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

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|  | Public Meeting held March 26, 2015 |
| Commissioners Present: |  |

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| Robert F. Powelson, Chairman |  |
| John F. Coleman, Jr., Vice ChairmanJames H. Cawley |  |
| Pamela A. Witmer |  |
| Gladys M. Brown |  |
|  |  |
| 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 ANNUAL UPDATE Tentative 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 that 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 proposed in its Phase III Tentative Implementation Order that the TRM again be adopted as a component of the EE&C Program evaluation process.[[10]](#footnote-11) However, the Commission proposed that the 2016 TRM 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 proposes several changes and additions for consideration for inclusion in the 2016 TRM. With the adoption of this Tentative Order, the Commission seeks comments on the proposed 2016 TRM. The proposed 2016 TRM and its associated Appendixes can be found on the Commission’s website at:

<http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>. A notice of the adoption of this Tentative Order and the proposed 2016 TRM will be published in the *Pennsylvania Bulletin* with comments on the proposed 2016 TRM due within 30 days following the entrance of this Tentative Order and reply comments due within 40 days after the entrance of this Tentative Order.

# DISCUSSION

The proposed 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 these recommended improvements. Specifically, the current proposed 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 proposed updates 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 believes that these proposed 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 proposed 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 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 proposed in this 2016 TRM 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 protocols.
7. Updates to Appendix C – Lighting Audit and Design Tool.
8. Updates to Appendix D – Motor and 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 proposed changes and updates. Minor administrative changes will not be discussed.

## 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. While we are not soliciting comments on this proposal in this proceeding, we do believe some changes to the TRM are necessary to reflect this proposal. We propose updating Section 1 of the TRM to reflect this shift away from annual updating. Additionally, as outlined herein, we propose updating many of the protocols to reflect the most up-to-date codes and standards. In some cases, we have proposed implementation timelines for known codes and standards changes that become effective throughout the course of the proposed Phase III program length. We believe these changes will ensure that the TRM remains reliable without annual updates.

## General Improvements

### DEER Effective Useful Life Values

Many of the measure life values in the TRM reference data from the Database for Energy Efficient Resources (DEER 2008).[[13]](#footnote-14) In 2014, DEER published an updated list of effective useful lives (EULs) for certain measures. The Commission proposes the use of these updated EULs the 2016 TRM.

###  Future Code Changes

There are several impending United States Department of Energy (U.S. DOE) Federal Standards[[14]](#footnote-15) 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 proposes including them, where appropriate, in the 2016 TRM and clearly designating the program years in which they will become effective. In protocols where these future standard changes are included, the remaining program year(s) for which the current standard is applicable will be clearly designated, as well. The specifics of these future standards changes will be noted below under the protocols in Sections D and E of this Order.

### Demand Response

 In its Phase III Tentative Implementation Order, the Commission proposed peak demand reduction targets[[15]](#footnote-16) for six of the seven EDCs[[16]](#footnote-17) subject to the Act 129 EE&C Program requirements.[[17]](#footnote-18) In order for the EDCs to attain these targets, the Commission also proposed a demand response program design for Phase III.[[18]](#footnote-19) Specifically, we proposed the following:[[19]](#footnote-20)

* Curtailment events shall be limited to the months of June through September.
* Curtailment events shall be called for the first six days that the peak hour of PJM’s day-ahead forecast[[20]](#footnote-21) for an EDC is greater than 96% of the EDC’s PJM summer peak demand forecast[[21]](#footnote-22) for the months of June through September each year of the program.
* Each curtailment event shall last four hours.
* Each curtailment event shall be called such that it will occur during the day’s forecasted peak hours.
* Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.
* Compliance will be determined based on the average MW performance across all event hours in a given program year.
* Customers participating in PJM’s Emergency Load Response Program (ELRP) shall not be eligible to participate.

 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 is not soliciting comments on the targets or the methodology in this proceeding. However, we are requesting, 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 provides 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 provides the eligibility requirements and the algorithms for calculating peak demand reductions for both direct load control and load curtailment programs. We believe this information is 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.

### Line Loss Guidance

The Commission proposes to add the following table to Section 1 of the 2016 TRM in order to provide guidance on the megawatt (MW) savings to be reported after taking into account line loss factors (LLFs). We believe these LLFs to be appropriate as they were the LLFs utilized by the SWE in its EE and DR Potential Studies.[[22]](#footnote-23)

|  |  |  |  |
| --- | --- | --- | --- |
| **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 Power | 1.0943 | 1.0790 | 1.0790 |

## 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 measurement and verification (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 these residential EE&C measure protocols. The four new residential EE&C measure protocols are:

* 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.

## 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 these EE&C programs. Based on collaborative discussions between the SWE and the EDCs, as well as a review of the available research, we propose 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.

