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

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|  | Public Meeting held September 11, 2014 |
| 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 2015 Update | Docket No. M-2012-2313373 M-00051865 |

**2015 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-1) In adopting the original version of the TRM, this Commission directed its Bureau of Conservation, Economics and Energy Planning (CEEP)[[2]](#footnote-2) to oversee the implementation, maintenance and periodic updating of the TRM.[[3]](#footnote-3) 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-4) 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-5)

Soon after the adoption of the EE&C Program 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 at the May 28, 2009 Public Meeting.[[6]](#footnote-6) In adopting the 2009 TRM, the Commission recognized the importance of updating the TRM on an annual basis.[[7]](#footnote-7)

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-8) The *Phase II Implementation Order* also recognized the importance of the continued use of an annual updating process for the TRM.[[9]](#footnote-9) With this Tentative Order, the Commission advances the sixth annual update of the TRM to be applied beginning with the 2015‑2016 AEPS Act and Act 129 EE&C Program Phase II compliance year.

**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 Test Manual (TRC) and to provide suggestions for possible revisions and additions to these manuals. A program evaluation group (PEG)[[10]](#footnote-10) was formed to, among other things, provide guidance to the SWE in clarifying energy savings measurement protocols and plans by recommending improvements to the existing TRM and other aspects of the EE&C program. In addition, the Commission convened a Technical Working Group (TWG)[[11]](#footnote-11) meeting to discuss the proposed 2015 TRM updates.[[12]](#footnote-12)

As indicated above, the Commission has previously updated the TRM on five other occasions. On each occasion, the Commission used a process, similar to the current process that offers all stakeholders multiple opportunities to provide input, in an open and collaborative way.[[13]](#footnote-13)

The SWE, in collaboration with the PEG and staff from the Commission’s Bureau of Technical Utility Services (TUS), with input from the TWG, reviewed the 2014 TRM and proposes several changes and additions for consideration for inclusion in the 2015 TRM. With the adoption of this Tentative Order, the Commission seeks comments on the proposed 2015 TRM. The proposed 2015 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 2015 TRM will be published in the *Pennsylvania Bulletin* with comments on the proposed 2015 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 2014 TRM update process were referred to the PEG for discussion in order to provide recommendations during the 2015 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 as part of their Phase II EE&C plans 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 the 2015 TRM update:

1. General Improvements to the TRM:
	1. Updates to Federal and the Environmental Protection Agency’s (EPA) ENERGY STAR requirements;
	2. Updates to the measure characterization assigned to all measures;
	3. Updates to the TRM measure format;
	4. Updates to coincidence factors;
	5. Updates to energy to demand factors;
	6. Incorporation of the results from the SWE’s 2014 Baseline Studies;[[14]](#footnote-14)
	7. Discussion of the weather impact on C&I measures;
	8. Updates to sources;
2. Inclusion of six new residential EE&C measure protocols.
3. Inclusion of twelve new C&I EE&C measure protocols.
4. Clarification of the existing residential EE&C measure protocols.
5. Removal of the Residential ENERGY STAR Audit and Electric Clothes Dryer with Moisture Sensor protocols.
6. Clarification of the existing C&I EE&C measure protocols.
7. Clarification of the existing agricultural EE&C measure protocols.
8. Updates to Appendix A – Measure Lives.
9. Updates to Appendix C – Lighting Audit and Design Tool.
10. Updates to Appendix D – Motor and VFD Audit and Design Tool.
11. Updates to 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.

## General Improvements

### Updates to Federal and Environmental Protection Agency’s ENERGY STAR Requirements

 For all program years of Act 129 to date, the TRM has recognized Federal codes and ENERGY STAR guidelines at the core of many measures. The Commission recognizes that the baseline standards of the TRM should align with industry standards as a whole and foster efficiency opportunities that move in step with applicable code changes as stated in Section 1.7 – Baseline Estimates of the 2014 TRM:

“Baselines will be updated to reflect changing codes, practices and market transformation effects, and will be handled in future versions of the TRM by describing the choice of and reasoning behind a shifting baseline assumption.”[[15]](#footnote-15)

 Accordingly, the Commission proposes to update multiple stipulated values[[16]](#footnote-16) in the TRM in accordance with federal code minimums.[[17]](#footnote-17) For Section 2.2.1 – Electric HVAC,[[18]](#footnote-18) the Commission proposes updating the Heating Seasonal Performance Factor of the Baseline Unit (HSPFb) used in a Replace on Burnout scenario from 7.7 to 8.2 for air source heat pumps (ASHPs). Additionally, we propose updating the seasonal energy efficiency ratio of the baseline unit (SEERb) used in a Replace on Burnout scenario from 13 to 14 for ASHPs. These proposed values align with the federal standards that become effective on January 1, 2015.[[19]](#footnote-19) We are proposing these same updates to the HSPFb and SEERb values in Section 2.2.3 – Ductless Mini-Split Heat Pumps.[[20]](#footnote-20)

 Similarly, the Commission proposes updating the HSPF and SEER values for the heating and cooling efficiencies of air source and geothermal heat pumps in Section 2.6.4 – Residential New Construction.[[21]](#footnote-21) The Commission proposes updating the HSPF value to 8.2 and the SEER value to 14 for both types of heat pumps, per the federal standards changes.

 Additionally, the Commission proposes to update multiple stipulated values for applicable measures using ENERGY STAR guidelines to the active version of the ENERGY STAR standards as determined by the EPA.[[22]](#footnote-22)

 The Commission proposes the following language in Section 1.7 – Baseline Estimates of the TRM to provide clarity in addressing which published standard will be applicable to a particular measure:

When an existing Federal standard expires in a given **calendar year**, then that change will be reflected in the **following** **program year**’s TRM.[[23]](#footnote-23) This applies only to measures where the Federal standard is considered the baseline as described in the TRM or otherwise required by law. In the case of a January 1st effective date for a new Federal standard, the previous standard will be said to have expired on December 31 of the previous calendar year, and thus the change will be reflected in the TRM to be released in June of that year. Likewise, it is proposed that when an existing ENERGY STAR Product Specification Version expires in a given **calendar year**, then that change will be reflected in the **following** **program year’s** TRM.[[24]](#footnote-24) This applies only to measures where the ENERGY STAR criterion is considered the eligibility requirement.

### Measure Characterizations Assigned to All Measures

Section 1.3 – Definitions of the 2014 TRM contains various measure characterization definitions in an effort to aid the user in understanding each measure’s intent. The measure characterizations act as a first step in defining the dual baselines used when determining measure or program savings used in the TRC test. These terms, also referred to as “vintages” or “program delivery types,” are subsequently provided in the 2014 TRM on a sporadic basis in order to help clarify certain measure requirements and include the following:

* Direct Install (DI) Measure;
* Early Retirement (ERET) Measure;
* Early Replacement (EREP) Measure;
* New Construction Measure (Substantial Renovation Measure);
* Replace on Burnout (ROB) Measure; and
* Retrofit Measure (RET).

 The Commission proposes to assign a measure characterization (entered as Vintage) to all measures listed in the 2015 TRM. The Vintage description will be listed at the beginning of the measure language to provide clarity to the intent of the measure and assist the user in classifying the approach.

### TRM Measure Formatting Changes

 **a. Organization of Measures**

The Commission proposes to reorganize the 2015 TRM in order to align with other statewide TRMs and to provide for a more intuitive way to locate data within the TRM. To accomplish this, the Commission proposes updating the Residential and C&I measure order and measure identification numbers to classify them by end use,[[25]](#footnote-25) intended as an expansion of Section 1.2.3 - End-Use Categories & Thresholds for Using Default Values of the TRM. For example, all residential heating, ventilation and air conditioning (HVAC) measures will be located together. Table 1-1: End-Use Categories and Measures in the TRM in Section 1.2.3 – End-Use Categories and Measures in the TRM will be updated as follows:

|  |  |
| --- | --- |
| **End-Use Categories** | **List of Measures (Sections)** |
| **Residential Market Sector** |
| Lighting - 2.1 | 2.1.1 – 2.1.5 |
| HVAC - 2.2 | 2.2.1 – 2.2.9 |
| Domestic Hot Water - 2.3 | 2.3.1 – 2.3.11 |
| Appliances – 2.4 | 2.4.1 – 2.4.11 |
| Consumer Electronics – 2.5 | 2.5.1 – 2.5.3 |
| Building Shell – 2.6 | 2.6.1 – 2.6.7 |
| Miscellaneous – 2.7 | 2.7.1 – 2.7.2 |
| **Commercial & Industrial Market Sector** |
| Lighting – 3.1 | 3.1.1 – 3.1.7 |
| HVAC – 3.2 | 3.2.1 – 3.2.9 |
| Motors & VFDs – 3.3 | 3.3.1 – 3.3.4 |
| Domestic Hot Water – 3.4 | 3.4.1 – 3.4.6 |
| Refrigeration – 3.5 | 3.5.1 – 3.5.14 |
| Appliances – 3.6 | 3.6.1 |
| Food Service Equipment – 3.7 | 3.7.1 – 3.7.5 |
| Building Shell – 3.8 | 3.8.1 |
| Consumer Electronics – 3.9 | 3.9.1 – 3.9.3 |
| Compressed Air – 3.10 | 3.10.1 – 3.10.3 |
| Miscellaneous – 3.11 | 3.11.1 |
| **Agricultural Market Sector** |
| Agricultural Equipment | 4.1 – 4.8 |

Additionally, the Commission proposes to update the layout of the information presented in each measure to be more uniform throughout the 2015 TRM. The changes listed below summarize the proposed changes across all measures:

* All Algorithms will become more uniform in format.
* All Definitions will be moved to table format.
* Any default savings parameters will be clearly listed adjacent to any designation of EDC Data Gathering option.
* The Evaluation Protocols and Eligibility will be listed for each applicable measure.
* All Source information will be moved to the end of the measure and hyperlink sources will be provided wherever feasible.
* The measures will be re-ordered and grouped by end-use.

 **b. Measure Titles**

 The Commission proposes changes to certain measure titles to more accurately represent the information included therein. We believe the revised titles will be more informative.

### Updating Coincident Factors

 **a. General Updates**

During Phase I of Act 129, the EDCs were required to determine the 100 hours of highest peak load used to meet their peak demand reduction obligations. For Phase II, no demand response or peak demand reduction goals were established.[[26]](#footnote-26) The Commission, however, proposes to update the factors used for estimating coincident peak demand savings, as we expect the EDCs to track relevant coincident peak demand reductions occurring as a result of their Phase II EE&C Programs.

Section 1.10 – Electric Resource Savings of the 2014 TRM states that the coincident summer peak period is defined as the period between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, that is not a weekend or federal holiday.[[27]](#footnote-27) The time periods for energy savings and coincident peak demand savings were chosen to best fit the Act 129 requirement, which reflects the seasonal avoided cost patterns for electric energy and capacity used for determining the energy efficiency program cost-effectiveness.

Additionally, the Commission proposes the addition of the following definition to be added to Section 1.3 – Definitions of the TRM:

Coincidence Factor - The ratio of the (1) sum of every unit’s average kW load during the PJM peak load period (June through August, non-holiday weekdays, 2 pm to 6 pm) to the (2) sum of the non-coincident maximum kW connected load for every unit.

