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

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|  | Public Meeting held April 11, 2019 |
| Commissioners Present: |  |

|  |  |
| --- | --- |
| Gladys M. Brown, Chairman |  |
| David W. Sweet, Vice ChairmanNorman J. Kennard |  |
| Andrew G. Place |  |
| John F. Coleman, Jr. |  |
|  |  |
| Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2021 Update | M-2019-3006867 |

**2021 TRM UPDATE Tentative Order**

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**BY THE COMMISSION:**

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

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

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

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

Regarding a potential Phase IV of the EE&C Program, in keeping with guidance from previous Implementation Orders, we anticipate that the TRM will be adopted as a component of the EE&C Program evaluation process. If a Phase IV of the EE&C Program is adopted, the Commission proposes a process for optional updates to keep the TRM aligned with updates to codes and standards that occur during the phase.

In this Order, the Commission proposes several updates to climate-related assumptions in the TRM, a revised taxonomy of commercial and industrial (C&I) building types, an adjustment to the definition of peak and off-peak periods, and other general changes described in greater detail in [Section B](#_General_Improvements) below. The Commission proposes 14 new residential and 26 new non-residential measures to include in the Phase IV TRM. See [Section C](#_Additional_Residential_EE&C) and [Section D](#_Additional_C&I_EE&C) of this Order for a listing of these measures. [Section E](#_Existing_Residential_EE&C) and [Section F](#_Existing_C&I_EE&C) of this Order describe the Commission’s proposed updates to residential and non-residential measures included from the Phase III TRM. [Section G](#_Removed_Residential_EE&C) and [Section H](#_Removed_C&I_EE&C) of this Order list six residential and three non-residential measures that the Commission proposes to remove from the TRM.

# 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 the NMR Group, Inc. in March 2016 to perform these duties as the Act 129 Statewide Evaluator (SWE). As part of its duties, the SWE is to review the TRM and the Total Resource Cost (TRC) Test and provide suggestions for possible revisions and additions to these guidance documents.

The SWE, in collaboration with the program evaluation group (PEG)[[12]](#footnote-13) and staff from the Commission’s Bureau of Technical Utility Services (TUS), reviewed the 2016 TRM and proposes several changes and additions for consideration for inclusion in the 2021 TRM. With the adoption of this Tentative Order, the Commission seeks comments on the proposed 2021 TRM. The proposed 2021 TRM and its associated Appendices 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 2021 TRM will be published in the *Pennsylvania Bulletin.*

# 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 2016 TRM update process were referred to the SWE to do further research in order to provide recommendations during the 2021 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 C&I EE&C measures. These proposed changes are intended to make the TRM a more effective and professional tool for validating energy savings and providing support for the Act 129 goals.

The major goals of the proposed modifications are as follows:

1. To add protocols for EE&C measures being implemented by the EDCs and to broaden the scope of the TRM;
2. To update the TRM baseline assumptions to reflect changes to building codes in the Commonwealth;
3. To split the TRM into three separate volumes – a general volume that describes the purpose of the TRM and how it should be used, a volume for residential measures, and a volume for non-residential (C&I and agricultural) measures;
4. To update TRM assumptions based on findings from the SWE’s residential and non-residential end-use saturation studies;
5. To appropriately balance the integrity and accuracy of claimed energy savings estimates with costs incurred to measure and verify the claimed energy savings;
6. To clarify existing calculation methods;
7. To allow more flexibility for the EDCs to use territory-specific or gathered data when calculating savings; and
8. To provide additional reasonable methods for measurement and verification of energy savings associated with EE&C measures without unduly burdening EE&C program and evaluation staff.

 Below is a summary list of the changes proposed in this 2021 TRM update.

1. General improvements to the TRM.
2. Inclusion of 14 new residential EE&C measure protocols.
3. Clarification of the existing residential EE&C measure protocols.
4. Inclusion of 26 new C&I EE&C measure protocols.
5. Clarification of the existing C&I EE&C measure protocols.
6. Clarification of demand response protocols.
7. Updates to Appendix C – Lighting Audit and Design Tool.
8. Updates to Appendix D – Motor and VFD Audit and Design Tool.