## Existing Residential EE&C Measure Protocols and Processes

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

### Section 2.1.1 – ENERGY STAR Lighting[[23]](#footnote-24)

#### Measure Life

The Commission proposes to adjust the measure lives for light-emitting diode bulbs (LEDs) and compact fluorescent lamps (CFLs). We propose that the LED measure life be updated to reflect the most recent hours of use (HOU) estimate as reported in the SWE’s *2014 Pennsylvania Statewide Act 129 Residential Baseline Study* (2014 Residential Baseline Study) and the *Pennsylvania Statewide Act 129 2014 Non-Residential End Use & Saturation Study* (2014 Commercial Baseline Study) as measure life is a direct function of HOU. We also propose 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.[[24]](#footnote-25) The baseline wattage now accounts for post-2020 installations (which we address later in this Tentative Order); therefore, the measure life will not be cut off at 2020.

#### Vintage

The Commission proposes to add the vintage of Early Replacement to the existing Replace on Burnout to reflect direct installation delivery mechanisms. Updates to baseline wattage for direct installation programs have been included in previous TRMs.

#### 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. If this goal has not been achieved by 2020, the legislation prohibits the sale of any general service lamp that does not meet the minimum efficiency standard. The Commission proposes 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 propose to specifically address the EISA backstop in Section 2.1.1.

#### Algorithms

The Commission proposes to consolidate the seven lighting technology algorithms into a single ENERGY STAR Lighting algorithm. Previous TRMs provided separate algorithms for ENERGY STAR CFL Bulbs, ENERGY STAR LED Bulbs, ENERGY STAR Torchieres, ENERGY STAR Indoor CFL Fixtures, ENERGY STAR Indoor LED Fixtures, ENERGY STAR Outdoor Fixtures and Ceiling Fan with ENERGY STAR Fixtures. These algorithms are fundamentally the same, with varying input values. To simplify the protocol, the Commission proposes a single, combined algorithm, with varying input values provided to account for variations between lighting technologies. We also propose changes to Table 2-1[[25]](#footnote-26) and the Sources section to reflect this consolidation.

#### In-Service Rate

The Commission proposes a revision to the In-Service Rate (ISR) value to reflect the updated 2015 U.S. DOE Uniform Methods Project (UMP) recommendations. The UMP relied on the best available primary research to determine an ISR trajectory of energy efficient lightbulbs. Additionally, this updated trajectory more closely represents current installation patterns.

#### Baseline Wattage for Post-2020 Installations

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

#### Reflector or Flood Lamp Baseline Wattage Values

During the updating process for previous TRMs, some parties requested a more comprehensive baseline wattage table for reflector or flood lamps. We propose updating Table 2-4[[26]](#footnote-27) to reflect that request. Reflector and flood lamp legislative requirements are more complicated to apply as varying bulb diameters and shapes require different lumens-per-watt algorithms. Additionally, the maximum allowable wattage for a given bulb does not necessarily represent what is available to the consumer. The proposed baseline wattage values are intended to represent a combination of the legislative wattage values and actual wattage values of bulbs sold by manufacturers.

#### Hours of Use and Peak Coincidence Factors

####  The Commission proposes to revise 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 propose the incorporation of the 2014 Residential Baseline Study results into Table 2-5.[[27]](#footnote-28) We would like to note that examination of efficient bulb saturation and HOU has not shown a clear linear relationship (*i.e.,* HOU does not appear to drop off as saturation increases). This seems 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 proposes 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.

### Section 2.2.1 – Electric HVAC[[28]](#footnote-29)

The Commission proposes, 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.

### Section 2.2.3 – Ductless Mini-Split Heat Pumps[[29]](#footnote-30)

Similar to the Electric HVAC protocol, the Commission proposes 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.

### Section 2.2.4 – ENERGY STAR Room Air Conditioners[[30]](#footnote-31)

 The Commission proposes updating the ENERGY STAR requirements and default combined energy efficiency ratio for the room air conditioner being installed (CEERee) values with the ENERGY STAR Room Air Conditioner Product Criteria Version 4.0 values[[31]](#footnote-32) that become effective on October 26, 2015. We propose updating the default savings values to reflect these new ENERGY STAR requirements.

### Section 2.2.5 – Room AC Retirement[[32]](#footnote-33)

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

### Section 2.3.2 – Heat Pump Water Heaters[[33]](#footnote-34)

#### ENERGY STAR Criteria

 The Commission proposes updating 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[[34]](#footnote-35) that become effective on April 16, 2015.

#### Federal Standard Requirements

 The Commission proposes updating the baseline energy factor (EF) values with the new Federal Standards for Residential Water Heaters[[35]](#footnote-36) that become effective on April 16, 2015.

#### Measure Life

 The Commission proposes updating the measure life for heat pump water heaters to reflect the most current DEER EUL value of ten years.[[36]](#footnote-37)

### Section 2.3.3 – Solar Water Heaters[[37]](#footnote-38)

 The Commission proposes updating the baseline EF values for solar heaters with the new Federal Standards for Residential Water Heaters.

### Section 2.3.4 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater[[38]](#footnote-39) and Section 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater[[39]](#footnote-40)

#### ENERGY STAR Criteria

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

#### Federal Standard Requirements

 The Commission proposes updating the baseline EF values with the new Federal Standards for Residential Water Heaters. As there are no ENERGY STAR ratings for oil water heaters, we propose that the oil EF be updated to the new Federal requirement.[[40]](#footnote-41) We propose that the default savings values be updated to reflect the new ENERGY STAR and Federal Standard changes.

