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|  | **PENNSYLVANIA****PUBLIC UTILITY COMMISSION**Harrisburg, PA 17105-3265 |  |

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|  | Public Meeting held July 8, 2015 |
| Commissioners Present: |  |

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| Gladys M. Brown, Chairman |  |
| John F. Coleman, Jr., Vice ChairmanJames H. Cawley |  |
| Pamela A. Witmer |  |
| Robert F. Powelson |  |
|  |  |
| Implementation of the Alternative Energy PortfolioStandards Act of 2004: Standards for the Participationof Demand Side Management Resources – TechnicalReference Manual 2016 Update | Docket No. M-2015-2469311 |

**2016 TRM UPDATE FINAL Order**

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**BY THE COMMISSION:**

As explained in our Order, entered June 1, 2009, at Docket No. M-00051865, in implementing the Alternative Energy Portfolio Standards Act (AEPS Act), 73 P.S. §§ 1648.1‑1648.8 and 66 Pa. C.S. § 2814,this Commission had adopted an *Energy‑Efficiency and DSM Rules for Pennsylvania’s Alternative Energy Portfolio Standard, Technical Reference Manual* (TRM).[[1]](#footnote-2) In adopting the original version of the TRM, this Commission directed its Bureau of Conservation, Economics and Energy Planning (CEEP)[[2]](#footnote-3) to oversee the implementation, maintenance and periodic updating of the TRM.[[3]](#footnote-4) Additionally, in the *Energy Efficiency and Conservation Program* Implementation Order for Phase I of Act 129’s Energy Efficiency and Conservation (EE&C) Program,[[4]](#footnote-5) this Commission adopted the TRM as a component of the EE&C Program evaluation process. In the Phase I Implementation Order, this Commission also noted that “as the TRM was initially created to fulfill requirements of the AEPS Act, it will need to be updated and expanded to fulfill the requirements of the EE&C provisions of Act 129.”[[5]](#footnote-6)

Soon after the adoption of the Phase I Implementation Order, Commission staff initiated a collaborative process to review and update the TRM with the purpose of supporting both the AEPS Act and the Act 129 EE&C program that culminated in the adoption of the 2009 TRM on May 28, 2009.[[6]](#footnote-7) In adopting the 2009 TRM, the Commission determined that the TRM would be updated on an annual basis.[[7]](#footnote-8)

With regard to Phase II of the Act 129 EE&C Program, the Commission again adopted the TRM as a component of the EE&C Program evaluation process.[[8]](#footnote-9) The Commission determined that an annual updating process would be appropriate for Phase II, as in Phase I.[[9]](#footnote-10)

Regarding Phase III of the EE&C Program, the Commission determined in its Phase III Final Implementation Order that the TRM again be adopted as a component of the EE&C Program evaluation process.[[10]](#footnote-11) However, the Commission determined that the 2016 TRM would be applicable for the entirety of Phase III, unless a mid-phase update was deemed necessary by the Commission.[[11]](#footnote-12)

# BACKGROUND

Act 129 of 2008, P.L. 1592, specifically directed this Commission to establish an evaluation process that monitors and verifies data collection, quality assurance and the results of each electric distribution company’s (EDC) EE&C plan and the EE&C program as a whole. *See* 66 Pa. C.S. § 2806.1(a)(2). To assist in meeting this obligation, the Commission contracted with GDS Associates, Inc. in August 2009 and again in February 2013, to perform these duties as the Act 129 Statewide Evaluator (SWE). As part of its duties, the SWE is to review the TRM and the Total Resource Cost (TRC) Test Manual and to provide suggestions for possible revisions and additions to these manuals.

The SWE, in collaboration with the program evaluation group (PEG)[[12]](#footnote-13) and staff from the Commission’s Bureau of Technical Utility Services (TUS), reviewed the 2015 TRM and proposed several changes and additions for consideration for inclusion in the 2016 TRM. The Commission released these proposed changes for comment when we adopted the 2016 TRM Annual Update Tentative Order at our March 26, 2015 Public Meeting.[[13]](#footnote-14) A notice of the Tentative Order and proposed 2016 TRM update was published in the *Pennsylvania Bulletin* on April 11, 2015. Comments were due on May 11, 2015, with Reply Comments due May 21, 2015.

The following parties filed comments in response to the Tentative Order: Citizens for Pennsylvania’s Future, the Clean Air Council, the Sierra Club, the Natural Resources Defense Council, the Environmental Defense Fund and the Keystone Energy Efficiency Alliance (collectively, the Joint Commentators); Duquesne Light Company (Duquesne); Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company and West Penn Power Company (collectively, FirstEnergy); Nest Labs (Nest); Northeast Energy Efficiency Partnerships (NEEP); OPower; PECO Energy Company (PECO); PPL Electric Utilities Corporation (PPL) and Tricklestar USA (Tricklestar). The following parties filed reply comments: FirstEnergy; PECO and PPL.

# DISCUSSION

The changes and improvements to the TRM are based on more recent research, a review of TRMs from other states and the needs and experiences of the EDCs. The EDCs provided, through the SWE evaluation, measurement and verification (EM&V) process, much of the data that forms the basis of the changes and improvements being adopted in the 2016 version of the TRM. Specifically, the current changes and improvements were the result of SWE site inspections, and comments from conservation service providers (CSPs) and EDC independent evaluators. Additionally, many of the issues raised during the 2015 TRM update process were referred to the SWE to do further research in order to provide recommendations during the 2016 TRM update. The adopted changes focus on improving assumptions for key parameters, algorithms and deemed savings values, as well as accounting for new codes and standards for residential, and commercial and industrial (C&I) EE&C measures. The Commission observes that the adopted changes will make the TRM a more effective and professional tool for validating energy savings and providing support for the Act 129 goals.

The major goals of the adopted modifications are as follows:

1. To add protocols for EE&C measures being implemented by the EDCs and to broaden the scope of the TRM;
2. To appropriately balance the integrity and accuracy of claimed energy savings estimates with costs incurred to measure and verify the claimed energy savings;
3. To clarify existing calculation methods;
4. To allow more flexibility for the EDCs to use territory-specific or gathered data when calculating savings; and
5. To provide additional reasonable methods for measurement and verification (M&V) of energy savings associated with EE&C measures without unduly burdening EE&C program and evaluation staff.

 Below is a summary list of the changes adopted in this update:

1. General improvements to the TRM.
2. Inclusion of four new residential EE&C measure protocols.
3. Clarification of the existing residential EE&C measure protocols.
4. Inclusion of three new C&I EE&C measure protocols.
5. Clarification of the existing C&I EE&C measure protocols.
6. Addition of demand response (DR) protocols.
7. Updates to Appendix C – Lighting Audit and Design Tool.
8. Updates to Appendix D – Motor and Variable Frequency Drive (VFD) Audit and Design Tool.
9. Removal of Appendix E – Lighting Audit and Design Tool for C&I New Construction Project.

Below, we will discuss in more detail the more significant TRM changes and updates that are being adopted. Minor administrative and uncontested changes being adopted will not be discussed. Regarding instances where the Commission refers an issue to the SWE for further research in collaboration with the PEG, we would like to make it clear that the SWE is not required to attain a consensus before providing its recommendations to the Commission.

##  Application of the TRM

 In our Phase III Tentative Implementation Order, the Commission proposed that the 2016 TRM remain in effect through the entirety of Phase III.[[14]](#footnote-15) While we did not, in our Tentative Order in this proceeding, solicit comments on this proposal, we did express a belief that some changes to the TRM are necessary to reflect the Phase III Tentative Implementation Order proposal. Specifically, we proposed updating Section 1 of the TRM to reflect the proposed shift away from annual updating. Additionally, as outlined in our Tentative Order, we proposed updating many of the protocols to reflect the most up-to-date codes and standards. In some cases, we proposed implementation timelines for known codes and standards changes that become effective throughout the course of the proposed Phase III program length. We noted these changes will ensure that the TRM remains reliable without annual updates.

**1. Comments**

 PPL opposes the removal of the following statement from the 2016 TRM: “*Any newly approved measure, whether in the TRM or approved as an interim protocol, may be applied retrospectively consistent with the EDC’s approved plan.*”[[15]](#footnote-16) PPL believes this statement is necessary so that EDCs can implement new measures during the phase and have a clearly-defined method to determine savings. PPL Comments at 2.

 The Joint Commentators request clarification regarding the process to address any updates to the TRM that may be necessary and suggest using the TRM Working Group for discussion of such issues. Joint Commentators Comments at 4-5. Further, the Joint Commentators believe that the TRM places too much emphasis on energy codes and standards and should move to concentrate more on market studies. *Id.* at 5.

FirstEnergy believes it unnecessary to clarify, as requested by the Joint Commentators, the process to perform updates for measures that are impacted by code changes, asserting that the processes in place are sufficient. FirstEnergy Reply Comments at 2-3. Additionally, FirstEnergy, PECO and PPL support the standing practice of using codes and standards as a baseline rather than a market baseline. FirstEnergy Reply Comments at 2-3; PECO Reply Comments at 2; PPL Reply Comments at 2. PECO further states that baseline assumptions should align with the SWE’s baseline studies and market potential studies. PECO Reply Comments at 2.

The Joint Commentators suggest that, due to low savings and high free-ridership, the residential ENERGY STAR Refrigerators[[16]](#footnote-17) measure should be discontinued except for those refrigerators meeting the “Most Efficient” criteria. Joint Commentators Comments at 10-12. The Joint Commentators also suggest that the residential ENERGY STAR Dehumidifier[[17]](#footnote-18) and ENERGY STAR Television[[18]](#footnote-19) measures be removed from the TRM due to high market saturation. *Id.* at 13. PPL disagrees with removing these measures, except for the ENERGY STAR Television measure, and notes that the TRM is used to determine gross savings. PPL Reply Comments at 3.

 **2. Disposition**

The Commission disagrees with PPL regarding the removal of the referenced language. We do not believe it appropriate to include this direction in the TRM itself. Such direction has been provided in the SWE’s Evaluation Framework.[[19]](#footnote-20) We also disagree with the Joint Commentators that a process must be outlined for addressing any necessary TRM updates. Because factors influencing the need for a TRM update may vary, so may there be variances in the procedures to be used in making any necessary changes. We also agree with the EDCs that the current process of utilizing codes and standards as a baseline is appropriate and aligns with the SWE’s EE and DR Potential Studies,[[20]](#footnote-21) which were utilized in developing the Phase III targets.

The Commission rejects the Joint Commentators’ suggestion to remove measures from the TRM due to high free-ridership or low savings levels. The Commission has maintained these measures in the TRM as they save electricity as compared to standard units. Additionally, we would like to make it clear to all stakeholders that the inclusion of a measure in the TRM does not mean EDCs are either required to or encouraged to offer it in Act 129 programs. The issues raised by the Joint Commentators about these measures is more appropriately addressed during an EDC’s EE&C plan approval proceeding.

Through the entirety of the EE&C Program, the Commission maintained its position that the TRM should be updated annually to reflect not only new protocols, but changes related to federal and state standards, code changes and technological upgrades. As such, our position has always been that the annual TRM update may include revisions to existing protocols to establish a more accurate reflection of savings values. While the Commission revised this position for Phase III, by making the 2016 TRM applicable for the entirety of Phase III, the Commission also reserved the right to perform mid-phase updating if deemed necessary. Therefore, we will reiterate our prior position on the application of such mid-phase changes of the TRM to EDC EE&C Plans.

As we stated in our prior TRM update orders, “the TRM is merely guidance or a statement of policy that is not binding regulation.”[[21]](#footnote-22) We continued by stating that

a final determination of an EDC’s EE&C Plan’s energy savings will be determined in an adjudicatory proceeding where the EDC will be afforded the opportunity to present evidence demonstrating what energy savings its plan obtained and the credibility of that evidence. An EDC is free to use any method to determine the energy savings produced by its plan, in place of the TRM, provided it can support such determinations with substantial credible evidence, if necessary. Furthermore, by updating the TRM methods and values based on the most recent credible and accurate data and facts, as they become known, is likely to reduce challenges to the credibility of the energy savings attributable to the EDCs’ Plans in any future proceeding.[[22]](#footnote-23)

We stress again that while the TRM is a tool EDCs can use to estimate the amount of energy savings a program offering can potentially provide to its plan as a whole, the TRM is first and foremost a measurement tool used to determine, in a reasonably cost‑effective way, the actual energy savings achieved by specific measures after they have been installed or implemented.

The Commission believes it has adequately explained its reasoning in performing annual or mid-phase updates to the TRM in a variety of proceedings, including past TRM updates.[[23]](#footnote-24) Specifically, in the Phase II Implementation Order, we stated the following:

In maintaining up-to-date information, the Commission assures that Act 129 monies collected from ratepayers are reflecting the truest savings possible. Additionally, while we recognize the concerns expressed by the EDCs regarding compliance, the Commission has not been provided with any arguments as to why updating the TRM any less frequently than annually is beneficial to ratepayers. To be more specific, the EDCs’ comments focus on the effects the annual TRM updating procedure has on their ability to attain their targets and in no way address the accuracy of the deemed savings values. We believe the focus should be on providing the most accurate measure of reductions in energy consumption possible and to ensure that Act 129 monies are being spent to acquire real energy savings, not fictitious savings values that only serve to protect the EDCs from potential penalties.[[24]](#footnote-25)

The Commission maintains this position in this proceeding.

##  General Improvements

###  Future Code Changes

There are several impending United States Department of Energy (DOE) standards[[25]](#footnote-26) updates that have been approved, but will not go into effect until after program year eight (June 1, 2016 through May 31, 2017). However, as both the details and effective dates of these updates are known, the Commission proposed including them, where appropriate, in the 2016 TRM and clearly designating the program years in which they will become effective. The specifics of these future standards changes will be noted below under the protocols in Sections D and E of this Order. As no party commented on this proposed change, the Commission has updated the TRM to include, where appropriate, DOE Federal Standards updates and has designated the program years in which current standards and new standards are effective.

###  Demand Response

 In its Phase III Tentative Implementation Order, the Commission proposed peak demand reduction targets[[26]](#footnote-27) for six of the seven EDCs[[27]](#footnote-28) subject to the Act 129 EE&C Program requirements.[[28]](#footnote-29) In order for the EDCs to attain these targets, the Commission also proposed a demand response program design for Phase III.[[29]](#footnote-30) The Commission solicited comments on this proposed DR model, as well as the proposed peak demand reduction targets, as part of the Phase III Implementation proceeding at Docket No. M‑2014-2424864. The Commission did not solicit comments on the targets or the methodology in this proceeding. However, we did request, in this proceeding, comments on the proposed inclusion of a demand response section in the 2016 TRM that is reflective of the Commission’s proposed DR methodology. This section would provide direction to the EDCs, CSPs and evaluators on how to evaluate, measure and verify the peak demand reductions resulting from the EDCs’ demand response programs. Specifically, Section 5 of the proposed 2016 TRM provided the eligibility requirements and the algorithms for calculating peak demand reductions for both direct load control and load curtailment (LC) programs. We expressed a belief that this information would be necessary to ensure the consistent EM&V of DR programs across all EDC service territories and the appropriate calculation of peak demand reductions from the EDCs’ DR programs.