Below, we will discuss in more detail the more significant proposed changes and updates. Minor administrative changes will not be discussed.

## Application of the TRM

 As discussed above, the Commission has previously updated the TRM on an annual basis in Phases I and II of the EE&C Program to capture changes in codes and regulations as they occur. In Phase III of the EE&C Program, the Commission adopted one TRM for the entire Phase with an option to propose modifications if necessary. While we have attempted to capture all known changes to codes and standards in this proposed TRM for Phase IV, we recognize that the codes and standards are not static and may change during the course of Phase IV. Accordingly, we have proposed a mechanism in Section B.2 of this Order through which we will update the TRM for currently unknown changes to codes and standards that may occur from now through Phase IV.

## General Changes

### Code Changes

Pennsylvania updated its building code from IECC 2009 to IECC 2015 in 2018. This affects the TRM in several places, as default values for several parameters in the 2016 TRM are drawn from IECC 2009. The Commission proposes updating the TRM, where appropriate, to reflect the updated building code within the state. Otherwise, the annual energy savings and peak demand savings may be overstated for any measures with inputs that are currently drawn from IECC 2009.

Additionally, a number of United States Department of Energy (U.S. DOE) Federal Standards and ENERGY STAR specifications have been updated since the last TRM update. Like with the updated building code, it is important for the TRM to reflect the most recent federal standards and ENERGY STAR specifications, so that annual energy savings and peak demand savings algorithms reflect the true savings.

### Process for Code Change Updates

For Phase IV, the Commission proposes a new process for incorporating codes, standards, and ENERGY STAR specifications that change during the phase without undertaking a full TRM update. Each year of the phase, the SWE will track code updates to federal standards, ENERGY STAR specifications, and state-adopted building energy codes. Based on the extent of code updates that occur, the SWE will recommend whether to open the TRM for a code refresh for the following program year. Code updates that are not finalized and in effect before July 1 of a program year will not be considered for inclusion in the TRM in that update cycle. Changes to the TRM proposed by the SWE through this process will be limited to updating values directly related to codes, standards and ENERGY STAR specifications.

The Commission proposes the following schedule for this process:

| **Estimated Date** | **Action** |
| --- | --- |
| March 15 | SWE memo analyzing impact of code or standards changes will be delivered to TUS. |
| April 15 | TUS will determine if an update is warranted.  |
| July 1 | Codes and standards must be in effect by this date. |
| July  | Tentative TRM Order and Manual on Public Meeting Agenda. |
| August - September  | Comment and review process.  |
| November  | Final TRM Order and Manual on Public Meeting Agenda.  |

### Division of the TRM into Volumes

The Commission proposes to split the TRM into three distinct volumes. The first volume of the TRM will contain the first section (Introduction) of the 2016 TRM, as well as the appendices. The second volume of the TRM will contain protocols for all of the residential measures, including the protocol for Direct Load Control and Behavior-Based Demand Response Programs (section 5.2 in the 2016 TRM). The third volume of the TRM will contain protocols for all of the non-residential measures (C&I and agricultural), as well as the protocol for Load Curtailment for Commercial and Industrial Programs (section 5.1 in the 2016 TRM).

### Updated Climate Assumptions

The Commission proposes to update the climate-dependent values used in the TRM. Many TRM measures incorporate climate-dependent terms (CDD, HDD, cooling/heating equivalent full load hours, coincidence factors, etc.) to reflect the variations in climate across the state. In the 2016 TRM, the weather reference cities included seven reference zones, defined by the major cities in the zone: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, and Williamsport. The Commission’s proposed update includes the addition of two new reference cities: Binghamton, NY and Bradford, PA. The Commission believes these nine cities better reflect the climate characteristics of the state and the need to incorporate other climate region systems from ASHRAE and IECC.