 **b. Residential Coincidence Factor Updates**

Given the guidelines for the peak period from PJM, the Commission proposes multiple updates to coincidence factors (CFs) throughout the 2015 TRM that will be based as closely as possible to the conditions found in the Pennsylvania electric distribution company service territories, using the most reliable and up-to-date data. Specifically, we propose the following updates:

|  |  |  |  |
| --- | --- | --- | --- |
| **Proposed 2015 TRM Section** | **2014 TRM CF** | **Proposed 2015 TRM CF** | **Source** |
| 2.2.1 – Electric HVAC | 70% | 64.7% | Baltimore Gas & Electric (BG&E) Study[[28]](#footnote-28) |
| 2.2.3 – Ductless Mini-Split Heat Pumps | 70% | 64.7% | BG&E Study |
| 2.2.4 – ENERGY STAR Room Air Conditioners | 58% | 30% | RLW Report[[29]](#footnote-29) |
| 2.2.5 – Room AC (RAC) Retirement | 58% | 30% | RLW Report |
| 2.2.6 – Duct Sealing | 70% | 64.7% | BG&E Study |
| 2.2.7 – Furnace Whistle | 70% | 64.7% | BG&E Study |
| 2.5.1 – ENERGY STAR Televisions | 28% | 17% | Efficiency Vermont TRM - 2013[[30]](#footnote-30) |
| 2.5.3 – Smart Strip Plug Outlets | 80% | 90.0% for Entertainment Center;83.2% for Unspecified Use | Efficiency Vermont TRM - 2013 |
| 2.6.1 – Ceiling/Attic and Wall Insulation | 70% for Air Source Heat Pumps and Central Air Conditioning Systems;58% for Room Air Conditioning Systems | 64.7% for Air Source Heat Pumps and Central Air Conditioning Systems;30% for Room Air Conditioning Systems | BG&E Study; RLW Report |
| 2.6.3 – ENERGY STAR Windows | 75% | 64.7% | BG&E Study |
| 2.6.4 – Residential New Construction | 70% | 64.7% | BG&E Study |
| 2.7.1 – Pool Pump Load Shifting | 23.5% | 30.6% | Pool Pump DR Potential Report[[31]](#footnote-31) |
| 2.7.2 – Variable Speed Pool Pumps (with Load Shifting Option) | 23.5% | 30.6% | Pool Pump DR Potential Report |

Additionally, there are three protocols for which the Commission is proposing to update the deemed demand savings with algorithms that include a CF. Specifically, the Commission is proposing this change for Section 2.4.4 – ENERGY STAR Clothes Washers;[[32]](#footnote-32) Section 2.4.7 – ENERGY STAR Dishwashers;[[33]](#footnote-33) and Section 2.4.8 – ENERGY STAR Dehumidifiers.[[34]](#footnote-34) In Section 2.4.4 – ENERGY STAR Clothes Washers,[[35]](#footnote-35) the 2014 TRM includes a CF of 1 (i.e. 100%), citing that the CF is already embedded in the summer peak demand reduction estimate and, as such, was built into the deemed demand savings number. The Commission believes that including a CF of 100% is misleading and proposes that the CF be 2.9% based on the 2014 Mid-Atlantic TRM,[[36]](#footnote-36) which has the same PJM peak period definition.

Regarding Section 2.4.7 – ENERGY STAR Dishwashers,[[37]](#footnote-37) again we believe that 2014 TRM’s CF value of 100% was misleading and propose updating the peak demand savings from a deemed value to an algorithm that includes a CF of 2.6%. The 2013 Illinois TRM[[38]](#footnote-38) includes a 2.6% CF and includes a peak definition of 1:00 to 5:00 P.M. on weekdays, from June through August. This definition is closely aligned with the PJM peak definition.

In Section 2.4.8 – ENERGY STAR Dehumidifiers, the Commission proposes updating the peak demand savings from a deemed value which includes a misleading CF of 100% to an algorithm that includes a CF of 40.5%. This value was developed through a 2013 metering study performed in Pennsylvania and Ohio by ADM Associates.[[39]](#footnote-39)

Section 2.5.2 – ENERGY STAR Office Equipment[[40]](#footnote-40) has used the same savings values for the previous four TRMs.[[41]](#footnote-41) The 2011, 2012 and 2013 TRMs used a CF of 1.0. During the 2014 TRM update, this was amended to a value of 1.18. The source and legitimacy of the value were questioned by the PEG. The source in the 2014 TRM states the following: “The coincidence factor, defined as kW\*8760/kWh, used for all office equipment is 1.18 as calculated by doing a covariance between the load shape and peak hours.” The covariance analysis could not be found by the SWE. The SWE determined that the last update to the calculator demand and energy savings occurred in 2011 and that only emission rates have been updated since that time. Some analysis of the data within the calculator showed that a CF was most likely built into the demand savings value. Therefore, the Commission proposes that the CF be removed from the algorithms and to keep the energy and demand savings that have been used in previous versions of the TRM.

 **c. Commercial and Industrial Coincidence Factors**

Regarding C&I CFs, the 2014 TRM included several commercial HVAC measures that reference CFs from a variety of sources. These measures typically have one CF for all eligible measure applications. However, following the SWE’s completion of a computer simulation study, using eQuest software, the Commission proposes new CFs for the HVAC measures which are based on reference-city-specific values that align with the peak demand definition. We are proposing specific CFs based on each reference city and building type. As such, there are too many to list within this Tentative Order and, therefore, we direct commenters to the following sections of the proposed TRM:

* Section 3.2.1 – HVAC Systems;[[42]](#footnote-42)
* Section 3.8.1 – Wall and Ceiling Insulation;[[43]](#footnote-43)
* Section 3.2.3 – Water Source and Geothermal Heat Pumps;[[44]](#footnote-44)
* Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons;[[45]](#footnote-45)
* Section 3.2.6 – Small C/I HVAC Refrigerant Charge Correction;[[46]](#footnote-46) and
* Section 3.2.7 – ENERGY STAR Room Air Conditioner.[[47]](#footnote-47)

The Commission also proposes referencing the same table of CFs for both the heat pump unit and ground source loop pump units and geothermal heat pumps, unless the ground source loop pump runs continuously, in which case, we propose the use of a value of 100%.

### Updating Energy to Demand Factors

 The Commission proposes updating the energy to demand factors from the 2014 TRM value of 0.00008294 to 0.00008047 for the following measures:

* Section 2.3.2 – Heat Pump Water Heaters;[[48]](#footnote-48)
* Section 2.3.3 – Solar Water Heaters;[[49]](#footnote-49)
* Section 2.3.8 – Water Heater Pipe Insulation;[[50]](#footnote-50)
* Section 2.3.4 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater;[[51]](#footnote-51)
* Section 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater;[[52]](#footnote-52) and
* Section 2.3.7 – Water Heater Temperature Setback.[[53]](#footnote-53)

 With regard to Section 2.3.9 – Low Flow Faucet Aerators,[[54]](#footnote-54) the Commission proposes updating the energy to demand factor from 0.000129 to 0.000134 after recalculating, based on the PJM peak definition, the “% faucet use during peak” from the existing source.[[55]](#footnote-55) The recalculated value is 19.5%.

 Lastly, the Commission proposes replacing the current CF of 100% with an energy to demand factor of 0.0001119 for the following measures: Section 2.4.3 – Refrigerator/Freezer Recycling with and without Replacement;[[56]](#footnote-56) Section 2.4.1 – ENERGY STAR Refrigerators;[[57]](#footnote-57) and Section 2.4.2 – ENERGY STAR Freezers.[[58]](#footnote-58) This value will better estimate peak demand savings and was calculated, according to the PJM peak demand definition, using 8760 refrigerator load shape data provided by PPL and Cadmus for TRC modeling.[[59]](#footnote-59)

### Incorporation of the 2014 Baseline Study Results

In the 2014 TRM Final Order, the Commission directed the PEG to review the baselines used in the TRM and address the potential for updating them based on the 2014 Residential Baseline Study, the 2014 C&I Baseline Study and the SWE Potential Studies.[[60]](#footnote-60) Section 1.7 – Baseline Estimates describes the process for updating the baseline information used in the measure savings calculations or protocols.

In April 2014, the SWE completed the 2014 Residential Baseline Study. The Commission proposes to use the information provided in the 2014 Residential Baseline Study to align the 2015 TRM sources with current data for multiple measures in the residential sector.

Specifically, in Section 2.2.1 – Electric HVAC[[61]](#footnote-61) of the TRM, the Commission proposes to update the default SEERb value, to be used in lieu of EDC data gathering, for Early Replacement measures from a value of ten for central air conditioning and ASHPs to values of 11 and 12, respectively. These changes represent an average of all available unit information for central air conditioners and ASHPs included in the survey for the 2014 Residential Baseline Study.

Additionally, for Section 2.4.4 – ENERGY STAR Clothes Washers,[[62]](#footnote-62) the Commission proposes updating the following variables using the 2014 Residential Baseline Study as a source: Cycles, which changes from 265 cycles per year to 250 cycles per year and %ElectricDryer, which changes from 64% to 76%. For Section 3.4.1 – Electric Resistance Water Heaters[[63]](#footnote-63) and Section 3.4.2 – Heat Pump Water Heaters,[[64]](#footnote-64) the Commission proposes updating the source to the 2014 Residential Baseline Study for those calculation assumptions that had previously used the 2012 Residential Baseline Study as a source. With regard to Section 3.4.7 – Heat Pump Water Heaters to Gas/Oil/Propane, the Commission proposes updating the source to the 2014 Residential Baseline Study for those hot water temperature assumptions that had previously used the 2012 Residential Baseline Study as a source.

While the SWE did perform a 2014 C&I Baseline Study, no assumptions or findings from the study necessitated updates in the TRM.

### Discussion of Weather Impacts on C&I Measures

There are two commercial refrigeration measures in the TRM (Section 3.5.11 – Auto Closers[[65]](#footnote-65) and Section 3.5.14 – Suction Pipe Insulation for Walk-In Coolers and Freezers[[66]](#footnote-66)) that rely on work and analysis completed in California. In the 2014 TRM, seven reference cities in Pennsylvania are mapped to a corresponding California climate zone, as shown in the Table 1-4: California CZ Mapping Table,[[67]](#footnote-67) based on cooling degree hours and wet bulb temperatures (CDH65). Stakeholders have raised concerns regarding the feasibility and appropriateness of the mapping methodology. Because there are significant weather differences between California and Pennsylvania, mapping Pennsylvania cities to California climate zones is not straightforward and could be addressed in a variety of ways. To simplify the issue, the Commission proposes using a single California climate zone when leveraging savings research conducted in California for weather dependent measures, particularly for refrigeration measures.

The Commission proposes using California climate zone 4 (CZ4) for all weather-dependent measures referencing California work papers and discarding the weather mapping table established in previous TRMs. For the 2015 TRM, the Commission proposes to revise savings protocols for the two refrigeration protocols. CZ4 is selected as the closest representation to Pennsylvania weather based on comparable average annual dry bulb temperature, wet bulb temperature, and relative humidity, as well as cooling degree hours.

It should be noted that, in the majority of cases when the Commission uses secondary research to develop savings estimates for TRM measures, the Commission will select sources that are most representative of Pennsylvania. Since there is a dearth of reliable references for commercial refrigeration measures and the collection of primary data to support savings estimates would be exceedingly cost-prohibitive compared to the value gained, the Commission believes that using California data with an effort to normalize for weather differences is sufficient. The Commission believes that there is very low risk associated with assuming a single California climate zone due to the small contribution of savings from the two measures to the overall portfolios (<0.1%).

### Updating Sources

The Commission proposes to update a variety of reference sources to provide more accurate information. This includes source additions or deletions in the following sections:

* Section 2.2.7 – Furnace Whistle;[[68]](#footnote-68)
* Section 3.2.1 – HVAC Systems;[[69]](#footnote-69)
* Section 3.5.1 – High-Efficiency Refrigeration/Freezer Cases;[[70]](#footnote-70)
* Section 3.5.2 – High-Efficiency Evaporator Fan Motors for Reach-In Refrigerated Cases;[[71]](#footnote-71)
* Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases;[[72]](#footnote-72)
* Section 3.7.2 – Controls: Beverage Machine Controls;[[73]](#footnote-73)
* Section 3.7.1 – High-Efficiency Ice Machines;[[74]](#footnote-74)
* Section 3.8.1 – Wall and Ceiling Insulation;[[75]](#footnote-75)
* Section 3.7.4 – ENERGY STAR Electric Steam Cooker;[[76]](#footnote-76)
* Section 3.9.2 – Office Equipment – Network Power Management Enabling;[[77]](#footnote-77)
* Section 3.5.14 – Suction Pipe Insulation for Walk-In Coolers and Freezers;[[78]](#footnote-78)
* Section 3.5.4 – Controls: Evaporator Fan Controllers;[[79]](#footnote-79)
* Section 3.6.1 – ENERGY STAR Clothes Washers;[[80]](#footnote-80)
* Section 3.4.2 – Heat Pump Water Heaters;[[81]](#footnote-81)
* Section 4.1.1 – Automatic Milker Takeoffs;[[82]](#footnote-82)
* Section 4.1.4 – Heat Reclaimers;[[83]](#footnote-83) and
* Section 4.1.6 – Livestock Waterer.[[84]](#footnote-84)

Where the update affects a variable or value, we will discuss the change in more detail below.

