measures.
- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-1 and the new peak period, and the section text updated accordingly.

2.3.4 Energy Factors Based on Tank Size

__Comments:__

- Table 2-5 should be renamed as "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed as "Minimum Energy Factors (EFbase)"

2.3.5 Deemed Savings

__Comments:__

- This section should be renamed as "Default Savings" because the measure has been adjusted to a partially deemed algorithm.
- The deemed algorithm for ΔkWh should be revised to the following:

$$\Delta kWh = \left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed}}\right) \bullet 3018.0$$

This reflects the revision of this measure to a default value for EF_{base} and $EF_{proposed}$ rather than a deemed value, and also reflects allows the default savings to be based on tank size.

2.4 Electroluminescent Nightlight

2.4.2 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 this estimate. We further recommend the ISR be an open variable subject to the EDC data gathering. 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.

- We recommend the baseline wattage also be modified to an open variable allowing EDC data gathering and renamed to W_{base}. This is particularly important for direct install, giveaway, and efficiency kit measures where the nightlights may be installed in locations that previously had no nightlight. It is also possible that these will be replacing LED nightlights rather than incandescent nightlights. As electroluminescent nightlights use only 3%-30% of the energy of an LED nightlight, this is still an acceptable installation, however the savings would be significantly lower than if replacing incandescent nightlights.

2.5 Furnace Whistle

2.5.2 Definition of Terms

Comments:

- Unit Definition Inclusion: PECO recommends the TRM define the units as kWh in the column header "Furnace Whistle Savings" of Table 2-9 through Table 2-15 to provide clarity.
- We suggest that a section heading be added before the sentence following Table 2-8 labeled, "Deemed Savings."
- We recommend the deemed demand savings clearly be labeled for which EDC or city the savings represent.
- See comments on CF in Section 2.1.

2.6 Heat Pump Water Heaters

Introduction Table

Comments:

- The deemed Unit Energy Savings and Unit Peak Demand Reduction should be removed from the introduction table as this measure is no longer deemed. They should be replaced with "Variable".

2.6.2 Algorithms

Comments:

- The kWh savings calculated using the algorithm in Section 2.6.2 (with default inputs) does not appear to be the same as the result of the algorithm in Section 2.6.6.
- Revise algorithm as follows:

$$\Delta kWh = \frac{\left\{\left(\frac{1}{EF_{Base}} - \left(\frac{1}{EF_{Proposed}} \times \frac{1}{F_{Deratest}}\right)\right) \times \left(HW \times 365\frac{days}{year} \times 1\ \frac{BTU}{lb-F} \times 8.3\frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{3413\frac{Btu}{kWh}}$$

2.6.3 Definition of Terms

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period, as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-2 and the new peak period, and the section text updated accordingly.

2.6.4 Energy Factors Based on Tank Size

Comments:

- Table 2-17 should be renamed as "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed "Minimum Energy Factors (EFbase)"

2.6.6 Deemed Savings

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The kWh savings calculated using the algorithm in Section 2.6.2 (with default inputs) does not yield the same result as the Deemed Savings algorithm in Section 2.6.6.
- The deemed algorithm for ΔkWh should be revised to the following:

$$\Delta kWh = \left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed} * 0.84}\right) * 3018.0$$

This reflects the revision of this measure to a default value for EF_{base} and $EF_{proposed}$ rather than a deemed value, and also reflects allows the default savings to be based on tank size.

2.7 LED Nightlight

2.7.2 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. We further recommend the ISR be an open variable subject to the EDC data gathering. 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.
- We recommend that variables in this measure be updated to match the variables in the Electroluminescent Nightlight measure to provide more consistency between similar measures. It would be reasonable to combine both of these measures to one protocol is different default values.

2.8 Low Flow Faucet Aerators

Introduction

Comments:

- The deemed Unit Energy Savings and Unit Peak Demand Reduction values should be removed from the introduction table and replaced with, "Varies by installation location."

2.8.1 Algorithms

Comments:

- We support the update of this measure to the findings in the recent Michigan metering study of faucet aerators and showerheads. We also support splitting savings estimates out for kitchen and bathroom aerators. With these splits however, the algorithm should be modified to allow input of the corresponding ΔT. We also recommend making the algorithm for faucet aerators and low flow showerheads as consistent as possible. We recommend modifying the formula as follows:

$$\Delta kWh = ISR \times ELEC \times [(F_B GPM_{Base} - F_P GPM_{low}) \times T_{Person\text{-}Day} \times N_{Persons} \times 365 \times \Delta T_L (T_{out} - T_{in}) \times U_H \times U_E \times DF/RE] / (F/home)$$

Where:

T_{out} = average mixed water temperature flowing from the faucet (F)

T_{in} = average temperature of water entering the house (F)

2.8.2 Definition of Terms

<u>*Comments:*</u>

- The parameters F_B (GPM_{base}) and F_P (GPM_{low}) should be default "open" variables rather than stipulated to allow direct install programs to use actual customer baseline and retrofit flow rates.
- Given that the TRM protocol references the Michigan Metering Study to update flow times, it also makes sense that all the factors available from the MI study also be used to update the protocol. By changing some variables, but leaving others that were only valid in combination with the changed variables, the savings estimates are drastically low. Per the MI study, the verified average savings for a bathroom faucet aerator was 47 kWh in a single family home and 49 kWh in a multifamily. For a kitchen aerator, the verified savings were 274 kWh for a single family home and 224 kWh for a multi-family home. These are significantly higher than the draft TRM calculated values of 11.5 kWh per faucet for a bathroom faucet in a single family home and 75.4 kWh for a kitchen faucet in a single family home. The multi-family home and unknown location estimates are similarly low. Based on the findings of the MI study we recommend the following updates:
  - The parameters F_B (GPM_{base}) and F_P (GPM_{low}) should be updated to the following:

    F_B (GPM_{base}): Bath = 1.91 GPM, Kitchen = 1.72 GPM, Unknown = 1.86 GPM[4]

    This is based on the baseline flow rates of the metered homes in the MI study which were:

    Table 4. Metered flow rates from MI Faucet Aerator and Showerhead study.

Faucet Location	Average Flow Rate (GPM)	Inefficient Use Flow Rate (GPM)[5]
Bathroom	1.91	2.44
Kitchen	1.72	2.17

[4] Based on weighted average flow rate of kitchen and bath aerators in a single family home as follows: ((1.91*2.8)+(1.72*1.0))/(1.0+2.8) = 1.86 GPM

[5] Inefficient use flow rate represents the average flow rate of installed inefficient fixtures. This was calculated by taking average flowrates of fixture with flowrate greater than 90% of the federal code 2.5 for showerhead and 2.22 for aerators.

- The parameter ΔT should be expanded to (T_{out} - T_{in}) with the following defaults: T_{out} = 86F for bathroom aerator, 91F for a kitchen aerator, 87.3F for an unknown aerator (based on weighted average similar to flow rate)
  T_{in} = 55F (See TRM section 2.9 Low Flow Showerheads)

- The average number of faucets in the home (F/home) values pertain to single family homes. The value of 2.8 for bathroom faucets in single family homes is high for multi-family. This value is 1.5 for multi-family in the Illinois TRM for example. PECO requests that values be added for multifamily homes from either the PA baseline study data, or using the Illinois TRM as a source for representative values.
- Using the above recommended changes, the default savings for faucet aerators would be as follows:

Table 5. Default Energy Savings for Faucet Aerators

Faucet Location	Single Family Energy Savings (kWh/yr)	Multi-Family Energy Savings (kWh/yr)	Unknown Home Type Energy Savings (kWh/yr)[6]
Bathroom	38	47	48
Kitchen	233	155	224
Unknown	93	94	108

To get to ex ante savings, the above values need to be multiplied by the ISR and percentage of homes with electric water heaters. These values are much more in line with the MI metering study verified savings shown above.

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-2 and the new peak period, and the section text updated accordingly.

2.8.3 Deemed Savings

__Comments:__

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The text should be removed and table a similar to the Table 5 above should be inserted.

2.9 Low Flow Showerheads

2.9.1 Algorithms

__Comments:__

- As with the Low Flow Faucet Aerator measure, we support a similar update of this measure to the findings in the recent Michigan metering study of faucet aerators and showerheads.

---

[6] Assumes average number of bathroom faucets per home between single family and multi-family homes for an F/home = 1.0 Kitchen, 2.15 Bathroom, and 3.15 Unknown location.

We also recommend making the algorithms for the two measures as consistent as possible. With this in mind, we recommend the following updates to the algorithm:

$$\Delta kWh = ISR \times ELEC \times [((((GPM_{base} - GPM_{low})/GPM_{base}) \times T_{Person\text{-}Day} \times N_{Persons} \times N_{showers\text{-}Day} \times gals/day \times 365) \times (TEMP_{ft} T_{out} - TEMP_{in} T_{in}) \times U_H \times U_E / RE)] / (S/home)$$

Where:

$T_{person\text{-}day}$ = average time of shower per person in minutes

$N_{showers\text{-}Day}$ = average number of showers per person per day

T_{out} = average mixed water temperature flowing from the showerhead (F)

T_{in} = average temperature of water entering the house (F)

2.9.2 Definition of Terms

<u>Comments:</u>

- The parameters GPM_{base} and GPM_{low} should be default "open" variables rather than stipulated to allow direct install programs to use actual customer baseline and retrofit flow rates.
- The TRM protocol should be updated to reference the Michigan Metering Study for flow rates and shower times. Based on the findings of the MI Metering study we recommend the following updates:
  - The parameters GPM_{base} and GPM_{low} should be updated to the following:

GPM_{base}	= 2.5 (for upstream programs, assumes most people are replacing a federal minimum standard device as recommended by MI study), 2.63 (for direct install programs targeting high flow devices)
GPM_{low}	= 1.5

This is based on the baseline flow rates of the metered homes in the MI study which were:

Table 6. Metered Showerhead flow rates from MI Faucet Aerator and Showerhead study.

Average Flow Rate (GPM)	Inefficient Use Flow Rate (GPM)[7]
1.91	2.63

  - $TEMP_{ft}$ and $TEMP_{in}$ should be updated to T_{out} and T_{in} to match the faucet aerator algorithms.
  - The source for $TEMP_{ft}$ (T_{out}) should be updated to reference the MI metering study.
  - gals/day should be removed.

[7] Inefficient use flow rate represents the average flow rate of installed inefficient fixtures. This was calculated by taking average flowrates of fixture with flowrate greater than 90% of the federal code 2.5 for showerhead and 2.22 for aerators.

- $T_{person\text{-}day}$ should be added referencing the MI metering study with a deemed value of 7.8 minutes/shower
- $N_{showers\text{-}day}$ should be added referencing the MI metering study with a deemed value of 0.6 showers/day/person

- Using the above recommended changes, the default savings for showerheads would be as follows:

Table 7. Default Energy Savings for Showerheads

Housing Type	Low Flow Rate (GPM_{low})	Upstream Program Unit Energy Savings (kWh)	Upstream Program Unit Demand Savings (kW)	Direct Install Program Unit Energy Savings (kWh)	Direct Install Program Unit Demand Savings (kW)
Single Family	2	155		186	
	1.75	233		264	
	1.5	311		342	
Multifamily	2	135		163	
	1.75	203		230	
	1.5	271		298	
Unknown	2	159		191	
	1.75	239		270	
	1.5	318		350	

To get to ex ante savings, the above values need to be multiplied by the ISR and percentage of homes with electric water heaters. These values are in line with the MI metering study verified savings of 351 kWh for a single family home and 291 kWh for a multi-family home.

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-5 and the new peak period, and the section text updated accordingly.

2.9.3 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The existing table should be removed and table a similar to the Table 7 above should be inserted.

2.10 Programmable Thermostat

2.10.2 Definition of Terms

Comments:

- The text for Source 1 is ambiguous. More detail should be added for clarity.

- Source 2 may give a low estimate of SEER (and consequently, higher consumption and higher savings). Based on PECO's baseline study completed in 2011, a more appropriate average SEER level for the existing population is around 13.5. The baseline study did not record the SEER values, but did record the age of each central air conditioner. The age of the system can be used and compared against federal standard minimum efficiencies. This approach was used to determine an average existing home central A/C SEER value of 13.5. We recommend the TRM be updated to use a default SEER of 13.5.
- The options for EFLHcool and EFLHheat also should include the EDC-specific alternative EFLH from Tables 2-2 and 2-3 in Section 2.1 Electric HVAC.

2.11 Room AC Retirement

2.11.2 Definition of Terms

Comments:

- In reference to source 6, this CF might be slightly high for room ACs. For Con Edison in NY, PECO engaged a third party to perform a thorough RAC metering study and found a CF of 0.30 for RACs installed in medium density areas (i.e. outside NYC). This low CF is attributed to the fact that 50% of RACs in the program are installed in bedrooms and only run at non-coincident times. The 0.30 CF was almost exactly 50% of the previous Con Edison value. Consider using a factor to translate CAC CF to RAC CF. Further, the CF should be based on the new peak demand period.
- The $EFLH_{RAC}$ in Table 2-23 should be updated to be based on the $EFLH_{cool}$ values in Section 2.1 Electric HVAC which were based on REM/Rate modeling of PA homes. Alternatively, the measure should also include using the EDC specific alternate EFLH from Tables 2-2 and 2-3 in Section 2.1 Electric HVAC to derive the $EFLH_{RAC}$.

2.12 Smart Strip Plug Outlets

2.12.3 Definition of Terms

Comments:

- It is unclear if the referenced CF of 0.8 is based on the new peak demand period. The CF should be reviewed and adjustments made if necessary. The load shape for Home Entertainment Appliances should be used from the Building America Benchmarks database for PA cities. These can be located here and include load shapes for several residential end-uses that can be used to update CFs in the TRM: http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip

2.12.5 Measure Life

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.

2.13 Solar Water Heaters

2.13.2 Algorithms

Comments:

- Revise algorithm as follows:

$$kWh = \frac{\left\{\left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed}}\right) \times \left(HW \times 365\frac{days}{year} \times 1\frac{BTU}{lb-F} \times 8.3\frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{3413\frac{Btu}{kWh}}$$

2.13.3 Definition of Terms

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-6 and the new peak period, and the section text updated accordingly.

2.13.4 Energy Factors Based on Tank Size

Comments:

- Table 2-27 should be renamed to, "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed "Minimum Energy Factors (EFbase)"

2.13.6 Deemed Savings

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- In addition to the default savings, a partially deemed algorithm could be provided similar to the other water heater measures as follows:

$$\Delta kWh = \left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed}}\right) * 3018.0$$

This reflects the revision of this measure to a default value for EF_{base} and $EF_{proposed}$ rather than a deemed value, and also reflects allows the default savings to be based on tank size.

2.14 Electric Water Heater Pipe Insulation

Introduction

Comments:

- Introductory text makes reference to a water heater setback measure as well. Remove this language unless the setback is included in the savings algorithms and defaults.

- The default measure savings are based on a standard efficiency electric water heater with an annual baseline energy usage of 3191 kWh based on Section 2.3 baseline assumptions, however, this has not been updated to reflect the recent updates to Section 2.3 assumptions. The measures savings for this protocol should be updated to be based on the current assumptions in Section 2.3 which yield a baseline energy usage of 3338 kWh.

2.14.2 Algorithms

Comments:

- This section should be updated based on the revised baseline energy consumption of 3338 kWh. This yields a default savings of 10.0 kWh per foot of installed insulation.

2.14.3 Definition of Terms

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-7 and the new peak period, and the section text should be updated accordingly.