#### Measure Life

 The Commission proposes updating the measure life of gas and propane water heaters with the most current DEER EUL value of 11 years.[[41]](#footnote-42)

### Section 2.3.9 – Low Flow Faucet Aerators[[42]](#footnote-43)

#### Measure Life

 The Commission proposes updating the measure life with the most current DEER EUL value of ten years.[[43]](#footnote-44)

#### Default Values

 The Commission proposes clarifying 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,” will be added to the Default Savings Table in order to provide the variable values for the default savings calculations. Additionally, the table will 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 is proposed for the Low Flow Showerheads[[44]](#footnote-45) and Thermostatic Shower Restriction Valve[[45]](#footnote-46) protocols, as well.

### Section 2.3.11 – Thermostatic Shower Restriction Valve[[46]](#footnote-47)

The Commission proposes updating the assumed temperature of water used by showerhead (Tout) variable to 104° F and default time (BehavioralWasteSeconds) to 59 seconds. These values were developed using information from PPL Electric Utilities, Inc.’s 2014 ShowerStart Pilot Study results.

### Section 2.4.3 – Refrigerator/Freezer Recycling With and Without Replacement[[47]](#footnote-48)

 During the 2015 TRM update, the Commission updated the Refrigerator/Freezer Recycling With and Without Replacement protocol to fully correspond with the UMP.[[48]](#footnote-49) However, the Commission recognizes 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 propose removing all text describing calculations of net savings. Additionally, we propose the inclusion of a reference to the SWE’s Evaluation Framework,[[49]](#footnote-50) which provides interested parties with more information regarding the application of the UMP.

### Section 2.4.4 – ENERGY STAR Clothes Washer[[50]](#footnote-51)

#### ENERGY STAR Criteria

 The Commission proposes updating 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[[51]](#footnote-52) that become effective on March 7, 2015. The Commission also proposes updating the algorithms and the modified energy factor (MEF) definition to the new IMEF definition, which includes standby and low power mode energy consumption.

#### Federal Standard Requirements

 The Commission proposes updating the baseline IMEF values with the new values from the Federal Standards for Residential Clothes Washers[[52]](#footnote-53) that become effective on March 7, 2015. Additionally, the Commission proposes adding the future Federal standards that become effective on January 1, 2018, as these are currently known. We propose their inclusion in a table specifying the years for which they are effective. Additionally, we propose updating the default savings values to reflect the new ENERGY STAR and Federal Standard changes.

### Section 2.5.1 – ENERGY STAR Televisions[[53]](#footnote-54)

#### ENERGY STAR Criteria

 The Commission proposes updating the ENERGY STAR Requirements, as well as the power use of the ENERGY STAR Version 6.0 while in the on mode (Wee) values with the ENERGY STAR Product Criteria for Televisions Version 7.0 values[[54]](#footnote-55) that become effective on October 30, 2015. In the 2015 TRM, the power use of the baseline television (TV) while in on mode (Wbase) values are the previous ENERGY STAR Requirements. To be consistent, we propose updating these to reflect the ENERGY STAR Product Criteria for Televisions Version 6.1 values.[[55]](#footnote-56) Additionally, the Commission proposes updating the Wee values for the ENERGY STAR Most Efficient TVs to the most recent version.[[56]](#footnote-57) Lastly, we propose that the deemed energy and demand savings be updated to reflect the inclusion of these new values.

### Section 2.5.3 – Smart Strip Plug Outlets[[57]](#footnote-58)

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

### Section 2.7.1 – Pool Pump Load Shifting[[58]](#footnote-59)

 The Commission proposes updating the value for the number of days per year that the pump is in operation (Daysoperating) from 100 to 122 in order to correspond to a newer and more reliable source. The current source is the Mid-Atlantic TRM[[59]](#footnote-60) and the root source in that TRM is not given. The Commission proposes using the value from the ENERGY STAR Pool Pump Calculator, which was last updated in December 2013.[[60]](#footnote-61) The days of operation are the calculator default for Pennsylvania (4 months per year).

### Section 2.7.2 – Variable Speed Pool Pumps (With Load Shifting Option)[[61]](#footnote-62)

 In the 2015 TRM Final Order, the Commission directed the SWE to investigate default values for the hours of operation per day for a VFD pump on cleaning mode (HOUVFD,clean) and on filtration mode (HOUVFD, filter); the hours of operation per day for a single speed pump(HOUSS); and the electric demand of variable frequency drive (VFD) pumps during cleaning mode (kWVFD,clean) and during filtration mode (kWVFD, filter).[[62]](#footnote-63) Based on this investigation, the Commission proposes updating the defaults for these values with values from the ENERGY STAR Pool Pump Calculator that was last updated in December, 2013.[[63]](#footnote-64) The current source is the Mid Atlantic TRM Version 2.0 and the root source in that TRM is not given. The proposed default kWVFD,clean and kWVFD, filter values are derived from the gallons-per-minute and the energy factor (gallons/watt-hour [Wh]) at each speed for a pipe that is two inches in diameter. The HOUVFD,clean, HOUVFD,filter and HOUSS are the default values in the calculator for Pennsylvania. The Commission also proposes updating the value for Days from 100 to 122 in order to correspond to this newer and more reliable source. The days of operation are the calculator default for Pennsylvania (4 months per year).