## Additional Residential EE&C Measure Protocols

The Commission understands 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 the inclusion of six new residential EE&C measure protocols. The EDCs’ independent evaluators, in collaboration with the SWE, produced, reviewed and edited these new residential EE&C measure protocols. The six new residential EE&C measure protocols are:

* Section 2.3.11 – Thermostatic Shower Restriction Valve;
* Section 2.4.5 – ENERGY STAR Dryers;
* Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer;
* Section 2.4.10 – ENERGY STAR Ceiling Fans;
* Section 2.6.2 – Air Sealing; and
* Section 2.6.6 – ENERGY STAR Manufactured Homes.

## Additional Commercial and Industrial EE&C Measure Protocols

 As with residential measures, expansion of the C&I section of the TRM is also essential for the M&V of the EDC EE&C programs. Based on collaborative discussions between the SWE and the EDCs and the available research, the following twelve new C&I EE&C measures and associated protocols are being proposed:

* Section 3.1.7 – LED [Light-Emitting Diode]: Refrigeration Display Case Lighting;
* Section 3.2.8 – Controls: Guest Room Occupancy Sensor;
* Section 3.2.9 – Controls: Economizer;
* Section 3.3.3 – ECM [Electronically Commutated Motor] Circulating Fan;
* Section 3.3.4 – VSD [Variable Speed Drive] on Kitchen Exhaust Fan;
* Section 3.5.7 – Controls: Evaporator Coil Defrost Control;
* Section 3.7.3 – Controls: Snack Machine Controls;
* Section 3.7.5 – ENERGY STAR Refrigerated Beverage Machine;
* Section 3.10.1 – Cycling Refrigerated Thermal Mass Dryer;
* Section 3.10.2 – Air-Entraining Air Nozzle;
* Section 3.10.3 – No-Loss Condensate Drains; and
* Section 3.11.1 – ENERGY STAR Servers.

## Existing Residential EE&C Measure Protocols and Processes

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

### 1. Section 2.2.1 – Electric HVAC

#### Heating Seasonal Performance Factor for Maintenance

 In its 2014 TRM Final Order, the Commission directed the PEG to consider a modification to the value used for Heating Seasonal Performance Factor for maintenance (HSPFm) of ASHPs receiving maintenance.[[85]](#footnote-85) We propose including the option of EDC Data Gathering to this measure to allow for EDC-specific information to be used in lieu of the default value provided by the TRM. Additionally, we propose to update the value of HSPFm from 6.8 to 6.9 in accordance with the adjustment to the Heating Seasonal Performance Factor of the Baseline Unit (HSPFb), as proposed below.

#### Heating Seasonal Performance Factor of the Baseline Unit

The Commission proposes to update the baseline HSPFb to include a default HSPF value of 6.9 for Early Replacement measures. This value was developed as a complement to the data from the 2014 Residential Baseline Study that found an average SEER of 12 for existing ASHPs. To determine the HSPF listing for 12 SEER heat pumps, a search was performed via the Air Conditioning, Heating and Refrigeration Association (AHRI) website and all available ASHP HSPFs were averaged with the fixed variable of 12 SEER.[[86]](#footnote-86) The source data was updated to include the AHRI website with reference to the 2014 Residential Baseline Study.

### 2. Section 2.1.1 – ENERGY STAR Lighting

In the 2014 TRM Final Order, the Commission noted that the 2014 TRM has been updated to clarify that any bulbs outside the lumen bins presented are exempt from the Energy Independence and Safety Act of 2007 (EISA)[[87]](#footnote-87) standards and should use the manufacturer-rated incandescent equivalent wattage.[[88]](#footnote-88) The Commission proposes to augment this language to include the following in Section 2.1.1 – ENERGY STAR Lighting: Variable Input Values:

For bulbs that do not fall within EISA regulations, such as exempt bulbs and bulbs with lumens greater than 2,600, the manufacturer rated equivalent wattage should be used as the baseline. The manufacturer rated wattage can vary by bulb type, but is usually clearly labeled on the bulb package. Note the EISA 2007 standards apply to general service incandescent lamps.  A complete list of the 22 incandescent lamps exempt from EISA 2007 is listed in the United States Department of Energy Impact of EISA 2007 on General Service Incandescent Lamps: FACT SHEET.[[89]](#footnote-89)

### 3. Section 2.6.5 – Home Performance with ENERGY STAR

#### a. Modeling Software

In the 2014 TRM Final Order, the Commission directed the PEG to review Section 2.6.5 – Home Performance with ENERGY STAR[[90]](#footnote-90) and provide recommendations on a more general reference to building simulation modeling software, with possible guidance on modeling homes in Pennsylvania’s Home Performance Program.[[91]](#footnote-91) The Commission proposes to remove all example language concerning the HomeCheck software from this measure and to instead refer to the operational manuals for the approved software. Additionally, the Commission proposes to include links to general guidance language on the Home Performance with ENERGY STAR program website, with reference to the version 1.5 Reference Manual.[[92]](#footnote-92) We also propose updating the eligibility of the measure to provide clarity on its applicability and updating the algorithms and definitions to include the demand savings addition as described in the following section.

#### b. Demand Savings

In the 2014 TRM Final Order, the Commission directed the PEG to develop an appropriate peak demand savings algorithm for outputs from the building simulation software.[[93]](#footnote-93) The Commission proposes to add a demand savings algorithm that will provide general guidance for the application of 8760 energy consumption data, available from the appropriate building modeling software, against the PJM peak period definition.

### 4. Section 2.2.6 – Duct Insulation

#### a. Guidance on Blower Door Subtraction Method

 The Commission proposes to add the following language to the description of the Blower Door Subtraction Method described in the introduction of Section 2.26 – Insulation[[94]](#footnote-94) in order to provide clarity:

This method involves performing a whole house depressurization test, an envelope depressurization test that excludes duct leakage, and finally a duct leakage pressurization test under envelope depressurization. The subtraction of the envelope leakage in the second test from the whole house leakage in the first test, multiplied by a correction factor determined by the third test will provide an accurate measurement of the duct leakage to the outside.

#### b. Addition of RESNET 803.7

 In the 2014 TRM Final Order, the Commission directed the PEG to research whether other options should be included as alternative methods to determine duct sealing savings.[[95]](#footnote-95) The Commission proposes to include the methods as outlined in the RESNET Energy Services Network, Standards for Performance testing as published on the RESNET website.[[96]](#footnote-96) The additional technique provides a third option for determining duct leakage by using a blower door and duct blaster in concert for both the base case and the efficient case. The Commission proposes to add an additional savings algorithm, definitions and source reference to accommodate the additional technique. Moreover, the following language will be added to the introduction of the measure:

***RESNET Test 803.***7 – this method involves the pressurization of the house to 25 Pascals with reference to outside and a simultaneous pressurization of the duct system to reach equilibrium with the envelope or inside pressure of zero Pascals. A blower door is used to pressurize the building to 25 Pascals with reference to outside, when that is achieved the duct blaster is used to equalize the pressure difference between the duct system and the house. The amount of air required to bring the duct system to zero Pascals with reference to the building is the amount of air leaking through the ductwork to the outside. This technique is described in detail in section 803.7 of the RESNET Standards: <http://www.resnet.us/professional/standards>

### 5. Section 2.3.2 – Heat Pump Water Heaters

#### a. Location Factor

In the 2014 TRM Final Order, the Commission directed the PEG to investigate the effect that installation location has on heat pump water heater (HPWH) performance.[[97]](#footnote-97) Based on a review of several studies, the Commission proposes the revision of the existing coefficient of performance de-rating factor (Fderate) to be location-dependent. New Fderate values have been adapted from a 2013 NEEA HPWH field study,[[98]](#footnote-98) which calculated the effective energy factor in various installation locations (Conditioned space, Garage, and Basement). The results used are for “Heating Zone 1,” which is comprised of Olympia, Washington and Portland, Oregon and have average dry (DB) and wet bulb (WB) temperatures (51˚F DB, 47˚F WB and 55˚F DB, 49˚F WB, respectively), comparable to Pennsylvania.[[99]](#footnote-99) The Commission proposes these same updates for Section 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater.[[100]](#footnote-100)

#### b. Interactive Effects

In the 2014 TRM Final Order, the Commission directed the PEG to investigate the effect that installation inside conditioned space has on HPWH net energy savings due to interactive effects.[[101]](#footnote-101) The Commission proposes adding to the ΔkWh/year and ΔkWpeak algorithms interactive effects terms to account for reduced cooling load in the summer and increased heating load in the winter due to the HPWH. The Commission proposes these same updates for Section 2.3.5 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater.[[102]](#footnote-102)

### 6. Section 2.3.9 – Low Flow Faucet Aerators

**a. Algorithm clarification**

The Commission proposes re-formatting the algorithms in Section 2.3.9 – Low Flow Faucet Aerators[[103]](#footnote-103) to include the conversion factors in the formulas themselves for clarity, rather than listed them in the Definition of Terms Section. Additionally, the energy to demand factor has been renamed from FED to ETDF to be consistent throughout the TRM. Also, the average number of faucets in the home factor has been renamed from F/home to #faucets to avoid confusion with having a division sign in a variable name.

**b. Data Gathering**

The Commission proposes opening the variable #faucets to allow EDC data gathering in addition to the default values provided in the TRM. This will match the EDC Data Gathering option for #showers in Section 2.3.10 – Low Flow Showerheads.[[104]](#footnote-104)

### 7. Section 2.3.10 – Low Flow Showerheads

The Commission proposes re-formatting the algorithms to include the conversion factors in the formulas themselves for clarity, rather than listing them in the Definition of Terms Section. Additionally, the energy to demand factor has been renamed from FED to ETDF to be consistent throughout the TRM. Also, the average number of faucets in the home factor has been renamed from S/home to #showers to avoid confusion with having a division sign in a variable name.

### 8. Section 2.5.3 – Smart Strip Plug Outlets

The Commission proposes updating the deemed kWpeak savings for Section 2.5.3 – Smart Strip Plug Outlets[[105]](#footnote-105) based on the new CFs discussed previously in this Tentative Order. The proposed deemed kWpeak savings are as follows:

|  |  |  |
| --- | --- | --- |
| Measure | 2014 TRM deemed kWpeak savings | Proposed 2015 TRM deemed kWpeak savings |
| 5-plug power strip, unspecified use or multiple purchase | 0.0054 | 0.0056 |
| 7-plug power strip, unspecified use or multiple purchased | 0.0064 | 0.0067 |
| 5-plug power strip, entertainment center | 0.0068 | 0.0077 |
| 7-plug power strip, entertainment center | 0.0082 | 0.0092 |

### Section 2.3.3 – Solar Water Heaters

In the 2014 TRM Final Order, the Commission directed the PEG to investigate the development of a partially deemed algorithm, similar to what is included in other water heater measures, for Section 2.3.3 – Solar Water Heaters.[[106]](#footnote-106) The Commission proposes adding a partially-deemed algorithm for both kWh/yr and kWpeak. These equations combine the fixed values into a single term, leaving only the energy factor of the baseline electric water heater (EFbase) and the year-round average energy factor of the proposed solar water heater (EFee) as the variables in the equations.

### Section 2.2.3 – Ductless Mini-Split Heat Pumps

The Commission proposes revising the algorithms for Section 2.2.3 – Ductless Mini-Split Heat Pumps[[107]](#footnote-107) based on data showing that the 2014 TRM algorithms under-estimated savings.[[108]](#footnote-108) We propose removing the Load Factor (LF) and instead, in certain cases, apply an Oversize Factor (OF) to the baseline capacity to account for the fact that central AC and ASHP systems are typically oversized.[[109]](#footnote-109) A ductless system is assumed to be either properly sized or sized to offset some portion of the central system’s load. Additionally, the Commission proposes applying, in instances where the baseline is a ducted system, a Duct Loss Factor (DLF) of 1.15 to the baseline energy usage to account for the fact that approximately 15% of the energy is lost to leakage and conduction through the ductwork.[[110]](#footnote-110) In addition, the Commission proposes revising the multi-zone algorithms to allow different baselines for each zone, if applicable.