 **a. Comments**

 PECO comments that for load curtailment optimizing the customer baseline (CBL) calculation on a site-by-site basis is impractical as there is likely to be hundreds of participants. PECO recommends that the first criteria listed for the CBL selected for each participating site in an EDC load curtailment program be changed to “Selected on a site-by-site basis where feasible, otherwise the most appropriate CBL for the program in aggregate should be selected.” PECO Comments at 14. Duquesne recommends the exclusion of DR programs. Duquesne Comments at 7-8.

 **b. Disposition**

 In our Phase III Final Implementation Order, this Commission tentatively adopted DR targets for six of the seven EDCs subject to the Act 129 EE&C Program.[[30]](#footnote-31) Therefore, we have determined it necessary to include protocols for evaluating the Phase III DR programs in the TRM. The Commission agrees with PECO’s concern regarding CBLs and has removed the section discussing the approval of CBLs. We have also added three other methodologies to estimate the reference load for C&I LC programs:[[31]](#footnote-32)

1. A comparison group analysis where the loads of a group of non-participating customers that are similar to participating customers with respect to observable characteristics (e.g. non-event weekday consumption) are used to estimate the reference load.
2. A ‘within-subjects’ regression analysis where the loads of participating customers on non-event days are used to estimate the reference load. The regression equation should include temperature and other variables that influence usage as explanatory variables.
3. A hybrid Regression-Matching method where matching is used for most customers and regression methods are used to predict reference loads for any large customers who are too unique to have a good matching candidate. This approach allows for matching methods to be used when good matches are available without dropping unique customers who do not have valid matches from the analysis.

The Commission strongly encourages the EDCs to utilize the first three methodologies, as outlined above and within the TRM, to estimate the reference load used to determine impacts from an LC program participant during a DR event. However, we recognize that there may be occasions where these three methodologies may not be appropriate in estimating a customer’s reference load. In such scenarios, an EDC may use the CBL approach; though, we expect the EDC to provide sound reasoning for the choice of the CBL approach as opposed to the methodologies outlined herein.

 In its Phase III Final Implementation Order, the Commission allowed customers participating in PJM Interconnection LLC’s Emergency Load Response Program (ELRP) to also participate in the Act 129 DR programs, provided that EDCs demonstrate in their plans that the cost to acquire megawatts (MW) from customers participating in PJM’s ELRP is no more than half the cost to acquire MWs from customers in the same rate class that are not participating in PJM’s ELRP. [[32]](#footnote-33) As such, our proposed DR section for the TRM required modifications. For the Residential Direct Load Control and Behavioral-Based Programs measure, the Commission has changed the target sector of the protocol to residential and commercial establishments. We have also removed the deemed peak kilowatt (kW) reduction table and provided prioritization of evaluation approaches.

###  Line Loss Guidance

The Commission proposed to add the following table to Section 1 of the 2016 TRM in order to provide guidance on the MW savings to be reported after taking into account line loss factors (LLFs). We expressed a belief that these LLFs are appropriate as they were the LLFs utilized by the SWE in its EE and DR Potential Studies.

|  |  |  |  |
| --- | --- | --- | --- |
| **EDC** | **Residential LLF** | **Commercial LLF** | **Industrial LLF** |
| Duquesne | 1.0741 | 1.0741 | 1.0081 |
| Met-Ed | 1.0945 | 1.0720 | 1.0720 |
| PECO | 1.0799 | 1.0799 | 1.0799 |
| Penelec | 1.0945 | 1.0720 | 1.0720 |
| Penn Power | 1.0949 | 1.0545 | 1.0545 |
| PPL | 1.0875 | 1.0875 | 1.0420 |
| West Penn | 1.0943 | 1.0790 | 1.0790 |

 **a. Comments**

 PECO comments that the values used in Table 1-4 should be updated to include the value submitted to the SWE, based on a 2012 study by Navigant. PECO Comments at 6. The Joint Commentators submit that there should be separate line loss factors for demand and energy, further stating that these line losses should be differentiated to match the current avoided cost definitions and that the text on page 13 of the TRM[[33]](#footnote-34) be reworded to include system peak line loss factors. Joint Commentators Comments at 6. PPL recommends reinstating language from the 2015 TRM[[34]](#footnote-35) into Section 1.14 of the 2016 TRM.

 **b. Disposition**

 The Commission rejects PECO’s request to modify the table as Table 1-4 is presented as a set of multipliers, resulting from the submitted data responses. The values PECO provided to the SWE (*e.g.*, 7.4%) were used in the following equation to determine the LLFs for Table 1-4:

x = 1/(1-losses expressed as a % of generation level kWh or kW).

The Commission also rejects the request from the Joint Commentators to use two LLFs, one for EE and one for DR, as it would be inconsistent with the SWE’s EE Potential Study.

 The Commission accepts the request from PPL to reinstate the language from the 2015 TRM, as modified below:

The TRM calculates the electric energy and peak demand savings at the customer meter level. The electric energy consumption reduction compliance targets for Phase III of Act 129 are established at the retail level. The energy savings must be reported to the Commission at the customer meter level without application of any line loss factor. These savings are used to determine if EDCs have met their statutory electric energy targets for Phase III.

These savings need to be increased by the amount of transmission and distribution system losses in order to determine the energy savings at the system level. The electric line loss factors multiplied by the savings calculated from the algorithms will result in savings at the system level.

Demand savings goals or compliance towards demand response targets are to be calculated at the system level. The EDC shall apply the proper line loss factor to the peak load reductions to assess progress towards Phase III demand reduction goals.

When performing benefit-cost savings calculations, it is important to value the savings at the system level and apply the line loss factors to both energy consumption and demand savings, at that level, when running the Total Resource Cost test.

###  Verified Gross Adjustments[[35]](#footnote-36)

The Commission did not propose any changes to the Section 1.12.4 – Verified Gross Adjustments. However, comments were received and are addressed below.

 **a. Comments**

PECO recommends and FirstEnergy agrees with the removal of the following phrase from the second paragraph of the section: “On the other hand, if the number of widgets found on-site is more than what is stated on the application, the savings will be capped at the application findings.” PECO Comments at 5;FirstEnergy Reply Comments at 4.

 **b. Disposition**

 The Commission declines to remove the sentence as it reflects current industry practice.

###  Behavioral Programs

The Commission did not provide any proposals regarding behavioral programs. However, comments were received on such programs and are addressed below.

* + - 1. **Comments**

OPower notes that its home energy report (HER) programs are becoming more widespread, providing more knowledge regarding their associated savings. OPower believes the persistence and composition of its HER programs should be revisited based on new evidence obtained from other jurisdictions. OPower avers that an average savings of 1% to 3% have been consistently verified by over fifty independent evaluations of its HER programs. OPower concludes that continued application of its HER programs improves persistence of savings, which suggests that savings become more durable as more reports are delivered. For long-running programs, OPower avers that savings persist for at least two years post-application and that this persistence seems to increase the longer a program is run before suspension. OPower requests that the Commission direct the SWE to work with stakeholders to consider these findings and update the custom measure protocol (developed in Phase I) and consider its inclusion in the TRM. OPower opines that the update should consider how to account for such savings appropriately to be consistent with the goals of Act 129 and the compliance structure for Phase III. OPower Comments at 2-3.

PECO agrees that behavioral programs are an important part of a comprehensive portfolio and believes OPower’s comments warrant consideration by the Commission. PECO recommends the development of a statewide interim measure protocol for HER programs consistent with the methodology provide in studies referenced by OPower. PECO believes this protocol should be established by August 15, 2015, to allow EDCs to incorporate the protocol into their EE&C Plans. PECO Reply Comments at 2-3.

* + - 1. **Disposition**

In Phases I and II, the effective useful life (EUL) of HERs was assumed to be one year. Compliance in Phases I and II was to be determined based on cumulative annual savings such that only the savings achieved by HERs in the final year of a phase counted towards compliance goals. In Phase III of Act 129, compliance goals are based on incremental annual savings, or the new first-year savings achieved by measures in a given program year. With either accounting method, the assumed EUL is critical to the EE&C planning process and is a key driver on how EDCs choose to deploy HER programs.

As noted by OPower, recent evaluation findings across North America suggest that the persistence of the HER program effect is longer than the one year. Research also indicates that both the magnitude of savings and the persistence of savings can vary depending on the duration of HER exposure. The Commission believes that the concept of measure life must be adjusted slightly in the context of HERs. Unlike an equipment measure which generates full savings for a number of years and then reaches the end of its mechanical life, the effect of HER exposure appears, based on the findings in the studies referenced by OPower, to deteriorate gradually once homes no longer participate in HERs.

The Commission believes that this is an important issue for Phase III of Act 129 and prefers that the decay rate assumption be based on Pennsylvania-specific data. We also believe that the deployment and subsequent cessation of HERs by PPL and Duquesne in Phases I and II creates the ideal experimental framework for assessing the HER decay rate in the Commonwealth. Because homes participated in HERs programs in Program Years Three and Four and then ceased participation in Program Years Five and Six, there is data available to estimate the rate at which the electric consumption of homes in the treatment group returns to the level observed in control group homes. Accordingly, the Commission directs the SWE to conduct an independent assessment of the HER’s program decay by analyzing billing data provided by PPL, Duquesne and any other EDC that withdrew HER application during Phase II. We direct the EDCs to work in cooperation with the SWE to provide this data. The SWE’s findings will be used to update the existing custom measure protocol for the HERs program. An update to a custom measure protocol does not require an update to the TRM for it to be available for EDC use. However, we can again consider the appropriateness of including the HER protocol in the TRM during a future TRM update.

 We recognize PECO’s desire to have an updated protocol available by mid-August to aid in EDC planning for Phase III. However, due to the SWE’s need to collect and review data, followed by an updating of the existing custom measure protocol, as well as giving stakeholders an opportunity to provide input, we will not require the SWE to complete its assessment by a date certain.

###

## C. Additional Residential EE&C Measure Protocols

The Commission recognizes that the expansion of the residential section of the TRM is essential for the accurate and timely M&V of the EDCs’ Act 129 EE&C programs and is proposing to include four new residential EE&C measure protocols. The EDCs’ independent evaluators, in collaboration with the SWE, produced, reviewed and edited the following proposed residential EE&C measure protocols:

* Section 2.2.10 – Packaged Terminal Systems;
* Section 2.6.6 – Residential Air Sealing;
* Section 2.6.7 – Crawl Space Wall Insulation; and
* Section 2.6.8 – Rim Joist Insulation.

**1. Section 2.6.6 – Residential Air Sealing**

**a. Comments**

 The Joint Commentators recommend providing more information regarding the assumptions used to develop the air sealing unit energy savings (UES) and unit demand savings (UDS) factors. The Joint Commentators provide an example where a comparison of the ratios for air source heat pumps (ASHP) versus electric resistance UES values implies an ASHP system coefficient of performance (COP) of between 1.7 to 1.9. They note that this result is lower than rated ASHP efficiencies and question if this is the result of duct losses in the ASHP prototype(s). The Joint Commentators Comments at 14-15.

**b. Disposition**

 The Commission rejects the Joint Commentators’ recommendation as we find that that sufficient information is already provided. As stated in the sources of the measure, “UES [and UDS] values were calculated by modeling a prototypical Pennsylvania single family detached house with statewide average characteristics determined through the 2014 Pennsylvania Residential Baseline Study.” The SWE’s *2014 Pennsylvania Statewide Act 129 Residential Baseline Study*[[36]](#footnote-37) findings informed all aspects of the model house, including heat pump heating seasonal performance factors (HSPF), air conditioning seasonal energy efficiency ratios (SEER), insulation, square footage, etc. We believe the use of 2014 Residential Baseline Study information provides not only a Pennsylvania-specific protocol, but allows for the easy repeatability of the analysis.

 As for the lower than expected effective COP mentioned by the Joint Commentators, this is a reflection of the amount of time the strip heating is on in the ASHP models. The observed trend reflects the highest effective COP for locations with the mildest winters and lowest with most severe winters. Additionally, the resistance heat (electric baseboard) had no duct losses whereas duct losses exist in the other heating types.

* 1. **Section 2.6.7 – Crawl Space Wall Insulation and Section 2.6.8 – Rim Joist Insulation**
		+ 1. **Comments**

 PPL recommends updating the default Rbase value for crawl space wall insulation and rim joist insulation based on the 2009 American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE) Fundamentals Chapters 25 and 26. PPL believes that Section 26 of the 2009 ASHRAE Fundamentals provides better citations and support for R-values than that currently listed in the TRM. PPL Comments at 3.

 **b. Disposition**

 The Commission agrees with PPL regarding R-values and notes that the other R-value references in the measure are from the ASHRAE Fundamentals Handbook as well, making the measure more consistent. The default value and source have been updated.

## D. Additional C&I EE&C Measure Protocols

 As with residential measures, expansion of the C&I section of the TRM is also essential for the accurate and timely M&V of the EE&C programs. Based on collaborative discussions between the SWE and the EDCs, as well as a review of the available research, we proposed the inclusion of the following three new C&I EE&C measures and associated protocols:

* Section 3.5.15 – Refrigerated Display Cases with Doors Replacing Open Cases;
* Section 3.5.16 – Adding Doors to Existing Refrigerated Display Cases; and
* Section 3.10.4 – Air Tanks for Load/No Load Compressors.

 **1. Comments**

 The Joint Commentators note that the only difference between Section 3.5.15 and Section 3.5.16 appears to be that the former requires no sweat doors. They believe it is unclear why this is only a requirement for a full replacement and not just adding doors. The Joint Commentators recommend combining the two measures and standardizing the requirement for no sweat doors. Joint Commentators Comments at 19.

 **2. Disposition**

 The Commission rejects the Joint Commentator’s recommendation. We find that the measures should be separate due to the eligibility requirement of the efficient equipment. For replacement measures, only cases with no sweat doors typically exceed the federal standard for closed cases.