### Removal of Residential EE&C Protocols

#### Efficient Electric Water Heaters[[64]](#footnote-65)

 The Commission proposes removing the Efficient Electric Water Heater protocol due to the increased new Federal Standards for residential water heaters that become effective on April 16, 2015. The minimum efficiency for tanks larger than 55 gallons now greatly exceeds the efficient requirement for this protocol and effectively requires a heat pump water heater. Below 55 gallons, the new federal minimum also exceeds the efficient requirement for the protocol. The Commission believes that, in the current market, standard electric resistance water heaters cannot be considered an “efficient” technology and should not be included in the TRM. The Commission also proposes removing a similar C&I protocol: Section 3.4.1— Electric Resistance Water Heaters.[[65]](#footnote-66)

## Commercial and Industrial EE&C Measure Protocols

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

### Section 3.1.1 – Lighting Fixture Improvements[[66]](#footnote-67)

#### Update Hours of Use and Coincidence Factors

In the 2015 TRM, savings from commercial lighting applications are calculated using Table 3-6,[[67]](#footnote-68) which contains default HOU and CF values. These values are referenced from different TRMs and sources and are not Pennsylvania-specific. In addition, the stipulated values do not distinguish screw-based CFL and LED bulbs from other bulb types (*e.g.,* linear fluorescents and high-intensity discharge [HID] lighting). However, the 2014 Commercial Baseline Study, as well as the SWE’s *Pennsylvania Statewide Act 129 2014 Commercial and Residential Light Metering Study*,[[68]](#footnote-69) suggest that there are HOU and CF differences between these two types of bulbs. Other recent TRMs, such as the Mid-Atlantic TRM[[69]](#footnote-70) and Illinois TRM,[[70]](#footnote-71) make a distinction by providing alternate HOU and CF values for screw-based bulbs.

Due to the high impact of cross-sector sales from Act 129 Residential Upstream Lighting Programs (*i.e.,* CFLs incented through the residential program but installed in commercial facilities), the Commission proposes establishing an alternate HOU and CF table for screw-based bulbs, in addition to the HOU and CF table for other general service lighting. The results of the 2014 Light Metering Study support this proposition. The Commission believes this approach will increase the reliability of CFL savings and the accuracy of assumptions based on Pennsylvania-specific information.

The Commission also proposes to add 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 proposes to remove the “other” building type. In the calculator, with the appropriate building type selected, the user will 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.

#### Interactive Factors

In the 2015 TRM, interactive effects are presented only as a factor of space conditioning type (comfort cooled space, freezer space, unconditioned space, etc.). However, we believe this to be 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 proposes to adopt, for all comfort-cooled spaces, the energy and demand interactive factors (Ifs) determined from the 2014 Light Metering Study. We propose 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 will 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 will 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 will be applied to all comfort-cooled spaces. In the event that fuel source is unknown or otherwise left blank, a default value of 0% will be used for the IFenergy value; the assumed IFdemand will be the default value corresponding to the facility-type selected as dictated in Table 3-9.[[71]](#footnote-72) The Commission believes this assumption is fair as the State average for electric heating saturation was found to only be 12%, implying that electricity is not the predominant heating fuel.

#### 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. 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 proposes the removal of the methodology and values (Table 3-2,[[72]](#footnote-73) Table 3-3,[[73]](#footnote-74) and Table 3-4[[74]](#footnote-75)) for calculating the adjusted lifetime savings.

To account for the baseline shift, the Commission also proposes to include 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 will be presented in the table.

#### Thresholds for Using Default Values

In the 2015 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.[[75]](#footnote-76) The SWE has 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 sees no evidence that the thresholds for site-specific data collection are 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 believes that verification approaches used for high-value projects within the sample should be rigorous and meaningful. Therefore, the Commission proposes to maintain current thresholds and to continue monitoring evaluation results and review thresholds annually.

#### Evaluation Protocols

The 2015 TRM allows EDCs to use the prescriptive lighting table in Appendix C to estimate savings for lighting projects with connected load savings less than 20 kW. The Commission proposes to remove this option and clarify that all lighting projects must use the proposed 2016 version of Appendix C to determine savings. The Commission believes that the enhanced usability and functionality of Appendix C will 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 defines assumptions based on multiple inputs including building type, space cooling type, heating fuel, etc. and, as such, is less linear than its predecessor. Use of Appendix C for all projects will ensure consistency in how these advanced savings are calculated and reported.

### Section 3.1.2 – New Construction Lighting[[76]](#footnote-77)

#### New Construction Savings Factors

In the 2015 TRM Final Order, the Commission directed the SWE to review the American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE) 90.1‑2007[[77]](#footnote-78) 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.[[78]](#footnote-79)

Based on the SWE’s research, the Commission proposes updating baseline savings factor (SVG) values for new construction projects. Previously, the baseline SVG value for new construction projects was assumed to be 0. The proposed baseline values will 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 2014 Light Metering Study.

### Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 Tons[[79]](#footnote-80)

#### Algorithm Revision

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.[[80]](#footnote-81) Based on the SWE’s research, the Commission believes 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 believes 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.

Therefore, the Commission proposes the following updates for new construction measures: 1) update the heating seasonal performance factor of the baseline heating unit (HSPF) from standard DHP to electric resistance heat; and 2) update the seasonable energy efficiency ratio (SEER) of the baseline cooling unit from central air conditioners to room air conditioners.

### Section 3.3.1 – Premium Efficiency Motors[[81]](#footnote-82)

#### Code Changes

The U.S. DOE published a final rule to update energy conservation standards for C&I electric motors.[[82]](#footnote-83) Compliance with the established standards is required on June 1, 2016 (PY8). The new standards incorporate a wider scope of electric motors that the U.S. DOE does not currently regulate and require more stringent efficiency levels of certain general purpose electric motors.

The Commission proposes updating Section 3.3.1 to account for these federal code changes. The updates would also impact Section 3.2.3 – Water Source and Geothermal

Heat Pumps,[[83]](#footnote-84) Section 3.3.2 – Variable Frequency Drive (VFD) Improvements[[84]](#footnote-85) and Appendix D – Motors and VFD Audit and Design Tool.

### Section 3.4.2 – Heat Pump Water Heaters[[85]](#footnote-86)

#### ENERGY STAR Criteria

The Commission proposes updating the ENERGY STAR Requirements and default efficient EF values with the ENERGY STAR Product Criteria for Residential Water Heaters Version 3.0 values.[[86]](#footnote-87) The Commission proposes the same updates for Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane[[87]](#footnote-88) and Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane.[[88]](#footnote-89)

#### Federal Standard Requirements

The Commission proposes updating the baseline EF values with the new Federal Standards for Residential Water Heaters values.[[89]](#footnote-90) The Commission proposes the same updates for Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane[[90]](#footnote-91) and Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane.[[91]](#footnote-92)

#### 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.[[92]](#footnote-93) The 2015 TRM only provides 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 kilowatt-hour (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 believes that the default savings values are a better representation of Pennsylvania data and therefore will increase accuracy in savings assumptions.

The Commission proposes 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[[93]](#footnote-94) and Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane.[[94]](#footnote-95)

### Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-in Refrigerated Cases[[95]](#footnote-96)

In the 2015 TRM Final Order, the Commission directed the SWE to develop savings value recommendations for 1-14W motors.[[96]](#footnote-97) 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[[97]](#footnote-98) and Tables 3-102.[[98]](#footnote-99) Table 3-103 provides default savings if refrigerated case temperature and/or motor size are not known.[[99]](#footnote-100) The Commission proposes to remove Table 3-103 since these parameters should be collected by the EDCs for more accurate savings. We also propose the removal of Table 3-98.[[100]](#footnote-101)

### Section 3.6.1 – ENERGY STAR Clothes Washer[[101]](#footnote-102)

On December 15, 2014, the U.S. DOE published a final rule adopting more stringent energy conservation standards for commercial clothes washers.[[102]](#footnote-103) Compliance with the new standards is required on January 1, 2018. As stated in Section 1.7 – Baseline Estimates of the TRM, if a new federal standard is effective on January 1st, changes will be reflected in the TRM to be released in June of that year. Therefore, the Commission proposes that the new standards be effective June 1, 2018 and thereafter, provided that there are no additional code changes.

The U.S. DOE test procedures for clothes washers are codified at title 10 of the Code of Federal Regulations part 430, subpart B, appendix J1 and appendix J2.[[103]](#footnote-104) The current standards use the test procedure in appendix J1 to determine the MEFs, while the new standards use the methodology in appendix J2. To understand how the new standards compare with the current standards for commercial clothes washers, the U.S. DOE provided equivalent appendix J1 and appendix J2 MEFs. Since the current algorithms in the TRM use appendix J1 MEFs, the Commission proposes to use the appendix J1 equivalent of appendix J2 MEFs beginning program year ten (June 1, 2018 through May 31, 2019) (PY10) and thereafter.

### Section 3.7.1 – High-Efficiency Ice Machines[[104]](#footnote-105)

The U.S. DOE published a final rule on January 28, 2015, adopting more stringent energy conservation standards for some classes of automatic commercial ice makers, as well as establishing new standards for continuous type ice-making machines that were not previously regulated by the U.S. DOE.[[105]](#footnote-106) Since compliance with the new standards is required on January 28, 2018, the Commission proposes to adopt the standards beginning PY10 and thereafter. In addition to federal code changes, the Commission proposes to add ENERGY STAR efficiencies for continuous type ice machines beginning PY10 and thereafter.

## 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

The proposed major revisions to the 2015 TRM Appendix C and E calculators are two-fold. The proposed 2016 TRM Appendix C calculator aims to increase customer usability while allowing for increased customization.