### Section 2.6.1 – Ceiling/Attic and Wall Insulation

#### Ground Source Heat Pump Option Addition

The Commission proposes adding the option of ground source heat pump (GSHP) as an HVAC system type to Section 2.6.1 – Ceiling/Attic and Wall Insulation.[[111]](#footnote-111) Additionally, we propose the addition of Algorithms for cooling savings and heating savings with a GSHP, as well as the definitions of any new terms included in the algorithms.

#### Default SEER and HSPF

The Commission proposes updating the default SEER and HSPF values for ASHPs to 14 and 8.2, respectively, for equipment installed after June 1, 2015, in order to align with the new federal standards[[112]](#footnote-112) effective January 1, 2015.

### Section 2.4.1 – ENERGY STAR Refrigerators

The Commission proposes updating the default Annual Energy Consumption values in Section 2.4.1 – ENERGY STAR Refrigerators[[113]](#footnote-113) based on the new Federal[[114]](#footnote-114) and ENERGY STAR[[115]](#footnote-115) standards that become effective September 14, 2014. These are a series of formulas giving the number of kWh per year, provided a known configuration and refrigerator volume (in ft3). Additionally, we propose updating the ENERGY STAR Most Efficient annual energy usage values based on the Most Efficient Version 5.0 ENERGY STAR criteria.[[116]](#footnote-116)

### Section 2.4.2 – ENERGY STAR Freezers

The Commission proposes updating the default Annual Energy Consumption values based on the new Federal[[117]](#footnote-117) and ENERGY STAR[[118]](#footnote-118) standards that become effective September 14, 2014. These are a series of formulas giving the number of kWh per year, provided a known configuration and refrigerator volume (in ft3). Additionally, we propose updating the ENERGY STAR Most Efficient annual energy usage values based on the Most Efficient Version 5.0 ENERGY STAR criteria.[[119]](#footnote-119)

### Section 2.4.4 – ENERGY STAR Clothes Washer

#### Percent dry/wash

The Commission proposes the addition of a factor to the dryer savings algorithm in Section 2.4.4 – ENERGY STAR Clothes Washer[[120]](#footnote-120) to account for the fact that not all clothes that are washed are then dried in a clothes dryer. The factor is called %wash/dry and the value is 95%. This value comes from a Federal Technical Support Document[[121]](#footnote-121) concerning clothes dryers and room ACs.

#### Default Savings Updates

The Commission proposes updating the default savings based on the new CF and the updated 2014 Residential Baseline Study values. These have been calculated and are included in Section 2.4.4 – ENERGY STAR Clothes Washer of the proposed TRM.

#### Future Standards Updates

The new Federal Standards for clothes washers (effective March 2015) will be proposed for incorporation into the 2016 TRM. However, since some washing machines are rated with a new integrated modified energy factor (IMEF) instead of modified energy factor (MEF) will be available in Program Year 6,[[122]](#footnote-122) the Commission proposes allowing the interchangeable substitution of the MEF variable with IMEF, if necessary.

### Section 2.7.2 – Variable Speed Pool Pumps (with Load Shifting Option)

In the 2014 TRM Final Order, the Commission directed the PEG to research variable speed pool pump operating modes and consider factoring this variable into the algorithms in Section 2.7.2 – Variable Speed Pool Pumps (with Load Shifting Option).[[123]](#footnote-123) After review, the Commission proposes breaking the electric demand of variable frequency drive pump at a given flow rate variable (kWVFD) into the electric demand of variable frequency drive (VFD) pump during cleaning mode (kWVFD,clean) and the electric demand of VFD pump during filtration mode (kWVFD, filter). Additionally, we propose breaking the hours of operation per day for a VFD pump (HVFD) into the hours of operation per day for a VFD pump on cleaning mode (HOUVFD,clean) and the hours of operation per day for a VFP pump on filtration mode (HOUVFD, filter). These proposals account for the fact that variable speed pool pumps usually have multiple operating modes that each run at different speeds. In addition, the Commission proposes breaking out kWVFD into kWVFD,clean and kWVFD, filter in the ΔkWpeak algorithm, where each is multiplied by the ratio of time it is used during the PJM peak.

### Section 2.4.9 – ENERGY STAR Water Coolers

#### ENERGY STAR Qualifications

The Commission proposes updating the ENERGY STAR requirements to Version 2.0, which became effective in February 2014, for use in Section 2.4.9 – ENERGY STAR Water Coolers.[[124]](#footnote-124) This revision to the ENERGY STAR Requirements splits the Hot and Cold Units into “Storage” and “On-Demand.” Both requirements are more stringent than the previous Hot and Cold Requirements.

#### Algorithm Update

To better accommodate the new ENERGY STAR requirements and to be more consistent with other algorithms throughout the TRM, the Commission proposes revising the algorithm to be a difference of a base value and an ENERGY STAR value rather than just a deemed value. The Default savings are now presented in the “Default Savings” table.

### Section 2.2.2 – Fuel Switching: Electric Heat to Gas/Propane/Oil Heat

The Commission proposes revising the algorithm for “Heating savings with electric baseboards or electric furnace” in Section 2.2.2 – Fuel Switching: Electric Heat to Gas/Propane/Oil Heat[[125]](#footnote-125) to be two separate formulas: one for electric baseboards and one for electric furnaces. Currently, the EFLH are provided for both electric baseboards and electric furnaces, but the algorithm only provides for the use of electric furnace EFLH. Additionally, the savings calculation for an electric furnace should not take into account the blower motor, as this will be very similar for both the before and after fuel switching cases.

### Section 2.4.3 – Refrigerator/Freezer Recycling with and without Replacement

The Commission proposes updating the REPLACEMENTUEC values in Section 2.4.3 – Refrigerator/Freezer Recycling with and without Replacement,[[126]](#footnote-126) based on the updated ENERGY STAR Appliance savings calculator, last modified in May 2014. Each new value is an average of the six options provided in the appliance savings calculator. For example, an ENERGY STAR Refrigerator has six different selectable configurations, each with a kWh/yr value. The proposed new REPLACEMENTUEC for an ENERGY STAR Refrigerator is the average of those six configurations (482 kWh/yr).

### Section 2.2.4 – ENERGY STAR Room Air Conditioners

New Federal Standards for Room ACs take effect June 1, 2014, but as of July 31, 2014, no new ENERGY STAR specifications have been proposed. The Commission proposes to update the default savings for Section 2.2.4 - ENERGY STAR Room Air Conditioners[[127]](#footnote-127) to those provided by the ENERGY STAR Version 3.1 standard, assuming a capacity of 8,000 Btuh from the 2014 Residential Baseline Study.

### Section 2.2.5 – Room AC (RAC) Retirement

New Federal Standards for Room ACs take effect June 1, 2014, but as of July 31, 2014, no new ENERGY STAR specifications have been proposed. The Commission proposes to update the default savings for ENERGY STAR Room ACs to those provided in the ENERGY STAR Version 3.1 standard, assuming a capacity of 8,000 Btuh from the 2014 Residential Baseline Study. Since the combined energy efficiency ratio metric (CEER) is used as the metric in the both of the new standards, this has been incorporated into the measure for the “After RUL years” savings calculations.

### Removal of Residential EE&C Protocols

#### ENERGY STAR Audit

Based on discussions with the PEG, the Commission proposes to delete the protocol for ENERGY STAR Audits[[128]](#footnote-128) as there are no definitive savings as a result of this measure. While the intent of the measure is to promote energy saving improvements discovered during the audit, the quantifiable savings exist in other measures including Residential New Construction and Home Performance with ENERGY STAR.

#### Electric Clothes Dryer with Moisture Sensor

 Due to the release of an ENERGY STAR Dryer specification,[[129]](#footnote-129) the Commission proposes removing the Electric Clothes Dryer with Moisture Sensor[[130]](#footnote-130) measure in favor of the new measure proposed previously in this Tentative Order: Section 2.4.5 – ENERGY STAR Dryers. This new measure uses the lab-tested metric combined energy factor (CEF), as well as behavioral data from the 2014 Residential Baseline Study, to calculate energy savings. These provide a better basis for estimating energy savings than the Electric Clothes Dryer with Moisture Sensor measure, as well as providing a better, more uniform standard for program eligibility.

## Commercial and Industrial EE&C Measure Protocols

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

### 1. Section 3.1 – Lighting Protocols

#### a. Update Measure Structure

 The Lighting Equipment Improvements[[131]](#footnote-131) protocol from the 2014 TRM contains methodology for calculating energy and demand savings for several types of lighting installations. To improve the simplicity and usability of this protocol, the Commission proposes separating the measure into five distinct protocols: Section 3.1.1 – Lighting Fixture Improvements; Section 3.1.2 – New Construction Lighting; Section 3.1.3 – Lighting Controls; Section 3.1.4 – Traffic Lights; and Section 3.1.5 – LED Exit Signs.

#### b. Section 3.1.4 – Traffic Lights Measure Updates

 The Traffic Lights protocol provides default values used to calculate savings for traffic signal and pedestrian signage upgrades. The Commission recommends updating the default values for traffic signals to include more fixture types. As there are too many to list within this Tentative Order, we direct commenters to Section 3.1.4 of the proposed TRM.

#### Data Source Consistency in Non-Residential Lighting Savings Calculations

 Based on the 2014 TRM, the evaluation of non-residential lighting projects with savings of less than 500,000 kWh/year may be completed using hours of usage (HOU) and CFs that are determined by TRM default values or by using site-specific data gathering, such as metering, facility staff interviews or posted hours. However, the TRM does not specify that implementers and evaluators must use the same data source when determining both HOU and CF for each project. This lack of clarity can potentially reduce the accuracy of savings due to the inconsistency of input parameter sources. Therefore, the Commission proposes clarifying, in the applicable lighting measures,[[132]](#footnote-132) that, if site-specific data is used to determine the HOU, then the same data must be used to determine the site-specific CF. Similarly, if the default TRM HOU is used, then the default TRM CF must also be used in the savings calculations.

#### **Section 3.1.2 – New Construction Lighting: Hours of Use, Coincidence Factor and Savings Factor**

 The Commission proposes adding a separate HOU and CF table, and a Savings Factor (SVG) table for new construction lighting.[[133]](#footnote-133) Because Table 3-9: Savings Control Factors Assumptions[[134]](#footnote-134) of the 2014 TRM lists 24% as the SVG for both time clocks and occupancy sensors, the Commission recommends applying an SVG factor of 24% to the current HOU table for spaces where ASHRAE 90.1-2007[[135]](#footnote-135) requires the installation of lighting controls. For example, the new construction office building HOU would be 2,567 × (1-0.24) = 1,951. Similarly, the Commission is proposing modifications to the CF values from Table 3-6: Lighting HOU and CF by Building Type or Function[[136]](#footnote-136) that are used to calculate demand savings from new construction lighting.

 For additional controls above code (dimmers, wireless on-off switches, bi-level switches, etc.), the Commission proposes using the new construction SVG of 10% provided in Table G3.2 of the ASHRAE 90.1 standard. The Commission suggests removing the SVG term from the algorithm used to calculate new construction demand savings because savings from incremental lighting controls are expected to produce savings primarily during off-peak hours. The Commission also proposes removing the distinction between projects with a change in connected load above and below 20 kW.

#### Source Updates

 The Commission proposes using the Measure Life Study[[137]](#footnote-137) as the source for a measure life of 13 years for lighting fixture improvements and a measure life of 15 years for new construction measures. The Commission also suggests using GDS’s Measure Life Report[[138]](#footnote-138) as the source for a measure life of ten years for traffic lights. Finally, the Commission proposes using DEER 2008’s Effective Useful Life[[139]](#footnote-139) as a source for a measure life of eight years for lighting controls and a measure life of 16 years for LED exit signs.

### 2. Section 3.3.1 – Premium Efficiency Motors and Section 3.3.2 – Variable Frequency Drive Improvements

#### a. Code Changes

 For electric motors, a review of U.S. DOE rulings and pending code changes was performed by the SWE. The baseline motor efficiencies provided in the 2014 TRM reference NEMA premium efficiency motor standards which differ from the federal code. For example, the efficiencies in Table 3-16: Baseline Motor Nominal Efficiencies for General Purpose Electric Motors (Subtype II)[[140]](#footnote-140) of the 2014 TRM do not include efficiency levels for Subtype II open and enclosed motors with eight poles. The Commission proposes updating, in Section 3.3.1 – Premium Efficiency Motors, the baseline efficiencies for electric motors with federal energy conservation standards.