2.16 Ductless Mini-Split Heat Pumps

2.16.1 Eligibility

Comments:

- PECO suggests stating explicitly that each zone must have a valid baseline (rather than each system). For example, we want to make sure a room AC does not get used as a baseline for more than one zone of DHP.

2.16.2 Algorithms

Comments:

- Savings for DHPs come from the zonal capabilities, the variable speed drives, and the fact that there are no ducts. PECO suggests adding a factor for the lack of ducts if the baseline is a central system. Could be similar to the inverse of the DuctSF that was used previously in the Electric HVAC section (section 2.1).
- PECO's consultant found runtime hours in NYC were much lower for heating than they were for cooling due to the fact that most people who got a DHP were still using their baseline heating technology as a primary heating source, and in many cases not using the DHP for heating at all. PECO suggests adding a factor to capture the effect of low usage of DHP for heating.

2.16.3 Definition of Terms

Comments:

- The options for $EFLH_{cool}$ and $EFLH_{heat}$ should also include using the EDC specific alternate EFLH from Tables 2-2 and 2-3 in Section 2.1 Electric HVAC.
- For sources 7 and 9, PECO suggests referencing documents other than the PA TRM for each piece of data used.

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using load profile for HVAC central cooling and the new peak period, and the section text should be updated accordingly.

2.17 Fuel Switching: Domestic Hot Water Electric to Gas, Oil, or Propane

2.17.1 Eligibility

Comments:

- There is often a delay for when a unit becomes available in the marketplace and when it actually earns the ENERGY STAR label. There are also several manufacturers that have chosen not to pay for the ENERGY STAR label even though their products meet the ENERGY STAR criteria. PECO recommends that the language in the TRM be clarified to include language such as, "Products meeting the ENERGY STAR criteria may be allowed to receive Act 129 incentives, even if they are not ENERGY STAR labeled. Product qualification should be confirmed through review of the AHRI testing reports."

2.17.3 Definition of Terms

Comments:

- Source notes for Table 2-31 are included in section 2.17.4 rather than directly below the table 2-31. They should be moved to section 2.17.3.
- Source notes are incorrectly numbered for "HW, Hot water used per day in gallons", "Thot, Temperature of hot water", and "Tcold, Temperature of cold water". Also, sources 7 and 8 in section 2.17.4 have inadvertently been combined. It is unclear which is which. They should be separated into different sources and Table 2-31 updated to the correct notes.
- We recommend adding the note about tankless water heater EF directly into the assumptions table rather than as a footnote.
- The "T_{cold}, Temperature of cold water supply" variable (source 8) refers to footnote #24 of the Mid-Atlantic TRM. Assuming this is a reference to Version 2.0 (July, 2011), footnote #24 pertains to hardwired CFL fixtures. Please specify the TRM version number and check the footnote number.
- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-8 and the new peak period, and the section text should be updated accordingly.

2.17.4 Energy Factors Based on Tank Size

Comments:

- Table 2-32 should be renamed to, "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed "Minimum Energy Factors (EFbase)".

2.17.5 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The deemed savings table 2-33 should be removed, and instead a deemed algorithm for ΔkWh should be added as follows:

$$\Delta kWh = \left(\frac{1}{EF_{elect,bl}}\right) * 3018.0$$

This reflects the revision of this measure to a default value for EF_{base} rather than a deemed value, and also reflects allows the default savings to be based on tank size.

2.18 Fuel Switching: Heat Pump Water Heater to Gas, Oil or Propane Water Heater

2.18.1 Eligibility

Comments:

- There is often a delay for when a unit becomes available in the marketplace and when it actually earns the ENERGY STAR label. There are also several manufacturers that have chosen not to pay for the ENERGY STAR label even though their products meet the ENERGY STAR criteria. PECO recommends that the language in the TRM be clarified to say something similar to, "Products meeting the ENERGY STAR criteria may be allowed to receive Act 129 incentives, even if they are not ENERGY STAR labeled. Product qualification should be confirmed through review of the AHRI testing reports."

2.18.2 Algorithms

Comments:

- Revise algorithms as follows:

$$\Delta kWh = \frac{\left\{\left(\frac{1}{EF_{HP,bl} \times F_{Derate}}\right) \times \left(HW \times 365\frac{days}{yr} \times 1\frac{BTU}{lb-F} \times 8.3\frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{3413\frac{Btu}{kWh}}$$

$$\text{Fuel Consumption (MMBtu)} = \frac{\left\{\left(\frac{1}{EF_{NG,inst}}\right) \times \left(HW \times 365\frac{days}{yr} \times 1\frac{BTU}{lb-F} \times 8.3\frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right\}}{1{,}000{,}000\frac{Btu}{MMBtu}}$$

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-9 and the new peak period, and the section text should be updated accordingly.

2.18.3 Definition of Terms

Comments:

- The Values for $EF_{NG,inst}$, $EF_{Propane,inst}$, and $EF_{Oil,inst}$ should be modified to include, "or EDC Data Gathering" to allow input of EF of actual incented units.
- The "T_{cold}, Temperature of cold water supply" variable (source 8) refers to footnote #24 of the Mid-Atlantic TRM. Assuming this is a reference to Version 2.0 (July, 2011), footnote #24 pertains to hardwired CFL fixtures. Please specify the TRM version number and check the footnote number.

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-9 and the new peak period, and the section text should be updated accordingly.

2.18.5 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm. All uses of "deemed" within the protocol should be corrected to "default."
- The deemed savings tables 2-36 and 2-37 should be removed, and instead a deemed algorithm for ΔkWh should be added as follows:

$$\Delta kWh = \left(\frac{1}{EF_{HP,BI} \cdot F_{Derate}}\right) \cdot 3018.0$$

  This reflects the revision of this measure to a default value for EF_{base} rather than a deemed value, and also reflects allows the default savings to be based on tank size.

  And a deemed algorithm for fossil fuel consumption should be added as follows:

$$\text{Fossil Fuel Consumption (MMBtu)} = \left(\frac{1}{EF_{NG,Inst}}\right) \cdot 10.3$$

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

Introduction

Comments:

- ENERGY STAR Requirements: Per language in the 2011 and 2013 TRC orders, the Commission has clearly stated a directive that fuel switching measures should only incent fuel switching to ENERGY STAR rated products. There are several versions of ENERGY STAR Furnace standards that have been made over the years. Each subsequent standard replaces the previous one; however, the standard applies to manufactured date of products, not sale date. As previous standards are replaced, existing stock eventually sells through and new stock meeting the current standards replaces them. This means there may be ENERGY STAR labeled products available for purchase at the same time based on multiple ENERGY STAR versions. It is appropriate to encourage the latest version of the ENERGY STAR standards as they provide a higher level of efficiency for the consumer. As such, we recommend adding language to the TRM, as suggested below, which includes a sunset date for which ENERGY STAR products are acceptable for receiving incentives. Further, we recommend the Commission allow not just ENERGY STAR rated equipment, but also ENERGY STAR equivalent products. Some manufacturers sell high efficiency units, but have chosen not to pursue the ENERGY STAR label or may still be in the process of obtaining it. Customers should still be allowed to receive incentives for those high efficiency units. We suggest that the following language be added to the protocol:

  To encourage adoption of the highest efficiency units, older units which meet outdated ENERGY STAR standards may be incented up through the given sunset dates. EDCs may *provide incentives for equipment with efficiencies greater than or equal to the ENERGY STAR requirements per the following table. Products meeting the ENERGY STAR criteria may be allowed to receive Act 129 incentives, even if they are not ENERGY STAR labeled. Product qualification should be confirmed through review of the AHRI testing reports.*

ENERGY STAR Product Criteria Version	ENERGY STAR Effective Manufacture Date	Act 129 Sunset Date[*]
ENERGY STAR Furnaces Version 4.0	February 1, 2013	N/A
ENERGY STAR Furnaces Version 3.0	February 1, 2012	May 31, 2014
ENERGY STAR Furnaces Version 2.0, Tier II units	October 1, 2008	May 31, 2013

[*] Date after which Act 129 programs may no longer offer incentives for products meeting the criteria for the listed ENERGY STAR version.

2.19.1 *Algorithms*

Comments:

- We recommend adding the following statement to the opening paragraph or in section 2.19.1: "EDC's may use billing analysis using program participant data to claim measure savings, in lieu of using the defaults provided in this measure protocol."
- Incorrect Parameter in Savings Calculation: In the equation calculating "Heating savings with electric baseboards or electric furnaces (assumed 100% efficiency)," the parameter $EFLH_{elec\ furnace}$ is incorrectly used for the term representing the energy consumption of the fossil fuel furnace blower motor. As such, PECO recommends that this EFLH parameter, bolded in the equation below, be updated in the TRM to properly represent the EFLH of the fossil fuel blower motor.

$$\Delta kWh_{elec\ heat} = \frac{CAPY_{elec\ heat} \times EFLH_{elec\ furnace}}{3412 \frac{Btu}{kWh}} - \frac{HP_{motor} \times \left(746 \frac{W}{HP}\right) \times \cancel{\mathbf{EFLH_{elec\ furnace}}}\, \mathbf{EFLH_{fuel\ furnace}}}{\eta_{motor} \times 1000 \frac{W}{kW}}$$

- Incorrect Parameter in Savings Calculation: In the equation calculating "Heating savings with electric air source heat pump," the parameter $EFLH_{heat}$ (which is not defined in the subsequent tables) is incorrectly used in the term representing the energy consumption of the fossil fuel furnace blower motor and the ASHP. As such, PECO recommends that this EFLH parameter, bolded in the equations below, be updated in the TRM to properly represent the EFLH of the fossil fuel blower motor and ASHP.

$$\Delta kWh_{ASHP\ heat} = \frac{CAPY_{ASHP\ heat} \times \cancel{\mathbf{EFLH_{heat}}}\, \mathbf{EFLH_{ASHP}}}{HSPF_{ASHP} \times 1000 \frac{W}{kW}} - \frac{HP_{motor} \times \left(746 \frac{W}{HP}\right) \times \cancel{\mathbf{EFLH_{heat}}}\, \mathbf{EFLH_{fuel\ furnace}}}{\eta_{motor} \times 1000 \frac{W}{kW}}$$

2.20 Ceiling / Attic and Wall Insulation

Cross Cutting

Comments:

- Each sub-section in this protocol is labeled with 2.21.X rather than the appropriate 2.20.X. Update all sub-section labels.

2.20.2 (2.21.2 in the draft) Definition of Terms

Comments:

- Based on feedback from the ICSPs, we recommend either adding additional insulation level options, or better yet, allowing EDC Data Gathering for the baseline and retrofit R-values. It should be made clear that the "assembly R-value" is required as opposed to the R-value of the added insulation alone.
- It appears the CF values have not been updated to reflect the new peak demand period. This should be corrected. These should be made to match updated CF from section 2.1 Electric HVAC and section 2.11 Room AC Retirement per the comments made under those sections.
- The options for $EFLH_{cool}$ and $EFLH_{heat}$ should also include using the EDC specific alternate EFLH from Tables 2-2 and 2-3 in Section 2.1 Electric HVAC.

2.21 Refrigerator/Freezer Recycling with and without Replacement

2.21.1 Algorithms

Comments:

- 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 also be changed in section 2.21.2 Definition of Terms and section 2.21.3 Deemed Savings Calculations.
- As currently written, this protocol improperly includes deemed savings values based on net savings rather than gross savings as is used on all other measures in the TRM. The Commission has made clear that Act 129 compliance is based on gross savings, not net savings, however, this measure deviates from that clear direction and instead bases the deemed values on net savings. There has been no justification for why this deviation is made, nor has the Commission given a directive that the protocol should use net savings versus gross. With all other measures, net-to-gross information is collected as part of the program evaluations and is reported to the Commission separate from gross savings. This measure should be treated like all others. The deemed savings values in this protocol should be corrected to be based solely on gross savings, and all discussion of net adjustments should be removed from the protocol and left to the EDC independent evaluators.
- If net savings adjustments are left in the protocol, the TRM protocol should at least be adjusted to be more consistent with the UMP protocol. The only time the UMP protocol subtracts energy consumption of a replacement unit is in the net savings calculation, and then only when the program induced the customer to replace their old unit with a new one and recycle the old. Per the language in the UMP protocol Section 5.2 (emphasis added):

> ***5.2 Induced Replacement (INDUCED_kWh)***
>
> *Evaluators must account for replacement units only when a recycling program induces replacement (that is, when the participant would not have purchased the replacement refrigerator in the absence of the recycling program). As previously noted, the purchase of a refrigerator in conjunction with program participation does not necessarily indicate induced replacement. (The refrigerator market is continuously replacing older refrigerators with new units, independent of any programmatic effects.) However, if a customer would have not purchased the replacement unit (put another appliance on the grid) in absence of the program, the net program savings should reflect this fact. This is, in effect, akin to negative spillover and should be used to adjust net program savings downward.*

This INDUCED_kWh variable only shows up in the algorithm for net savings in the UMP protocol as shown here:

NET_kWh = N(NET_FR_SMI_kWh – INDUCED_kWh)*

Where:

NET_FR_SMI_kWh	*= average per unit energy savings net naturally occurring removal from grid and secondary market impacts*
INDUCED_kWh	*= average per unit energy consumption caused by the program inducing participants to acquire refrigerators they would not have independent of program participation*

We strongly support following the UMP protocol for Refrigerator Recycling for both gross and net savings evaluations. However, as currently written, the TRM protocol subtracts the energy consumption of the replacement unit from the energy savings regardless of whether the program did not influence that replacement. This is a key deviation from the UMP for "NET_kWhsaved Per Unit" that PECO believes leads to improper savings estimates. Since replacement is a net-to-gross issue, replacement units should be left to the EDC evaluations and the evaluations should be allowed to account for these adjustments in a consistent manner with the UMP protocol using the INDUCED_kWh factor.

2.21.2 Definition of Terms

__*Comments:*__

- In the definition for EXISTING_UEC, and PART_USE, default values from PY3 are shown. These should be removed from the definition. If default values are to be provided, they should be listed in a table consistent with other TRM measure protocols.
- In the definition for REPLACEMENTUEC, default values are shown. These should be removed from the definition and listed in a table consistent with other TRM measure protocols.

2.21.3 Deemed Savings Calculations

__*Comments:*__

- Although we support the breakout of the savings by EDC, we recommend the savings be listed as default savings values calculated using the partially deemed algorithm with deemed coefficients, and default variable inputs by EDC. We further recommend allowing each EDC to calculate program savings using the partially deemed algorithm, the deemed coefficients, and actual program year recycled refrigerator/freezer data which will provide a more accurate annual ex ante savings estimate due to changing mix of program participation year-to-year. Since this data is already gathered by the program implementer, it is readily available information that can be used to provide more accurate savings estimates if an EDC chooses. If this change is made as recommended, this section heading should be modified to read, "Default Savings Calculations."
- The algorithm for Existing Refrigerator UEC should be modified to remove the average age of units recycled of 27.036 as follows:

  *Existing Refrigerator UEC = 365.25 *(0.582+0.027 *(average age of appliance~~27.036~~)...*
- It would be useful to provide a table of the deemed coefficients so that EDC's and incorporate them into their tracking systems more easily. Such tables were included in the 2013 TRM, however, they were removed in the 2014 TRM. It is unclear why the tables were removed.

- It is unclear where the coefficients for the Existing Freezer UEC algorithm come from. The note indicates the source for freezer UEC equation to be the US DOE Uniform Methods Project, Savings Protocol for Refrigerator Retirement. This reference however does not provide any coefficients for freezers. A proper reference for the freezer algorithm and deemed coefficients should be provided.
- **The** last rows in table 2-46 and 2-47 are both incorrectly labeled as "Estimated UEC Savings." These should both be relabeled to "Existing_UEC" to be consistent with the previously defined terms.