We propose that Appendix C be redesigned in a way that enhances usability to customers of all levels of TRM knowledge. The proposed formatting includes 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 includes sorting and filtering options, where possible, to help the customer sort and view information appropriately.

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

Additionally, the “controls” and “fixtures” forms have been 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 provides 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 has 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 will 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 propose 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 will be performed against the appropriate T-8 fixture and the user will be notified of this adjustment.

## Section 5.4 – Appendix D: Motors and VFD Audit and Design Tool

The Commission proposes to update Appendix D to reflect the electric motors code changes discussed previously in this Tentative Order.

##

# CONCLUSION

With this Tentative Order, the Commission seeks comments on the proposed additions and updates to the TRM. This Tentative 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. We look forward to receiving comments from interested stakeholders regarding the proposed changes to the TRM; **THEREFORE,**

 **IT IS ORDERED:**

1. That the proposed 2016 Technical Reference Manual update be issued for comment.
2. That a copy of this Tentative 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 commented on the 2015 Technical Reference Manual update.
3. That the Secretary shall deposit a notice of this Tentative Order and proposed 2016 version of the Technical Reference Manual with the Legislative Reference Bureau for publication in the *Pennsylvania Bulletin*.
4. That interested parties shall have 30 days from the date the notice of this Tentative Order is published in the *Pennsylvania Bulletin* to file written comments referencing Docket Number M-2015-2469311 with the Pennsylvania Public Utility Commission.
5. That interested parties shall have 40 days from the date the notice of this Tentative Order is published in the *Pennsylvania Bulletin* to file written reply comments referencing Docket Number M-2015-2469311 with the Pennsylvania Public Utility Commission.
6. That a Word formatted copy of all comments and reply comments shall be electronically mailed to Megan G. Good at megagood@pa.gov and Kriss Brown at kribrown@pa.gov. Attachments may not exceed three megabytes.
7. That this Tentative Order, the proposed 2016 version of the TRM and all filed comments and reply comments related to this Tentative Order 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>.

1. That the contact person for technical issues related to this Tentative Order and the proposed 2016 version of the TRM is Megan G. Good, Bureau of Technical Utility Services, 717-425-7583 or megagood@pa.gov. The contact person for legal and process issues related to this Tentative Order and the proposed 2016 version of the TRM is Kriss Brown, Law Bureau, 717-787-4518 or kribrown@pa.gov.

**BY THE COMMISSION**

Rosemary Chiavetta

Secretary

(SEAL)