#### **b. Update** Annual Run Hours and Coincidence Factors

 The Premium Efficiency Motors[[141]](#footnote-141) and VFD Improvements[[142]](#footnote-142) protocols in the 2014 TRM use default annual run hours adopted from the 2012 Connecticut TRM as calculation assumptions. The Motors measure provides two CFs (one for single motor configurations and one for duplex motor configurations), while the VFD measure provides only one CF for all VFD applications. All CFs are sourced from the California DEER 2005 study.[[143]](#footnote-143) For the 2015 TRM update, the Commission directed the SWE to run computer simulation models to determine Pennsylvania-specific annual run hours and CFs using eQuest software.[[144]](#footnote-144)

 The SWE used available DEER prototypes, updated in September 2013, to model 21 facility types. The DEER module utilizes building prototype and measure characterization information grouped by building type, vintage and climate zone in its estimation of building energy consumption. The SWE selected the 1993 to 2001 vintage for all models and kept the building shell, schedules and loads parameters constant while altering the HVAC system type. Typical meteorological year three (TMY3) weather data for Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton and Williamsport were also incorporated to account for differences in climate and to create Pennsylvania-specific building prototypes.

 The eQuest simulation outputs files which contain annual hourly energy consumption for HVAC equipment are split into separate profiles for heating and cooling. The SWE developed a procedure to extract the data and manipulate the hourly data to calculate the summer peak CF and annual run hours for five distinct motor applications in commercial buildings: Supply Fans, Chilled Water Pumps, Cooling Tower Fans, Heating Hot Water Pumps and Condenser Water Pumps.

 The Commission proposes to update the annual run hours and CFs for Section 3.3.1 – Premium Efficiency Motors and Section 3.3.2 – Variable Frequency Drive (VFD) Improvements measures with new values determined from eQuest modeling. The Commission believes that this will provide more accurate and Pennsylvania-specific values.

#### c. Source Updates

 The Commission proposes to use CF values derived from the SWE’s eQuest modeling analysis to reflect more accurate CF values based on Pennsylvania-specific information. There are too many to list within this Tentative Order and, therefore, we direct commenters to the Section 3.3.1 – Premium Efficiency Motors[[145]](#footnote-145) of the proposed TRM. The 2014 TRM does not provide a source for the VFD measure life value of 15 years. The Commission proposes to revise, using GDS’s Measure Life Report, the measure life value to 13 years for retrofits.

### 3. Section 3.2.1 – HVAC Systems

#### a. Update Algorithms, Data Sources and Equipment Classification

In the 2014 TRM, baseline efficiencies for water-cooled and evaporatively-cooled AC equipment are provided in Table 3-66: Default Baseline Equipment Efficiencies in Section 3.17 – Water Source and Geothermal Heat Pumps.[[146]](#footnote-146) The Commission proposes moving any reference of water-cooled and evaporatively-cooled AC equipment from the Water Source and Geothermal Heat Pumps protocol to Section 3.2.1: HVAC Systems as we believe the information is more appropriate for the HVAC Systems protocol.[[147]](#footnote-147)

 Many HVAC algorithms in the 2014 TRM reference the energy efficiency ratio (EER) in energy savings equations. EER is an efficiency measurement of an HVAC system that measures cooling output (MBh) versus power input (kW) at design conditions. This is full load efficiency and is appropriate for demand savings calculations; however, it does not represent the seasonal effects that weather will have on HVAC operation and performance. IEER is an integrated energy efficiency ratio that accounts for these changes and the impacts they have on HVAC operation and is a better representation in energy savings calculations than EER. The definition of IEER is as follows:

*A single-number figure of merit expressing cooling part-load EER efficiency for commercial unitary air conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment integrated part-load value (IPLV)*

*-ASHRAE Standard 90.1 2010*

 Other part-load efficiency ratings such as CEER, SEER and IPLV are used for different equipment classes and are also appropriate to use in energy savings calculations. The following measures in the 2014 TRM utilize EER or an equivalent to calculate energy savings: Section 3.5: HVAC Systems;[[148]](#footnote-148) Section 3.6: Electric Chillers;[[149]](#footnote-149) Section 3.15: Wall and Ceiling Insulation;[[150]](#footnote-150) Section 3.17: Water Source & Ground Source Heat Pumps;[[151]](#footnote-151) and Section 3.32: Small C/I HVAC Refrigerant Charge Correction.[[152]](#footnote-152) The Commission proposes that IPLVs be used in the energy savings algorithms for these five measures.

 Air conditioning equipment is used mainly for comfort-cooling applications, but there are needs for process cooling where weather is not the main factor in system operation. In the Eligibility information for different HVAC measures, it is not clear if process cooling equipment is eligible to participate. The Commission proposes that the HVAC protocols not apply to process cooling equipment and that rebates for such equipment be considered as custom measures.

#### b. Code Changes

The TRM currently uses International Energy Conservation Code (IECC) 2009[[153]](#footnote-153) for HVAC baseline codes unless there are more stringent federal codes. The SWE reviewed federal code changes that have taken effect or will soon take effect and will impact HVAC baselines in the TRM.

For water-cooled & evaporatively-cooled AC, there have been two federal code changes in the previous two years that were not accounted for in the 2014 TRM. On June 1, 2013, there were updates for water-cooled packaged AC with cooling capacity (≥ 65,000 Btu/hr and <135,000 Btu/hr), while on June 1, 2014, there were updates for all other cooling capacities except those greater than 760,000 Btu/hr.[[154]](#footnote-154) Below is an outline comparing the 2014 TRM values and the new federal code, in conjunction with IECC 2012[[155]](#footnote-155) values for the IEER.

|  |  |  |
| --- | --- | --- |
| Equipment Type and Capacity | 2014 TRM(IECC 2009 + ASHRAE 90.1-2007 Addendum S) | 2015 TRM Proposal(Federal Code + IECC 2012) |
| Water-Cooled and Evaporatively-Cooled AC | Water-Cooled AC | Evaporatively-Cooled AC |
| <65,000  | 12.1 EER / 12.3 IEER | 12.1 EER / 12.3 IEER | 12.1 EER / 12.3 IEER |
| >65,000 and <135,000  | 11.5 EER / 11.7 IEER | 12.1 EER / 12.3 IEER | 12.1 EER / 12.3 IEER |
| >135,000 and <240,000  | 11.0 EER / 11.2 IEER | 12.5 EER / 12.7 IEER | 12.0 EER / 12.2 IEER |
| >240,000 Btu/hr and <760,000  | 11.0 EER / 11.1 IEER | 12.4 EER / 12.6 IEER | 11.9 EER / 12.1 IEER |
| > 760,000  | 11.0 EER / 11.1 IEER | 11.0 EER / 11.1 IEER | 11.0 EER / 11.1 IEER |

The Commission proposes revisions to the TRM to account for these federal code changes and to use IECC 2012 where federal codes do not provide a value. The following sections are impacted by these changes: Section 3.2.1 – HVAC Systems;[[156]](#footnote-156) Section 3.2.3 – Water Source and Geothermal Heat Pumps;[[157]](#footnote-157) and 3.8.1 – Wall and Ceiling Insulation.[[158]](#footnote-158)

#### c. Update Heating and Cooling EFLH

 The 2014 TRM calculates EFLHs[[159]](#footnote-159) for HVAC measures by adjusting EFLH values reported in the Connecticut Program Savings Documentation[[160]](#footnote-160) using full load hours from the U.S. DOE ENERGY STAR Calculator based on a degree-day scaling methodology. Degree-day scaling ratios were calculated using heating degree day and cooling degree day values for seven Pennsylvania cities: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton and Williamsport. These reference cities provide a representative sample of the various climate and utility regions in Pennsylvania. The Commission directed the SWE to update the cooling and heating EFLH values by running eQuest simulations.

 The SWE applied a similar methodology as was used to estimate annual run hours and CFs for Motors and VFDs to estimate default parameter values for HVAC systems by building type and city from over 7,000 eQuest models. The EFLH values are defined as the annual consumption (kWh) of the equipment divided by the total power for the equipment at full capacity. The Commission proposes adopting the new air conditioning and heat pump EFLH values for the 2015 TRM. The proposed changes will also impact the values cross-referenced in the following TRM measures:

* Section 3.2.3 – Water Source and Geothermal Heat Pumps;
* Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons;
* Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas / Propane / Oil Heat;
* Section 3.2.6 – Small C/I HVAC Refrigerant Charge Correction;
* Section 3.2.7 – ENERGY STAR Room Air Conditioner; and
* Section 3.8.1 – Wall and Ceiling Insulation.

#### **d. Sourc**e Updates

 No sources are provided in the 2014 TRM for the EER to SEER conversion factor. To address this issue, the Commission recommends using the U.S. DOE Building America House Simulation Protocol[[161]](#footnote-161) as a source for a conversion factor of 11.3/13. The Commission also proposes updating the EFLH and CF values with the results from the SWE’s eQuest modeling analysis to provide more accurate, Pennsylvania-specific assumptions. There are too many to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.1 – HVAC Systems[[162]](#footnote-162) of the proposed TRM.

### 4. Section 3.2.2 – Electric Chillers

#### a. Update EFLH and CF Default Values

The EFLH values provided in the Electric Chillers measure[[163]](#footnote-163) were determined by adjusting EFLH values reported in the Connecticut Program Savings Documentation using full load hours from the U.S. DOE ENERGY STAR Calculator based on a degree-day scaling methodology. The deemed CF provided in the measure was determined by averaging CF values from nine different sources. The SWE used the same eQuest modeling methodology used to determined EFLH and CFs for HVAC measures to determine more accurate and reference city-specific EFLHs and CFs for electric chiller applications. The Commission proposes adopting the updated EFLHs and CFs for the 2015 TRM.

#### b. Source Updates

The Commission recommends using DEER 2008 Effective Useful Life as a source for the measure life of 20 years. The Commission also proposes updating the EFLH and CF values with results derived from the SWE’s eQuest modeling analysis to provide more accurate, Pennsylvania-specific assumptions. There are too many to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.2 – Electric Chillers[[164]](#footnote-164) of the proposed TRM.

### 5. Section 3.2.3 – Water Source and Geothermal Heat Pumps

The Commission also proposes updating the CF values with results derived from the SWE’s eQuest modeling analysis to provide more accurate, Pennsylvania-specific assumptions. There are too many to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.3 – Water Source and Geothermal Heat Pumps[[165]](#footnote-165) of the proposed TRM.

### 6. Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons

#### a. Source Updates

 The Commission proposes replacing sources that refer to heating/cooling EFLHs with updated EFLH values derived from SWE’s eQuest modeling analysis. The Commission also recommends using ENERGY STAR Key Product Criteria”[[166]](#footnote-166) as the source for the measure’s energy efficiency performance. There are too many to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.4 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons[[167]](#footnote-167) of the proposed TRM.

#### b. Algorithm Revision

The Commission proposes revising the energy savings algorithms to remove the Load Factor term. The eQuest modeling conducted by the SWE to determine the EFLHcool and EFLHheat values for HVAC systems represents the equivalent number of hours the baseline or retrofit system would run at full capacity to satisfy the cooling needs of the space. The Commission believes that discounting these values by a load factor would underestimate energy savings.

### 7. Section 3.9.2 – Office Equipment – Network Power Management Enabling

 In an effort to update or incorporate CFs for as many measures as possible, the SWE researched this measure to see if any published data existed that could provide a CF that aligned with the PJM peak. In this exercise, a well-documented value was not found. Also, it was unclear how the deemed demand savings was determined. The source for this value, the San Diego Gas and Electric Program Evaluation Report,[[168]](#footnote-168) was reviewed by the SWE and a different savings number was determined. This study used load shapes from the Northwest RTF workbook for this measure. The Commission believes that this is a valid source and proposes that the peak demand savings should be updated from 0.0078 kW to 0.00625 kW per power management device.