2.22 Residential New Construction

2.22.2 Definition of Terms

Comments:

- It appears the CF value has not been updated to reflect the new peak demand period. This should be corrected. These should be made to match updated CF from section 2.1 Electric HVAC per the comments made under that section.

2.23 ENERGY STAR Refrigerators

2.23.1 Algorithms

Comments:

- This protocol underestimates savings when tables 2-53 or 2-55 are used. The formulas provided in the tables calculate the maximum allowable energy consumption, not the actual energy consumption of the installed unit. Many ENERGY STAR rated refrigerators use significantly less than the maximum allowable energy consumption. Most refrigerators have test data which estimates annual energy consumption. We recommend this section be modified to allow use of the actual incented refrigerator test data for annual energy consumption for the kWh_{EE} variable to calculate energy savings. It is reasonable to use the given formulas for the federal standard maximum usage as the baseline when the actual volume and configuration is known. To make these changes we recommend the following edits:

  If the volume and configuration of the refrigerator is known, the baseline ~~the federal minimum efficiency and ENERGY STAR qualified~~ models' annual energy consumption (kWh_{base}) may be ~~are~~ determined using table 2-53. The efficient models' annual energy consumption (kWh_{EE} or kWh_{ME}) may be determined using manufacturers' test data for the given model. Where test data is not available the algorithms in tables 2-53 and 2-55 for "ENERGY STAR and ENERGY STAR Most Efficient maximum energy usage in kWh/year" may be used to determine the efficient energy consumption for a conservative savings estimate.

2.23.2 Definition of Terms

Comments:

- The first paragraph in this section should also be modified consistent with the language used above. We recommend the following edits:

  . . . If this information is known, annual energy ~~usage~~ consumption (kWh_{base}) of the ~~ENERGY STAR model and~~ federal standard model ~~can be calculated~~ may be determined using table 2-53. The efficient models' annual energy consumption (kWh_{EE} or kWh_{ME}) may be determined

> *using manufacturers' test data for the given model. Where test data is not available, the algorithms in tables 2-53 and 2-55 for "ENERGY STAR and ENERGY STAR Most Efficient maximum energy usage in kWh/year" may be used to determine efficient energy consumption for a conservative savings estimate. The term "AV" in the equations refers to "Adjusted Volume," which is AV = (Fresh Volume) +1.63 × (Freezer Volume). Note, ENERGY STAR algorithms are not given for the categories "bottom mounted freezer with through-the-door ice", "refrigerator only-single door without ice" and "refrigerator/freezer-single door." Refer to table 2-54 for default values for these categories. Table 2-53 is also provided for planning purposes to compare to the changing federal standards detailed in table 2-57.*

- The paragraph after table 2-54 should be modified consistent with the language used above. We recommend the following edits:

> *ENERGY STAR Most Efficient annual energy ~~usage can be calculated using Table 2-55~~ consumption (kWh_{ME}) may be determined using manufacturers' test data for the given model. Where test data is not available, the algorithms in Table 2-55 for "ENERGY STAR Most Efficient maximum energy usage in kWh/year" may be used to determine efficient energy consumption for a conservative savings estimate. Baseline annual energy ~~usage~~ consumption (kWh_{base}) of the federal standard model ~~can be calculated~~ may be determined using Table 2-53.*

2.24 ENERGY STAR Freezers

2.24.1 Algorithms

Comments:

- Similar to the ENERGY STAR Refrigerator protocol, this protocol under estimates savings when table 2-58 is used. The formulas provided in the table calculate the maximum allowable energy consumption, not the actual energy consumption of the installed unit. Many ENERGY STAR rated freezers use significantly less than the maximum allowable energy consumption. Most freezers have test data which estimates annual energy consumption. We recommend this section be modified to allow use of the actual incented freezer test data for annual energy consumption for the kWh_{EE} variable to calculate energy savings. It is reasonable to use the given formulas for the federal standard maximum usage as the baseline when the actual volume and configuration is known. To make these changes, we recommend the following edits:

> *If the volume and configuration of the freezer is known, the baseline ~~the federal minimum efficiency and ENERGY STAR qualified~~ models' annual energy consumption (kWh_{base}) may be ~~are~~ determined using table 2-58. The efficient models' annual energy consumption (kWh_{EE}) may be determined using manufacturers' test data for the given model. Where test data is not available the algorithms in table 2-58 for "ENERGY STAR maximum energy usage in kWh/year" may be used to determine the efficient energy consumption for a conservative savings estimate.*

2.24.2 Definition of Terms

Comments:

- The first paragraph in this section should also be modified consistent with the language used above. We recommend the following edits:

> *... If this information is known, annual energy ~~usage~~ consumption (kWh_{base}) of the ~~ENERGY STAR model and~~ federal minimum efficiency standard model ~~can be calculated~~ may be determined using table 2-58. The efficient models' annual energy consumption (kWh_{EE}) may*

be determined using manufacturers' test data for the given model. Where test data is not available, the algorithms in table 2-58 for "ENERGY STAR maximum energy usage in kWh/year" may be used to determine efficient energy consumption for a conservative savings estimate. The term "AV" in the equations refers to "Adjusted Volume," which is AV = 1.73 × Total Volume. Note this table is also provided for planning purposes to compare to the changing federal standards detailed in table 2-60.

2.25 ENERGY STAR Clothes Washers

2.25.1 Algorithms

Comments:

- Edit / Grammar: Delete the crossed out word and add the bolded and underlined words to the following sentence: "Where MEF is the Modified Energy Factor, which is the energy performance ~~meteric~~ **metric for** clothes washers".

2.25.2 Definition of Terms

Comments:

- The algorithm for ΔkWh savings has been updated to no longer include percentage signs. The terms defined still have percentage signs accompanying the variables. They should be updated to be consistent with the nomenclature in the algorithm. For example:
    - The defined variable $\%CW_{base}$ is not a variable in the algorithm, but CW_{base} is. Update the affected variables by removing the percentage signs to make them consistent with the algorithm, ~~$\%CW_{base}$~~.
- Edit / Grammar: Delete the crossed out word and add the bolded and underlined words to the following sentence: "WF is the quotient of the total weighted per-cycle water consumption ~~dividied~~ **divided** by the capacity of the clothes washer".
- Reference 129: The most up-to-date version of the Energy Star Program Requirements is Version 6.1, effective February 15, 2013. Consider updating the source information. The information that the source refers to remains unchanged, no further updates are needed.
- Edit / Grammar: Delete the crossed out word and add the bolded and underlined words to the following sentence: "[129] Based on ENERGY STAR Version 6.0 requirements, ENERGY STAR Program Requirements Product Specification for ~~Cltohes~~ **Clothes** Washers, Eligibility Criteria Version 6.0. Accessed August 2012".
- Reference 130: The source listed, "ENERGY STAR Clothes Washers Key Product Criteria website: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers", does not correspond to the data it refers to. Consider updating it to a current source such as the following: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39
- Sources 1-6: Table 2-61 lists sources from 1 to 8 for the terms included, yet only 6 sources are listed under the table. All 8 sources should be listed; update and add the sources as necessary.

- The $DSav_{CW}$ deemed value has not been updated to represent the new peak demand period. This should be reviewed and updated. A load shape for clothes washers should be used from the Building America Benchmarks database for PA cities. These can be located at the following web address and include load shapes for several residential end-uses that can be used to update CFs in the TRM: http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip
- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimate. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the $DSav_{CW}$ variable.

2.25.4 *Future Standards Changes*

__*Comments:*__

- Edit / Grammar: Delete the crossed out words and add the bolded and underlined words to the following sentence: "The efficiency standards and the effective TRM ~~that~~ **in which** these standards become the baseline are detailed in Table 2-63".

2.26 ENERGY STAR Dishwashers

2.26.2 *Definition of Terms*

__*Comments:*__

- In Table 2-64, delete the crossed out word and add the bolded and underlined word to the following sentence: "Federal Standard and ENERGY STAR v 5.0 Residential ~~Dishwaster~~ __**Dishwasher**__ Standard".
- In Table 2-65, the values for kWh_{base} and kWh_{EE} do not match the values listed in the Energy Star Appliance Calculator for electrically heated hot water. The values currently listed correspond instead to gas heated hot water. The following updates are recommended to reflect the correct values for electrically heated hot water:
  - kWh_{base} = ~~151 kWh/yr~~ **355 kWh/yr**
  - kWh_{EE} = ~~126 kWh/yr~~ **295kWh/yr**
- Edit / Grammar: Delete the crossed out words and spaces, and add the bolded and underlined words to the following sentence: "The default values for electric and non-electric water heating and the default fuel mix from Table 2-64~~is~~ __**are**__ given in Table 2-66".
- In Table 2-66, the values for ΔkWh/yr do not have a reference; consider adding the appropriate reference for completeness. In addition, the Default Fuel Mix is listed as having $\%Electric_{DHW}$ = 42%, yet Table 2-65 lists the default as $\%Electric_{DHW}$ = 43%. A revision is recommended for consistency.
- Edit / Grammar: Delete the crossed out words in the following table heading: "Table 2-66: Default Dishwasher Energy ~~and Demand~~ Savings".

- Sources 1-3: Table 2-65 lists sources from 1 to 4 for the terms included, yet only 3 sources are listed under the table. All 4 sources should be listed; update and add the sources as necessary.
- Edit / Grammar: Delete the crossed out number and add underlined space in the following sentence: "~~3.~~ Statewide average for all housing types from Pennsylvania Statewide Residential End-Use and Saturation Study, 2012,_Demand savings derived using dishwasher load shape."
- The $DSav_{DW}$ deemed value has not been updated to represent the new peak demand period. This should be reviewed and updated. A load shape for dishwashers should be used from the Building America Benchmarks database for PA cities. These can be located at the following web address and include load shapes for several residential end-uses that can be used to update CFs in the TRM:
http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip
- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimate. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the $DSav_{DW}$ variable.

2.27 ENERGY STAR Dehumidifiers

2.27.2 Definition of Terms

Comments:

- In Table 2-68, the savings values for do not have a reference; consider adding the appropriate reference for completeness. In addition, the values listed in Table 2-68 do not match the values listed in the Energy Star Appliance Calculator for the stipulated dehumidifier capacity ranges. The following updates are recommended:

Table 2-68: Dehumidifier Default Energy Savings

Capacity Range (pints/day)	Default Capacity (pints/day)	Federal Standard (kWh/yr)	ENERGY STAR (kWh/yr)	ΔkWh
≤ 35	35	~~686~~ 834	~~500~~ 609	~~186~~ 225
> 35 ≤ 45	45	~~905~~ 965	~~733~~ 782	~~172~~ 183
>45 ≤ 54	54	~~988~~ 1,086	~~854~~ 939	~~134~~ 147
>54 < 75	74	~~1,211~~ 1,400	~~1,113~~ 1,287	~~98~~ 114
75 ≤ 185	130	~~1,660~~ 1,673	~~1,482~~ 1,493	~~178~~ 179

- The $DSav_{DH}$ deemed value has not been updated to represent the new peak demand period. This should be reviewed and updated. A load shape for dehumidifiers should be used from the Building America Benchmarks database for PA cities. These can be located at the following web address and include load shapes for several residential end-uses that can be used to update CFs in the TRM:
http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip

- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimate. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the $DSav_{DH}$ variable.

2.28 ENERGY STAR Room Air Conditioners

Introduction

Comments:

- Edit / Grammar: Delete the crossed out word and add the bolded and underlined word to the following sentence: "This measure relates to the purchase and installation of a room air conditioner meeting ENERGY STAR ~~criterion~~ **criteria**".

2.28.2 Definition of Terms

- $DSav_{RAC}$ and CF each list references, yet no details are provided about the specific inputs that went into those references. Consider adding more details for completeness.
- In reference to the source for CF, this CF might be slightly high for room ACs. For Con Edison in NY, PECO engaged a third party to conduct a thorough RAC metering study and found a CF of 0.30 for RACs installed in medium density areas (i.e. outside NYC). This low CF is attributed to the fact that 50% of RACs in the program are installed in bedrooms and only run at non-coincident times. The 0.30 CF was almost exactly 50% of the previous Con Edison value. Consider using a factor to translate CAC CF to RAC CF. Further, the CF should be based on the new peak demand period. The CF for Room AC Retirement and ENERGY STAR Room Air Conditioners should both be updated accordingly.
- The $EFLH_{RAC}$ in Table 2-72 should be updated to be based on the $EFLH_{cool}$ values in Section 2.1 Electric HVAC which were based on REM/Rate modeling of PA homes. Alternatively, the measure should also include using the EDC specific alternate EFLH from Tables 2-2 and 2-3 in Section 2.1 Electric HVAC to derive the $EFLH_{RAC}$.

2.29 ENERGY STAR Lighting

Comments:

- PECO supports the significant updates to this protocol for the 2014 TRM. Given the significance of these updates, PECO intends to base PY5 verified savings for CFL measures on the updated protocol, including the recommended updates given below.
- We recommend combining the ENERGY STAR Lighting and ENERGY STAR LED protocols into one common protocol. The US DOE has released a final Version 1.0 ENERGY STAR Lamps Specification on August 28, 2013 which will replace the previous ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps V1.4 specifications on September 30, 2014[8]. As the algorithms are exactly the same and they are both residential lighting measures, it makes sense to combine them into one overall residential lighting protocol and

[8] See ENERGY STAR website for details at: http://www.energystar.gov/products/specs/node/273

provide LED and CFL specific tables. We further recommend that the protocols be updated to the new standard given that it will be the governing document for a majority of the PY6 program year (June 1, 2014 through May 31, 2015). The following comments are made assuming the protocols remain separate.

- Consider adding the following paragraph from the ENERGY STAR LEDs section, since it should apply equally:

  For upstream buy-down, retail (time of sale), or efficiency kit programs, baseline wattages can be determined using the tables included in this protocol below. For direct install programs, wattage of the existing lamp removed may be used in lieu of the tables below.

- We recommend the introductory language be updated as follows and a new sub-section 2.29.1 Eligibility be added for consistency with the rest of the TRM and to provide further clarity for the measures.

  2.29 ENERGY STAR Lighting

  ~~2.29.1 Algorithms~~

  Savings from installation of screw-in ENERGY STAR CFLs (general service and specialty bulbs), ENERGY STAR fluorescent torchieres, ENERGY STAR indoor fluorescent fixtures, ~~and~~ ENERGY STAR outdoor fluorescent fixtures, and a Ceiling Fan with ENERGY STAR fluorescent light fixture are based on a straightforward algorithm that calculates the difference between ~~existing~~ baseline and new wattage, and uses the average daily hours of usage for the lighting unit being replaced. An "in-service" rate is used to reflect the fact that not all lighting products purchased are actually installed immediately.

  2.29.1 Eligibility

  Definition of Efficient Equipment

  In order for this measure protocol to apply, the high-efficiency equipment must be a screw-in ENERGY STAR CFLs (general service or specialty bulb), ENERGY STAR fluorescent torchiere, ENERGY STAR indoor fluorescent fixture, ENERGY STAR outdoor fluorescent fixture, or a Ceiling Fan with ENERGY STAR fluorescent light fixture.

  Definition of Baseline Equipment

  The baseline equipment is assumed to be a socket, fixture, torchiere, or ceiling fan with a standard general service incandescent light bulb(s).