##

## E. Existing Residential EE&C Measure Protocols and Processes

The following sections describe clarifications and modifications to existing residential measure protocols:

### 1. Section 2.1.1 – ENERGY STAR Lighting[[37]](#footnote-38)

#### Measure Life

The Commission proposed to adjust the measure lives for light-emitting diode bulbs (LEDs) and compact fluorescent lamps (CFLs). We proposed that the LED measure life be updated to reflect the most recent hours of use (HOU) estimate as reported in the SWE’s 2014 Residential Baseline Study and SWE’s *Pennsylvania Statewide Act 129 2014 Non-Residential End Use & Saturation Study*[[38]](#footnote-39) as measure life is a direct function of HOU. We also proposed that the CFL measure life be updated to reflect two primary changes: the most recent HOU estimate as reported in the 2014 Residential and Commercial Baseline Studies, as well as a more recent study that estimates degradation factors for ENERGY STAR CFL lighting.[[39]](#footnote-40) The baseline wattage now accounts for post-2020 installations; therefore, the measure life would not be cut off at 2020.

 **i. Comments**

PECO believes that a correction is required to adjust the LED life from 15,000 hours to 25,000 hours. PECO Comments at 6. Similarly, the Joint Commentators suggest that the LED life be adjusted from 15,000 to 25,000 hours and the CFL life from 8,000 to 10,000 hours. The Joint Commentators also suggest a review of the cited 2008 ACEEE study to ensure that it is appropriate to apply the degradation from the study to the rated life of the CFL and to determine if the study is used in other jurisdictions. Joint Commentators Comments at 6.

 **ii. Disposition**

The Commission agrees with the recommended adjustment to CFL and LED lifetime hours. The operating life for CFLs has been updated to 10,000 hours, with the operating life updated to 25,000 hours for LEDs. This includes updates to the associated measure lives to reflect the increased expected operating life of the two bulb types, noting Act 129’s measure life cap of 15 years.[[40]](#footnote-41) To clarify, the TRM uses a degradation factor from a 2013 ENERGY STAR Study,[[41]](#footnote-42) not the 2008 ACEEE Study[[42]](#footnote-43) referenced by the Joint Commentators. The 2013 ENERGY STAR Study is the most current study regarding degradation factors and is based on the most current technology. This technology was not available at the time of the 2008 ACEEE Study.

#### Introduction of 2020 Backstop

The Energy Independence and Securities Act of 2007 (EISA) includes a “backstop” provision where any bulb sold after 2020 will need to meet a 45 lumens per watt standard. This provision is technology neutral, ensuring that the previous EISA requirements produce savings equal to or greater than an efficiency standard of 45 lumens per watt (lm/W). The legislation prohibits the sale of any general service lamp that does not meet the minimum efficiency standard. The Commission proposed the inclusion, in this protocol, of an outline of the EISA backstop provision. While the provision was already incorporated in previous TRMs, it is of increased importance in the 2016 TRM as it will be applicable for of the entirety of Phase III. Therefore, we proposed to specifically address the EISA backstop in Section 2.1.1.

 **i. Comments**

FirstEnergy argues that column E in Table 2-2 should be removed and replaced with a reference to the EISA 2007 legislation, which specifies that general service lamps will be required to achieve 45 lm/W by 2020.[[43]](#footnote-44) The values in column E appear to correspond with typical current CFL wattages for the lumen range, implying a CFL baseline that is inconsistent with EISA 2007 legislation. FirstEnergy also requests a clarification regarding footnote 37 discussing dual baselines. FirstEnergy recommends that the first part of the footnote be changed to “Example Approach to cost-effectiveness calculation using column.” FirstEnergy Comments at 3.

The Joint Commentators argue the opposite of FirstEnergy and request a correction noting that the post-2020 baseline wattages in Table 2-2 may be too high. They state that it appears that these baselines are based on the 45 lm/W backstop standard in the EISA legislation. The Joint Commentators aver that the average efficiency of CFLs is already substantially above this standard requirement. Therefore, they recommend using efficiencies of the typical CFL for the post 2020 baseline, as opposed to the 45 lm/W backstop. They acknowledge that the baseline will most likely not shift immediately in 2020 and that there will be a lag of several years while existing inventory is de-stocked. Joint Commentators Comments at 7. FirstEnergy disagrees with the Joint Commentators’ analysis and recommendation. FirstEnergy Reply Comments at 3.

 **ii. Disposition**

There appears to be continued confusion surrounding the proposed EISA backstop provision for 2020. While many CFLs may exceed the 45 lm/W requirement, they do remain the least efficient technology to meet the EISA requirement, therefore, the Commission finds that the use of CFL efficiencies as proxies to serve as the baseline efficiencies in Table 2-2 to be reasonable at this time.

Regarding the lag of several years to allow existing inventory to de-stock, the legislation for 2020 pertains directly to the sale of inefficient bulbs that do not meet the standard (bulbs with < 45 lm/W), as opposed to the manufacturing and import of such bulbs, as was required for the 2012-2014 phase-in. As such, the current TRM has not allowed for a “sell-through” period, but the TRM does note that the post-2020 baseline should be re-evaluated if the 2020-backstop requirement is altered, delayed, or not implemented as planned. The Commission also directs the SWE to research the effects of the backstop provision on screw-based bulbs in commercial applications. If it deems it appropriate, the SWE may collaborate with the PEG in developing a recommendation.

#### Baseline Wattage for Post-2020 Installations

As the Commission had proposed that the 2016 TRM be effective throughout Phase III, we proposed that additional language be added to the TRM to account for bulbs installed after the 2020 EISA backstop provision. The Commission noted that these baseline assumptions would need to be adjusted in the event the backstop provision is altered, delayed, or not implemented as planned.

 **i. Comments**

The Joint Commentators comment that the baseline equipment is defined to be “a standard or specialty incandescent bulb.” They believe that this implies that there are no CFLs assumed in the baseline for the LED measure. Given high rates of free ridership typically found in CFL programs in other jurisdictions, as well as research in other states, the Joint Commentators believe it is clear that CFLs would have a significant market share even in the absence of program activity. Therefore, they suggest that the baseline for the LED measure assume a weighted average of EISA compliant incandescent bulbs and CFLs, as opposed to 100% CFLs. Joint Commentators Comments at 7.

 **ii. Disposition**

The Commission finds that the consistent treatment of the defined baseline equipment between the TRM and the SWE’s EE Potential Study addresses this issue. Specifically, for LEDs, the SWE’s EE Potential Study assumed an EISA-compliant halogen code baseline for LEDs, consistent with what is currently in the TRM. In this way there is consistency between the stated savings for LEDs in the SWE’s EE Potential Study – used to determine EDC savings goals – and the TRM values.

#### Hours of Use and Peak Coincidence Factors

####  The Commission proposed a revision of the HOU and peak coincident factor (CF) values to reflect the results of the SWE’s 2014 Residential and Commercial Baseline Studies. The SWE’s approach followed the methodology as set forth in the UMP. We proposed the incorporation of the 2014 Residential Baseline Study results into Table 2‑5.[[44]](#footnote-45) We noted that examination of efficient bulb saturation and HOU had not shown a clear linear relationship (*i.e.,* HOU does not appear to drop off as saturation increases). This seemed to indicate that the “all bulbs” number is appropriate only as homes approach maximum efficient bulb saturation (*e.g.,* 90% or greater sockets with efficient bulbs). Therefore, the Commission proposed the adoption of the efficient bulb HOU and CF for all upstream programs and direct installation programs that involve replacement of less than 90% of a home’s lighting sockets with efficient bulbs; whereas for direct installation programs that replace more than 90% of a home’s bulbs, the “all bulbs” HOU and CF would be used.

 **i. Comments**

PECO requests a correction to account for confusion surrounding the inclusion of two sets of HOU and CFs and suggests that Table 2-5 be updated to use only one set of values that closely reflects the actual program savings. PECO believes it unrealistic to require a determination of the percentage of a home’s sockets that have efficient bulbs. If the Commission keeps these in Table 2-5, PECO believes it is should clearly explain when each value should be used. PECO Comments at 6. PPL also suggests that the efficient hours of use and coincidence factors be clearly defined. PPL Comments at 4.

Regarding the CFs, the Joint Commentators suggest that, in Table 2-1, the summer CF of 0.091 is below the CF derived from a recent NMR lighting study in Massachusetts, New York, Rhode Island and Connecticut. The CF from that study most applicable to Pennsylvania is 0.14. Joint Commentators Comments at 6.

 **ii. Disposition**

 The proposed TRM included a paragraph immediately preceding Table 2-5 to directly address questions surrounding the use and application of the HOU and CFs. An additional sentence has been added to make it explicitly clear when the efficient values should be used relative to the all bulbs values and to clarify that the efficient bulb values should be used in cases where the home saturation of efficient bulb use is unknown (*e.g.,* upstream programs).

####  Regarding the Joint Commentator’s concerns about the CFs, the Commission is unsure of the 0.091 value that is referenced, since the TRM explicitly recommends using the 0.106 for efficient bulbs. Furthermore, the 0.106 is derived from the SWE’s 2014 Light Metering Study,[[45]](#footnote-46) which we find to be a more appropriate source.

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### 2. Section 2.2.1 – Electric HVAC[[46]](#footnote-47)

The Commission proposed, for Section 2.2.1, the addition of a “de facto” space heating baseline for scenarios in which a customer is relying on space heaters as the primary heating source where the customer’s oil furnace or boiler has failed and is beyond repair.

 **a. Comments**

PPL recommends adding a heating baseline to “New Construction Ground Source Heat Pump” in Table 2-11[[47]](#footnote-48) of the 2016 TRM, in order to align with other residential HVAC measures. PPL also suggests that footnote 53 be deleted as it is not applicable. PPL Comments at 4.

The Joint Commentators suggest that the default values include the data gathering option for the value EERe in the measure. The Joint Commentators also comment that the source listed for the furnace fan retrofit savings default values may not be applicable as the study looked at fans in newly installed furnaces. They note that the programmable thermostat savings of 2% for cooling and 3.6% for heating are low compared to other jurisdictions and further recommend the addition of a wifi or learning thermostat protocol. Joint Commentators Comments at 8-9.

FirstEnergy comments that the furnace fan retrofit is described as a fan retrofit, although it is more common to replace the entire air handler to improve fan efficiency. It recommends that the measure be categorized as “efficient furnace fan or air handler retrofit.” FirstEnergy Comments at 3.

 **b. Disposition**

The Commission rejects PPL’s request to strike footnote 53 as it exists to represent the instance where cooling that is integral to a new HVAC system is consequentially added to a residence where the heating system was defunct and replaced, resulting in calculations necessary to account for the energy consumption of both modes of operation. The Commission agrees, however, with PPL’s suggestion to add a heating baseline to “New Construction Ground Source Heat Pump” and has updated the TRM accordingly.

The Commission agrees with the Joint Commentators that EERe can be extended to EDC Data Gathering and has added that designation as an option. The value of SEER will continue to be acknowledged as the primary variable in the energy savings algorithms as it is commonly used in the industry to communicate efficiency. The Commission directs the SWE to review the studies used for the existing fan motor efficiency savings for future updates to the TRM as the current protocol has been modified to include motor savings with regards to air handler replacement, making the original source for motor savings more applicable in its research on new air handler units. The Commission further directs the SWE to review programmable thermostat and wifi‑enabled or smart thermostat measure research for modification of protocols in future TRM updates. The Commission also agrees with FirstEnergy and has adjusted the protocol to include air handler retrofits.

### 3. Section 2.2.3 – Ductless Mini-Split Heat Pumps[[48]](#footnote-49)

Similar to the Electric HVAC protocol, the Commission proposed the addition of a “de facto” space heating baseline in which a customer is relying on space heaters as the primary heating source where the customer’s oil furnace or boiler has failed and is beyond repair.

 **a. Comments**

The Joint Commentators note that the ENERGY STAR requirements are not up to date. Joint Commentators Comments at 9. FirstEnergy suggests that the Oversize Factor (OF) for de-facto space heaters should be 0.85 instead of 0.60. FirstEnergy states that, if the space heaters are providing all of the home’s space heating needs, then the OF should be 1.0. A ductless system has versatility similar to space heaters, therefore an OF factor of 1.0 would apply. To keep the TRM internally consistent, FirstEnergy avers that the OF would be the product of the 1.4 or 1.5 for central systems relative to ductless systems and the 0.6 for space heaters relative to central systems. This would make the OF value equal to 0.84 or 0.9. FirstEnergy Comments at 3. PPL requests that footnote 69 be removed as it addresses net savings, which it believes to be inappropriate. PPL Comments at 5.

 **b. Disposition**

The Commission agrees with the Joint Commentators that the ENERGY STAR requirements are not current and has updated the requirement to Air Source Heat Pump Eligibility Criteria Version 5.0, which is effective September 15, 2015. The Commission rejects FirstEnergy’s suggestion to make the OF 0.85. We note that the assumption used to derive the 0.60 OF value was that the space heaters are *failing* to provide the required load and are 40% undersized relative to a properly sized (OF=1.0) system. EDC data gathering is the preferred option for this variable and the observed capacity of de facto space heaters in a residence, relative to a correctly sized system, should be used.

The Commission also rejects PPL’s request to remove footnote 69. This footnote is meant to call attention to the fact that, in certain instances when a low income customer does not have cooling and *would not* have installed cooling in absence of the program, then the added cooling load from an ASHP operating in the summer would need to be factored into net savings calculations. The same goes for peak savings which are *negative* in that instance. The footnote does not include algorithms for net savings, but rather directs this specific situation toward another document, similar to Section 2.4.3 – Refrigerator/Freezer Recycling With and Without Replacement.[[49]](#footnote-50)

### 4.  Section 2.2.5 – Room AC Retirement[[50]](#footnote-51)

 Similar to Section 2.2.4, the Commission proposed updates to the ENERGY STAR requirements and default CEERee value with the ENERGY STAR Room Air Conditioner Product Criteria Version 4.0 value. We proposed updates to the default savings values to reflect these new ENERGY STAR requirements.

 **a. Comments**

PECO requests clarification of Source 5 regarding the default EER value of 12.1 and how it was determined. PECO Comments at 7.

  **b. Disposition**

 The Commission agrees and has clarified Source 5 by adding “Version 3.1 has both EER and CEER requirements for each RAC size and type. Version 4.0 does not. Therefore, the ratio of EER requirement to CEER requirement for an 8000 Btu/h unit with louvered sides (11.3/11.2) was applied to the CEER requirement (12.0) in Version 4.0 to get an equivalent EER of 12.1.”

### 5. Section 2.2.8 – Programmable Thermostat[[51]](#footnote-52)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

The Joint Commentators submit that the 2% cooling and 3.6% heating savings listed for programmable thermostats is low compared to other jurisdictions. Further, they recommend a separate characterization for wifi-enabled or learning thermostats. Joint Commentators Comments at 9. PPL agrees that a separate characterization for wifi‑enabled thermostats would benefit the TRM and recommends that an interim measure protocol be added for this measure. PPL Reply Comments at 3.