### 8. Section 3.4.4 – Low Flow Pre-Rinse Sprayers for Time of Sale/Retail Programs

 The Commission proposes using, in Section 3.4.4 – Low Flow Pre-Rinse Sprayers for Time of Sale/Retail Programs,[[169]](#footnote-169) the Engineering ToolBox[[170]](#footnote-170) as the source for specific heat of water definition and associated value of 1.0. The Commission also recommends using verification measurements derived from the Impact and Process Evaluation Final Report[[171]](#footnote-171) as the source for hot water temperatures from spray nozzles (105.6 °F).

### 9. Section 3.2.6 – Small C/I HVAC Refrigerant Charge Correction

 The Commission recommends using, in Section 3.2.6 – Small C/I HVAC Refrigerant Charge Correction,[[172]](#footnote-172) the U.S. DOE Building America House Simulation Protocol as a source for a conversion factor of 11.3/13.

### 10. Section 3.5.13 – Refrigeration – Special Doors with Low or No Anti-Sweat Heat for Low Temp Cases

 The Commission recommends using PG&E’s Refrigeration Rebate Catalog[[173]](#footnote-173) as the source for door rail, glass, and frame heater amperage maximum requirement of 0.39 amps per door for low temperature display cases. The Commission also proposes using the SDG&E Statewide Express Efficiency Program[[174]](#footnote-174) as the source for energy savings and demand reduction calculation assumptions. There are too many assumptions to list within this Tentative Order and, therefore, we direct commenters to the Section 3.5.13 – Special Doors with Low or No Anti-Sweat Heat for Low Temp Case[[175]](#footnote-175) of the proposed TRM.

### 11. Section 3.2.7 – ENERGY STAR Room Air Conditioners

 The Commission recommends using GDS’s Measure Life Report as the source for the measure life of 12 years for Section 3.2.7 – ENERGY STAR Room Air Conditioners.[[176]](#footnote-176) The Commission also proposes using updated cooling EFLH values derived from SWE’s eQuest modeling analysis. There are too many EFLH values to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.7 of the proposed TRM.

### 12. Section 3.5.8 – Variable Speed Refrigeration Compressors

 The Commission recommends using, in Section 3.5.8 – Variable Speed Refrigeration Compressors,[[177]](#footnote-177) the DEER 2008 Effective Useful Life value of 15 years as the source for measure life.

### 13. Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas/Propane/Oil Heat

 The Commission proposes using, in Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas/Propane/Oil Heat,[[178]](#footnote-178) updated heating EFLH values derived from SWE’s eQuest modeling analysis. There are too many EFLH values to list within this Tentative Order and, therefore, we direct commenters to the Section 3.2.5 of the proposed TRM.

## Agricultural EE&C Measure Protocols

 The following section describes clarifications and modifications to the agricultural measure protocols:

### 1. Section 4.1.5 – High Volume Low Speed Fans

The 2014 TRM calculates energy savings from High Volume Low Speed Fans[[179]](#footnote-179) using the change in connected load between a baseline and efficient fan and the expected annual hours of operation of the fan. The Commission proposes modifications to the algorithms defining annual energy savings and peak demand savings to correct a circular referencing issue. The changes increase the accuracy of the energy and demand savings calculations and utilize terminology consistent with other protocols in the TRM. The “Hours of Use” term in the protocol is defined as the expected number of hours per year when the outdoor air temperature is above 65 °F. The Commission proposes revising the default CF to 1.0 based on historic weather patterns, which show that temperatures across Pennsylvania are nearly always above 65 °F during the peak demand window of non-holiday weekdays from 2:00 pm to 6:00 pm in June, July and August.

## Section 5.1 – Appendix A: Measure Lives

 The proposed improvements to the 2015 TRM measure lives will be reflected in Section 5.1 – Appendix A: Measure Lives.[[180]](#footnote-180) The major changes include updating the measure order structure, adding nineteen measure lives and removing thirteen measure life values. As there are too many updates to list within this Tentative Order, we direct commenters to Section 5.1 of the proposed TRM.

## Section 5.3 – Appendix C: Lighting Audit and Design Tool

### 1. Update Wattage Table

 The Commission proposes updating the Wattage Table in Appendix C, with major improvements including the addition of new fixture codes and modification and removal of existing codes. As there are too many updates to list within this Tentative Order, we direct commenters to Section 5.3 of the proposed TRM.

### 2. Update Prescriptive Lighting Table

 The Commission proposes to add the updated default values for traffic lights to the Prescriptive Lighting Table in Appendix C. As there are too many updates to list within this Tentative Order, we direct commenters to Section 5.3 of the proposed TRM.

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

 As stated previously in this Tentative Order, the proposed improvements to the Premium Efficiency Motor measure include updating baseline motor nominal efficiencies with federal standards for electric motors and updating annual run hours and CFs for five motor functions (supply fan, chilled water pump, cooling tower fan, heating hot water pump, and condenser water pump). The proposed changes in the 2015 TRM will be captured in Section 5.4 – Appendix D – Motors and VFD Audit and Design Tool.[[181]](#footnote-181) The Commission is also proposing several enhancements to the Appendix D calculator that aim to increase the usability of the tool. As there are too many updates to list within this Tentative Order, we direct commenters to Section 5.4 of the proposed TRM.

## Section 5.5 – Appendix E: Lighting Audit and Design Tool for C&I New Construction Projects

 The Commission proposes updating Section 5.5 – Appendix E: Lighting Audit and Design Tool for C&I New Construction Projects[[182]](#footnote-182) to reflect the recommended improvements to the New Construction Lighting protocol.[[183]](#footnote-183) The major changes include updating the algorithms used to calculate energy savings to include new construction HOU, CF and SVG factors. As there are too many updates to list within this Tentative Order, we direct commenters to Section 5.5 of the proposed TRM.

# 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 2015 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 2014 Technical Reference Manual update.
3. That the Secretary shall deposit a notice of this Tentative Order and proposed 2015 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 this Tentative Order is entered to file written comments referencing Docket Number M-2012-2313373 with the Pennsylvania Public Utility Commission.
5. That interested parties shall have 40 days from the date this Tentative Order is entered to file written reply comments referencing Docket Number M-2012-2313373 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 2015 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>.
8. That the contact person for technical issues related to this Tentative Order and the proposed 2015 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 2015 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: September 11, 2014