  An adjustment to the baseline wattage for general service screw-in CFLs and some specialty CFLs is ~~also~~ made to account for the Energy Independence and Security Act of 2007 (EISA 2007), which requires that all general service lamps and some specialty lamps between 40 W and 100 W meet minimum efficiency standards in terms of amount of light delivered per unit of energy consumed. The standard is phased in over two years, between January 1, 2012 and January 1, 2014. This adjustment affects ENERGY STAR CFLs, and may affect ENERGY STAR Fluorescent Torchieres, ENERGY STAR Indoor Fluorescent Fixtures, ENERGY STAR Outdoor Fluorescent Fixtures, and a Ceiling Fan with ENERGY STAR ~~Ceiling Fans~~ fluorescent light fixture where the baseline condition is assumed to be a general service, standard screw-in incandescent light bulb, or specialty, screw-in incandescent lamp.

For upstream buy-down, retail (time of sale), or efficiency kit programs, baseline wattages can be determined using the tables included in this protocol below. For direct install programs, wattage of the existing lamp removed by the program may be used in lieu of the tables below.

2.29.2 Algorithms

The general form of the equation for the ENERGY STAR or other residential high-efficiency lighting energy savings algorithm is:

Total Annual Savings = Number of Units X Annual Savings per Unit

ENERGY STAR CFL Bulbs (screw-in general service and specialty bulbs, e.g. EISA non-exempt and exempt bulbs):

2.29.1 Algorithms

Comments:

- The Ceiling Fan algorithms for energy and demand include the Interactive Effects component as: $(1\text{-}IE_{kWh})$ and $(1\text{-}IE_{kW})$. These should instead be corrected to: $(1+IE_{kWh})$ and $(1+IE_{kW})$.
- Each pair of energy and demand algorithms by bulb type currently contain a "/1000" conversion factor from watts to kilowatts. However, this term immediately follows the delta watts section in the energy algorithms and is placed later in the demand algorithms. For consistency and clarity it should immediately follow the delta watts section in all algorithms.

2.29.2 Definition of Terms

Comments:

- The definition of $Watts_{base}$ lists the wrong table. It should be corrected to reference Table 2-74 and 2-75.
- The input in the Value cell for $Watts_{base}$ should be updated to include an option for direct install programs where the actual removed wattage is known. Also, the Source should be updated to include both table 2-74 and 2-75. We recommend the following updates:

Table 8. Recommended updates to Table 2-73 in the 2014 TRM.

Component	Type	Value	Sources
$Watts_{base}$	Variable	Upstream retail and giveaway programs: See Tables 2-74 and 2-75	Table 2-74 and Table 2-75
		Direct install programs: EDC Data Gathering	Data Gathering

- The note for Source #2 from Table 2-73 explains the ISR of 97% is based on discounting future savings back to the current program year. What is the discount rate underlying this calculation?
- The ISRcfl is shown at 96%, but the reference says it should be 97%. We further express disagreement with the concept of "discounting" future energy savings to a present value. A kWh is not like money in which 1 kWh in the future is measured at less than 1 kWh today.

There may be a lower value of that kWh, but the kWh itself is fundamentally the same. This is analogous to saying one mile of road in the future is anything less than one mile of road today. The difference in value can be accounted for in the TRC calculations, however, the EDCs should be given credit towards compliance for the energy savings achieved, regardless of whether it happens today or in the future. Thus, we recommend the ISR_{CFL} be set at 99% as the California lighting study found.

- We recommend adding a separate $ISR_{CFL,DI}$ 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. An evaluation of PECO's PY4 Low-Income Energy Efficiency Program (LEEP) included 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.
- 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 CF be clearly identified as a "default" value rather than a "deemed" value and "or EDC Data Gathering" should be added to the Value cell in table 2-73 to allow EDC specific CF's to be developed. PECO 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. (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.) PECO's consultant, Navigant, plans to use this CF for establishing verified savings from PECO's residential lighting measures during all of Phase II including PY5 given acknowledgment by the SWE of an error in the CF in the 2013 TRM.
- Currently there is a footnote on the ISRcfl figure saying that the value can be updated if evaluation findings reveal a value that differs from the default. This same comment can instead be applied more broadly to all of Table 2-73, or at a minimum, applied specifically to the CF value and IE factors as well.
- The text notes that "In the absence of EDC data gathering, the default values for Energy and Demand HVAC Interactive Effects are in Table 2-76 below". We recommend preceding this with a note in Table 2-73 in the Value cell for IE_{kWh} and IE_{kW} saying "Data Gathering, or see Table 2-76".
- We recommend Table 2-76 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[9], 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 Table 2-76 be updated as follows:

Table 9. Updates for Table 2-76 in the 2014 TRM.

EDC	IE_{kWh}	IE_{kW}
Duquesne	8%	13%
FE (MetEd)	-8%	13%
FE (Penn Elec)	1%	10%
FE (Penn Power)	0%	20%
FE (WPP)	-2%	30%
PPL	-6%	12%
PECO[10]	~~9%~~1%	~~14%~~22.8%

- Formatting: Table 2-73 lists Source #6 for the Interactive Effects Factors, but the GDS simulation modeling down below the table is incorrectly listed as Source #4.
- Add 1-2 sentences introducing the Delta Watts tables, or just move Table 2-74 below, rather than above, the text that begins to describe the protocol for determining base wattage.
- 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, the directions to determine $Watts_{base}$ are unclear and have led to some confusion among PECO's ICSPs. Also, the Table 2-75 is incomplete in reference to the various types of ENERGY STAR specialty bulbs available and the appropriate baseline wattages. There are multiple wattage ranges for each type of specialty bulb, however, Table 2-75 assumes a single baseline wattage rather than the appropriate baseline wattage as determined by lumen output. We recommend the directions to use Table 2-74 be moved prior to the table, and the entire section be updated as follows:

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[9] 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

[10] 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.

EISA Non-Exempt[11] General Service Lamp (GSL) CFLs and LEDs

To determine the $Watts_{Base}$ for non-exempt GSLs, follow these steps:

1. *Identify the ENERGY STAR CFL or LED screw-in lamp, Torchiere, Indoor Fixture or Outdoor Fixture's rated lumen output*
2. *In Table 2-74, find the lumen range into which the lamp falls (see columns (a) and (b).*
3. *Find the baseline wattage ($Watts_{Base}$) in column (d). Values in column (c) are used for reference of the pre-EISA incandescent wattage, but are no longer a baseline option for the 2014 TRM as can be seen by the Effective dates listed under column (e).*

Table 2-74. EISA Non-exempt General Service Screw-in CFL and LED Baseline Wattage by Lumen Output[12,13]

Lower Lumen Range (a)	Upper Lumen Range (b)	Incandescent Equivalent Pre-EISA 2007 ($Watts_{Base}$) (c)	Incandescent Equivalent Post-EISA 2007 ($Watts_{Base}$) (d)	Post – EISA 2007 Effective date (e)
310	749	40	29	2014 TRM
750	1049	60	43	2014 TRM
1050	1489	75	53	2013 TRM
1490	2600	100	72	2012 TRM

[11] The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of *Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET.*

[12] EISA non-exempt GSLs include the following lamp types: General Service Screw-in CFL (A-lamp), Dimmable Twist, Globe (less than 5" in diameter and > 749 lumens), candle (shapes B, BA, CA > 749 lumens), Candelabra Base Lamps (>1049 lumens), Intermediate Base Lamps (>749 lumens).

[13] GSLs with lumen outputs outside the given ranges are EISA exempt bulbs and should follow the baseline methodology for exempt bulbs.

~~Table 2-74: Baseline Wattage by Lumen Output for General Service Lamps (GSL)~~[14]

~~Minimum Lumens (a)~~	~~Maximum Lumens (b)~~	~~Incandescent Equivalent $Watts_{Base}$ (Pre-EISA 2007) (c)~~	~~$Watts_{Base}$ (Post-EISA 2007) (d)~~	~~Post-EISA 2007 Effective Date (e)~~
~~1490~~	~~2600~~	~~100~~	~~72~~	~~2012 TRM~~
~~1050~~	~~1489~~	~~75~~	~~53~~	~~2013 TRM~~
~~750~~	~~1049~~	~~60~~	~~43~~	~~2014 TRM~~
~~310~~	~~749~~	~~40~~	~~29~~	~~2014 TRM~~

~~To determine the $Watts_{Base}$ for GSLs, follow these steps:~~

4. ~~Identify the ENERGY STAR CFL, Torchiere, Indoor Fixture or Outdoor Fixture's rated lumen output~~
5. ~~In Table 2-74, find the lumen range into which the lamp falls (see columns (a) and (b).~~
6. ~~Find the baseline wattage ($Watts_{Base}$) in column (c) or column (d). Values in column (c) are used for $Watts_{Base}$ until the TRM listed under column (e) is effective. Afterwards, values in column (d) are used for $Watts_{Base}$~~

~~For EISA exempt[15] GSL bulbs, use the WattsBase value in column (c) in Table 2-74, above. Commonly used EISA exempt bulbs include 3-way bulbs, globes with ≥5" diameter or ≤749 lumens, and candelabra base bulbs with ≤1049 lumens. See EISA legislation for full list of exemptions.~~

~~Reflector (directional) bulbs fall under legislation different from GSL bulbs. For these bulbs, EDCs can use the manufacturer-rated equivalent wattage as printed on the retail packaging, or use the default WattsBase (column (c)) in Table 2-75 below.~~

EISA Exempt[16] General Service Lamp (GSL) and Specialty CFLs and LEDs

To determine the $Watts_{Base}$ for EISA-exempt GSLs and Specialty bulbs, follow these steps:

~~1.~~ Identify the CFL or LED lamp type and rated lumen output

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[14] ~~United States Department of Energy. Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET. http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/general_service_incandescent_factsheet.pdf~~

[15] ~~The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET.~~

[16] The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of *Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET.*

2. In Table 2-75, find the lamp type and lumen range into which the lamp falls (see columns (a), (c) and (d).

3. Find the baseline wattage ($Watts_{Base}$) in column (c).

Table 2-75. Default Baseline Wattage for Reflector Bulbs[17]

Bulb Type (a)	Incandescent Equivalent (Pre-EISA) (b)	$Watts_{Base}$ (Post-EISA) (c)
PAR20	50	35
PAR30	50	35
R20	50	45
PAR38	60	55
BR30	65	EXEMPT
BR40	65	EXEMPT
ER40	65	EXEMPT
BR40	75	65
BR30	75	65
PAR30	75	55
PAR38	75	55
R30	75	65
R40	75	65
PAR38	90	70
PAR38	120	70
R20	≤45	EXEMPT
BR30	≤50	EXEMPT
BR40	≤50	EXEMPT
ER30	≤50	EXEMPT
ER40	≤50	EXEMPT

[17] Based on manufacturer recommended replacements for EISA affected lamps. Manufacturer ratings may differ from the list above, in which case EDCs should default to the manufacturer equivalent rating.

Table 2-75. EISA Non-exempt General Service and Specialty Screw-in CFL and LED Baseline Wattage by Lumen Output[18,19]

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[20]	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

[18] Based ENERGY STAR Lamps V1.0 Final Specification released August 28, 2013 and effective September 30, 2014, which will replace the previous ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps V1.4 specifications. http://www.energystar.gov/products/specs/sites/products/files/ENERGY%20STAR%20Lamps%20V1%200%20Final%20Specification.pdf

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

[20] 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

- Although the modified Table 2-75 above is a long table, it is much more complete than the table 2-75 provided in the draft TRM. To avoid continued confusion among the ICSPs, we strongly suggest including the comprehensive table provided above.
- We recommend a sub-section heading "2.29.4 Default Savings" be added after the Table 2-76.
- Tables 2-77 and 2-78 need updating to reflect savings modifications for all EDCs using the new IE's and CF. It may be better to just provide the default $Watts_{base}$ and $Watts_{ee}$ for these fixtures and let the EDCs calculate the savings using the EDC specific IE's and CF. If they are kept, we recommend providing savings for a range of fixture bulb combinations such as 2-13W CFLs, 3-13W CFLs, 1-27W CFLs, etc. Many fixtures have more than one integral bulb.

2.32 Home Performance with ENERGY STAR

Introduction

<u>Comments:</u>

- Building simulation models typically only calculate non-coincident peak demand savings. A peak demand savings algorithm needs to be specified.

2.32.1 - 2.32.8 HomeCheck Software Example

<u>Comments:</u>

- While a short, generalized summary of the workings of building energy simulation software could be helpful to some users, this is not necessary information to be detailed in a TRM protocol. This section conveys opinions of CSG and reads like an exhaustive brochure for the company's proprietary software. Furthermore, very few references can be found online about this software, which is not even mentioned on CSG's website. It is not clear that this is still commercially available software. Consider replacing entire section with a short, general summary about simulation software, or simply provide an external link for additional information.

2.33 ENERGY STAR Televisions

2.33.2 Definition of Terms

<u>Comments:</u>

- It is unclear if the referenced CF of 0.28 is based on the new peak demand period. The CF should be reviewed and adjustments made if necessary. The load shape for Home Entertainment Appliances should be used from the Building America Benchmarks database for PA cities. These can be located here and include load shapes for several residential end-uses that can be used to update CFs in the TRM: http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip

2.34 ENERGY STAR Office Equipment

2.34.2 Definition of Terms

<u>Comments:</u>

- It is unclear if the referenced DSav variables are based on the new peak demand period. The deemed values should be reviewed and adjustments made if necessary. The load shape for Home Entertainment Appliances should be used from the Building America Benchmarks database for PA cities. These can be located here and include load shapes for several residential end-uses that can be used to update CFs in the TRM: http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip
- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimates. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the DSav variables.

- A new sub-section heading "2.34.3 Default Savings" should be added prior to Table 2-85.
- The source #9 at the end of the protocol is not referenced anywhere. A cross reference to the source should be added and the source number updated to reflect the correct number of sources.

2.35 ENERGY STAR LEDs

Comments:

- PECO supports the significant updates to this protocol for the 2014 TRM. Given the significance of these updates, PECO intends to base PY5 verified savings for LED measures on the updated protocol, including the recommended updates given below.
- We recommend combining the ENERGY STAR Lighting and ENERGY STAR LED protocols into one common protocol. The US DOE has released a final Version 1.0 ENERGY STAR Lamps Specification on August 28, 2013 which will replace the previous ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps V1.4 specifications on September 30, 2014[21]. As the algorithms are exactly the same and they are both residential lighting measures, it makes sense to combine them into one overall residential lighting protocol and provide LED and CFL specific tables. We further recommend that the protocols be updated to the new standard given that it will be the governing document for a majority of the PY6 program year (June 1, 2014 through May 31, 2015). The following comments are made assuming the protocols remain separate.
- See additional comments for section 2.29 ENERGY STAR Lighting

2.35.1 *Eligibility Requirements*

Comments:

- This protocol should be updated to reference the new final Version 1.0 ENERGY STAR Lamp Specification as noted above. Footnote 177 should be updated to reflect this.

2.35.2 *Algorithms*

Comments:

- Consider renaming $Hours_{LED}$ to LED_{Hours} to be more consistent with the algorithm and terminology in section 2.29 ENERGY STAR Lighting.
- The energy and demand algorithms currently contain a "/1000" conversion factor from watts to kilowatts. However, this term immediately follows the delta watts section in the demand algorithm and is placed later in the energy algorithm. For consistency and clarity it should immediately follow the delta watts section in both algorithms.
- In sub-section 2.35.3 Definition of Terms, the variables IE_{kWh} and IE_{kW} were correctly added to the table and definitions, however, the algorithm was not updated to include these terms. The algorithms should be updated to include the terms IE_{kWh} and IE_{kW} as follows:

Energy Impact (kWh) $= ((Watts_{Base} - Watts_{LED}) / 1000)$ ***** $($~~$Hours_{LED}$~~$LED_{Hours} * 365)$ ~~/ 1000)~~ ***** $(1 + IE_{kWh}) * ISR_{LED}$

Peak Demand Impact (kW) $= ((Watts_{Base} - Watts_{LED}) / 1000) * (1 + IE_{kW}) * CF * ISR_{LED}$

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[21] See ENERGY STAR website for details at: http://www.energystar.gov/products/specs/node/273

2.35.2 Definition of Terms

<u>*Comments:*</u>

- The input in the Value cell for $Watts_{base}$ should be updated to include an option for direct install programs where the actual removed wattage is known. Also, the Source should be updated to include both table 2-87 and 2-88. We recommend the following updates:

Table 10. Recommended updates to Table 2-87 in the 2014 TRM.