Nest requests that the Commission add a new residential protocol for the inclusion of a smart, internet connected thermostat (SICT). Additionally, Nest requests that the Commission should allow for an update process for the TRM to include new technologies, in order to avoid having to wait until the year 2021. Nest Comments at 2.

 **b. Disposition**

The Commission will continue to encourage new technology as a growing part of the TRM. At this time, the Commission rejects the request to modify the existing thermostat savings or add an additional thermostat measure without further investigation. Instead, the Commission directs the SWE to investigate the applicability of all smart, wifi-enabled or internet connected thermostats for future modifications to the TRM.

### 6. Section 2.3.2 – Heat Pump Water Heaters[[52]](#footnote-53)

 The Commission proposed updates to the ENERGY STAR Requirements and the default energy factor of proposed efficient water heater (EFee) values with the ENERGY STAR Product Criteria for Residential Water Heaters Version 3.0 values[[53]](#footnote-54) that became effective on April 16, 2015.

 **a. Comments**

The Joint Commentators note that the SEER and HSPF values used for interactive effects estimations are not consistent with those in other measures in the TRM. Joint Commentators Comments at 9.

 **b. Disposition**

The Commission agrees that the SEER and HSPF should be consistent with other sections of the TRM that use 2014 Residential Baseline Study values. These values have been updated to 11.0 and 6.9, respectively. Additionally, this change has been made to Section 2.3.4 Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater.

### 7. Section 2.3.4 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater[[54]](#footnote-55) and Section 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater[[55]](#footnote-56)

 The Commission proposed updates to the ENERGY STAR Requirements and default fossil fuel EF values with the ENERGY STAR Product Criteria for Residential Water Heaters Version 3.0 values.

 **a. Comments**

PECO suggests updating the subscript for EF in the Fuel Consumption algorithm from EFNG,inst so that it is not specific to natural gas. PECO Comments at 8.

 **b. Disposition**

The Commission agrees with PECO and has updated “EFNG,inst”to “EFinstalled” to apply to other types of fossil fuels and to clarify that “inst” refers to the “installed” water heater, not “instantaneous.” This change has been made to both Sections 2.3.4 and 2.3.5.

### 8. Section 2.3.7 – Water Heater Pipe Insulation[[56]](#footnote-57)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 PECO suggests that instead of this measure stating that it applies to “insulating 10 feet of exposed pipe," the statement refer to "insulating exposed pipe" and no length specification. PECO Comments at 8.

 **b. Disposition**

 The Commission agrees and has modified the eligibility language to allow the installation of any length of pipe insulation.

### 9. Section 2.3.9 – Low Flow Faucet Aerators[[57]](#footnote-58)

 The Commission proposed clarification of the variable for the percentage of homes with electric water heating (ELEC) by specifying the implied default as “Unknown” and further adding the EDC data gathering options as “Electric” and “Fossil Fuel.” For clarity, a new column, titled “ELEC,” would be added to the Default Savings Table in order to provide the variable values for the default savings calculations. Additionally, the table would be expanded to provide default savings values for a case in which the water heater fuel is known to be electric and the ELEC equals 100%. This variable clarification and default savings table expansion were proposed for the Low Flow Showerheads[[58]](#footnote-59) and Thermostatic Shower Restriction Valve[[59]](#footnote-60) protocols, as well.

 **a. Comments**

 The Joint Commentators suggest that the electric savings accommodate homes with a HPWH, which would provide fewer savings than a standard electric. Additionally, they suggest that the water heater Energy Factor (EF) be used instead of Recovery Efficiency (RE). These comments were made for Sections 2.3.8, 2.3.9 and 2.3.10.

 **b. Disposition**

The Commission agrees that HPWHs should be able to be included in the savings analysis of these measures and has added the option to use a RE of 2.1 for homes with a HPWH. The default will remain 0.98 (standard electric) since the 2014 Residential Baseline Study showed that less than 1% of electric water heaters are HPWHs.

The Commission rejects the suggestion that EF be used instead of RE for calculating the savings. These measures calculate the energy saved through using less hot water due to the installation of retrofit accessories. As such, they do not affect the standby energy usage of the water heater, but rather the volume of water that is heated from the input temperature to the output temperature. EF has standby losses incorporated into it, whereas RE does not.

### 10. Section 2.4.1 – ENERGY STAR Refrigerators[[60]](#footnote-61)

 The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

#### a. Comments

The Joint Commentators point out that the statement regarding 20% savings over standard, as well as Most Efficient being 30% better than the Federal standard, is incorrect. They also note that the default values for Most Efficient should be updated to reflect the current list of qualifying units. Joint Commentators Comments at 10-12.

 **b. Disposition**

 The Commission agrees that the ENERGY STAR refrigerator savings are only about 10% over standard and that the “Most Efficient” savings are about 15%. This change has been made in the Eligibility description of the measure. The Commission also agrees that the Most Efficient default values should be updated with the most current qualifying unit data. This change has been made with reference to the list as of June 2, 2015.[[61]](#footnote-62)

### 11. Section 2.4.3 – Refrigerator/Freezer Recycling With and Without Replacement[[62]](#footnote-63)

 During the 2015 TRM update, the Commission updated the Refrigerator/Freezer Recycling With and Without Replacement protocol to fully correspond with the UMP.[[63]](#footnote-64) However, in its Tentative Order, the Commission recognized that the inclusion of references to net calculations and savings may be confusing as the EDCs are only required to calculate savings on a gross basis. Therefore, we proposed the removal of all text describing calculations of net savings. Additionally, we proposed the inclusion of a reference to the SWE’s Evaluation Framework,[[64]](#footnote-65) which provides interested parties with more information regarding the application of the UMP.

 **a. Comments**

 The Joint Commentators note that the refrigerator/freezer recycling algorithms estimate savings based on data collected in Program Year Five (PY5). However, a key input in the algorithm is the percentage of units manufactured before 1990. They aver that one would expect this value to decline over time. Given the proposed multi-year nature of the 2016 TRM, the Joint Commentators believe that there should be some attempt to estimate how this variable will change (*i.e.,* decline, over time). The Joint Commentators also note that the regression equations are informed by data or protocols developed in 2013 for refrigerators (and most likely using 2011 and/or 2012 program data) and 2011-2012 for freezers. As the stock of older units continues to turn over, they believe one might expect that the savings from recycled refrigerators would fall. Therefore, they recommend looking at data from long-standing programs (*e.g.,* those in California) that might inform how recycling savings trend over time. Joint Commentators Comments at 12. PPL recommends updating the "PART\_USE" values as the PART USE values listed in the proposed 2016 TRM are based on Program Year Three data and were calculated before the release of the UMP. PPL Comments at 6.

 **b. Disposition**

 The Commission agrees with the Joint Commentators that the savings values for recycled units will decline over time as the stock of program appliances includes more recent, rather than older, vintages. The largest single driver of this importance is the percentage of units manufactured prior to 1990 and we do recognize that the default values from PY5 will likely overstate the percent of units manufactured prior to 1990 for program units that enter the Phase III programs. Given that the program tracking contains a field for age of the unit, we have removed these default values and required EDC data gathering for this parameter input value. Where age is missing in the tracking data, average values can be used.

 Regarding modifying the regression model, the model included in the TRM is from the UMP and is based off of five different metering efforts throughout the United States. Additionally, we believe it reflects the most rigorous and reliable information available. Predicting how the coefficients would change over time would be speculative, and thus we have not modified the regression model. However, we direct the SWE to monitor this issue and provide recommendations, as necessary, for a future TRM updates.

 While PART USE values provided in the TRM may have been derived prior to the finalization of the UMP, they are the most current information available that reflect Pennsylvania-specific data. The TRM does include a note that EDCs may elect to calculate an EDC-specific part-use factor and, if electing to do so, should follow the methodology described in Section 4.3 of the UMP protocols. Research values could then be used to inform future versions of the TRM.

### 12. Section 2.4.4 – ENERGY STAR Clothes Washer[[65]](#footnote-66)

 The Commission proposed updates to the ENERGY STAR Requirements and integrated modified energy factor (IMEF) values with the ENERGY STAR Product Criteria for Residential Clothes Washers Version 7.0 values[[66]](#footnote-67) that became effective on March 7, 2015. The Commission also proposed updates to the algorithms and the modified energy factor (MEF) definition to the new IMEF definition, which includes standby and low power mode energy consumption.

 **a. Comments**

 PECO suggests that Source 6 be changed to a root source rather than referencing other TRMs. PECO Comments at 8.

 **b. Disposition**

 The Commission agrees and has updated timecycle to 1.04 based on metered data from Navigant Consulting’s *EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Appliance Rebate Program*, March 21, 2014, page 36. This is the source used by the Mid-Atlantic TRM, with the 1.04 value derived from 254 cycles per year and 265 hours per year run time.

### 13. Section 2.4.5 – ENERGY STAR Dryers [[67]](#footnote-68)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 The Joint Commentators state that current ENERGY STAR clothes dryer default savings of 25 kilowatt-hours (kWh) for a standard dryer are too low. ENERGY STAR states that savings are 20% and the TRM dryer fuel switch measure has base dryer consumption at 905 kWh/yr. The Joint Commentators aver that savings should, therefore, be around 150 -170 kWh/yr. Further, savings from an ENERGY STAR heat pump clothes dryer will likely be twice that of a standard ENERGY STAR dryer. Therefore, they recommend that this be characterized as a separate measure.

 **b. Disposition**

The Commission disagrees that the savings are too low. They are based on Pennsylvania-specific cycles per year, standard test load weight and combined energy factors (CEFs) that are derived through standard test requirements. However, comparing savings to the dryer fuel switching measure[[68]](#footnote-69) did alert the Commission to the fact that the fuel switching deemed savings required updating based on the amended federal standard which is discussed later. Regarding heat pump clothes dryers, the Commission directs the SWE to research this emerging technology and investigate whether a new measure is required to accommodate it.

### 14. Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer[[69]](#footnote-70)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 The Joint Commentators state that deemed savings of this measure are high compared to the ENERGY STAR Dryer measure. They also note that the fuel switch dryer measure calculates the increased gas use simply by taking the eliminated kWh usage and converting it to MMBtu. They believe this is not necessarily accurate, as the gas dryer will have a different efficiency than the electric dryer. Therefore, they recommend that the characterization specify that the gas dryer is ENERGY STAR rated and that the EDCs manually calculate the increased gas use with the appropriate efficiency value. Joint Commentators Comments at 12.

 **b. Disposition**

The Commission agrees that this measure should be consistent with the ENERGY STAR Dryer measure and has updated the deemed savings based on the new federal standard requirements. The deemed savings value now comes from an ENERGY STAR Market and Industry Scoping Report for Residential Clothes Dryers,[[70]](#footnote-71) with the annual kWh scaled to that of Pennsylvania using the cycles per year from the 2014 Residential Baseline Study. Additionally, the Commission agrees that the new gas dryer should have an ENERGY STAR requirement, similar to the other residential fuel switching measures and that the increased gas usage should be based on a gas dryer with the corresponding ENERGY STAR efficiency.

### 15. Section 2.5.2 – ENERGY STAR Office Equipment[[71]](#footnote-72)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 The Joint Commentators suggest that the deemed values in this measure be updated with reference to the newest ENERGY STAR requirements and ENERGY STAR savings calculator. Joint Commentators Comments at 13.

 **b. Disposition**

 The Commission agrees with this suggestion and has updated all deemed values with the appropriate ones in the ENERGY STAR Office Equipment Calculator (updated December, 2014).[[72]](#footnote-73) Additional sub-categories have also been added corresponding with the newest ENERGY STAR calculator: laptop computer, ink jet printer, ink jet multifunction machine, and additional image/min selections.

### 16. Section 2.5.3 – Smart Strip Plug Outlets[[73]](#footnote-74)

The Commission proposed the addition of savings algorithms and estimates for Tier 2 Smart Strips.

 **a. Comments**

Tricklestar requests that the language in the eligibility section be changed to specifically state that commercial applications are also appropriate for Smart Plug Outlets. Additionally, Tricklestar recommends that the Tier 2 smart strip definition be revised to be more general so as to apply to all manufacturers equally. Tricklestar Comments at 2. Duquesne notes that there are inconsistencies between the smart strip sections for residential and C&I. Measure life for C&I applications is specified as half of the value as that given for residential uses of smart strips. Also, the residential section provides deemed savings and algorithms for both tier 1 and tier 2 smart strips; however, the C&I section does not make this distinction. Duquesne suggests that the two sections be made consistent. Duquesne Comments at 9-10.

 **b. Disposition**

The Commission accepts Tricklstar’s request and has clarified in the eligibility section that smart strips are also appropriate for commercial applications, providing a reference to the Commercial protocol, Section 3.9.3. The Commission also agrees with Tricklestar’s recommendation to revise the Tier 2 definition so as to be more general and has updated the TRM accordingly.

The Commission also agrees with Duquesne that the measure life should be the same for both residential and C&I smart strip measures and has amended the residential measure life to five years, using the same source as C&I. The Commission disagrees, however, with the recommendation to have the residential and C&I savings mirror each other. The primary use for smart strips in the residential sector is for entertainment systems, whereas the C&I is office computer workstations. Both the controlled equipment and usage patterns differ greatly between residential and C&I.

### 17. Section 2.6.1 – Ceiling / Attic and Wall Insulation[[74]](#footnote-75)

The Commission did not propose any changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

The Joint Commentators recommend that energy modeling be used for cooling savings for insulation as it would provide a simplified savings adjustment and would possibly eliminate the need for the Discretionary Use Adjustment and Attic Heating Factor, as these values do not show much use. Further, the Joint Commentators state the use of cooling degree day (CDD) base 65 and heating degree day (HDD) base 65 is not appropriate for current homes and that the Discretionary Use Adjustment factor be applied to heating as it is for cooling. Joint Commentators Comments at 13-14. PECO suggests the removal of footnotes 195 and 196 in Table 2-106[[75]](#footnote-76) as they no longer apply. PECO Comments at 8.

 **b. Disposition**

The Commission rejects the suggestion to use energy modeling for cooling savings with regards to insulation due to the time intensity of energy modeling and the variables that would need to be determined across multiple rating files and homes. The Commission directs the SWE to investigate further the applicability of energy modeling for insulation savings. The Commission rejects the adjustment of CDD base 65 and HDD base 65 or the Discretionary Use Adjustment factor and further directs the SWE to investigate the appropriateness of the inputs. The Commission also rejects the removal of footnotes 195 and 196 as we find that they are still applicable.