ORDER ENTERED: September 11, 2014

1. Order entered on October 3, 2005, at Docket No. M-00051865 (October 3, 2005 Order). [↑](#footnote-ref-1)
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. *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 page 4. [↑](#footnote-ref-2)
3. *See* October 3, 2005 Order at page 13. [↑](#footnote-ref-3)
4. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M-2008-2069887, (Phase I Implementation Order), at page 13, entered January 16, 2009. [↑](#footnote-ref-4)
5. *Id*. [↑](#footnote-ref-5)
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, (2009 TRM), entered June 1, 2009. [↑](#footnote-ref-6)
7. *Id*. at pages 17 and 18. [↑](#footnote-ref-7)
8. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M-2012-2289411, (*Phase II Implementation Order*), entered August 3, 2012, at page 71. [↑](#footnote-ref-8)
9. *Id*. at page 75. [↑](#footnote-ref-9)
10. 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 evaluation, measurement and verification. [↑](#footnote-ref-10)
11. The TWG is chaired by staff of the Commission’s Bureau of Technical Utility Services and is comprised of representatives from the EDCs, the SWE and other interested parties for the purpose of encouraging discussion of the technical issues related to the evaluation, measurement and verification of savings programs to be implemented pursuant to Act 129. [↑](#footnote-ref-11)
12. The Commission held a TWG meeting on July 11, 2014, to provide stakeholders with the opportunity to review proposed high impact changes to residential, commercial and industrial measures, and also allow for a question and answer session regarding those changes. Additionally, stakeholders had the opportunity to propose any other changes they would like to have made to the TRM. [↑](#footnote-ref-12)
13. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Final Order at Docket No. M-00051865, (2010 TRM), entered June 8, 2010. *Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update*, Final Order at Docket No. M-00051865, (2011 TRM), entered February 28, 2011. *Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2012 Update*, Final Order at Docket No. M‑00051865, (2012 TRM), entered December 16, 2011. And *Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2013 Update*, Final Order at Docket No. M-2012-2313373, (2013 TRM), entered December 20, 2012. *See Implementation of Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2014 Update*, Final Order at Docket No. M-2012-2313373, (2014 TRM), entered December 19, 2013. [↑](#footnote-ref-13)
14. *See 2014 Pennsylvania Statewide Act 129 Residential Baseline Study* and *Pennsylvania Statewide Act 129 2014 Non-Residential End Use & Saturation Study*, submitted to the Pennsylvania Public Utility Commission by GDS Associates, *et al.* (2014 Residential Baseline Study) (2014 C&I Baseline Study) Apr. 4, 2014. [↑](#footnote-ref-14)
15. *See* Section 1.7 – Baseline Estimates, page 10, of the 2014 TRM. [↑](#footnote-ref-15)
16. A stipulated value for a stipulated variable refers to a single input value to an algorithm. [↑](#footnote-ref-16)
17. *See* <http://energy.gov/node/773531/residential/residential_cac_hp.html>. [↑](#footnote-ref-17)
18. *See* Section 2.1 – Electric HVAC, page 19, of the 2014 TRM. [↑](#footnote-ref-18)
19. *See* Federal Code of Regulations 10 CFR 430, which may be found at <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75>. [↑](#footnote-ref-19)
20. *See* Section 2.16 – Ductless Mini-Split Heat Pumps, page 81, of the 2014 TRM. [↑](#footnote-ref-20)
21. *See* Section 2.22 – Residential New Construction, page 121, of the 2014 TRM. [↑](#footnote-ref-21)
22. *See* <https://www.energystar.gov/index.cfm?c=partners.pt_products_and_program_reqs>. [↑](#footnote-ref-22)
23. For new Federal standards that become effective on January 1st, the previous standards are considered to expire on December 31 of the prior calendar year. [↑](#footnote-ref-23)
24. For new ENERGY STAR product specifications that become effective on January 1st, the previous specifications are considered to expire on December 31 of the prior calendar year. [↑](#footnote-ref-24)
25. An end-use category describes the categories of equipment that provide a service to an individual or building. [↑](#footnote-ref-25)
26. *See Phase II Implementation Order* at pages 32-42. [↑](#footnote-ref-26)
27. PJM Manual 18B for Energy Efficiency Measurement & Verification: <http://www.pjm.com/~/media/documents/manuals/m18b.ashx>. [↑](#footnote-ref-27)
28. *See Using Available Information for Efficient Evaluation of Demand-Side Management Programs*, Mary M. Straub and Sheldon Switzer, The Electricity Journal, Volume 24, Issue 7, (BG&E Study) Pages 83-96. [↑](#footnote-ref-28)
29. *See Final Report – Coincidence Factor Study – Residential Room Air Conditioners*, Prepared for Northeast Energy Efficiency Partnerships’ New England Evaluation and State Program Working Group, by RLW Analytics, (RLW Report) June 23, 2008. [↑](#footnote-ref-29)
30. *See Efficiency Vermont Technical Reference Manual (TRM) - Measure Savings Algorithms and Cost Assumptions*, TRM User Manual No. 2013-82, (Efficiency Vermont TRM – 2013) Aug. 9, 2013. [↑](#footnote-ref-30)
31. *See Pool Pump Demand Response Potential – Demand and Run-Time Monitored Data*, DR 07.01 Report, Prepared by Design and Engineering Services, Customer Service Business Unit, Southern California Edison, (Pool Pump DR Potential Report) June 2008. [↑](#footnote-ref-31)
32. *See* Section 2.25 – ENERGY STAR Clothes Washers, page 134, of the 2014 TRM. [↑](#footnote-ref-32)
33. *See* Section 2.26 – ENERGY STAR Dishwashers, page 139, of the 2014 TRM. [↑](#footnote-ref-33)
34. *See* Section 2.27 – Dehumidifiers, page 142, of the 2014 TRM. [↑](#footnote-ref-34)
35. *See* Section 2.25 – ENERGY STAR Clothes Washers, page 134, of the 2014 TRM. [↑](#footnote-ref-35)
36. *See Mid-Atlantic Technical Reference Manual*, Version 3.0, Prepared by Shelter Analytics, (2014 Mid-Atlantic TRM) March 2013. [↑](#footnote-ref-36)
37. *See* Section 2.26 – ENERGY STAR Dishwashers, page 139, of the 2014 TRM. [↑](#footnote-ref-37)
38. *See Illinois Statewide Technical Reference Manual for Energy Efficiency*, Version 2.0, (2013 Illinois TRM) June 7, 2013. [↑](#footnote-ref-38)
39. *See Dehumidifier Metering in Pennsylvania and Ohio*, completed by ADM Associates, July 17, 2013 through September 22, 2013 (ADM Metering Study). [↑](#footnote-ref-39)
40. *See* Section 2.34 – ENERGY STAR Office Equipment, page 169, of the 2014 TRM. [↑](#footnote-ref-40)
41. *See* Section 3.12 – ENERGY STAR Office Equipment, page 186, of the 2011 TRM; Section 2.31 – ENERGY STAR Office Equipment, page 121, of the 2012 TRM; Section 2.35 – ENERGY STAR Office Equipment, page 147, of the 2013 TRM; Section 2.34 – ENERGY STAR Office Equipment, page 169, of the 2014 TRM. [↑](#footnote-ref-41)
42. *See* Section 3.5 – HVAC Systems, page 234, of the 2014 TRM. [↑](#footnote-ref-42)
43. *See* Section 3.15 – Wall and Ceiling Insulation, page 276, of the 2014 TRM. [↑](#footnote-ref-43)
44. *See* Section 3.17 – Water Source and Geothermal Heat Pumps, page 291, of the 2014 TRM. [↑](#footnote-ref-44)
45. *See* Section 3.18 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons, page 299, of the 2014 TRM. [↑](#footnote-ref-45)
46. *See* Section 3.32 – Small C/I HVAC Refrigerant Charge Correction, page 359, of the 2014 TRM. [↑](#footnote-ref-46)
47. *See* Section 3.34 – ENERGY STAR Room Air Conditioner, page 366, of the 2014 TRM. [↑](#footnote-ref-47)
48. *See* Section 2.6 – Heat Pump Water Heaters, page 41, of the 2014 TRM. [↑](#footnote-ref-48)
49. *See* Section 2.13 – Solar Water Heaters, page 72, of the 2014 TRM. [↑](#footnote-ref-49)
50. *See* Section 2.14 – Heater Pipe Insulation, page 76, of the 2014 TRM. [↑](#footnote-ref-50)
51. *See* Section 2.17 – Fuel Switching: DHW Electric to Fossil Fuel Water Heater, page 87, of the 2014 TRM. [↑](#footnote-ref-51)
52. *See* Section 2.18 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater, page 93, of the 2014 TRM. [↑](#footnote-ref-52)
53. *See* Section 2.41 – Water Heater Temperature Setback, page 192, of the 2014 TRM. [↑](#footnote-ref-53)
54. *See* Section 2.8 – Low Flow Faucet Aerators, page 48, of the 2014 TRM. [↑](#footnote-ref-54)
55. *See The End Uses of Hot Water in Single Family Homes From Flow Trace Analysis*, Published by Aquacraft, Inc. – Water Engineering and Management, 2001. [↑](#footnote-ref-55)
56. *See* Section 2.21 – Refrigerator/Freezer Recycling with and without Replacement, page 113, of the 2014 TRM. [↑](#footnote-ref-56)
57. *See* Section 2.23 – ENERGY STAR Refrigerators, page 126, of the 2014 TRM. [↑](#footnote-ref-57)
58. *See* Section 2.24 – ENERGY STAR Freezers, page 131, of the 2014 TRM. [↑](#footnote-ref-58)
59. *See Assessment of Energy and Capacity Savings Potential in Iowa* Final Report – Volume 1, Prepared for the Iowa Utility Association, by Quantec *et al.*, February 2008. [↑](#footnote-ref-59)
60. *See* page 35 of the 2014 TRM Final Order and *Request for Proposals – Act 129 Statewide Evaluator*, RFP-2012-8, Pennsylvania Public Utility Commission – Bureau of Technical Utility Services, (November 30, 2012). *See Energy Efficiency and Conservation Program Final Order*, at Docket No. M-2012-2289411, (February 20, 2014). [↑](#footnote-ref-60)
61. *See* Section 2.1.3 – Electric HVAC: Definition of Terms, page 21, of the 2014 TRM. [↑](#footnote-ref-61)
62. *See* Section 2.25 – ENERGY STAR Clothes Washers, page 134, of the 2014 TRM. [↑](#footnote-ref-62)
63. *See* Section 3.27 – Electric Resistance Water Heaters, page 332, of the 2014 TRM. [↑](#footnote-ref-63)
64. *See* Section 3.28 – Heat Pump Water Heaters, page 337, of the 2014 TRM. [↑](#footnote-ref-64)
65. *See* Section 3.22 – Refrigeration – Auto Closers, page 315, of the 2014 TRM. [↑](#footnote-ref-65)
66. *See* Section 3.24 - Refrigeration – Suction Pipes Insulation for Walk-in Coolers and Freezers, page 319, of the 2014 TRM. [↑](#footnote-ref-66)
67. *See* Section 1.17 – Impact of Weather, page 15, of the 2014 TRM. [↑](#footnote-ref-67)
68. *See* Section 2.5 – Furnace Whistle, page 36, of the 2014 TRM. [↑](#footnote-ref-68)
69. *See* Section 3.5 – HVAC Systems, page 234, of the 2014 TRM. [↑](#footnote-ref-69)
70. *See* Section 3.8 – High-Efficiency Refrigeration/Freezer Cases, page 249, of the 2014 TRM. [↑](#footnote-ref-70)
71. *See* Section 3.9 – High-Efficiency Evaporator Fan Motors for Reach-In Refrigerated Cases, page 252, of the 2014 TRM. [↑](#footnote-ref-71)
72. *See* Section 3.10 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases, page 258, of the 2014 TRM. [↑](#footnote-ref-72)
73. *See* Section 3.13 – Beverage Machine Controls, page 271, of the 2014 TRM. [↑](#footnote-ref-73)
74. *See* Section 3.14 – High-Efficiency Ice Machines, page 273, of the 2014 TRM. [↑](#footnote-ref-74)
75. *See* Section 3.15 – Wall and Ceiling Insulation, page 276, of the 2014 TRM. [↑](#footnote-ref-75)
76. *See* Section 3.19 – ENERGY STAR Electric Steam Cooker, page 306, of the 2014 TRM. [↑](#footnote-ref-76)
77. *See* Section 3.21 – Office Equipment – Network Power Management Enabling, page 312, of the 2014 TRM. [↑](#footnote-ref-77)
78. *See* Section 3.24 – Refrigeration: Suction Pipes Insulation for Walk-In Coolers and Freezers, page 319, of the 2014 TRM. [↑](#footnote-ref-78)
79. *See* Section 3.25 – Refrigeration: Evaporator Fan Controllers, page 322, of the 2014 TRM. [↑](#footnote-ref-79)
80. *See* Section 3.26 – ENERGY STAR Clothes Washer, page 325, of the 2014 TRM. [↑](#footnote-ref-80)
81. *See* Section 3.28 – Heat Pump Water Heaters, page 337, of the 2014 TRM. [↑](#footnote-ref-81)
82. *See* Section 4.1 – Automatic Milker Takeoffs, page 398, of the 2014 TRM. [↑](#footnote-ref-82)
83. *See* Section 4.4 – Heat Reclaimers, page 409, of the 2014 TRM. [↑](#footnote-ref-83)
84. *See* Section 4.6 – Livestock Waterer, page 415, of the 2014 TRM. [↑](#footnote-ref-84)
85. *See* page 56 of the 2014 TRM Final Order. [↑](#footnote-ref-85)
86. *See* <https://www.ahridirectory.org/ahridirectory/pages/home.aspx>.  [↑](#footnote-ref-86)
87. *See* <http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf>. [↑](#footnote-ref-87)
88. *See* page 70 of the 2014 TRM Final Order. [↑](#footnote-ref-88)
89. *See* <http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/general_service_incandescent_factsheet.pdf>. [↑](#footnote-ref-89)
90. *See* Section 2.32 – Home Performance with ENERGY STAR, page 161, of the 2014 TRM. [↑](#footnote-ref-90)
91. *See* page 123 of the 2014 TRM Final Order. [↑](#footnote-ref-91)
92. *See* <https://www.energystar.gov/ia/home_improvement/downloads/HPwES_Sponsor_Guide_v1-5.pdf?07e7-3320>.  [↑](#footnote-ref-92)
93. *See* page 123 of the 2014 TRM Final Order. [↑](#footnote-ref-93)
94. *See* Section 2.40 – Duct Insulation and Sealing, page 187, of the 2014 TRM. [↑](#footnote-ref-94)
95. *See* page 124 of the 2014 TRM Final Order. [↑](#footnote-ref-95)
96. *See* Resnet Energy Services Network, Standards for Performance Testing. Available at <http://www.resnet.us/standards/DRAFT_Chapter_8_July_22.pdf>. [↑](#footnote-ref-96)
97. *See* pages 93 and 94 of the 2014 TRM Final Order. [↑](#footnote-ref-97)