Component	Type	Value	Sources
$Watts_{base}$	Variable	Upstream retail and giveaway programs: See Tables 2-87 and 2-88	Table 2-87 and Table 2-88
		Direct install programs: EDC Data Gathering	Data Gathering

- 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 CF be clearly identified as a "default" value rather than a "deemed" value and "or EDC Data Gathering" should be added to the Value cell in table 2-73 to allow EDC specific CF's to be developed. PECO 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. (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.) Navigant plans to use this CF for establishing verified savings from PECO's residential lighting measures during all of Phase II including PY5 given acknowledgment by the SWE of an error in the CF in the 2013 TRM.
- The ISR_{LED} of 95% cites the Mid-Atlantic TRM as a source. Given the protocol in the ENERGY STAR Lighting section of applying future installations to the recommended ISR value, this should also be applied to LEDs. It is surprising that an ISR for LEDs would be less than that for CFLs given their significant expense. We recommend the default ISR_{LED} be updated to match the ISR_{CFL} at a minimum.
- We recommend adding a separate $ISR_{LED,DI}$ 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 LEDs 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 LEDs are initially installed and evaluation finds some to be subsequently removed by the customer with no plans to re-install. PECO's evaluation of its PY4 Low-Income Energy Efficiency Program (LEEP) included site visits to verify the appropriate ISR for direct install CFLs. The findings from the program yielded an ISR_{CFL} of 97.3%. It is reasonable to expect a similar ISR_{LED} for direct install

programs. 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.

- Currently there is a footnote on the ISR_{LED} figure saying that the value can be updated if evaluation findings reveal a value that differs from the default. This same comment can instead be applied more broadly to all of Table 2-86, or at a minimum, applied specifically to the CF value as well.
- The text prior to Table 2-89 notes that "In the absence of EDC data gathering, the default values for Energy and Demand HVAC Interactive Effects are in Table 2-89 below". We recommend preceding this with a note in Table 2-86 saying "Data Gathering, or see Table 2-89"
- Formatting: Table 2-86 lists Source #4 for the Interactive Effects Factors, but there is no source #4. The Source list should be updated to include a Source #4 referencing the GDS simulation modeling. It appears the text for source #4 was inadvertently turned into a sub-section heading 2.35.4. This should be corrected.
- We recommend Table 2-89 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[22], 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 Table 2-89 be updated as follows:

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[22] 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

Table 11. Updates for Table 2-89 in the 2014 TRM.

EDC	IE_{kWh}	IE_{kW}
Duquesne	8%	13%
FE (MetEd)	-8%	13%
FE (Penn Elec)	1%	10%
FE (Penn Power)	0%	20%
FE (WPP)	-2%	30%
PPL	-6%	12%
PECO[23]	~~9%~~1%	~~14%~~22.8%

- 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, the directions to determine $Watts_{base}$ are unclear and have led to some confusion among PECO's ICSPs. Also, the Table 2-88 is incomplete in reference to the various types of ENERGY STAR specialty bulbs available and the appropriate baseline wattages. There are multiple wattage ranges for each type of specialty bulb, however, Table 2-88 assumes a single baseline wattage rather than the appropriate baseline wattage as determined by lumen output. We recommend the directions to use Table 2-87 be moved prior to the table, and the entire section be updated as follows:

EISA Non-Exempt[24] General Service Lamp (GSL) CFLs and LEDs

To determine the $Watts_{Base}$ for non-exempt GSLs, follow these steps:

7. *Identify the ENERGY STAR CFL or LED screw-in lamp, Torchiere, Indoor Fixture or Outdoor Fixture's rated lumen output*
8. *In Table 2-87, find the lumen range into which the lamp falls (see columns (a) and (b).*
9. *Find the baseline wattage ($Watts_{Base}$) in column (d). Values in column (c) are used for reference of the pre-EISA incandescent wattage, but are no longer a baseline option for the 2014 TRM as can be seen by the Effective dates listed under column (e).*

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[23] 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.

[24] The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of *Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET*.

Table 2-87. EISA Non-exempt General Service Screw-in CFL and LED Baseline Wattage by Lumen Output[25,26]

Lower Lumen Range (a)	Upper Lumen Range (b)	Incandescent Equivalent Pre-EISA 2007 (Watts$_{Base}$) (c)	Incandescent Equivalent Post-EISA 2007 (Watts$_{Base}$) (d)	Post – EISA 2007 Effective date (e)
310	749	40	29	2014 TRM
750	1049	60	43	2014 TRM
1050	1489	75	53	2013 TRM
1490	2600	100	72	2012 TRM

~~*Table 2-87: Baseline Wattage by Lumen Output for General Service Lamps (GSL)*[37]~~

~~Minimum Lumens (a)~~	~~Maximum Lumens (b)~~	~~Incandescent Equivalent Watts$_{Base}$ (Pre-EISA 2007) (c)~~	~~Watts$_{Base}$ (Post-EISA 2007) (d)~~	~~Post-EISA 2007 Effective Date (e)~~
~~1490~~	~~2600~~	~~100~~	~~72~~	~~2012 TRM~~
~~1050~~	~~1489~~	~~75~~	~~53~~	~~2013 TRM~~
~~750~~	~~1049~~	~~60~~	~~43~~	~~2014 TRM~~
~~310~~	~~749~~	~~40~~	~~29~~	~~2014 TRM~~

[25] EISA non-exempt GSLs include the following lamp types: General Service Screw-in CFL (A-lamp), Dimmable Twist, Globe (less than 5" in diameter and > 749 lumens), candle (shapes B, BA, CA > 749 lumens), Candelabra Base Lamps (>1049 lumens), Intermediate Base Lamps (>749 lumens).

[26] GSLs with lumen outputs outside the given ranges are EISA exempt bulbs and should follow the baseline methodology for exempt bulbs.

~~[37] United States Department of Energy. Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET. http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/general_service_incandescent_factsheet.pdf~~

~~To determine the Watts$_{Base}$ for GSLs, follow these steps:~~

1. ~~*Identify the ENERGY STAR LED's rated lumen output*~~
2. ~~*In Table 2-87, find the lumen range into which the lamp falls (see columns (a) and (b).*~~
3. ~~*Find the baseline wattage (Watts$_{Base}$) in column (c) or column (d). Values in column (c) are used for Watts$_{Base}$ until the TRM listed under column (e) is effective. Afterwards, values in column (d) are used for Watts$_{Base}$.*~~

~~*For EISA exempt[28] GSL bulbs, use the WattsBase value in column (c) in Table 2-87, above. Commonly used EISA exempt bulbs include 3-way bulbs, globes with ≥5" diameter or ≤749 lumens, and candelabra base bulbs with ≤1049 lumens. See EISA legislation for full list of exemptions.*~~

~~*Reflector (directional) bulbs fall under legislation different from GSL bulbs. For these bulbs, EDCs can use the manufacturer rated equivalent wattage as printed on the retail packaging, or use the default WattsBase (column (c)) in Table 2-88 below.*~~

EISA Exempt[29] General Service Lamp (GSL) and Specialty CFLs and LEDs

To determine the Watts$_{Base}$ for EISA-exempt GSLs and Specialty bulbs, follow these steps:

1. *Identify the CFL or LED lamp type and rated lumen output*
2. *In Table 2-88, find the lamp type and lumen range into which the lamp falls (see columns (a), (c) and (d).*
3. *Find the baseline wattage (Watts$_{Base}$) in column (c).*

~~*Table 2-88. Default Baseline Wattage for Reflector Bulbs*~~[30]

~~Bulb Type (a)~~	~~Incandescent Equivalent (Pre-EISA) (b)~~	~~Watts$_{Base}$ (Post-EISA) (c)~~
~~PAR20~~	~~50~~	~~35~~
~~PAR30~~	~~50~~	~~35~~
~~R20~~	~~50~~	~~45~~
~~PAR38~~	~~60~~	~~55~~
~~BR30~~	~~65~~	~~EXEMPT~~

[28] ~~The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of *Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET*.~~

[29] The EISA 2007 standards apply to general service incandescent lamps. A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of *Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET*.

[30] ~~Based on manufacturer recommended replacements for EISA affected lamps. Manufacturer ratings may differ from the list above, in which case EDCs should default to the manufacturer equivalent rating.~~

~~BR40~~	~~65~~	~~EXEMPT~~
~~ER40~~	~~65~~	~~EXEMPT~~
~~BR40~~	~~75~~	~~65~~
~~BR30~~	~~75~~	~~65~~
~~PAR30~~	~~75~~	~~55~~
~~PAR38~~	~~75~~	~~55~~
~~R30~~	~~75~~	~~65~~
~~R40~~	~~75~~	~~65~~
~~PAR38~~	~~90~~	~~70~~
~~PAR38~~	~~120~~	~~70~~
~~R20~~	~~≤45~~	~~EXEMPT~~
~~BR30~~	~~≤50~~	~~EXEMPT~~
~~BR40~~	~~≤50~~	~~EXEMPT~~
~~ER30~~	~~≤50~~	~~EXEMPT~~
~~ER40~~	~~≤50~~	~~EXEMPT~~

Table 2-88. EISA Non-exempt General Service and Specialty Screw-in CFL and LED Baseline Wattage by Lumen Output[31,32]

Lamp Type (a)	***Rated Wattage of the Referenced Incandescent Lamp (Watts[illegible]) (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

[31] Based ENERGY STAR Lamps V1.0 Final Specification released August 28, 2013 and effective September 30, 2014, which will replace the previous ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps V1.4 specifications. http://www.energystar.gov/products/specs/sites/products/files/ENERGY%20STAR%20Lamps%20V1%200%20Final%20Specification.pdf

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

Lamp Type (a)	*Rated Wattage of the Referenced Incandescent Lamp (Watts) (b)*	*Minimum Lower Lumen Range (c)*	*Upper Lumen Range (d)*
Covered A-Lamp[33]	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
	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

[33] 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)*
	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

- Although the modified Table 2-88 above is a long table, it is much more complete than the table 2-88 provided in the draft TRM. To avoid continued confusion among the ICSPs, we strongly suggest including the comprehensive table provided above.

2.36 Residential Occupancy Sensors

2.36.1 Algorithms

<u>*Comments:*</u>

- The algorithm for this measure should be updated to include the interactive effects factor IE_{kWh} similar to sections 2.29 ENERGY STAR Lighting and 2.35 ENERGY STAR LEDs. See the notes for those measures for updates to the draft IE_{kWh} values.
- Given that this is a lighting measure, we recommend the algorithm be updated to use similar variable terminology as the other lighting protocols 2.29 and 2.35. We recommend the follow updates to the algorithm:

$$\Delta kWh = \sout{kW_{controlled}}(Watts_{controlled} / 1000)\ \sout{x\ 365}\ x\ ((RH_{old} - RH_{new}) * 365) * (1 + IE_{kWh})$$

2.38 Water Heater Tank Wrap

2.39.2 Definition of Terms

<u>*Comments:*</u>

- A new definition was added for R value, however, it would be more helpful to include a text description of the R-value and move the algorithm for converting R-value to U-value in the definition for U-value as "(U = 1/R)"

2.39 Pool Pump Load Shifting

2.39.3 Definition of Terms

<u>*Comments:*</u>

- The definitions and values for CF_{pre} and CF_{post} should be updated to reflect the new peak demand period.

2.39.5 *Evaluation Protocol*

__*Comments:*__

- The recommended verification should refer to an average daily load shape rather than "run time." Load shifting verification requires estimates of coincidence rather than hours of operation per day.

2.40 Variable Speed Pool Pumps (with Load Shifting Option)

2.40.1 *Eligibility*

__*Comments:*__

- Clarify whether this measure is a retrofit measure, a replace-on-burnout measure or some blend of the two. The appropriate baseline demand is dependent on this clarification.
- The eligibility criteria should be updated to reflect the new peak demand period.

2.40.2 *Algorithms*

__*Comments:*__

- The energy and demand savings algorithms should account for pumps operating in several modes. Variable speed pumps usually operate at two different modes (cleaning and filtration) in a given day, and some pumps may even run at three settings in a single day. kW_{vfd} and kWh_{vfd} should be broken into $kW_{vfd\_cleaning}$ and $kW_{vfd\_filtration}$, and $kWh_{vfd\_cleaning}$ and $kWh_{vfd\_filtration}$, where the demand in cleaning mode is higher.
- The text for CF needs to be updated to reflect the new peak demand period.

2.40.3 *Definition of Terms*

__*Comments:*__

- The definitions and values for CF_{ss} and CF_{VFD} should be updated to reflect the new peak demand period.

2.40.4 *Deemed Savings*

__*Comments:*__

- The heading of this sub-section should be changed to "Default Savings" as the measure has opened up several of the variables.

2.40.6 *Evaluation Protocol*

__*Comments:*__

- Working with pool service professionals, in addition to surveying customers, to obtain pump settings may lead to more accurate data as well as more data points. Some customers may not be comfortable operating their pump controls. Working with pool service professionals enables a verification team to capture these customers' data.
- Tracking variable speed pump settings, such as the demand and time of operation for the various modes, can expedite verification activities.

2.41 Duct Insulation and Sealing

Introduction

Comments:

- Overall comment: This section provides no guidance on how to evaluate savings from duct insulation in the case of measuring leakage with Method 1: modified blower door subtraction (preferred method). The only scenario in which insulation is considered in this section is by using the look-up table for Method 2: evaluation of distribution efficiency. Consider adding guidance for insulation evaluation to Method 1, or changing the scope/title of the measure to include duct sealing only.
- Source revision: The link to the Energy Conservatory Blower Door Manual does not work. The new address is: http://www.energyconservatory.com/sites/default/files/documents/mod_3-4_dg700_-_new_flow_rings_-_cr_-_tpt_-_no_fr_switch_manual_ce_0.pdf
- Grammatical error: Revise the first sentence of the second paragraph begins "Two methodologies for estimating the savings *associate from* sealing the ducts" change "*associate from*" to "associated with".

2.41.3 Definition of Terms

Comments:

- Definition clarification: More clarification is needed on the definition of the SLF and RLF terms. Consider writing them as in the Illinois 2013 TRM. RLF is currently defined as "Portion of % leaks sealed located in Return ducts" which is not correct. It is actually 50% of the % leaks sealed in the Return ducts. Notes 3 and 4 should be referenced here to add further explanation.

SLF	= Supply Loss Factor = % leaks sealed located in Supply ducts * 1 Default = 0.5
RLF	= Return Loss Factor = % leaks sealed located in Return ducts * 0.5 Default = 0.25

- Source revision: Note 1 references Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf The updated link should be: http://www.neep.org/Assets/uploads/files/emv/emv-library/measure_life_GDS%5B1%5D.pdf
- Source revision: Note 4 references "Appendix E Estimating HVAC System Loss From Duct Airtightness Measurements" from http://www.energyconservatory.com/download/dbmanual.pdf Assumes 50% of leaks are in supply ducts. We are unable to locate this Appendix and the associated information because the link is incorrect and it appears the manual has been updated
- Formatting revision: There are two sources listed as number 7. Change the last source to 8.