### 18. Section 2.6.2 – ENERGY STAR Windows[[76]](#footnote-77)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 The Joint Commentators recommend using RESFEN[[77]](#footnote-78) to model window savings as opposed to REM/Rate as RESFEN was developed specifically to model residential window energy use. Joint Commentators Comments at 14.

 **b. Disposition**

The Commission does not believe it has enough information, at this time, regarding the RESFEN model to warrant a change to the TRM. Therefore, we direct the SWE to investigate whether an update is required for the measure and whether the suggested software is the best option and provide recommendations, as necessary, in future TRM updates.

### 19. Section 2.6.3 – Residential New Construction[[78]](#footnote-79)

The Commission did not propose any changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

The Joint Commentators recommend the use of onsite surveys instead of code minimums for setting a baseline, citing the uncertainties involved in code enforcement and regulation. Further, the Joint Commentators recommend that the CF of 0.647 should be adjusted to an average of all CFs applicable to new construction, notably lighting. Joint Commentators Comments at 14. PPL recommends updating any applicable values in the User Defined Reference Home Table 2-111 to reflect the most recent codes and standards. PPL Comments at 11.

 **b. Disposition**

 As discussed previously, the Commission rejects the suggestion by the Joint Commentators to move towards a market baseline. Further, the Commission rejects the suggestion to aggregate the CFs in a new construction home to one CF as the coincident peak aligns primarily with HVAC cooling. The Commission accepts the recommendation to update any applicable values in the User Defined Reference Home table addressed later in this Order.

### 20. Section 2.6.4 – Home Performance with ENERGY STAR[[79]](#footnote-80)

The Commission did not propose any changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

The Joint Commentators provide comments with reference to the Home Performance with ENERGY STAR measure; however these comments reference a Table 2-111 in the Residential New Construction measure (Table 2-110 in the 2015 TRM). The Joint Commenters state that the ground source heat pump (GSHP) efficiencies seem low; the boiler baseline is now higher; the modeling temperature for heating is likely high; the 2009 IRC code does not require 50% efficient lighting when using the compliance path, and further requests an update on the timing of the code adoption in Pennsylvania. Joint Commentators Comments at 15.

 **b. Disposition**

The Commission rejects both the adjustment to the GSHP efficiencies as they are current and any modification to the modeling temperature of 70 degrees as it exists in IRC N1103.1.1.[[80]](#footnote-81) The Commission accepts the suggestion to adjust the lighting requirement of the reference home and has removed the 50% efficacy requirement for lighting and clarified the boiler efficiencies by adding the boiler types to the table.

### 21. Section 2.6.5 – ENERGY STAR Manufactured Homes[[81]](#footnote-82)

The Commission did not propose any changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

 PPL states that the reference to Table 2-111 is incorrect and should refer to Table 2-114. Further, PPL recommends updating Table 2-114 to reflect any updates resulting from code changes. PPL Comments at 11.

 **b. Disposition**

 The Commission agrees with PECO and has updated the references and some values in the Table 2-114 to align with Table 2-111.

## F. Commercial and Industrial EE&C Measure Protocols

 The following sections describe clarifications and modifications to the C&I measure protocols:

### 1. Section 3.1.1 – Lighting Fixture Improvements[[82]](#footnote-83)

#### a. Update Hours of Use and Coincidence Factors

In the Tentative Order, the Commission proposed updating the HOU and CF values for general service lighting with the results from the SWE’s 2014 Light Metering Study*.* In addition, the Commission recommended establishing an alternate HOU and CF table for screw-based CFL and LED bulbs. The Commission also proposed the addition of default HOU and CF values for street lighting associated with an EDC-specific rate schedule. Rate schedule burning hours per year better align with how the EDCs bill these accounts for electric service.

As the Appendix C – Lighting Inventory Tool allows users to input custom operating schedules with calculated HOU and CF values regardless of the chosen facility type, the Commission proposed the removal of the “other” building type. In the calculator, with the appropriate building type selected, the user would specify if they intend to use the TRM assumptions or site-specific operating schedules. Site-specific values will be calculated based on customer input of a facility-specific operating schedule.

 **i. Comments**

PECO notes that it is not clear why HOU and CF values for eleven building types were removed. PECO also comments that the removal of the “other” option will lead to confusion when the implementers and evaluators try to apply a project that may not clearly fit into any of the default building types. Therefore, PECO recommends retaining the eleven space types and including an option to use the general service lighting HOU and CF if default values are not available for screw-based lamps for these building types. PECO Comments at 10. FirstEnergy agrees with PECO’s comment to keep the “other” facility category and also recommends revising the HOU for photocell-controlled lighting to be consistent with HOU for street lighting. FirstEnergy Comments at 4; FirstEnergy Reply Comments at 6.

Duquesne comments that the default HOU and CF values are overly simplistic and lower than other regional sources. For example, HOU in a dentist’s office is treated the same as that in a hospital since they are both labeled “health.” Duquesne argues that treatment of such different environments as the same will result in skewed values as lighting is used significantly less in a dentist’s office than in a hospital. Duquesne Comments at 3-4. PPL avers that there is inconsistency in the TRM regarding site-specific versus default CF values. PPL Comments at 9-10.

 **ii. Disposition**

While the Commission recognizes that default HOU and CF values may not be applicable for all projects, we emphasize that the TRM includes an option for EDCs to use site-specific data when default values are not available. The Commission notes that most of the default building types were determined from the results of the SWE’s 2014 Light Metering Study. HOU and CF values for building types that were not evaluated in the 2014 Light Metering Study were retained from the 2015 TRM. The SWE’s approach to the 2014 Light Metering Study was to achieve results with ±15% precision at the 90% confidence level. To provide more granular values would decrease the confidence intervals and consequently reduce the validity of the results. The Commission believes that the precision of the values was important, especially since the TRM allows the EDCs to use site-specific HOU and CF values when the defaults are not applicable. The Commission also notes that, with the exception of the “multi-family (common area)” building type, all of the removed building types were included in the results of the 2014 Light Metering Study. Therefore, we will retain the “multi-family (common area)” default values in the TRM. Since the “other” category was already represented in the “miscellaneous” building type, we have modified the “miscellaneous” label to “miscellaneous/other.”

The Commission rejects PECO’s recommendation to use general service lighting defaults where screw-based defaults are unknown as the results of the 2014 Light Metering Study show that screw-based bulbs operate 9% less across all building types. We also reject FirstEnergy’s recommendation to use the street lighting HOU for exterior lighting as exterior lights may be controlled by a variety of technologies such as photocells and timers.

Regarding Duquesne’s comment, the Commission emphasizes that the HOU and CF values are averages of all space types occurring within all building types. Not all space types are always indicative of the way we perceive the building type as a whole. For example, buildings with larger footprints (*e.g*., hospitals and nursing homes) were found to have larger portions of spaces where lighting was rarely used; these spaces include private restrooms, storage areas, conference rooms, shipping and receiving bays, and patient rooms/wing. Buildings with smaller footprints (*e.g.,* dentist and doctor offices) had much more consistent lighting loads across all spaces as they do not have the footprint to accommodate unused rooms. The goal of the default values is to capture all of these possibilities of space types within one building type. So while the default value does not apply to every space type inside the building, it is an accurate representation of the entire building.

The Commission agrees with PPL and clarifies that site-specific CFs must be used to calculate savings if actual operating hours are used. We have removed the referenced sentence from the TRM.

#### b. Interactive Factors

In the 2015 TRM, interactive effects were presented only as a factor of space conditioning type (comfort cooled space, freezer space, unconditioned space, etc.). However, in our Tentative Order, we expressed a belief that this was an oversimplification of a much more complicated calculation based on several factors, such as lighting load shape, installed and removed lighting specifications, heating and cooling efficiencies, heating and cooling set points, heating fuel type, and dry bulb temperature. Therefore, the Commission proposed to adopt, for all comfort-cooled spaces, the energy and demand interactive factors (IFs) determined from the 2014 Light Metering Study. We proposed that spaces with other conditioning types remain consistent with the 2015 TRM as they were not evaluated as part of the 2014 Light Metering Study.

Appendix C would allow for unique IF values associated with each line item, which will be calculated as a function of lighting load shape (as dictated by the facility type), space conditioning type and primary heating fuel. In the event that electricity is the primary heating fuel source, the IF values calculated at 100% electric heat would apply to all spaces marked as being comfort-cooled. Similarly, if any other fuel source is the predominant fuel source, the IF values calculated at 0% electric heat would be applied to all comfort-cooled spaces. In the event that fuel source is unknown or otherwise left blank, a default value of 0% would be used for the IFenergy value; the assumed IFdemand would be the default value corresponding to the facility-type selected as dictated in Table 3-9.[[83]](#footnote-84) The Commission expressed a belief that this assumption would be fair as the state average for electric heating saturation was found to be 12%, implying that electricity is not the predominant heating fuel.

 **i. Comments**

PPL seeks clarification on whether the “cooled space” IFs should be removed from Table 3-8.[[84]](#footnote-85) PPL Comments at 9-10. FirstEnergy notes that IFenergy and IFdemand distributions that correspond to the two different heating fuels are so homogenous that differentiation by building type can raise potential for calculation errors. For consistency, FirstEnergy recommends applying average IF values to all building types. FirstEnergy Comments at 4-5.

 **ii. Disposition**

The Commission accepts PPL’s recommendation and has removed “cooled space” IFs from Table 3-8. We also agree with FirstEnergy to average the IF values by heating fuel and has revised Appendix C accordingly.

#### c. Linear Fluorescent Baseline Shift

The Energy Policy Act of 2005 (EPAct 2005) and EISA 2007 effectively phased out magnetic ballasts as of October 1, 2010 and most T-12 bulbs as of July 14, 2012.[[85]](#footnote-86) To account for the time required for the market to adjust to the new codes, standard T-8s are assumed to become the baseline for all T-12 linear fluorescent retrofits beginning June 1, 2016 (program year eight). The 2015 TRM provided savings adjustment factors and adjusted EUL values to calculate lifetime savings for standard T-8, HPT8 and T-5 measures. EDCs were able to claim full first-year savings and then apply the savings adjustment factor or reduced EUL to adjust lifetime savings due to the baseline shift from T-12s to T-8s. Because the 2016 TRM will be effective starting June 1, 2016, these savings adjustment factors and adjusted EULs will no longer be applicable. Therefore, the Commission proposed the removal of the methodology and values (Table 3-2,[[86]](#footnote-87) Table 3-3,[[87]](#footnote-88) and Table 3-4[[88]](#footnote-89)) for calculating the adjusted lifetime savings.

To account for the baseline shift, the Commission also proposed the inclusion of a table in the 2016 TRM that maps T-12 fixture configurations to a comparable T-8 baseline fixture of the same length and lamp count with a normal ballast factor (0.85). The standard T-8 fixture codes and wattages associated with the most common T-12 fixture configurations would be presented in the table.

 **i. Comments**

Duquesne avers that a dual baseline does not accurately reflect the way customers behave as there is a high saturation of equipment that remains in use far beyond manufacturer’s estimated useful life. Duquesne also notes that its tracking system lacks the capability to address this change for measures with dual baselines and anticipates that a system change would take substantial time and have a significant cost. Duquesne Comments at 5. Duquesne also states that T-12 bulbs and magnetic ballasts continue to be available for purchase and that there is a lack of enforcement of these non-compliant products by the federal government. Therefore, Duquesne asserts that the baseline assumptions are overly severe and recommends moving the baseline shift back three years. *Id.* at 6.

The Joint Commentators recommend adjusting the incremental cost of retrofitting T-12 fixtures to High Performance T-8s (HPT8s) to the incremental cost of retrofitting standard T-8s to HPT8s. Joint Commentators Comments at 16. PPL requests clarification regarding the source of the assumed T-8 baseline wattages and the SWE’s use of varying linear fluorescent lighting baselines in the SWE’s EE Potential Study. PPL Comments at 9-10.

 **ii. Disposition**

The Commission rejects Duquesne’s recommendation to remove the dual baseline language from the TRM. Although the Commission recognizes that this approach may add complexity to program tracking, evaluation and TRC calculations, the Commission believes that it is the most accurate way to capture savings. The dual baseline method takes into account improvements in technology that would be driven by the market in cases where baseline changes are known and significant. To credit an EE&C program with lifetime energy and peak savings that will be necessitated by market changes would produce distorted benefit-cost ratios in the TRC Test. The Commission further clarifies that the dual baseline approach will not impact EDCs’ first year energy and peak demand savings, which are used to determine EDC compliance. The measure vintages and measure lives provide guidelines for TRC tests as energy savings or useful life are reduced to reflect the changing baseline values. In response to PPL’s comment, the Commission clarifies that the assumed T-8 baseline wattages are derived from the standard wattage table that was developed in previous TRMs and continuously revised based on EDC input.

The Commission also rejects Duquesne’s recommendation to move back the baseline shift for three years as compliance with these federal code changes have been introduced since the 2013 TRM and continuously discussed during each TRM update. We believe that the EDCs had sufficient time to prepare and adjust their program offerings to account for this baseline shift. The Commission agrees with the Joint Commentators’ suggestion and notes that the incremental costs have been adjusted in the SWE’s Incremental Cost Database.

#### d. Thresholds for Using Default Values

In the 2015 TRM Final Order, the Commission directed the SWE to review the evaluation results from program year five (June 1, 2013 to May 31, 2014) (PY5) in order to research thresholds for future TRM updates that will balance the level of evaluation rigor and the need for accurate savings estimates with the level of costs required to collect customer-specific data.[[89]](#footnote-90) The SWE reviewed sampled PY5 projects and determined that only 54 C&I projects above 500,000 kWh were recorded statewide. Only a subset of these 54 projects were lighting projects. The Commission saw no evidence that the thresholds for site-specific data collection were overly burdensome to EDCs or their contractors.

In order to justify a sampling precision requirement of 15% at the 85% confidence level and the relatively low resulting sample sizes, the Commission expressed a belief, in its Tentative Order, that verification approaches used for high-value projects within the sample should be rigorous and meaningful. Therefore, the Commission proposed to maintain current thresholds and to continue monitoring evaluation results and review thresholds annually.