98. *See NEEA Heat Pump Water Heater Field Study Report*, Prepared by Fluid Market Strategies, (NEEA HPWH field study) Oct. 22, 2013. <http://neea.org/docs/default-source/reports/heat-pump-water-heater-field-study-report.pdf?sfvrsn=5>. [↑](#footnote-ref-98)
99. Based on average weather data from [www.weatherbase.com](http://www.weatherbase.com) for the seven Pennsylvania cities referenced elsewhere in this TRM (Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, and Williamsport). [↑](#footnote-ref-99)
100. *See* Section 2.18 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater, page 93, of the 2014 TRM. [↑](#footnote-ref-100)
101. *See* pages 93 and 94 of the 2014 TRM Final Order. [↑](#footnote-ref-101)
102. *See* Section 2.18 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater, page 93, of the 2014 TRM. [↑](#footnote-ref-102)
103. *See* Section 2.8 – Low Flow Faucet Aerators, page 48, of the 2014 TRM. [↑](#footnote-ref-103)
104. *See* Section 2.9 – Low Flow Showerheads, page 54, of the 2014 TRM. [↑](#footnote-ref-104)
105. *See* Section 2.12 – Smart Strip Plug Outlets, page 69, of the 2014 TRM. [↑](#footnote-ref-105)
106. *See* page 97 of the 2014 TRM Final Order and Section 2.13 – Solar Water Heaters, page 72, of the 2014 TRM. [↑](#footnote-ref-106)
107. *See* Section 2.16 – Ductless Mini-Split Heat Pumps, page 81, of the 2014 TRM. [↑](#footnote-ref-107)
108. *See EM&V Forum: Primary Research ‒ Ductless Heat Pumps*, prepared by Northeast Energy Efficiency Partnerships, April 2014. Available at <http://neep.org/Assets/uploads/files/emv/emv-library/NEEP%20DHP%20Report%20Final%205-28-14%20and%20Appendices.pdf>. [↑](#footnote-ref-108)
109. *See Energy Savings Potential from Addressing Residential Air Conditioner and Heat Pump Installation Problems*, by C. Neme, J. Proctor and S. Nadel, American Council for an Energy-Efficient Economy, Report No. A992, Feb. 1999. Confirmed by Central Air Conditioning in Wisconsin, a compilation of recent field research, Energy Center of Wisconsin, May 2008, Amended Dec. 2010 and *Verifying ACCA Manual S Procedures*, ACCA. Available at <http://www.acca.org/Files/?id=67>. [↑](#footnote-ref-109)
110. Assumption used in Illinois 2014 TRM, Ductless Heat Pumps Measure, pg. 531. [↑](#footnote-ref-110)
111. *See* Section 2.20 – Ceiling/Attic and Wall Insulation, page 107, of the 2014 TRM. [↑](#footnote-ref-111)
112. *See* U*.S. DOE Federal Standards for Central Air Conditioners and Heat Pumps*. Available at <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75>. [↑](#footnote-ref-112)
113. *See* Section 2.23 – ENERGY STAR Refrigerators, page 129, of the 2014 TRM. [↑](#footnote-ref-113)
114. *See Federal Standards for Residential Refrigerators and Fre*ezers, Effective Sept. 2014. <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43>. [↑](#footnote-ref-114)
115. *See ENERGY STAR Program Requirements Product Specifications for Residential Refrigerators and Freezers*, Version 5.0, Effective Sept. 2014. Available at <https://www.energystar.gov/products/specs/residential_refrigerators_and_freezers_specification_version_5_0_pd>. [↑](#footnote-ref-115)
116. *See ENERGY STAR Recognition Criteria for Most Efficient Refrigerator-Freezers,* Table 2. Available at <http://www.energystar.gov/ia/partners/downloads/most_efficient/final_criteria/Refrigerator-Freezers.pdf?6a37-2bde>. [↑](#footnote-ref-116)
117. *See Federal Standards for Residential Refrigerators and Freezers*, Effective Sept. 2014. Available at <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43>. [↑](#footnote-ref-117)
118. *See ENERGY STAR Program Requirements Product Specifications for Residential Refrigerators and Freezers*, Version 5.0. Effective Sept. 2014. Available at <http://www.energystar.gov/products/specs/system/files/ENERGY%20STAR%20Final%20Version%205.0%20Residential%20Refrigerators%20and%20Freezers%20Program%20Requirements.pdf>. [↑](#footnote-ref-118)
119. *See ENERGY STAR Recognition Criteria for Most Efficient Refrigerator-Freezers*, Table 2. Available at <http://www.energystar.gov/ia/partners/downloads/most_efficient/final_criteria/Refrigerator-Freezers.pdf?6a37-2bde>. [↑](#footnote-ref-119)
120. *See* Section 2.25 – ENERGY STAR Clothes Washer, page 134, of the 2014 TRM. [↑](#footnote-ref-120)
121. *See 2011-04 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Residential Clothes Dryers and Room Air Conditioners*, Chapter 7, Clothes Dryer Frequency from Table 7.3.3 for Electric Standard. Available at <http://www.regulations.gov/contentStreamer?objectId=0900006480c8ee11&disposition=attachment&contentType=pdf>. [↑](#footnote-ref-121)
122. Program Year 6 is effective June 1, 2015, and expires May 31, 2016. [↑](#footnote-ref-122)
123. *See* pages 110 and 111 of the 2014 TRM Final Order and Section 2.39 – Variable Speed Pool Pumps (with Load Shifting Option), page 183, of the 2014 TRM. [↑](#footnote-ref-123)
124. *See* Section 2.42 – ENERGY STAR Water Coolers, page 198, of the 2014 TRM. [↑](#footnote-ref-124)
125. *See* Section 2.19 – Fuel Switching: Electric Heat to Gas/Oil/Propane Heat, page 100, of the 2014 TRM. [↑](#footnote-ref-125)
126. *See* Section 2.21 – Refrigerator/Freezer Recycling with and without Replacement, page 113, of the 2014 TRM. [↑](#footnote-ref-126)
127. *See* Section 2.28 – ENERGY STAR Room Air Conditioners, page 145, of the 2014 TRM. [↑](#footnote-ref-127)
128. *See* Section 2.31 – ENERGY STAR Audit, page 160, of the 2014 TRM. [↑](#footnote-ref-128)
129. Effective Jan 2015. Available at <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/36>. [↑](#footnote-ref-129)
130. *See* Section 2.2 – Electric Clothes Dryer with Moisture Sensor, page 28, of the 2014 TRM. [↑](#footnote-ref-130)
131. *See* Section 3.2 – Lighting Equipment Improvements, page 202, of the 2014 TRM. [↑](#footnote-ref-131)
132. Section 3.1.1 – Lighting Fixture Improvements; Section 3.1.2 – New Construction Lighting; Section 3.1.3 – Lighting Controls. [↑](#footnote-ref-132)
133. *See* Section 3.1.2 – New Construction Lighting, page 219, of the proposed 2015 TRM. [↑](#footnote-ref-133)
134. *See* Table 3-9: Savings Control Factors Assumptions, page 218, of the 2014 TRM [↑](#footnote-ref-134)
135. The ASHRAE 90.1 Standard is available at: <https://law.resource.org/pub/us/code/ibr/ashrae.90.1.2007.pdf> [↑](#footnote-ref-135)
136. *See* Table 3-6: Lighting HOU and CF by Building Type or Function, page 214, of the 2014 TRM [↑](#footnote-ref-136)
137. *See Measure Life Study*, prepared for the Massachusetts Joint Utilities, by Energy and Resource Solutions, (Measure Life Study), Nov. 2005. Available at <http://rtf.nwcouncil.org/subcommittees/nonreslighting/Measure%20Life%20Study_MA%20Joint%20Utilities_2005_ERS-1.pdf>. [↑](#footnote-ref-137)
138. *See Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures*, prepared for the New England State Program Working Group, prepared by GDS Associates, Inc. (GDS’s Measure Life Report) June 2007. Available at <http://neep.org/Assets/uploads/files/emv/emv-library/measure_life_GDS%5B1%5D.pdf>. [↑](#footnote-ref-138)
139. *See* DEER 2008 Effective Useful Life. Available at <http://www.deeresources.com/>. [↑](#footnote-ref-139)
140. *See* Section 3.3 – Premium Efficiency Motors, page 223 in the 2014 TRM [↑](#footnote-ref-140)
141. *See* Section 3.3 – Premium Efficiency Motors, page 223, of the 2014 TRM. [↑](#footnote-ref-141)
142. *See* Section 3.4 – Variable Frequency Drive (VFD) Improvements, page 231, of the 2014 TRM. [↑](#footnote-ref-142)
143. Available at <http://www.deeresources.com/>. [↑](#footnote-ref-143)
144. *See* page 136 of the 2014 TRM Final Order. [↑](#footnote-ref-144)
145. *See* Section 3.3 – Premium Efficiency Motors, page 224, of the 2014 TRM. [↑](#footnote-ref-145)
146. *See* Section 3.2.3 – Water Source and Geothermal Heat Pumps, page 267, of the proposed 2015 TRM. [↑](#footnote-ref-146)
147. *See* Section 3.5 – HVAC Systems, page 234, of the 2014 TRM. [↑](#footnote-ref-147)
148. Section 3.2.1 – HVAC Systems, page 253, of the proposed 2015 TRM. [↑](#footnote-ref-148)
149. Section 3.2.2 – Electric Chillers, page 262, of the proposed 2015 TRM. [↑](#footnote-ref-149)
150. Section 3.8.1 – Wall and Ceiling Insulation, page 439, of the proposed 2015 TRM. [↑](#footnote-ref-150)
151. Section 3.2.3 – Water Source and Geothermal Heat Pumps, page 267, of the proposed 2015 TRM. [↑](#footnote-ref-151)
152. Section 3.2.6 – Small C/I HVAC Refrigerant Charge Correction, 286, of the proposed 2015 TRM. [↑](#footnote-ref-152)
153. Available at <http://publicecodes.cyberregs.com/icod/iecc/2009/>. [↑](#footnote-ref-153)
154. Available at <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/77>. [↑](#footnote-ref-154)
155. Available at <http://publicecodes.cyberregs.com/icod/iecc/2012/>. [↑](#footnote-ref-155)
156. *See* Section 3.5 – HVAC Systems, page 234, of the 2014 TRM. [↑](#footnote-ref-156)
157. *See* Section 3.17 – Water Source and Geothermal Heat Pumps, page 291, of the 2014 TRM. [↑](#footnote-ref-157)
158. *See* Section 3.15 – Wall and Ceiling Insulation, page 276, of the 2014 TRM. [↑](#footnote-ref-158)
159. *See* Section 3.5, page 234, of the 2014 TRM. [↑](#footnote-ref-159)
160. *See Connecticut* *Program Savings Documentation for 2012 Program Year*, by The United Illuminating Company and Connecticut Light and Power Company, (Connecticut Program Savings Documentation) Sept. 2011. [↑](#footnote-ref-160)
161. *See Building America House Simulation Protocols*, by R. Hendron and C. Engebrecht, National Renewable Energy Laboratory, U.S. Department of Energy (U.S. DOE Building America House Simulation Protocol) Oct. 2010. Available at <http://www.nrel.gov/docs/fy11osti/49246.pdf>. [↑](#footnote-ref-161)
162. *See* Section 3.5 – HVAC Systems, page 234, of the 2014 TRM. [↑](#footnote-ref-162)
163. *See* Section 3.6 – Electric Chillers, page 241, of the 2014 TRM. [↑](#footnote-ref-163)
164. *See* Section 3.6 – Electric Chillers, page 241, of the 2014 TRM. [↑](#footnote-ref-164)
165. *See* Section 3.17 – Water Source and Geothermal Heat Pumps, page 291, of the 2014 TRM. [↑](#footnote-ref-165)
166. *See Air-Source Heat Pumps and Central Air Conditioners Key Product Criteria*, ENERGY STAR (ENERGY STAR Key Product Criteria). Available at <http://www.energystar.gov/index.cfm?c=airsrc_heat.pr_crit_as_heat_pumps>. [↑](#footnote-ref-166)
167. *See* Section 3.18 – Ductless Mini-Split Heat Pumps – Commercial < 5.4 tons, page 299, of the 2014 TRM. [↑](#footnote-ref-167)
168. *See San Diego Gas & Electric 2004-2005 Local Energy Savers Program Evaluation Report*, prepared by S. Dimetrosky, *et al.*, Quantec LLC (San Diego Gas and Electric Program Evaluation Report) July 2006. Available at <http://www.calmac.org/publications/SDGE_ESP_EMV_Report_073106_Final.pdf>. [↑](#footnote-ref-168)
169. *See* Section 3.31 – Low Flow Pre-Rinse Sprayers for Time of Sale/Retail Programs, page 353, of the 2014 TRM. [↑](#footnote-ref-169)
170. *See Water- Thermal Properties*, The Engineering Toolbox (The Engineering Toolbox). Available at <http://www.engineeringtoolbox.com/water-thermal-properties-d_162.html>. [↑](#footnote-ref-170)
171. *See Impact and Process Evaluation Final Report for California Urban Water Conservation Council: 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2)*, submitted to California Public Utilities Commission, prepared by SBW Consulting, Inc. *et al.* (Impact and Process Evaluation Final Report) Feb. 2007. Available at <http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=976>. [↑](#footnote-ref-171)
172. *See* Section 3.32 – Small C/I HVAC Refrigerant Charge Correction, page 359, of the 2014 TRM. [↑](#footnote-ref-172)
173. *See Refrigeration Rebate Catalog: Saving Energy for a Brighter Future*, by Pacific Gas and Electric Company (PG&E’s Refrigeration Rebate Catalog). Available at [http://www.fishnick.com/saveenergy/rebates/2014\_PG&E\_refrigeration\_catalog\_final.pdf](http://www.fishnick.com/saveenergy/rebates/2014_PG%26E_refrigeration_catalog_final.pdf). [↑](#footnote-ref-173)
174. *See SDG&E Statewide Express Efficiency Program*. Available at <https://www.sdge.com/sites/default/files/regulatory/Express%20and%20SBS%20Workpapers.pdf>. [↑](#footnote-ref-174)
175. *See* Section 3.33 – Refrigeration: Special Doors with Low or No Anti-Sweat Heat for Low Temp Case, page 363, of the 2014 TRM. [↑](#footnote-ref-175)
176. *See* Section 3.34 – ENERGY STAR Room Air Conditioner, page 366, of the 2014 TRM. [↑](#footnote-ref-176)
177. *See* Section 3.36 – Variable Speed Refrigeration Compressor, page 373, of the 2014 TRM. [↑](#footnote-ref-177)
178. *See* Section 3.39 – Fuel Switching: Small Commercial Electric Heat to Natural Gas/Oil/Propane Heat, page 390, of the 2014 TRM. [↑](#footnote-ref-178)
179. See Section 4.5, page 412, in the 2014 TRM. [↑](#footnote-ref-179)
180. *See* Section 5.1 – Appendix A: Measure Lives, page 425, of the 2014 TRM. [↑](#footnote-ref-180)
181. *See* Section 5.4 – Appendix D: Motor and VFD Audit and Design Tool, page 433, of the 2014 TRM. [↑](#footnote-ref-181)
182. *See* Section 5.5 – Appendix E: Lighting Audit and Design Tool for C&I New Construction Projects, page 434, of the 2014 TRM. [↑](#footnote-ref-182)
183. *See* Section 3.1.2 – New Construction Lighting, page 222, of the proposed 2015 TRM. [↑](#footnote-ref-183)