2.42 Water Heater Temperature Setback

Introduction

__*Comments:*__

- Given that measure has several open variables, the Unit Energy Savings and Unit Peak Demand Reduction values should be removed and replaced with "Variable".

2.42.2 Algorithms

__*Comments:*__

- Algorithm is unclear on where factor of 0.6 comes from. Text should clarify what each portion of the algorithm is meant to calculate. Is there a source for the algorithm?
- The algorithm should be re-written. The total hot water consumption does not change as a result of the measure, but rather, only the passive tank losses. The user of the faucet does not generally change the mixed water temperature that they use out of the faucet, therefore, they use the same number of BTU/day to heat the water consumed. The savings from this measure come from reduced heat loss from the tank to the surroundings by turning the tank temperature down. The algorithm would be more reasonable if it used a similar algorithm as section 2.39 Water Heater Tank Wrap as follows:

$$\Delta kWh = \left[\frac{U * A * HOU}{\left(3412\frac{Btu}{kWh}\right) * \eta_{elec}}\right] * (T_{pre-set} - T_{post-set})$$

$$\Delta kW = \frac{\Delta kWh}{HOU} * CF$$

Where:

U = Overall heat transfer coefficient of water heater (Btu/Hr-F-ft^2) (assume typical R-value = 12 (Hr-F-ft^2/Btu), then U = 1/R = 0.0833)

A = Surface area of storage tank (square feet) (based on tank capacity, assume 50 gal default, A = 24.99 ft^2)

η_{Elec} *= Thermal efficiency of electric heater element = 98%*

$T_{pre-set}$ *= Water heater setpoint pre-adjustment (F) (default = 130F)*

$T_{post-set}$ *= Water heater setpoint post-adjustment (F) (default = 120F)*

HOU = 8760

CF = 1.0 as the tank losses occur year round

Using the above defaults, ΔkWh = 54.5 kWh, and ΔkW = 0.0062 kW.

- The text should be updated to reflect the new peak demand period. (Comment assumes algorithm is not updated as recommended)
- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy

period was being used. This factor should be revised using the provided water heater load profile in Figure 2-11 and the new peak period, and the section text updated accordingly. (Comment assumes algorithm is not updated as recommended)

2.42.3 Definition of Terms

Comments:

- Protocol should allow EDCs to substitute actual pre- and post-turndown temperature setpoints. It is possible that some customers will not want to turn the setpoint all the way down to 120F. Since this is usually a direct-install measure, contractors often record this information.
- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 2-11 and the new peak period, and the section text updated accordingly. (Comment assumes algorithm is not updated as recommended)

2.42.5 Deemed Savings

Comments:

- The heading of this sub-section should be changed to "Default Savings" as the measure has several open variables.
- Default values should be updated based on above recommendations.

2.42.6 Evaluation Protocol

Comments:

- Given that the protocol has open variables, there are no "stipulated" values that evaluation should apply. Evaluation may use defaults or verify temperature setbacks and calculate savings accordingly. The wording of this sub-section should be updated.

2.43 ENERGY STAR Water Coolers

Introduction

Comments:

- Consider adding a summary table about the measure at the beginning of the section, much like other measures throughout the TRM have.
- Add a sub-section 2.43.1 Eligibility

2.43.2 Definition of Terms

Comments:

- The $\dot{D}Sav_{WC}$ deemed value has not been updated to represent the new peak demand period. This should be reviewed and updated. A load shape for water coolers should be used from the Building America Benchmarks database for PA cities. It may require finding an alternative load profile that may be similar to water coolers. These can be located at the following web address and include load shapes for several residential end-uses that can be

used to update CFs in the TRM:
http://www1.eere.energy.gov/buildings/residential/docs/analysis_existing_homes.zip

- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimate. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the DSavwc variable.

Section 3: Commercial and Industrial Measures

3.2 Lighting Equipment Improvements

3.2.2 Algorithms

Comments:

- Clarification of algorithm needed: It does not appear as though the Appendix C controls savings calculation follows page 195 of the TRM with respect to SVG_{EE} and SVG_{base}. Ensure that the definitions in the TRM are as intended, and ensure consistency between the TRM and Appendix C.
- We support the separation of savings calculations between fixture retrofits and control retrofits. However, there are some fixture retrofits that are done on systems that already have controls installed. There is no way to make an adjustment to the HOU in the "all lighting fixture improvements" algorithm. We recommend the algorithms be updated as follows:

$$\Delta kWh = (kW_{base} - kW_{EE}) * HOU * SVG_{base} * (1+IF_{energy})$$

$$\Delta kW_{peak} = (kW_{base} - kW_{EE}) * SVG_{base} * (1+IF_{demand}) * CF$$

3.2.6 Quantifying Annual Hours of Operation

Comments:

- Where reference to "metering" is made, it should be clarified as to the intended purpose. Metering typically refers to recording of power data, but in this context it appears to mean logging of run hours only. The wording of this section should be updated to clarify this distinction as it has been confusing in the past what has been required by the term "metering."
- Building Monitoring System (BMS) data concerns: The allowed methods of quantifying annual hours of operation for connected load savings of 20 kW or more on page 199 mentions building monitoring system (BMS) data as a possible source of information. This section would benefit from additional specificity, as BMS data can include a wide variety of schedules, including HVAC and lighting, and BMS lighting schedules generally only control building area lighting (common areas and exterior), unless a specialized addressable lighting control system is installed. Additionally, care should be used with respect to BMS data, since the programmed schedule may not reflect regular hours-long unscheduled overrides of the lighting system, such as for nightly cleaning in office buildings, and may not reflect how the lights were actually used, but only the times of day the common area lighting is commanded on and off by the BMS.
- Similar cautionary comments apply to the 'Metering' section on the same page, for **Projects with savings of 500,000 kWh or higher.** If BMS data is to be used in lieu of metering, certain conditions should apply. The BMS trends should represent the actual status of the lights (not just the command sent to the lights), and the implementation contractor and evaluation contractor should be required to demonstrate that the BMS system is functioning as expected, prior to relying on the data for evaluation purposes. The BMS data utilized should be specific to the lighting systems, and should be required to be representative of the building areas included in the lighting project.

3.2.7 Calculation Method Description by Building Classification—Prescriptive Lighting Improvements

Comments:

- Clarification: Regarding Tables 3-4 and 3-5 pertaining to savings adjustment factors due to phasing out T12 fixture types in the baseline, the text appears to state that these adjustment factors only take effect on June 1, 2016. We suggest considering including the 2016 start date in the title of the tables, to clarify that they are not yet required in the determination of first year savings. This would prevent inadvertent and unnecessary docking of savings prior to 2016.

3.3 Premium Efficiency Motors

3.3.3 Description of Calculation Method

Comments:

- Hyperlinks not functional: the hyperlink in footnote 237 is an old link, and the link in footnote 238 is not hyperlinked.

3.4 Variable Frequency Drive (VFD) Improvements

3.4.2 Definition of Terms

Comments:

- The CF is based on the CA DEER. This is not an appropriate source for CF as peak demand periods vary by jurisdiction. A proper load shape for HVAC systems in PA should be determined and the CF calculated based on the new peak demand period.

3.5 Variable Frequency Drive (VFD) Improvement for Industrial Air Compressors

Introduction

Comments:

- General: As stated on page 226 of the TRM, compressed air system electrical use is highly variable. As such, additional specificity is appropriate for this measure in order to be used as prescriptive. For example, the assumed range of HP applicable for the referenced stipulated savings factors; the operating PSI assumed; the assumed baseline compressor control type; and typical hours of operation used to derive the stipulated savings factors, actual load factors, and other supporting documentation from recognized industry sources such as the Department of Energy (DOE) and the Compressed Air and Gas Institute (CAGI). If this type of information is not available from the referenced publication, then consider making this a custom measure until the appropriate research can be performed.

3.5.1 Algorithms

Comments:

- The peak demand algorithm includes both a DSF and CF. It is unclear from the original source document whether or not the CF is already included in the DSF or not. We recommend investigating this further to ensure demand savings are not being underreported.

3.6 HVAC Systems

Introduction

Comments:

- General: In the first paragraph which states that this section does not cover water source, ground source, and groundwater source heat pumps, it may be helpful to say that this equipment is covered under the protocol in Section 3.18.

3.6.1 Algorithms

Comments:

- Recommend revising algorithm for ΔkWh such that part load efficiency (IEER) values can be used for larger units. Addendum S to ASHRAE 90.1-2007 updates Tables 6.8.1A and 6.8.1B to include minimum IEER ratings for air, water and evaporatively cooled air conditioners and air cooled heat pumps.[14] Since most units are more efficient at part load capacity, this will allow EDCs to claim the full kWh savings due to high efficiency cooling equipment.

3.6.2 Definition of Terms

Comments:

- Coincidence Factor: The sources of the coincidence factors used to obtain the average 80% HVAC CF are not referenced, and 80% looks high compared with coincidence factors found in the NEEP C&I Unitary HVAC Loadshape Project, for example in the range of 44% to 63% for Mid-Atlantic PJM hours. The existing fixed value of the CF could substantially overstate the coincident demand savings for HVAC measures. The CF is based on an average CF for multiple other jurisdictions. The current source is not appropriate for PA as peak demand periods vary by jurisdiction. A proper load shape for HVAC systems in PA should be determined and the CF calculated based on the new peak demand period.
- Heating EFLH have been reduced from 2,562 hours to 259 hours for Multi-Family (Common Areas) (as well as Hospitals/Health care and Police/Fire Stations). These hours values are very low and are equivalent to the heating systems being oversized by a factor of 5 or more. Verify these modified EFLH are appropriate.

3.7 Electric Chillers

3.7.2 Definition of Terms

Comments:

- The CF is based on an average CF for multiple other jurisdictions. This is not an appropriate source for CF as peak demand periods vary by jurisdiction. A proper load shape for chillers should be determined and the CF calculated based on the new peak demand period.

3.9 High-Efficiency Refrigeration/Freezer Cases

3.9.2 Definition of Terms

Comments:

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[14] ANSI/ASHRAE/IESNA Addenda to ANSI/ASHRAE/IESNA Standard 90.1-2007: 2008 Supplement. ASHRAE, 2009.

- The CF is set at 1.0, however, the reference source #2 is not included in the TRM. A CF of 1.0 appears high for these units as the compressors do cycle as needed. A proper load shape for refrigeration cases should be determined and the CF calculated based on the new peak demand period.

3.12 ENERGY STAR Office Equipment

3.12.2 Definition of Terms

Comments:

- The $DSav_{cw}$ deemed value has not been updated to represent the new peak demand period. The source for CF indicates the CF is already incorporated into DSav. If this is the case, DSav should be updated. A load shape for office electronics should be developed for PA cities.
- A CF of 1.0 is not appropriate. The source note for the CF indicates that the coincidence factor is already embedded in the summer peak demand reduction estimate. If this is the case, the CF should be removed from the algorithm and the source should be listed instead as a note on the $DSav_{cw}$ variable.

3.13 Smart Strip Plug Outlets

3.12.2 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for office electronics should be developed for PA cities and the CF updated using the new peak period.

3.15 High Efficiency Ice Machines

3.15.2 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for ice machines should be developed for PA cities and the CF updated using the new peak period.

3.16 Wall and Ceiling Insulation

3.16.2 Algorithms

Comments:

- Per ASHRAE Handbook, CDD is an unreliable way to estimate cooling savings. They recommend using cooling degree hours as a more reliable method. We suggest the switch to using CDH be considered.

3.16.3 Definition of Terms

Comments:

- Definitions: 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.
- The CF has not been updated to account for the new peak demand period. The reference for EFLH and CF is outdated. This should reference a specific table or chart rather than just referencing a previous version of the TRM which is no longer accurate. The source note should reference Table 3-21 from section 3.6 HVAC Systems for the CF, however, we have also made recommendations that the value from that table be updated.

3.17 Strip Curtains for walk-in Freezers and Coolers

3.17.3 Algorithms

Comments:

- PECO was unable to duplicate the savings that are represented in table 3-8 using the equations and information provided in this section. Either the equation or results need to be adjusted to ensure that the calculations are correct.
- The equation format in this section needs to be adjusted to include all operation symbols. As currently written it is confusing. Assuming a correct formula, we recommend the following edits, however, as stated above, it is unclear whether or not this algorithm is indeed correct.

$$\Delta kWh = 365 \times t_{open} \times (\eta_{new} - \eta_{old}) \times 20 \times C_D \times A \times [[(T_i - T_r)/T_i] \times g \times H]^{0.5} \times (\rho_i \times h_i - \rho_r \times h_r) / (3413 \times COP_{adj})$$

3.17.3 Definition of Terms

Comments:

- PECO was unable to duplicate the savings that are represented in table 3-8 using the equations and information provided in this section. Either the equation or results need to be adjusted to ensure that the calculations are correct.
- The term ETD is not used in this measure and should be removed or added to the equations where appropriate.
- Saving for warehouses reported in table 3-8 is much higher than savings reported in the EM&V report that is used several times in this measure (http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf). Deemed savings for Refrigerated Warehouse in the TRM range from 254-728 whereas the savings in the EM&V report are 177. Savings difference in the TRM should be justified or adjusted to match measured data.

3.18 Water Source and Geothermal Heat Pumps

3.18.3 Definition of Terms

Comments:

- Definitions: Regarding the definitions of EER_{base} and EER_{ee}, in some cases covered by the protocol, such as for existing system replacement, the heat pump EER variation with working fluid temperature is an essential aspect of the definition. While it is true that for new systems, the ratio of the baseline and efficient system EERs would likely be the same across a range of base and efficient source fluid temperatures, for projects where the baseline is an existing system running at a specific source temperatures, the project specific EERs based on the working temperatures could significantly impact the heat pump unit energy savings. Consider revising the definitions of EER to make reference to the working temperature of the fluid in cases where an existing system is being replaced, since differences in project specific baseline and efficient fluid temperatures could significantly impact the savings.

- Definitions: Some unitary HVAC rating systems for EER include factors for auxiliary equipment, such as pumps. Since pumping energy is correctly accounted for explicitly in the protocol, consider clarifying the definition of base and efficient EERs such that for projects with significant pumping energy, the EERs are corrected if necessary to represent the refrigeration cycle only, without any allowance for auxiliaries. This would avoid double counting of the pumping energy.

3.18.3 Definition of Terms

Comments:

- The CF is based on an average CF for multiple other jurisdictions. This is not an appropriate source for CF as peak demand periods vary by jurisdiction. The sources of the coincidence factors used to obtain the average 80% CF_{cool} are not referenced, and 80% looks high compared with coincidence factors found in the NEEP C&I Unitary HVAC Loadshape Project, for example in the range of 44% to 63% for Mid-Atlantic PJM hours. The existing fixed value of the CF could substantially overstate the coincident demand savings for HVAC measures. A proper load shape for chillers should be determined and the CF calculated based on the new peak demand period.
- Sources: Hyperlink not functional: The link in footnote 293 on page 290 is not hyperlinked.

3.19 Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons

3.19.1 Eligibility

Comments:

- General: Some of the existing systems mentioned as baseline systems could easily co-exist with the installation of a DHP system. In order to ensure the full savings is realized, consider requiring that the old systems are de-energized, completely uninstalled and removed.

3.19.3 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for commercial DHP's should be developed for PA cities and the CF updated using the new peak period.

3.20 ENERGY STAR Electric Steam Cooker

3.20.2 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for commercial food service equipment should be developed for PA cities and the CF updated using the new peak period.