 **i. Comments**

PPL recommends instituting a cap on the number of projects that must be metered per program year. PPL comments that, based on historical program year data, PY5 was an anomaly for all EDCs, resulting in a smaller number of projects above the threshold. PPL notes that there are 47 projects to date that would require metering in Program Year Six (PY6). Therefore, PPL proposes that each EDC’s evaluator annually meter a sample of up to 15 lighting projects with reported savings of 500,000 kWh or more. If there are 15 or fewer projects, the evaluator will select a random sample of 15 projects. PPL Comments at 7. FirstEnergy generally agrees with PPL’s recommendation to cap the number of “above threshold” projects that must be metered per program year. However, FirstEnergy recommends raising the thresholds to 1,000 megawatt-hours (MWh) for lighting. So far, FirstEnergy has conducted metering for at least 60 projects in PY6 and believes that the current thresholds will result in sub-optimal evaluation resource allocation. FirstEnergy Reply Comments at 5.

 **ii. Disposition**

The Commission recognizes that PY5 may have been an anomaly since PPL and FirstEnergy saw significant increases in the number of lighting projects that require metering in PY6. The Commission rejects PPL’s recommendation to cap the number of “above threshold” projects required for metering to 15 projects, because we believe that there is no clear way of determining a single cap that can be applicable to all EDCs. The Commission, however, has increased the lighting metering threshold to 750,000 kWh. We believe that the new threshold will balance the level of evaluation rigor and the need for accurate savings estimates with the level of costs required to collect customer-specific data. The Commission also clarifies that EDC evaluation results will be monitored to determine if thresholds need to be adjusted in future TRM updates.

#### Evaluation Protocols

The 2015 TRM allowed EDCs to use the prescriptive lighting table in Appendix C to estimate savings for lighting projects with connected load savings less than 20 kW. In the Tentative Order, the Commission proposed to remove this option. The Commission expressed a belief that the enhanced usability and functionality of Appendix C would increase accuracy in savings calculations while reducing tediousness associated with filling out the calculator for projects of minimal savings. The prescriptive lighting table in the 2015 TRM was based on linear calculations where all assumptions were based largely on the selected building type. The proposed version of Appendix C for the 2016 TRM defined assumptions based on multiple inputs, including building type, space cooling type, heating fuel, etc. and, as such, is less linear. Use of Appendix C for all projects would ensure consistency in how these advanced savings are calculated and reported.

 **i. Comments**

No comments were received regarding the use of Appendix C for all lighting improvement project savings calculations. However, the Joint Commentators recommend including language in the TRM to explicitly allow lighting loggers as a means of fulfilling the M&V requirements for projects above the metering threshold. Joint Commentators Comments at 17.

 **ii. Disposition**

The Commission adopts the proposed changes to Appendix C. The Commission further clarifies that Appendix C does not provide savings calculation tools for traffic lights, exit signs and LED channel signage. Savings algorithms for these technologies are provided in Section 3.1.4 – Traffic Lights,[[90]](#footnote-91) Section 3.1.5 – LED Exit Signs[[91]](#footnote-92) and Section 3.1.6 – LED Channel Signage,[[92]](#footnote-93) respectively. The Commission agrees with the Joint Commentators’ recommendation and has added language in Section 3.1.1 – Lighting Improvements and Section 3.1.2 – New Construction Lighting to allow lighting loggers as an M&V method.

#### Measure Life

The Commission did not propose changes to the measure life of this protocol. However, comments were received and are addressed below.

 **i. Comments**

Duquesne recommends using the same measure life for both lighting fixture improvement and new construction measures given that deep retrofits of a facility are often treated as new construction measures. Duquesne Comments at 6. The Joint Commentators note that the measure life for screw-based bulbs is typically much shorter than for lighting fixtures. The Joint Commentators recommend revising the protocol to include a table showing different measure lives for different lighting technologies such as lighting fixtures, screw-based CFLs and screw-based LEDs. Joint Commentators Comments at 15.

 **ii. Disposition**

The Commission rejects Duquesne’s recommendation to use the same measure life for both measures and accepts the Joint Commentators’ comment to establish different measure lives based on lighting technologies. The new measure life values are calculated by dividing the rated life values[[93]](#footnote-94) of lamps and ballasts by the average HOU for all building types. The Commission has also revised the measure name of the protocol to “Lighting Improvements” to reflect the measure life changes.

#### Operation & Maintenance (O&M) Benefits

The Commission did not propose the addition of O&M benefits to this protocol. However, comments were received and are addressed below.

 **i. Comments**

The Joint Commentators recommend adding a table in the TRM that includes estimated replacement costs for common lighting measures. Joint Commentators Comments at 16. PPL believes that O&M benefits should be accounted for in the TRC calculations instead of the TRM. PPL Reply Comments at 3.

 **ii. Disposition**

The Commission rejects the Joint Commentators’ recommendation and agrees with PPL that the TRM is not intended to define how to estimate non-electric savings, such as O&M.

### 2. Section 3.1.2 – New Construction Lighting[[94]](#footnote-95)

In the 2015 TRM Final Order, the Commission directed the SWE to review the ASHRAE 90.1‑2007[[95]](#footnote-96) standards that require occupancy sensors in three new construction space types (classrooms, meeting/conference areas, and lounge/break rooms) and provide recommendations to the Commission.[[96]](#footnote-97) Based on the SWE’s research, in our Tentative Order, the Commission proposed updates to the baseline savings factor (SVG) values for new construction projects. The proposed baseline values would be specific to each building type and were determined by scaling the mandated SVG of 24% associated with mandatory occupancy sensors by the percentage of load contribution found to occur in spaces where controls are required (*i.e.,* classrooms, meeting/conference areas and lounge/break rooms), as found in the SWE’s 2014 Light Metering Study.

 **a. Comments**

Duquesne comments that the (1-SVGbase) term has been omitted from the demand savings formula. Duquesne Comments at 7. FirstEnergy recommends revising the metering requirements to EDC data gathering given the uncertainties associated with early occupancy in new construction. FirstEnergy also recommends clarifying the default SVG values as default values absent of EDC data gathering. FirstEnergy Comments at 6.

 **b. Disposition**

The Commission agrees with both Duquesne and FirstEnergy’s recommendations and has updated the TRM accordingly. The Commission had also updated Appendix C based on Duquesne’s feedback.

### 3. Section 3.2.1 – HVAC Systems[[97]](#footnote-98)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

PECO comments that the equivalent full load hours (EFLHs) and CFs in the HVAC protocol no longer include several building type options that were available in the previous TRMs. PECO emphasizes that the “multi-family (common areas)” is of key concern as most multi-family buildings do not have building management systems in place and requiring modeling or logging to determine EFLH would be a significant barrier to participation. PECO also recommends that an “other” building type be included to allow for buildings that do not fit into the default building types. The values provided for this “other” category could either be an average of the rest of the building types or the TRM could require EDC data gathering to develop values. PECO Comments at 11. FirstEnergy agrees with PECO that the “other” building type should be included. FirstEnergy also believes that, since prescriptive HVAC projects usually represent an insignificant portion of portfolio costs or impacts, there is little risk related to using stipulated hours of use rather than relying on EDC data gathering. FirstEnergy Reply Comments at 6. PECO also recommends updating the “manufacturing - bio/tech” category to something more descriptive. PECO Comments at 11.

 **b. Disposition**

The Commission accepts PECO’s recommendation to include default EFLH and CF values for the “multi-family (common areas)” building type. The Commission rejects PECO’s and FirstEnergy’s recommendation to add an “other” category as the TRM already has an option for EDCs to gather site-specific data if default EFLH values are not applicable. We also added an “EDC Data Gathering” option for CF values. Finally, the Commission agrees with PECO to update the “manufacturing - bio/tech” category and has revised the option to “manufacturing – bio tech/high tech.”

### 4. Section 3.2.2 – Electric Chillers[[98]](#footnote-99)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

Duquesne notes that this protocol does not apply to Variable Frequency Drive (VFD) retrofits to an existing chiller because the Integrated Part Load Value (IPLV) for the old chiller or the new VFD would be unknown. Duquesne asserts that this eligibility restriction provides little to no direction in cases where an existing chiller is being modified by adding a VFD. IPLV is a performance characteristic developed based on the Air-Conditioning, Heating and Refrigeration Institute’s (AHRI) test conditions. Duquesne notes that it is common for systems to be operated at conditions other than those designated by AHRI. Duquesne recommends clarifying that if a manufacture-certified IPLV rating is not available, the Nonstandard Part Load Value (NPLV) should be used with parameters specified (chilled water set point, returning water temperature, condenser water flow rate, and entering condenser water temperature). Duquesne Comments at 12-13.

 **b. Disposition**

The Commission generally agrees with Duquesne concerning the use of NPLV. The Commission recognizes that it is common for systems to be operated at conditions other than those designated by AHRI. However, the Commission believes that the algorithm in the TRM should rely solely on a standardized test condition (*i.e.,* IPLV), as it provides a consistent means of comparing baseline and retrofit part-load efficiencies. To illustrate the point, consider three possible scenarios:

1. Both the baseline and retrofit chiller IPLVs are known. In this case, the TRM may be used. In the case of replace on burnout or new construction measures, the baseline IPLV is listed in the TRM.

2. One chiller’s IPLV is known (either baseline or retrofit) and the other chiller's NPLV is known. In this case, the chillers’ performances are being tested at two separate test conditions and their part-load efficiencies are therefore not comparable. Thus, the IPLV for each chiller must be used.

3. Both the baseline and retrofit chiller’s NPLVs are known. In this case, the Commission agrees with Duquesne that a valid approach to determining savings would be to use the TRM's methodology and substitute NPLV for IPLV. However, it is important to ensure that the baseline chiller’s NPLV meets code minimum IPLV performance when the vintage is replace on burnout or new construction. For this scenario, Section 503.2.3 of the 2009 International Energy Conservation Code (IECC)[[99]](#footnote-100) includes a method for adjusting IPLV ratings to NPLV based on the chiller’s specific design conditions, which should be followed to ensure the code minimum efficiency is being met. This methodology is custom in nature and is therefore not applicable for inclusion in the TRM.

### 5. Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 Tons[[100]](#footnote-101)

In the 2015 TRM Final Order, the Commission directed the SWE to investigate if a standard duct loss factor for C&I forced air systems can be established in the algorithm.[[101]](#footnote-102) Based on the SWE’s research, the Commission expressed a belief, in its Tentative Order, that a duct loss factor is not the most appropriate savings assumption. While ductless heat pumps (DHP) do not have duct losses, they do have other losses. For example, DHPs use refrigerant lines that run outside the house which could result in thermal losses when transferring energy from conditioned space to non-conditioned space. Also, the Commission believed that, for new construction spaces, the more appropriate baseline would be electric resistance heating and cooling with a window air conditioner. In addition, a standard DHP offers significant savings opportunities. By incenting even a standard DHP, the EDCs can prevent people from installing strip heat in spaces that were previously unheated. As such, the Commission proposed the following updates for new construction measures: 1) update the HSPF from standard DHP to electric resistance heat; and 2) update the SEER of the baseline cooling unit from central air conditioners to room air conditioners.

 **a. Comments**

PECO comments that the SEERb value for new space or no cooling in an existing space is updated to be the same as the Room air conditioner (AC) value and recommends adding a footnote to explain the reasoning for this decision. PECO Comments at 12.

 **b. Disposition**

The Commission clarifies that room AC is assumed to be the baseline equipment because it is the least expensive way to air condition a new space.

### 6. Section 3.2.9 – Controls: Economizer[[102]](#footnote-103)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

Duquesne comments that the only eligible vintage or installation scenario for this protocol is retrofit. However, in Duquesne’s experience, there are new construction and replace on burnout situations that arise in which an economizer is an option to a base model piece of equipment rather than a retrofit. Duquesne requests that the applicable scenario for these measures be changed to new construction, replace on burnout, or retrofit. Duquesne also recommends the same measure vintage for Section 3.3.2 – Variable Frequency Drive (VFD) Improvements.[[103]](#footnote-104)

 **b. Disposition**

The Commission agrees with Duquesne that allowing economizer and VFD upgrades of new construction or replace on burnout measures will help encourage more energy efficient projects. The Commission has updated the TRM accordingly. However, the Commission cautions that economizers and VFDs have become fairly commonplace even without utility incentives; therefore, utilities that incentivize these projects should focus on program free-ridership rates to ensure the true impact of the program is being tracked.

### 7. Section 3.4.2 – Heat Pump Water Heaters[[104]](#footnote-105)

#### a. Federal Standard Requirements

The Commission proposed updates to the baseline EF values to reflect the new Federal Standards for Residential Water Heaters values.[[105]](#footnote-106) The Commission proposed the same updates for Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane[[106]](#footnote-107) and Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane.[[107]](#footnote-108)

 **i. Comments**

 PECO and PPL both recommend updating Table 3-82: Minimum Baseline Energy Factors Based on Tank Size[[108]](#footnote-109) with the new federal standards. PECO Comments at 12; PPL Comments at 11.

 **ii. Disposition**

 The Commission agrees with PECO and PPL’s recommendation and has updated the TRM accordingly.

#### b. Measure Expansion

In the 2015 TRM Final Order, the Commission directed the SWE to review appropriate sources and provide recommendations to expand the measure to include larger commercial food service buildings.[[109]](#footnote-110) The 2015 TRM only provided default savings algorithms for three building types: motel, small office and small retail. The SWE developed default algorithms for additional building types by using data from the SWE’s 2014 Commercial Baseline Study and DEER 2008. For each building type, the SWE calculated average square footage from the 2012 kWh sales in Pennsylvania, energy use intensity (kWh per square feet) and the premise count. The average square footage was multiplied by the average annual heating load (kBtu/sqft) to determine the average annual gallons of hot water use. The Commission, in its Tentative Order, expressed a belief that the default savings values are a better representation of Pennsylvania data and therefore would increase accuracy in savings assumptions. The Commission proposed to use the same methodology to determine default savings algorithms for two similar measures: Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane[[110]](#footnote-111) and Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane.[[111]](#footnote-112)

 **i. Comments**

The Joint Commentators note that it is unclear if one is required to use the default square footage values or whether one can use the actual square footage of the facility. Joint Commentators Comments at 19. PECO comments that the SWE’s 2014 Commercial Baseline Study does not appear to define the typical square footage for the building types. PECO suggests that the information for this source be updated to include more details about the way the typical square footage for the listed building types was calculated. PECO also comments that the source for the resistive discount factor references an engineering assumption and requests that more details be added to explain the background of the engineering assumption. Alternatively, PECO suggests that another source be used for this parameter. PECO Comments at 12.

 **ii. Disposition**

The Commission agrees with the Joint Commentators and has added an EDC data gathering option for the typical square footage variable. The Commission has also made similar updates to the loads variable. The Commission rejects PECO’s recommendation and notes that the TRM already clarifies that the “average square footage for each building type is calculated by dividing the Pennsylvania 2012 kWh sales by the energy use intensity (kWh/sqft) and premise count.” The Commission further notes that all of the parameters used to determine the average square footage can be found in the SWE’s 2014 Commercial Baseline Study. The Commission agrees with PECO’s comment regarding the source for the resistive discount factor and directs the SWE to look for an alternate source.