ORDER ADOPTED: March 26, 2015

ORDER ENTERED: March 26, 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, entered August 11, 2011, at Docket No. M‑2008-2071852, 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 January 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 August 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* Tentative Implementation Order, at Docket No. M‑2014-2424864, entered March 11, 2015 (Phase III Tentative Implementation Order), at 77. [↑](#footnote-ref-11)
11. *Id.* at 80 and 81. [↑](#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* <http://www.deeresources.com/>. [↑](#footnote-ref-14)
14. *See* U.S. DOE Standards and Test Procedures for Residential and Commercial Products. <http://energy.gov/eere/buildings/standards-and-test-procedures>. [↑](#footnote-ref-15)
15. 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-16)
16. 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-17)
17. *See Phase III Tentative Implementation Order* at 35-37. [↑](#footnote-ref-18)
18. *Id.* at 37 and 38. [↑](#footnote-ref-19)
19. *Id.* [↑](#footnote-ref-20)
20. The Commission proposed that the EDCs use the PJM 7-day load forecast found at the following link: <http://www.pjm.com/markets-and-operations/energy/real-time/7-day-load-forecast.aspx>. [↑](#footnote-ref-21)
21. The Commission proposed that the EDCs use Table B-1 of the annual PJM Load Forecast Report. A copy of the January 2015 report can be found at the following links: <http://www.pjm.com/~/media/documents/reports/2015-load-forecast-report.ashx> and <http://www.pjm.com/~/media/documents/reports/2015-load-report-data-xls.ashx>. [↑](#footnote-ref-22)
22. *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-23)
23. *See* Section 2.1.1 –ENERGY STAR Lighting, page 17, of the 2015 TRM. [↑](#footnote-ref-24)
24. *See* <http://www.energystar.gov/ia/partners/downloads/ENERGY_STAR_CFLs_Batch_3_Report_Public_Feb_2013.pdf>. [↑](#footnote-ref-25)
25. *See* Section 2.1.1 – ENERGY STAR Lighting, Table 2-1: ENERGY STAR Lighting References of the 2015 TRM at 20. [↑](#footnote-ref-26)
26. *See* Section 2.1.1 – ENERGY STAR Lighting, Table 2-4: Default Baseline Wattages for Reflector Bulbs of the 2015 TRM at 23. [↑](#footnote-ref-27)
27. *See* Section 2.1.1 – ENERGY STAR Lighting, Table 2-5: CFL and LED Energy and Demand HVAC Interactive Effects by EDC of the 2015 TRM at 24. [↑](#footnote-ref-28)
28. *See* Section 2.2.1 – Electric HVAC of the 2015 TRM at 35. [↑](#footnote-ref-29)
29. *See* Section 2.2.3 –Ductless Mini-Split Heat Pumps of the 2015 TRM at 49. [↑](#footnote-ref-30)
30. *See* Section 2.2.4 –ENERGY STAR Room Air Conditioners of the 2015 TRM at 55. [↑](#footnote-ref-31)
31. *See* <http://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air%20Conditioners%20Program%20Requirements.pdf>. [↑](#footnote-ref-32)
32. *See* Section 2.2.5 –Room AC (RAC) Retirement of the 2015 TRM at 59. [↑](#footnote-ref-33)
33. *See* Section 2.3.2 –Heat Pump Water Heaters of the 2015 TRM at 84. [↑](#footnote-ref-34)
34. *See* <http://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Water%20Heaters%20Version%203%200%20Program%20Requirements_0.pdf>. [↑](#footnote-ref-35)
35. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27>. [↑](#footnote-ref-36)
36. Updated February 5, 2015. *See* <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>. [↑](#footnote-ref-37)
37. *See* Section 2.3.3 –Solar Water Heaters of the 2015 TRM at 90. [↑](#footnote-ref-38)
38. *See* Section 2.3.4 –Fuel Switching: Electric Resistance to Fossil Fuel Water Heater of the 2015 TRM at 93. [↑](#footnote-ref-39)
39. *See* Section 2.3.5 –Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater of the 2015 TRM at 97. [↑](#footnote-ref-40)
40. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27>. [↑](#footnote-ref-41)
41. Updated February 5, 2015. *See* <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>. [↑](#footnote-ref-42)
42. *See* Section 2.3.9 –Low Flow Faucet Aerators of the 2015 TRM at 113. [↑](#footnote-ref-43)
43. Updated February 5, 2015. *See* <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>. [↑](#footnote-ref-44)
44. *See* Section 2.3.10 –Low Flow Showerheads of the 2015 TRM at 118. [↑](#footnote-ref-45)
45. *See* Section 2.3.11 –Thermostatic Shower Restriction Valve of the 2015 TRM at 123. [↑](#footnote-ref-46)
46. *See* Section 2.3.11 –Thermostatic Shower Restriction Valve of the 2015 TRM at 123. [↑](#footnote-ref-47)
47. *See* Section 2.4.3 –Refrigerator/Freezer Recycling With and Without Replacement of the 2015 TRM at 139. [↑](#footnote-ref-48)
48. *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-49)
49. 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-50)
50. *See* Section 2.4.4 –ENERGY STAR Clothes Washer of the 2015 TRM at 152. [↑](#footnote-ref-51)
51. *See* <http://www.energystar.gov/sites/default/files/specs//private/ENERGY%20STAR%20Final%20Version%207.0%20Clothes%20Washer%20Program%20Requirements.pdf>. [↑](#footnote-ref-52)
52. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39>. [↑](#footnote-ref-53)
53. *See* Section 2.5.1 –ENERGY STAR Televisions of the 2015 TRM at 174. [↑](#footnote-ref-54)
54. *See* <http://www.energystar.gov/sites/default/files/FINAL%20Version%207.0%20Television%20Program%20Requirements%20%28Dec-2014%29_0.pdf>. [↑](#footnote-ref-55)
55. *See* <http://www.energystar.gov/sites/default/files/FINAL%20Version%206.1%20Television%20Program%20Requirements%20%28Rev%20Oct-2014%29_0.pdf>. [↑](#footnote-ref-56)