3.24 Refrigeration – Door Gaskets for Walk-in and Reach-in Coolers and Freezers

3.24.3 Definition of Terms

<u>*Comments:*</u>

- The TRM states "Due to the relatively small contribution of savings toward EDC portfolios as a whole and lack of Pennsylvania specific data, the ex ante savings based on the SCE work paper will be used until further research is conducted." Indoor conditions are the major driving factor of savings for this measure and are unlikely to greatly differ from the measured referenced EM&V results (this is the EM&V report called out in this section). The SCE results are more conservative, but in some cases are more than 10 times the measured ex post savings. We recommend using the evaluated ex post savings for this measure rather than the SCE ex ante savings as shown below:

Table 5-3 Energy Savings Achievable for New Gaskets Replacing Baseline Gaskets of Various Efficacies

	PGE Ex-Ante Savings (kWh/ft)	SCE Ex-Ante Savings (kWh/ft)	Savings if Baseline Gaskets are 0% Effective	Savings if Baseline Gaskets are 50% Effective	Savings if Baseline Gaskets are 90% Effective	Ex-Post Savings (Baseline Gaskets 98.5% Effective)
Freezers	105	21.7	228	114	23	3.3
Coolers	105	10.2	30	15	3	0.4

3.28 Electric Resistance Water Heaters

3.28.1 Eligibility

<u>*Comments:*</u>

- 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.

3.28.2 Algorithms

<u>*Comments:*</u>

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 3-2 and the new peak period, and the section text updated accordingly.

3.28.3 Definition of Terms

Comments:

- T_{hot} should be updated to match the T_{hot} = 123F in the residential water heater measures.

3.28.4 Energy Factors based on Tank Size

Comments:

- The numbering scheme for Sources is incorrect.
- "Factors" is misspelled in this text. Text should read:
    - *"Federal Standards for Energy Factors are equal to 0.97 -0.00132 x Rated Storage in Gallons. The following table shows the Energy Factors for various tank sizes."*
- Table 3-94 should be renamed to, "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed "Minimum Energy Factors (EF_{base})"

3.28.5 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The deemed values should be removed, and instead, a deemed algorithm for ΔkWh should be included similar to the residential water heater measure protocols. This reflects the revision of this measure to a default value for EF_{base} and $EF_{proposed}$ rather than a deemed value, and also reflects allows the default savings to be based on tank size.

3.29 Heat Pump Water Heaters

3.29.1 Eligibility

Comments:

- 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.

3.29.2 Algorithms

Comments:

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 3-2 and the new peak period, and the section text updated accordingly.
- PECO's ICSP requests that a Building Type (table 3-96) be added for Multi-Family (Common Areas), or for 'Other' that would apply to several building types including Multi-Family common areas.

3.29.3 Definition of Terms

Comments:

- T_{hot} should be updated to match the T_{hot} = 123F in the residential water heater measures.

3.29.4 Energy Factors based on Tank Size

Comments:

- The numbering scheme for Sources is incorrect.
- Table 3-99 should be renamed to, "Minimum Baseline Energy Factors based on Tank Size" and the second column should be renamed "Minimum Energy Factors (EF_{base})"
- "Factors" is misspelled in this text. Text should read:

  "Federal Standards for Energy Factors are equal to 0.97 -0.00132 x Rated Storage in Gallons. The following table shows the Energy Factors for various tank sizes."

3.29.5 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The deemed values should be removed, and instead, a deemed algorithm for ΔkWh should be included similar to the residential water heater measure protocols. This reflects the revision of this measure to a default value for EF_{base} and $EF_{proposed}$ rather than a deemed value, and also reflects allows the default savings to be based on tank size.

3.30 LED Channel Signage

3.30.1 Eligibility Requirements

Comments:

- The sentence, "Neon lamps are used for red signage and argon-mercury lamps for white signage." should be removed. It adds no value to the eligibility requirements and may inappropriately limit the protocol to only red or white tubes, even though there are a multitude of gas filled tubes, all of which are referred to generically as "neon tubes" even though they may be filled with other gases.

3.30.2 Algorithms

Comments:

- Although it is most likely that the baseline signage did not have controls, it is possible that the baseline did have controls. As currently written, the algorithms do not allow for accounting of reduced hours due to baseline controls. The algorithms should be modified as follows (edits marked in bold):

  Indoor applications:

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

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

  Outdoor applications:

  $\Delta kWh = [kW_{base} \times HOU\ \mathbf{\times (1-SVG_{base})}] - [kW_{ee} \times HOU \times (1 - SVG_{EE})]$

  $\Delta kW_{peak} = 0$

  Corresponding definitions for SVG_{base} and SVG_{EE} should be added.

3.30.3 Definition of Terms

<u>*Comments:*</u>

- In Table 3-101, the Component "EFLH" should be replaced with "HOU" to be consistent with the algorithms. Corresponding entries for SVG_{base} and SVG_{EE} should be added.

3.31 Low Flow Pre-Rinse Sprayers for Retrofit Programs

3.31.1 Algorithms

<u>*Comments:*</u>

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 3-7 and the new peak period, and the section text updated accordingly.

3.31.2 Definition of Terms

<u>*Comments:*</u>

- See comment above on Energy to Demand Factor

3.31.3 Deemed Savings

<u>*Comments:*</u>

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.

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

3.32.1 Algorithms

<u>*Comments:*</u>

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 3-7 and the new peak period, and the section text updated accordingly.

3.32.2 Definition of Terms

<u>*Comments:*</u>

- See comment above on Energy to Demand Factor

3.32.3 Deemed Savings

<u>*Comments:*</u>

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The section text and table heading should be modified to remove "deemed" and replace it with "default".

3.33 Small C/I HVAC Refrigerant Charge Correction

3.33.3 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for commercial small HVAC units should be developed for PA cities and the CF updated using the new peak period.

3.35 ENERGY STAR Room Air Conditioner

3.35.2 Definition of Terms

Comments:

- The CF has not been updated to account for the new peak demand period. The source note for the CF does not clarify what peak period the CF is based on. A load shape for commercial room air conditioners should be developed for PA cities and the CF updated using the new peak period.

3.37 Variable Speed Refrigeration Compressor

3.37.1 Eligibility

Comments:

- This measure should not apply to reciprocating compressors. These types of compressor do not run inefficiently at partial load and therefore do not benefit from VFD's. Grocery stores often use compressor in a multiplex rack that prevents compressor from running at high partial loads. Grocery store therefore should not be eligible for this measure. This measure should apply only to screw compressor that are common in industrial or agricultural applications. Copy in and modify paragraph, strike through and underline. The paragraph in this section should be changed as follows:

  > *This measure, VSD control for refrigeration systems and its eligibility targets applies to retrofit construction in the commercial and industrial building sectors; it is most applicable to ~~grocery stores or~~ food processing applications with refrigeration systems. This protocol does not apply to reciprocating compressors. This protocol is for a VSD control system replacing a slide valve control system.*

3.38 Fuel Switching: Domestic Hot Water Electric to Gas/Oil/Propane

3.38.1 Eligibility

Comments:

- See comments on 3.28.1 and 3.29.1
- 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.

- To be consistent with the updates to the residential fuel switching measures, the minimum EF for the fossil fuel units should be raised to ENERGY STAR standards where those standards exist.

3.38.2 Algorithms

Comments:

- The Energy to Demand Factor has not been updated to represent coincident demand for the new peak demand period as it has not been adjusted from when the peak 100 hour proxy period was being used. This factor should be revised using the provided water heater load profile in Figure 3-11 and the new peak period, and the section text updated accordingly.

3.38.3 Definition of Terms

Comments:

- T_{hot} should be updated to match the T_{hot} = 123F in the residential water heater measures.
- To be consistent with 3.28 and 3.29, add table of energy factors by tank size and update language in definition of terms accordingly
- See comment above on Energy to Demand Factor
- If tankless water heaters are considered, algorithms and terms should be updated with a derating factor of 0.91 to account for the difference between rated and actual performance of tankless water heaters. As cited in the 2012 Illinois TRM, "The disconnect between rated energy factor and in-situ energy consumption is markedly different for tankless units due to significantly higher contributions to overall household hot water usage from short draws. In tankless units the large burner and unit heat exchanger must fire and heat up for each draw. The additional energy losses incurred when the mass of the unit cools to the surrounding space in-between shorter draws was found to be 9% in a study prepared for Lawrence Berkeley National Laboratory by Davis Energy Group, 2006. "Field and Laboratory Testing of Tankless Gas Water Heater Performance" Due to the similarity (storage) between the other categories and the baseline, this derating factor is applied only to the tankless category."

3.38.4 Deemed Savings

Comments:

- This section should be renamed "Default Savings" as the measure has been adjusted to a partially deemed algorithm.
- The section text and table heading should be modified to remove "deemed" and replace it with "default".
- Fully deeming savings for this measure is inconsistent with changes to measures 3.28 and 3.29, where savings for one size and efficiency are shown as an example only. Recommend updating language and table to be consistent with 3.28 and 3.29.
- PECO's ICSP requests that a Building Type (table 3-96) be added for Multi-Family (Common Areas), or for 'Other' that would apply to several building types including Multi-Family common areas.

3.39 Fuel Switching: Heat Pump Water Electric to Gas/Oil/Propane

Comments:

- See comments on Section 3.38.

3.40 Fuel Switching: Commercial Electric Heat to Gas/Oil/Propane

__Comments:__

- See comments for 2.19 Fuel Switching: Electric Heat to Gas/Propane/Oil Heat and update this measure accordingly.
- If this measure is intended for smaller commercial facilities where equipment is similar to residential equipment (as indicated by low HP of default blower motor/negligible pumping energy), eligibility for this measure should be limited to smaller systems. The Illinois TRM uses 225,000 kBtu as a cutoff for "small" furnaces and boilers. The default blower motor HP could be inappropriate for larger systems.
- As with the commercial hot water fuel switching measures, fossil fuel replacement equipment should be required to meet ENERGY STAR ® standards where they exist.

Section 4: Agricultural Measures

4.1 Automatic Milker Takeoffs

Introduction

Comments:

- Measures / Section Order Revision: Consider having the vacuum pump variable speed drive measure prior to the automatic milker takeoffs measure. The majority of the savings for the automatic milker takeoff measure come from the installation of a variable speed drive (VSD). VSDs are an integral part of automatic milker takeoffs and are referenced extensively, not only in the automatic milker takeoffs section, but also in the subsequent agricultural sections.

4.1.1 Eligibility

Comments:

- Edit / Grammar: Make the change to the following sentence: "In addition, the vacuum pump system serving the ~~affected~~ **impacted** milking units must be equipped with a variable speed drive (VSD) to qualify for incentives."

4.1.2 Algorithm

Comments:

- The Algorithm for Peak Demand Reduction 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, please find the 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. ($\Delta kW = \Delta kWh$ / **HRS** x CF)

4.1.4 Description of Calculation Method

Comments:

- Problems with the Definition and Description of the Coincidence Factor:
  - Table 4-1 incorrectly shows the source for the CF as source #2. This should reference source #6.
  - This is not the same definition of the coincidence factor used in other parts of the TRM. PECO recommends 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.
- Source Notes Require Number References: In the first source note, the calculation used for the ESC (energy savings per cow per year) needs to be referenced. Additionally, the source used for average vacuum pump horsepower actually does not specify an average horsepower. The source details the energy savings of a range of vacuum pumps but does not specifically mention that 10 is the average horsepower.

4.2 Dairy Scroll Compressors

Introduction

Comments:

- Edit / Grammar: Delete the following sentence from the introduction: "The milk cooling equipment can consume 20 percent to 25 percent of all electrical energy use on a dairy farm."
    - While the milk cooling equipment is typically the highest electrical consumer on dairy farms, it is not always the case if the farm is utilizing plate coolers or pre-coolers. Additionally, as the algorithm gives options for farms utilizing pre-coolers, the range in consumption does not necessarily always apply.
- Edit / Grammar: Add the bolded and underlined words to the following sentence: "The compressor is used to cool milk **<u>in the bulk tank</u>** for preservation and packaging."
    - It is important to over-emphasize that the compressor replacement is for milk cooling purposes only, and an effective way to do so is to mention the compressors arrangement with the bulk tank.

4.2.2 Algorithms

Comments:

- The Algorithm for Peak Demand Reduction is Incorrect: The run hours of the compressor need to be factored 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)

4.2.3 Definition of Terms

Comments:

- 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 last source note references how the compressor will cycle on and off, emphasizing how it will have an alternative run time in comparison to the milking parlor.

4.2.4 Description of Calculation Method

Comments:

- Table 4-2 calls out for nameplate EER to be collected in order to calculate savings for these upgrades. 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 F.
- 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. PECO recommends 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.

- Elaborate on Milk Delta T Definition: In the third source note, milk delta T is currently defined as "...between cow temperature milk **and** cooled milk".
  - Consider elaborating as follows; "...delta T is the difference between the temperature of the milk as it leaves the cow and the target temperature to which the milk is cooled".
- Edit / Grammar: Make the changes to the following sentence from the fourth 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."

4.3 High Efficiency Ventilation Fans with and without Thermostats

Introduction

Comments:

- 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.

4.3.2 Algorithms

Comments:

- The Algorithm for Peak Demand Reduction is Incorrect: The run hours of the fans need to be factored into the equation. The correct formula would have the kWh savings divided by the fan run hours and then multiplied by the coincidence factor. ($\Delta kW = \Delta kWh$ / **HRS** $\times$ CF)

4.3.3 Definition of Terms

Comments:

- CFM Definition: For the CFM definition, include the caveat that this value is to be at a static pressure of 0.1 inches water, similar to what is included on the definitions of the fan efficiency and baseline terms.

4.3.4 Description of Calculation Method

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. PECO recommends 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 temperatures of 70 degrees Fahrenheit. If the fans do not have a thermostat, the load shape would be 1. This is because a typical farm will keep their fans running continuously through the summer months.
- 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.

4.4 Heat Reclaimers

4.4.2 Algorithms

Comments:

- The Algorithm for Peak Demand Reduction is Incorrect: The run hours of the water heater need to be factored 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 / **HRS** x CF). The energy and demand savings of a heat reclaimer come from the reduction in use of the existing/traditional water heater.

4.4.4 Description of Calculation Method

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. PECO recommends 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.
- Source Note Number Revision: The second source note mentions an assumed cow production of 6.5 gallons of milk per day. The correct value, which is accurately mentioned in the dairy scroll compressor section, is 6 gallons of milk per day.
- Include Default Value for Cows in the Table for the Variables for Heat Reclaimers: The default value is 75 and this number is referenced in other parts of the TRM.
- Elaborate on Milk Delta T Definition: In the second source note, milk delta T is currently defined as "...between cow temperature milk and cooled milk".
  - Consider elaborating as follows; "...delta T is the difference between the temperature of the milk as it leaves the cow and the target temperature to which the milk is cooled".

4.4.5 Measure Life

Comments:

- Maintain Consistency: In the introduction the measure life is given as 15 years and then in the measure life section it is given as 14 years. Please change the 14 years to 15 years in the measure life section.

4.5 High Volume Low Speed Fans

4.5.2 Algorithms

Comments:

- Problems with the Peak Demand Reduction Algorithm and the Coincidence Factor Algorithm: The existing algorithm used in calculating the coincidence factor is incorrect. The algorithm is actually the formula for calculating demand reduction. PECO recommends incorporating the coincidence factor into this algorithm so it accurately calculates the peak demand reduction. The adjusted algorithm is as follows:

(~~CF~~ $\Delta kW = (W_{conventional} - W_{HVLS}) / 1000 * CF$)

4.5.4 Description of Calculation Methods

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. PECO recommends 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 0.0005. 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 be 1.
    - TMY3 data could also be used to find a more precise load shape of the summer peak period when the temperature is above 65 degrees (when the fans will be in operation).