### 8. Section 3.5.1 – High-Efficiency Refrigeration/Freezer Cases[[112]](#footnote-113)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

PECO notes that this protocol does not address the upcoming federal standards for commercial refrigeration products that require compliance on March 27, 2017.

 **b. Disposition**

The Commission agrees with PECO’s comment and has incorporated the new federal standards to be effective beginning Program Year Nine (PY9) and thereafter.

### 9. Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-in Refrigerated Cases[[113]](#footnote-114)

In the 2015 TRM Final Order, the Commission directed the SWE to develop savings value recommendations for 1-14W motors.[[114]](#footnote-115) The SWE used 1-14W motor specifications, such as input watts, efficiency and output watts, from Section 3.5.2 – High-Efficiency Evaporator Fan Motors for Reach-In Refrigerated Cases to determine default savings for Tables 3-101[[115]](#footnote-116) and Tables 3-102.[[116]](#footnote-117) Table 3-103 provides default savings if refrigerated case temperature and/or motor size are not known.[[117]](#footnote-118) The Commission proposed the removal of Table 3-103 since these parameters should be collected by the EDCs for more accurate savings. We also proposed the removal of Table 3-98.[[118]](#footnote-119)

 **a. Comments**

No comments were received regarding the proposed changes.

 **b. Disposition**

The Commission has removed Table 3-103 since these parameters should be collected by the EDCs for more accurate savings. We have also removed Table 3-98.

### 10. Section 3.5.4 – Controls: Evaporator Fan Controllers[[119]](#footnote-120)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

 **a. Comments**

FirstEnergy notes that the ∆kWhcontrol term relates to incremental savings associated with direct digital controls and recommends that the term be included only if direct digital controls are used. FirstEnergy also recommends correcting the ∆kWcontrol term to ∆kWhcontrol. FirstEnergy Comments at 6.

 **b. Disposition**

The ∆kWhcontrol term represents the savings from the controls on the compressor and evaporator. The ∆kWhfan and ∆kWhheat terms represent the savings from the evaporator fan and do not represent savings from the compressor and evaporator. Therefore, the algorithm will remain unchanged. The Commission accepts FirstEnergy’s recommendation to update ∆kWcontrol to reference ∆kWhcontrol and has updated the TRM accordingly.

### 11. Section 3.7.4 – ENERGY STAR Electric Steam Cooker[[120]](#footnote-121)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

**a. Comments**

FirstEnergy believes that the formulas for calculating energy savings are confusing and that the units do not appear to match. FirstEnergy recommends updating the formula to the latest ENERGY STAR calculation. FirstEnergy Comments at 7.

 **b. Disposition**

The Commission agrees with FirstEnergy regarding the potential confusion surrounding this protocol and directs the SWE to review appropriate sources and provide recommendations for future TRM updates.

### 12. Section 3.9.1 – ENERGY STAR Office Equipment[[121]](#footnote-122)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

**a. Comments**

The Joint Commentators note that there is a new ENERGY STAR specification that came into effect on January 1, 2014, that is unlikely to be reflected in the current savings numbers. Since ENERGY STAR office equipment has high baseline penetration, the Joint Commentators recommend revising the savings numbers to reflect the new ENERGY STAR specification for the efficient equipment. Joint Commentators Comments at 19.

 **b. Disposition**

The Commission agrees with the Joint Commentators that updated information may be available but requires further research. Therefore, we direct the SWE to review appropriate sources and provide recommendations in future TRM updates.

### 13. Section 3.10.1 – Cycling Refrigerated Thermal Mass Dryer[[122]](#footnote-123)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

**a. Comments**

FirstEnergy comments that the energy savings algorithm needs to be revised as it currently does not produce the correct unit of kWh savings. FirstEnergy Comments at 7.

 **b. Disposition**

The Commission agrees with FirstEnergy’s comment and notes that the error is found in the CFMcomp/kWdryer term. The Commission has updated the term to kWdryer/CFMcomp and revised the units for the term to kW/CFM.

## G. Section 6.1 – Appendix A: Measure Lives[[123]](#footnote-124)

The Commission did not propose any changes to the Measure Life formatting of the TRM measures. However, the Commission received comments on measure life issues and addresses them below.

 **1. Comments**

 PECO notes that the measure life for each measure is listed in both the introductory table at the beginning of each measure as well as in Appendix A. PECO recommends that all measure lives and supporting documentation be moved to Appendix A to reduce the chance for error when updating a particular measure life in two places. PECO Comments at 4. PPL recommends moving ENERGY STAR Ceiling Fans to the Appliance End Use section. PPL Comments at 11.

 **2. Disposition**

 The Commission rejects PECO’s request to move all measure life information to Appendix A. While there is an increased level of rigor to maintain measure life information in two different places, this is done in order to provide ease of access for the TRM user in finding information. The Commission accepts PPL’s comment to move ENERGY STAR Ceiling Fan measure life.

## H. Section 5.2 – Appendix B: Relationship between Program Savings and Evaluation Savings[[124]](#footnote-125)

The Commission did not propose changes to this protocol. However, comments were received and are addressed below.

**1. Comments**

Duquesne commented that utilizing a standard of reasonableness for deemed or partially deemed measures is a source of conflict between the implementers and the evaluators. Duquesne requests that the evaluators accept the default values used by the implementers without further review. Duquesne Comments at 9.

**2. Disposition**

 The Commission recognizes Duquesne’s concerns; however, we believe the issues raised by Duquesne are issues that the EDCs themselves must resolve. An EDC contracts for services from both implementers and evaluators. If there is a conflict between the two, it is the EDC’s responsibility to resolve that conflict as it may affect the EDC’s ability to determine savings.

## I. Section 5.3 – Appendix C: Lighting Audit and Design Tool and Section 5.5 – Appendix E: Lighting Audit and Design Tool for C&I New Construction Projects[[125]](#footnote-126)

The Commission proposed major revisions to the 2015 TRM Appendix C and E calculators. The proposed 2016 TRM Appendix C calculator aimed to increase customer usability while allowing for increased customization. We proposed that Appendix C be redesigned in a way that enhances usability to customers of all levels of TRM knowledge. The proposed formatting included the consolidation of tabs into more organized tables and forms with detailed instructions, including pop-up notes and highlighting of errors, where necessary, to guide the user through the calculator. It also included sorting and filtering options, where possible, to help the customer sort and view information appropriately.

We also proposed multiple changes to help customers and EDCs organize data more efficiently. Most notably, the proposed Appendix C calculator had the capability to work with both new construction and retrofit projects, rendering a separate Appendix E calculator for New Construction Projects obsolete. Accordingly, we proposed the removal of Appendix E from the TRM.

Additionally, the “controls” and “fixtures” forms were consolidated so that all inputs are collectively housed on one sheet and calculations are broken out accordingly on the back-end, reducing the amount of forms the user is required to edit. The proposed calculator provided a more robust and user-friendly custom HOU and CF value generator which accurately takes into consideration custom operating schedules, as well as holidays and seasonal operation, all without the need of an “other” building type designation. Custom cut sheet generation had been turned into a hybrid-custom process where LED fixture codes are generated based on a few key parameters of the fixture, helping to consolidate like cut sheets. This would allow for better data collection regarding installed custom LED measures while reducing the amount of custom cut sheets received by EDCs. To account for the recent changes in EPAct and EISA standards, we proposed that the Appendix C calculator assign a baseline T-8 fixture to all available T-12 fixtures. When a T-12 fixture is selected as the baseline fixture, the savings calculations would be performed against the appropriate T-8 fixture and the user will be notified of this adjustment.

**1. Comments**

Duquesne comments that some of the Appendix C entry forms seem to be sensitive to the order in which data are entered. For example, Appendix C exhibited errors in the “space designation” lookup on the “general information” sheet when trying to enter a new construction example. Duquesne also comments that the “wattage controlled by newly installed lighting controls” value is reporting kW instead of W. In addition, Duquesne comments that the categories of fixture types available in the custom LED fixture identity generator section of the fixture identities sheet are overly restrictive. Duquesne Comments at 13.

**2. Disposition**

 The Commission disagrees that Appendix C entry forms are too sensitive. Input fields are clearly marked as to their intended order of completion. The construction type field is in the “project/site information” section, which is marked to be filled out first. The Commission agrees with Duquesne’s comment regarding the “wattage controlled by newly installed lighting controls” value and has made adjustments to Appendix C. The Commission disagrees with Duquesne’s comments that the LED fixture identity generator is overly restrictive. The generator was designed to group as many custom cut sheets as possible for evaluation purposes.

## J. Section 5.4 – Appendix D: Motors and VFD Audit and Design Tool[[126]](#footnote-127)

The Commission proposed an update to Appendix D to reflect the electric motors code changes proposed throughout its Tentative Order.

 **1. Comments**

Duquesne recommends placing the facility type, utility, program year and city inputs in a “general input and summary” sheet. Duquesne also recommends updating the range of dates and program years available for entry on the summary sheet for Phase III and revising the table references to the TRM on the lookup table sheet. Duquesne Comments at 14.

 **2. Disposition**

The Commission accepts Duquesne’s recommendations and has updated Appendix D accordingly.

## K. Section 5.6 – Appendix F: Eligibility Requirements for Solid State Lighting Products in Commercial and Industrial Applications[[127]](#footnote-128)

The Commission did not propose an update to Appendix F in its Tentative Order. However, comments were received and are addressed below.

 **1. Comments**

PPL requests confirmation that there will no longer be restrictions on commercial LED eligibility considering that Appendix F has been removed. PPL Comments at 11.

 **2. Disposition**

The Commission notes that Appendix F was unintentionally removed and has been added back to the TRM.

# CONCLUSION

This Order represents the Commission’s continuing efforts in establishing a comprehensive TRM with a purpose of supporting both the AEPS Act and the EE&C Program provisions of Act 129. The Commission is referring several of the comments we received to the SWE to consider and provide recommendations for future TRM updates. As such, Commission staff will provide an update on the final disposition of all such comments in the next TRM update order. We extend our thanks to all who provided comments; **THEREFORE,**

**IT IS ORDERED:**

1. That the 2016 Technical Reference Manual update, as modified by this Order, is adopted and replaces all prior versions of the Technical Reference Manual as of June 1, 2016.
2. That a copy of this Order shall be served upon the Office of Consumer Advocate, the Office of Small Business Advocate, the Commission’s Bureau of Investigation and Enforcement, the Pennsylvania Department of Environmental Protection and all parties who filed comments.
3. That the Secretary shall deposit notice of this Order and the 2016 version of the Technical Reference Manual with the Legislative Reference Bureau for publication in the Pennsylvania Bulletin.
4. That this Order and the 2016 Technical Reference Manual update, as well its appendices be published on the Commission’s website at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>.



**BY THE COMMISSION**

Rosemary Chiavetta

Secretary

(SEAL)