56. *See* <http://www.energystar.gov//ia/partners/downloads/most_efficient/2015/Final_ENERGY_STAR_Most_Efficient_2015_Recognition_Criteria_Televisions.pdf?60be-105c>. [↑](#footnote-ref-57)
57. *See* Section 2.5.3 –Smart Strip Plug Outlets of the 2015 TRM at 181. [↑](#footnote-ref-58)
58. *See* Section 2.7.1 –Pool Pump Load Shifting of the 2015 TRM at 207. [↑](#footnote-ref-59)
59. *See* *Mid-Atlantic TRM, version 2.0. Prepared by Vermont Energy Investment Corporation. Facilitated and managed by the Northeast Energy Efficiency Partnerships. July 2011.* [↑](#footnote-ref-60)
60. *See* <http://www.energystar.gov/sites/default/files/asset/document/Pool%20Pump%20Calculator.xlsx>. [↑](#footnote-ref-61)
61. *See* Section 2.7.2 –Variable Speed Pool Pumps (With Load Shifting Option) of the 2015 TRM at 210. [↑](#footnote-ref-62)
62. *See* 2015 TRM Final Order at 51. [↑](#footnote-ref-63)
63. *See* <http://www.energystar.gov/sites/default/files/asset/document/Pool%20Pump%20Calculator.xlsx>. [↑](#footnote-ref-64)
64. *See* Section 2.3.1 –Efficient Electric Water Heaters of the 2015 TRM at 81. [↑](#footnote-ref-65)
65. *See* Section 3.4.1 – Electric Resistance Water Heaters of the 2015 TRM at 326. [↑](#footnote-ref-66)
66. *See* Section 3.1.1 – Lighting Fixture Improvement of the 2015 TRM at 215. [↑](#footnote-ref-67)
67. *See* Section 3.1.1 – Lighting Fixture Improvement of the 2015 TRM at 219. [↑](#footnote-ref-68)
68. *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-69)
69. *See* <http://www.neep.org/mid-atlantic-technical-reference-manual-v40>. [↑](#footnote-ref-70)
70. *See* <http://www.ilsag.info/technical-reference-manual.html>. [↑](#footnote-ref-71)
71. *See* Section 3.1.1 – Lighting Fixture Improvements, Table 3-9: Lighting Power Densities from ASHRAE 90.1-2007 Building Area Method of the 2015 TRM at 228. [↑](#footnote-ref-72)
72. *See* Section 3.1.1 – Lighting Fixture Improvements, Table 3-2: 2016 Savings Adjustment Factors and Adjusted EULs for Standard T-8 Measures of the 2015 TRM at 217. [↑](#footnote-ref-73)
73. *See* Section 3.1.1 – Lighting Fixture Improvements, Table 3-3: 2016 Savings Adjustment Factors and Adjusted EULs for HPT8 Measures of the 2015 TRM at 217. [↑](#footnote-ref-74)
74. *See* Section 3.1.1 – Lighting Fixture Improvements, Table 3-4: 2016 Savings Adjustment Factors and Adjusted EULs for T5 Measures of the 2015 TRM at 218. [↑](#footnote-ref-75)
75. *See* 2015 TRM Final Order at 55. [↑](#footnote-ref-76)
76. *See* Section 3.1.2 – New Construction Lighting of the 2015 TRM at 226. [↑](#footnote-ref-77)
77. The ASHRAE 90.1 Standard is available at: <https://law.resource.org/pub/us/code/ibr/ashrae.90.1.2007.pdf>. [↑](#footnote-ref-78)
78. *See* 2015 TRM Final Order at 53. [↑](#footnote-ref-79)
79. *See* Section 3.2.4 – Ductless Mini-Split Heat Pumps of the 2015 TRM at 277. [↑](#footnote-ref-80)
80. *See* 2015 TRM Final Order at 64. [↑](#footnote-ref-81)
81. *See* Section 3.3.1 – Premium Efficiency Motors of the 2015 TRM at 304. [↑](#footnote-ref-82)
82. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/50>. [↑](#footnote-ref-83)
83. *See* Section 3.2.3 – Water Source and Geothermal Heat Pumps of the 2015 TRM at 267. [↑](#footnote-ref-84)
84. *See* Section 3.3.2 – Variable Frequency Drive (VFD) Improvements of the 2015 TRM at 316. [↑](#footnote-ref-85)
85. *See* Section 3.4.2 – Heat Pump Water Heaters of the 2015 TRM at 332. [↑](#footnote-ref-86)
86. *See* <http://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Water%20Heaters%20Version%203%200%20Program%20Requirements_0.pdf>. [↑](#footnote-ref-87)
87. *See* Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane of the 2015 TRM at 351. [↑](#footnote-ref-88)
88. *See* Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane of the 2015 TRM at 358. [↑](#footnote-ref-89)
89. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27>. [↑](#footnote-ref-90)
90. *See* Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane of the 2015 TRM at 351. [↑](#footnote-ref-91)
91. *See* Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane of the 2015 TRM at 358. [↑](#footnote-ref-92)
92. *See* 2015 TRM Final Order at 67 and 68. [↑](#footnote-ref-93)
93. *See* Section 3.4.5 – Fuel Switching: Electric Resistance Water Heaters to Gas/Oil/Propane of the 2015 TRM at 351. [↑](#footnote-ref-94)
94. *See* Section 3.4.6 – Fuel Switching: Heat Pump Water Heaters to Gas/Oil/Propane of the 2015 TRM at 358. [↑](#footnote-ref-95)
95. *See* Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases of the 2015 TRM at 377. [↑](#footnote-ref-96)
96. *See* 2015 TRM Final Order at 72. [↑](#footnote-ref-97)
97. *See* Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, Table 3-101: PSC to ECM Deemed Savings of the 2015 TRM at 380. [↑](#footnote-ref-98)
98. *See* Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, Table 3-102: Shaded Pole to ECM Deemed Savings of the 2015 TRM at 381. [↑](#footnote-ref-99)
99. *See* 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 of the 2015 TRM at 381. [↑](#footnote-ref-100)
100. *See* 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 of the 2015 TRM at 375. [↑](#footnote-ref-101)
101. *See* Section 3.6.1 – ENERGY STAR Clothes Washer of the 2015 TRM at 421. [↑](#footnote-ref-102)
102. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39>. [↑](#footnote-ref-103)
103. *See* <http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title10/10cfr430_main_02.tpl>. [↑](#footnote-ref-104)
104. *See* Section 3.7.1 – High-Efficiency Ice Machines of the 2015 TRM at 429. [↑](#footnote-ref-105)
105. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/21>. [↑](#footnote-ref-106)