4.6 Livestock Waterer

Introduction

Comments:

- Edit / Grammar: Make the changes to the following sentence from the introduction; "The following protocol for the calculation of energy and demand savings applies to the installation of energy-efficient livestock waterers. In freezing climates, low energy livestock waterers are used to prevent livestock water from freezing. These waterers are enclosed and insulated watering containers ~~which typically use super insulation, he relatively warmer ground water temperature, and the livestock's use of the waterer to~~ which keep the water from freezing with the use of a buoyant ball that livestock use to agitate the water.

4.6.1 Eligibility

__*Comments:*__

- Additions to the Eligibility Requirements: PECO recommends including energy-free livestock waterers as a viable replacement option. Energy-free livestock waterers do not have heating elements and are subsequently 0 watts (or utilize a back-up heating element that is no larger than 50 watts). Please see the recommendation/note in reference to changing the algorithm to accommodate for energy-free units.

4.6.2 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 ($W_{eff} = 0$).

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

Introduction

__*Comments:*__

- Edit / Grammar: Delete from the following sentence: "The vacuum pump operates during the milk harvest and equipment washing ~~and can consume 20 percent to 25 percent of all electrical energy use on a dairy farm.~~"
    - The range in electrical consumption depends on whether or not the vacuum pump is oversized. If a vacuum pump is not over-sized in comparison to the number of milking units being deployed by the farm, then the percentage of electrical consumption afforded to the vacuum pump will be significantly lower.

4.7.1 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.
    - Additionally, variable speed drives require three-phase power to operate. If a farm is using single-phase power 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.

4.7.2 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. PECO recommends 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 Algorithm for Peak Demand Reduction is Incorrect: The run hours of the vacuum pump needs to be factored 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. ($\Delta kW = \Delta kWh$ / **HRS** x CF)

4.7.4 Description of Calculation Methods

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."

4.8 Low Pressure Irrigation System

4.8.1 Eligibility

Comments:

- Edit / Grammar: Add the highlighted and underlined words to the following sentence: "The pressure reduction can be achieved in several ways, such as nozzle or valve replacement, sprinkler head replacement, **alterations or retrofits to the pumping plant**, or drip irrigation system installation, and is left up to the discretion of the owner."

4.8.3 Definition of Terms

Comments:

- Include a Definition for the 1,714 $\frac{gpm-psi}{HP}$ Constant: This is a constant used in calculating hydraulic horsepower and can be defined as such.

4.8.4 Description of Calculation Method

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. PECO recommends 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.

4.8.5 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.

Section 5: Appendix

5.3 Appendix C: Lighting Audit and Design Tool

Comments:

- Fixture Code Legend tab—Definitions:
    - RSILL and SLED are not yet included in the legend tab. In order to make it easier to use the wattage table, consider adding these to the legend.
- Wattage Table tab—Lumens:
    - Lumens have not yet been included in the wattage table, and several LED fixtures have been added. The inclusion of lumens in the wattage table will make it easier to accurately compare wattages between baseline and efficient fixtures on the basis of equivalent illumination performance in lumens. Consider including initial lumens in the wattage table for all fixtures.
- Controls Form tab—Headings and Labeling, and Consistency with TRM:
    - The heading in cell A1 of the Controls Form tab says 'Lighting Form', which could be confusing to the user. Consider changing cell A1 on the Controls Form tab to say 'Lighting Controls Form' to distinguish it from the lighting form.
    - The HOU and CF Lookup Table is the same on the controls form as on the lighting form. Including the lighting CFs on the controls form could be confusing because some secondary sources may provide CFs for the controls measure itself (intended to be applied directly to the controlled load, without additional savings factors). Consider labeling the lighting CFs on the Controls Form tab as base lighting usage CFs, to distinguish them from controls measure CFs.
    - It does not appear as though the Appendix C controls savings calculation follows page 195 of the TRM with respect to SVG_{EE} and SVG_{base}. Further, the TRM calculation of coincident peak savings for lighting controls on page 195 includes a factor of CF that does not appear to be needed in the calculation for controls coincident demand savings. Ensure that the definitions in the TRM are as intended, and ensure consistency between the TRM and Appendix C.
    - Cell D8 on the Control Form tab is entitled 'Usage Group' which is the same as on the Fixtures Form tab. This could be confusing if there are different controls strategies within a given efficient lighting Usage Group. Consider changing cell D8 to Control Usage Group on the Controls Form tab.
- Glossary tab—Definitions:
    - The definition of CF in cells B71/72 and E65/66 refers to the '100 hours' definition of CF. Revise if appropriate to reflect current definition.
    - Cell E46 in the controls section refers to Post Fixture No. as the number of fixtures. This may cause confusion for a large project involving both controls and fixture upgrades, because there could be a difference between the automatically controlled loads and the total number of fixtures. Consider saying "number of fixtures controlled by the measure" instead of "number of fixtures" in the control section.
- General - Additional lamp/fixture wattages are requested to cover Commercial MF (common area) measures, Including:
    - High Performance T8s
    - Reduced Wattage High Performance T8s

- Exterior High Wattage Pin Based CFL Fixtures

5.5 Appendix E: Lighting Audit and Design Tool for New Construction Projects

Comments:

- This section should be renamed, *"Appendix E: Lighting Audit and Design Tool for Commercial and Industrial New Construction Projects"*
- Tab 01 Interior Lighting Form
    - Recommend applying a load reduction factor to both allowed and installed watts to account for dimming requirements in code.
- Tab 03 Exterior Lighting Form
    - The formula in cell H76 should be revised to:
        - =IF(SUM(*H47*:H75)=0,"",SUM(**H47**:H75)) from
        - =IF(SUM(**H48**:H75)=0,"",SUM(**H48**:H75)) to include the first row of user input cells.
    - There is a rounding function in the formula for "kilowatts below code" for interior lighting, but not for exterior lighting. Since this value is used in savings calculations, we recommend eliminating the rounding function in the interior lighting form.
    - Drop-down menu for exterior lighting spaces is not working (references non-existent named range)
        - Named range "IntFacilityType" references blank cells
- Tab 08 Fixture Code Locator - Cells B18 and B29 have external link to an Appendix C file

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 2.29 ENERGY STAR Lighting and Section 2.35 ENERGY STAR LEDs.

NAVIGANT

Memorandum

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.[15] 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, Navigant averaged the lighting and HVAC savings over the peak 100 hours for PECO in 2012.

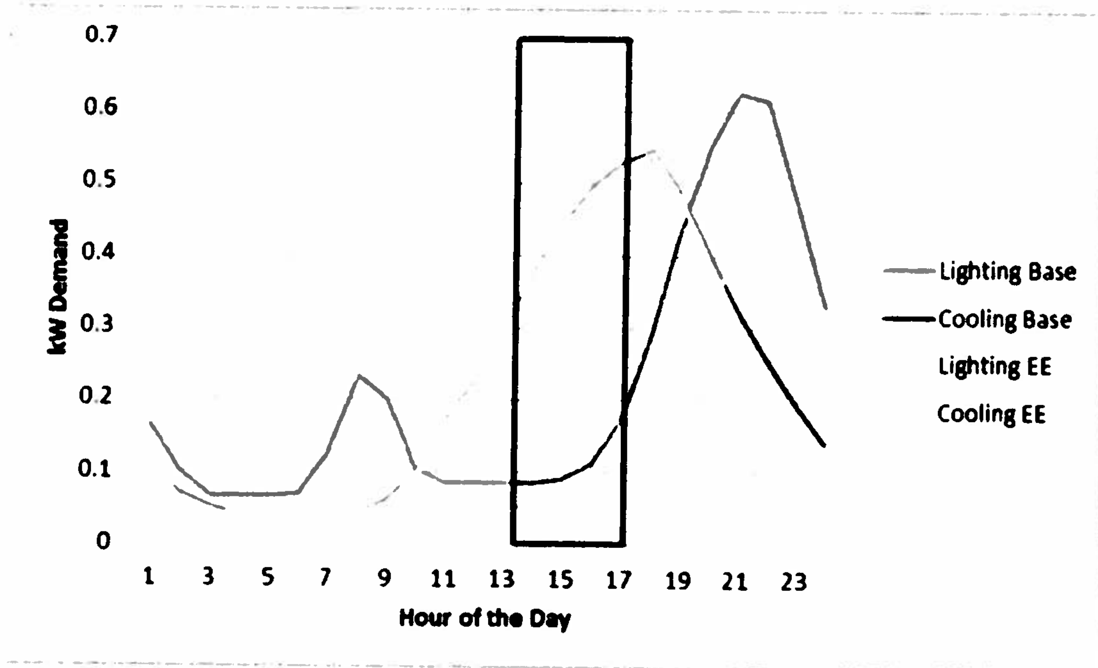
[15] These calibration parameters were chosen because they are largely independent of the physical structure of the house. Thermostat set points and natural ventilation are determined by the behavior of the house occupants, and the thermal mass of the house is affected by the amount of furniture etc.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

To determine a PECO-specific IEF_d for the Act 129 Phase II statewide Technical Reference Manuals, Navigant 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.

Navigant 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.

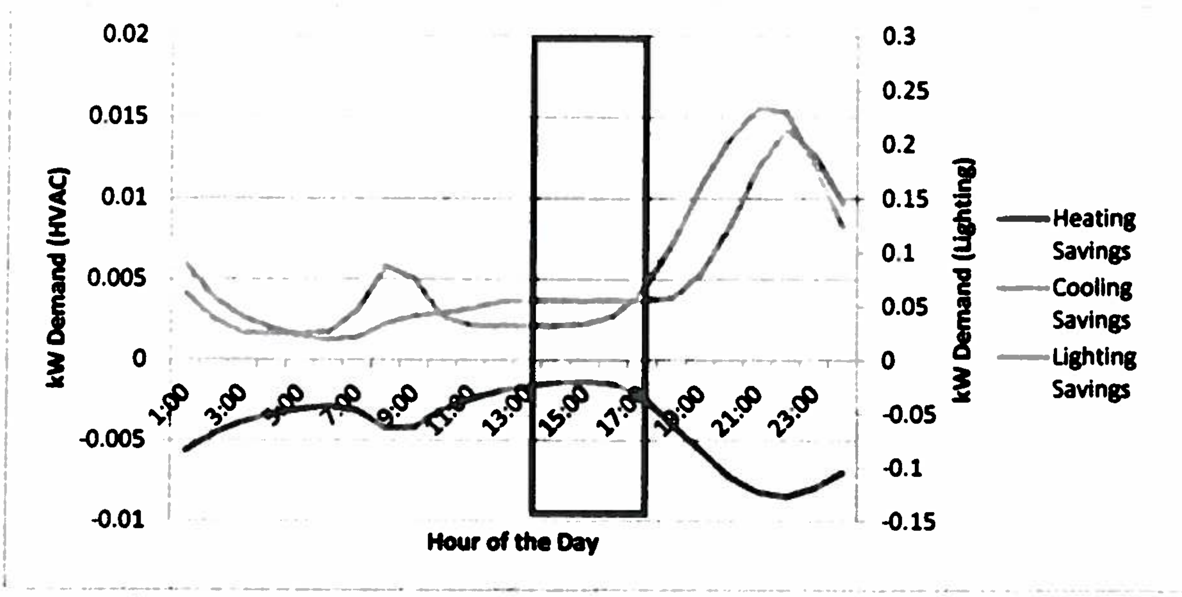
Figure 1. Weighted Average Lighting and Cooling Demand for Baseline and EE Models



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.

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

Navigant 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.

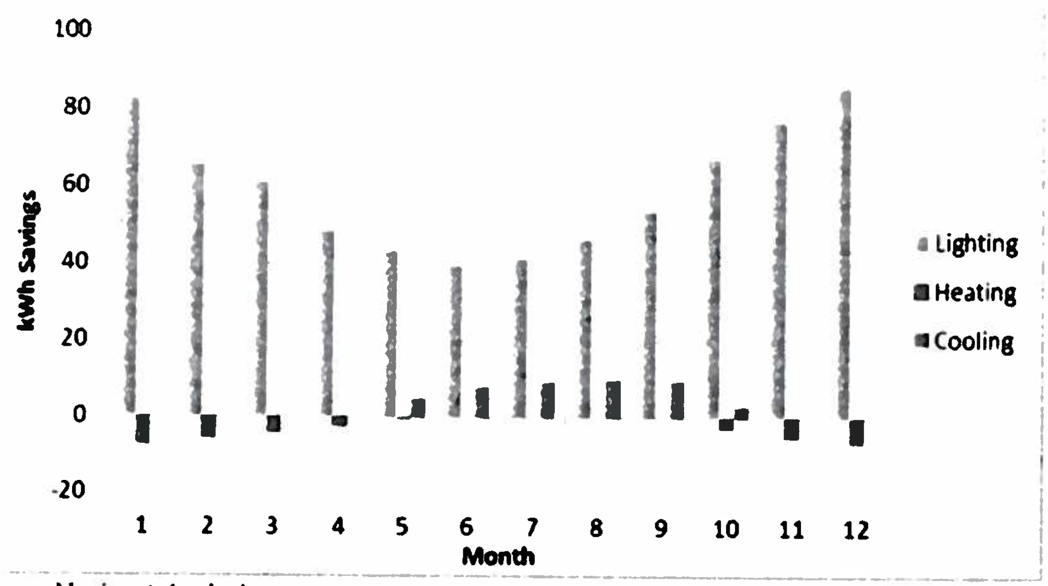
Energy Interaction Effects Factor

Navigant 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 12 through Table 14 shows the results of Navigant's 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.

Navigant 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. Navigant 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 12.

Table 12. 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

Navigant 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 13.

Table 13. 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:

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

Application of this adjustment yielded a weighted summer IEF_d of 1.228 (TMY) and 1.194 (2012 AMY), as shown in Table 14.

Table 14. 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 Navigant 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 15. 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

Navigant 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.

Appendix A: List of PECO Model Inputs

Characteristic	Single Family Gas	Single Family Heat Pump	Multifamily Gas	Multifamily Electric Resistance	Multifamily Heat Pump
Baseline Weight	59%	11%	24%	4%	1%
Size (sq. ft.)	2504		1423		
Floors	1.5		1.5		
Wall Height (ft)	8		8		
Age	45		61		
Beds	3		2		
Heating Set Point (F)	66				
Cooling Set Point	71.8				
Wall Insulation	R-8.2		R-6.9		
Attic Insulation	R-19		R-12.6		
Crawlspace Insulation	Uninsulated, Vented				
Window Area (F/B/L/R sq. ft.)	16, 16, 18, 19		50, 50, 0, 0		
Window Characteristics (U-value, SHGC)	.53, .55				
Infiltration	8 ACH50		10 ACH50		
Lighting (%CFL, %LED, %LFL)	0.19, 0.0, 0.08		0.34, 0.0, 0.05		
Air Conditioning	Central AC, SEER 12	Heat Pump, SEER 12	Central AC, SEER 12	Central AC, SEER 12	Heat Pump, SEER 12
Heating	Furnace, 78% AFUE	ASHP, 7.7 HSPF	Furnace, 78% AFUE	Electric Baseboard	ASHP, 7.7 HSPF
Duct Location	Crawlspace				
Duct Leakage	15%				
DHW	Electric, 0.92 EF				

Additional notes:

- All homes were modeled with a partial finished basement and partial crawlspace
- All appliances are Building America Benchmark Standards
- 28% of all homes had electric water heating, all models were created using 100% electric water heating and adjusted accordingly

Source: PECO 2011 Baseline Study