ORDER ADOPTED: July 8, 2015

ORDER ENTERED: July 8, 2015

1. Order entered on October 3, 2005, at Docket No. M-00051865 (October 3, 2005 Order). [↑](#footnote-ref-2)
2. As of August 11, 2011, the Bureau of CEEP was eliminated and its functions and staff transferred to the newly created Bureau of Technical Utility Services (TUS). *See Implementation of Act 129 of 2008; Organization of Bureaus and Offices*, Final Procedural Order, at Docket No. M‑2008-2071852 (entered Aug. 11, 2011), at 4. [↑](#footnote-ref-3)
3. *See* October 3, 2005 Order at 13. [↑](#footnote-ref-4)
4. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M‑2008‑2069887 (entered Jan. 16, 2009) (Phase I Implementation Order), at 13. [↑](#footnote-ref-5)
5. *Id*. [↑](#footnote-ref-6)
6. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual* Update Order, at Docket No. M‑00051865 (entered June 1, 2009) (2009 TRM). [↑](#footnote-ref-7)
7. *Id*. at 17 and 18. [↑](#footnote-ref-8)
8. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M‑2012‑2289411 (entered Aug. 3, 2012) (Phase II Implementation Order), at 71. [↑](#footnote-ref-9)
9. *Id*. at 75. [↑](#footnote-ref-10)
10. *See Energy Efficiency and Conservation Program* Final Implementation Order, at Docket No. M‑2014‑2424864 (entered June 19, 2015) (Phase III Final Implementation Order), at 95. [↑](#footnote-ref-11)
11. *Id.* at 97-98. [↑](#footnote-ref-12)
12. The PEG is chaired by staff of the Commission’s Bureau of Technical Utility Services and is comprised of representatives from the EDCs and the SWE for the purpose of encouraging discussion of EDC program-specific issues and associated EM&V. [↑](#footnote-ref-13)
13. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual* 2016 TRM Annual Update Tentative Order, at Docket No. M‑00051865 (entered March 26, 2015) (Tentative Order). [↑](#footnote-ref-14)
14. *See Energy Efficiency and Conservation Program* Tentative Implementation Order, at Docket No. M‑2014-2424864 (entered Mar. 26, 2015) (Phase III Tentative Implementation Order), at 5. [↑](#footnote-ref-15)
15. *See* 2015 TRM at 10. [↑](#footnote-ref-16)
16. *See* Section 2.4.1 – ENERGY STAR Refrigerators of the 2015 TRM at 127. [↑](#footnote-ref-17)
17. *See* Section 2.4.8 – ENERGY STAR Dehumidifiers of the 2015 TRM at 166. [↑](#footnote-ref-18)
18. *See* Section 2.5.1 –ENERGY STAR Televisions of the 2015 TRM at 174. [↑](#footnote-ref-19)
19. The SWE’s Evaluation Framework is available at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx>. [↑](#footnote-ref-20)
20. *See Demand Response Potential for Pennsylvania – Final Report*, submitted by GDS Associates, Inc., *et al.*, February 25, 2015, (DR Potential Study). *See also Energy Efficiency Potential for Pennsylvania – Final Report*, submitted by GDS Associates, Inc., *et. al*, February 2015, (EE Potential Study). [↑](#footnote-ref-21)
21. *See* 2011 TRM Final Order at 49,2012 TRM Final Order at 72, 2013 TRM Final Order at 118, 2014 TRM Final Order at 178 and 2015 TRM Final Order at 78. [↑](#footnote-ref-22)
22. *See* 2011 TRM Final Order at 49 and 50, 2012 TRM Final Order at 72, 2013 TRM Final Order at 118 and 119, 2014 TRM Final Order at 178 and 179 and 2015 TRM Final Order at 79 and 80. [↑](#footnote-ref-23)
23. *See* Phase II Implementation Order at 75; 2015 TRM Final Order at 80; 2014 TRM Final Order at 179; 2013 TRM Final Order at 118-120; 2012 TRM Final Order at 71-73; 2011 TRM Update Order at 47-50. [↑](#footnote-ref-24)
24. *See* Phase II Implementation Order at 75. [↑](#footnote-ref-25)
25. *See* DOE Standards and Test Procedures for Residential and Commercial Products. <http://energy.gov/eere/buildings/standards-and-test-procedures>. [↑](#footnote-ref-26)
26. The Commission would like to clarify that it proposed peak demand reduction targets to be met through the implementation of demand response programs only, and not through the attainment of coincident peak demand reductions resulting from the installation of energy efficiency measures. [↑](#footnote-ref-27)
27. The SWE found no cost-effective potential peak demand reduction net of anticipated PJM commitments in the Penelec service territory. *See Application of Market Potential Study Results to Phase III Goals – Addendum to 2015 SWE Market Potential Studies*, February 23, 2015, at 5. [↑](#footnote-ref-28)
28. *See Phase III Tentative Implementation Order* at 35-37. [↑](#footnote-ref-29)
29. *Id.* at 37 and 38. [↑](#footnote-ref-30)
30. *See Phase III Final Implementation Order* at 35. [↑](#footnote-ref-31)
31. These methodologies are listed as numbers one through three, respectively, in Section 5.1 of the 2016 TRM. [↑](#footnote-ref-32)
32. *See Phase III Final Implementation Order* at 43-44. [↑](#footnote-ref-33)
33. *See* 2015 TRM, Section 1.14 – Transmission and System Distribution Losses, at 13. [↑](#footnote-ref-34)
34. *See* 2015 TRM, Section 1.14 – Transmission and System Distribution Losses, at 13. [↑](#footnote-ref-35)
35. *See* Section 1.12.4 – Verified Gross Adjustments, page 12, of the 2015 TRM. [↑](#footnote-ref-36)
36. *See 2014 Pennsylvania Statewide Act 129 Residential Baseline Study*, Submitted by GDS Associates, Inc., in partnership with Nexant, Inc., Research Into Action and Apex Analytics. April 2014. (2014 Residential Baseline Study). Available at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx>. [↑](#footnote-ref-37)
37. *See* 2015 TRM, Section 2.1.1 –ENERGY STAR Lighting, at 17. [↑](#footnote-ref-38)
38. *See Pennsylvania Statewide Act 129 2014 Non-Residential End Use & Saturation Study*, Submitted by Nexant, Inc., in partnership with GDS Associates, Research Into Action and Apex Analytics. April 2014. (2014 Commercial Baseline Study). Available at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx>. [↑](#footnote-ref-39)
39. *See* <http://www.energystar.gov/ia/partners/downloads/ENERGY_STAR_CFLs_Batch_3_Report_Public_Feb_2013.pdf>. [↑](#footnote-ref-40)
40. Act 129 limits the “effective life of each plan” to 15 years of less. 66 Pa. C.S. § 2806.1(m), defining “TRC test.” [↑](#footnote-ref-41)
41. *See* <http://www.energystar.gov/ia/partners/downloads/ENERGY_STAR_CFLs_Batch_3_Report_Public_Feb_2013.pdf>. [↑](#footnote-ref-42)
42. *See* <http://aceee.org/files/proceedings/2008/data/papers/2_111.pdf>. [↑](#footnote-ref-43)
43. *See* 42 U.S.C.A. § 6295(i)(6)(A)(v). [↑](#footnote-ref-44)
44. *See* 2015 TRM, Section 2.1.1 – ENERGY STAR Lighting, Table 2-5: CFL and LED Energy and Demand HVAC Interactive Effects by EDC, at 24. [↑](#footnote-ref-45)
45. *See Pennsylvania Statewide Act 129 2014 Commercial and Residential Light Metering Study*. January 13, 2015. (2014 Light Metering Study). Available at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx>. [↑](#footnote-ref-46)
46. *See* 2015 TRM, Section 2.2.1 – Electric HVAC, at 35. [↑](#footnote-ref-47)
47. *See* 2015 TRM, Section 2.2.1 – Electric HVAC, at 37. [↑](#footnote-ref-48)
48. *See* 2015 TRM, Section 2.2.3 –Ductless Mini-Split Heat Pumps, at 49. [↑](#footnote-ref-49)
49. See 2016 TRM, Section 2.4.3 – Refrigerator/Freezer Recycling With and Without Replacement, at 140. [↑](#footnote-ref-50)
50. *See* 2015 TRM, Section 2.2.5 –Room AC (RAC) Retirement, at 59. [↑](#footnote-ref-51)
51. *See* 2015 TRM, Section 2.2.8 – Programmable Thermostat, at 76. [↑](#footnote-ref-52)
52. *See* 2015 TRM, Section 2.3.2 –Heat Pump Water Heaters, at 84. [↑](#footnote-ref-53)
53. *See* <http://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Water%20Heaters%20Version%203%200%20Program%20Requirements_0.pdf>. [↑](#footnote-ref-54)
54. *See* 2015 TRM, Section 2.3.4 –Fuel Switching: Electric Resistance to Fossil Fuel Water Heater, at 93. [↑](#footnote-ref-55)
55. *See* 2015 TRM, Section 2.3.5 –Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater, at 97. [↑](#footnote-ref-56)
56. *See* 2015 TRM, Section 2.3.7 – Water Heater Pipe Insulation, at 111. [↑](#footnote-ref-57)
57. *See* 2015 TRM, Section 2.3.9 – Low Flow Faucet Aerators, at 113. [↑](#footnote-ref-58)
58. *See* 2015 TRM, Section 2.3.10 –Low Flow Showerheads, at 118. [↑](#footnote-ref-59)
59. *See* 2015 TRM, Section 2.3.11 –Thermostatic Shower Restriction Valve, at 123. [↑](#footnote-ref-60)
60. *See* 2015 TRM, Section 2.4.1 – ENERGY STAR Refrigerators, at 127. [↑](#footnote-ref-61)
61. <https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Most-Efficient-Residential-Refrigerato/hgxv-ux9b> [↑](#footnote-ref-62)
62. *See* 2015 TRM, Section 2.4.3 –Refrigerator/Freezer Recycling With and Without Replacement, at 139. [↑](#footnote-ref-63)
63. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2015 Update* Final Order, at Docket No. M-2012-2313373, entered December 18, 2014, at page 46 (2015 TRM Final Order). [↑](#footnote-ref-64)
64. The SWE’s Evaluation Framework is available at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx>. [↑](#footnote-ref-65)
65. *See* 2015 TRM, Section 2.4.4 –ENERGY STAR Clothes Washer, at 152. [↑](#footnote-ref-66)
66. *See* <http://www.energystar.gov/sites/default/files/specs//private/ENERGY%20STAR%20Final%20Version%207.0%20Clothes%20Washer%20Program%20Requirements.pdf>. [↑](#footnote-ref-67)
67. *See* 2015 TRM, Section 2.4.5 – ENERGY STAR Dryers, at 157. [↑](#footnote-ref-68)
68. *See* 2015 TRM, Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer, at 160. [↑](#footnote-ref-69)
69. *See* 2015 TRM, Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer, at 160. [↑](#footnote-ref-70)
70. ENERGY STAR Market and Industry Scoping Report. Residential Clothes Dryers, November, 2011, at 7. <https://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf> [↑](#footnote-ref-71)
71. *See* 2015 TRM, Section 2.5.2 – ENERGY STAR Office Equipment, at 178. [↑](#footnote-ref-72)
72. *See* <http://www.energystar.gov/sites/default/files/asset/document/Office%20Equipment%20Calculator.xlsx>. [↑](#footnote-ref-73)
73. *See* 2015 TRM, Section 2.5.3 –Smart Strip Plug Outlets, at 181. [↑](#footnote-ref-74)
74. *See* 2015 TRM, Section 2.6.1 – Ceiling / Attic and Wall Insulation, at 184. [↑](#footnote-ref-75)
75. *See* 2015 TRM, Section 2.6.1 – Ceiling / Attic and Wall Insulation, FNs 186 and 187. [↑](#footnote-ref-76)
76. *See* 2015 TRM, Section 2.6.2 – ENERGY STAR Windows, at 191. [↑](#footnote-ref-77)
77. <http://windows.lbl.gov/software/resfen/resfen.html>. [↑](#footnote-ref-78)
78. *See* 2015 TRM, Section 2.6.3 – Residential New Construction, at 194. [↑](#footnote-ref-79)
79. *See* 2015 TRM, Section 2.6.4 – Home Performance with ENERGY STAR, at 199. [↑](#footnote-ref-80)
80. <http://publicecodes.cyberregs.com/icod/irc/2009/icod_irc_2009_11_sec003.htm> [↑](#footnote-ref-81)
81. *See* 2015 TRM, Section 2.6.5 – ENERGY STAR Manufactured Homes, at 201. [↑](#footnote-ref-82)
82. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvement, at 215. [↑](#footnote-ref-83)
83. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvements, Table 3-9: Lighting Power Densities from ASHRAE 90.1-2007 Building Area Method, at 228. [↑](#footnote-ref-84)
84. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvements, Table 3-8: Interactive Factors for All Bulb Types, at 227. [↑](#footnote-ref-85)
85. *See* 42 U.S.C.A. § 6295(i) and 10 C.F.R. § 430.32(x). [↑](#footnote-ref-86)
86. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvements, Table 3-2: 2016 Savings Adjustment Factors and Adjusted EULs for Standard T-8 Measures, at 217. [↑](#footnote-ref-87)
87. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvements, Table 3-3: 2016 Savings Adjustment Factors and Adjusted EULs for HPT8 Measures, at 217. [↑](#footnote-ref-88)
88. *See* 2015 TRM, Section 3.1.1 – Lighting Fixture Improvements, Table 3-4: 2016 Savings Adjustment Factors and Adjusted EULs for T5 Measures, at 218. [↑](#footnote-ref-89)
89. *See* 2015 TRM Final Order at 55. [↑](#footnote-ref-90)
90. *See* 2015 TRM, Section 3.1.4 – Traffic Lights, at 242. [↑](#footnote-ref-91)
91. *See* 2015 TRM, Section 3.1.5 – LED Exit Signs, at 245. [↑](#footnote-ref-92)
92. *See* 2015 TRM, Section 3.1.6 – LED Channel Signage, at 248. [↑](#footnote-ref-93)
93. *See* <https://assets.sylvania.com/assets/onlinemedia/ihdp/Lamp-and-Ballast-Catalog/>. [↑](#footnote-ref-94)
94. *See* 2015 TRM, Section 3.1.2 – New Construction Lighting, at 226. [↑](#footnote-ref-95)
95. The ASHRAE 90.1 Standard is available at: <https://law.resource.org/pub/us/code/ibr/ashrae.90.1.2007.pdf>. [↑](#footnote-ref-96)
96. *See* 2015 TRM Final Order at 53. [↑](#footnote-ref-97)
97. *See* 2015 TRM, Section 3.2.1 – HVAC Systems, at 254. [↑](#footnote-ref-98)
98. *See* 2015 TRM, Section 3.2.2 – Electric Chillers, at 263. [↑](#footnote-ref-99)
99. <https://law.resource.org/pub/us/code/ibr/icc.iecc.2009.pdf> [↑](#footnote-ref-100)
100. *See* 2015 TRM, Section 3.2.4 – Ductless Mini-Split Heat Pumps, at 277. [↑](#footnote-ref-101)
101. *See* 2015 TRM Final Order at 64. [↑](#footnote-ref-102)
102. *See* 2015 TRM, Section 3.2.9 – Controls: Economizer, at 300. [↑](#footnote-ref-103)
103. *See* 2015 TRM, Section 3.3.2 – Variable Frequency Drive (VFD) Improvements, at 316. [↑](#footnote-ref-104)
104. *See* 2015 TRM, Section 3.4.2 – Heat Pump Water Heaters, at 332. [↑](#footnote-ref-105)
105. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27>. [↑](#footnote-ref-106)
106. *See* 2015 TRM, Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane, at 351. [↑](#footnote-ref-107)
107. *See* 2015 TRM, Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane, 358. [↑](#footnote-ref-108)
108. *See* 2015 TRM, Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, at 377. [↑](#footnote-ref-109)
109. *See* 2015 TRM Final Order at 67 and 68. [↑](#footnote-ref-110)
110. *See* 2015 TRM, Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane, at 351. [↑](#footnote-ref-111)
111. *See* 2015 TRM, Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane, at 358. [↑](#footnote-ref-112)
112. *See* 2015 TRM, Section 3.5.1 – High-Efficiency Refrigeration/Freezer Cases, at 367. [↑](#footnote-ref-113)
113. *See* 2015 TRM,Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, at 377. [↑](#footnote-ref-114)
114. *See* 2015 TRM Final Order at 72. [↑](#footnote-ref-115)
115. *See* 2015 TRM, Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, Table 3-101: PSC to ECM Deemed Savings, at 380. [↑](#footnote-ref-116)
116. *See* 2015 TRM, Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, Table 3-102: Shaded Pole to ECM Deemed Savings, at 381. [↑](#footnote-ref-117)
117. *See* 2015 TRM, Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, Table 3-103: Default High-Efficiency Evaporator Fan Motor Deemed Savings, at 381. [↑](#footnote-ref-118)
118. *See* 2015 TRM, Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Reach-In Refrigerated Cases, Table 3-98: Default High-Efficiency Evaporator Fan Motor Deemed Savings, at 375. [↑](#footnote-ref-119)
119. *See* 2015 TRM, Section 3.5.4 – Controls: Evaporator Fan Controllers, at 383. [↑](#footnote-ref-120)
120. *See* 2015 TRM, Section 3.7.4 – ENERGY STAR Electric Steam Cooker, at 438. [↑](#footnote-ref-121)
121. *See* 2015 TRM, Section 3.9.1 – ENERGY STAR Office Equipment, at 451. [↑](#footnote-ref-122)
122. *See* 2015 TRM, Section 3.10.1 – Cycling Refrigerated Thermal Mass Dryer, at 461. [↑](#footnote-ref-123)
123. *See* 2015 TRM, Section 5.1 – Appendix A: Measure Lives, at 504. [↑](#footnote-ref-124)
124. Section 6.2 in the 2016 Draft TRM. [↑](#footnote-ref-125)
125. Section 6.3 in the 2016 Draft TRM. [↑](#footnote-ref-126)
126. Section 6.4 in the 2016 Draft TRM. [↑](#footnote-ref-127)
127. To be added to 2016 TRM as Appendix E. [↑](#footnote-ref-128)