In cases where a climate-dependent value for one of the two new weather cities is unknown, the Commission proposes that the value be estimated via regression modeling. The regression models will be based on the seven established weather reference cities, and the models will use CDD and HDD as explanatory variables. For Residential HVAC equipment, the Commission proposes a different approach, which is discussed in the next section. Regarding CDD and HDD, there is a Class 1 weather station in each of the nine weather reference cities that provides typical meteorological year (TMY) weather data for the city.[[13]](#footnote-14) Weather data from these stations was used to calculate CDD and HDD for the relevant weather reference cities.

Additional weather regionalization results in a better representation of climate variations in Pennsylvania. New measures affected by this update include Weather Stripping, Caulking and Outlet Gaskets, Basement Wall Insulation, and Residential Window Repair. Existing TRM Protocols affected by this update include the following:

* 2.4.3 – Refrigerator / Freezer Recycling with and without Replacement;
* 2.6.1 – Ceiling /Attic and Wall Insulation;
* 2.6.7 – Crawl Space Wall Insulation;
* 3.2.1 – HVAC Systems;
* 3.2.2 – Electric Chillers;
* 3.2.4 – Ductless Mini-split Heat Pumps – Commercial < 5.4 Tons;
* 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas / Propane / Oil Heat;
* 3.2.6 – Small C/I HVAC Refrigerant Charge Correction;
* 3.2.7 – ENERGY STAR Room Air Conditioners;
* 3.2.9 – Controls: Economizer;
* 3.3.1 – Premium Efficiency Motors;
* 3.3.3 – ECM Circulating Fan;
* 3.5.5 – Controls: Floating Head Pressure Controls;
* 3.8.1 – Wall and Ceiling Insulation;
* 4.1.3 – High-efficiency Ventilation Fans with and without Thermostats;
* 4.1.5 – High-volume Low-speed Fans; and
* 4.1.6 – Livestock Waterer.

### Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment

The Commission proposes to revise the Equivalent Full Load Hour (EFLH) and Coincidence Factor (CF) values for residential HVAC equipment to reflect actual HVAC operating data from thousands of households across Pennsylvania and the bordering states. The analysis dataset was collected through ecobee’s Donate Your Data[[14]](#footnote-15) platform. The update also aligns the EFLH and CF assumptions with updated normal weather assumptions by city. New measures affected by this update include Properly Sized Cooling, ECM Circulation Fans, GSHP Desuperheaters, Air Conditioner & Heat Pump Maintenance, ENERGY STAR Connected Thermostats, Furnace Maintenance, and Basement Wall Insulation. Existing TRM Protocols affected by this update include the following:

* 2.2.1 – Electric HVAC;
* 2.2.2 – Fuel Switching: Electric Heat To Gas / Propane / Oil Heat;
* 2.2.3 – Ductless Mini-split Heat Pumps (with primary and secondary impacts relating to the EFLH estimate);
* 2.2.4 – ENERGY STAR Room Air Conditioners (with a correction factor to de-rate for RAC);
* 2.2.5 – Room AC (RAC) Retirement;
* 2.2.6 – Duct Sealing;
* 2.2.7 – Furnace Whistle;
* 2.2.10 – Packaged Terminal Systems;
* 2.3.1 – Heat Pump Water Heaters;
* 2.6.1 – Ceiling / Attic and Wall Insulation;
* 2.6.2 – ENERGY STAR Windows;
* 2.6.3 – Residential New Construction;
* 2.6.6 – Residential Air Sealing;
* 2.6.7 – Crawl Space Wall Insulation; and
* 2.6.8 – Rim Joist Insulation.

The proposed structure includes a set of city-specific CF and EFLH values for both primary and secondary cooling systems, heat pump heating systems, and non-heat pump heating systems.

The SWE team’s analysis uses Wi-Fi connected thermostat data from April 2015 to September 2017 and TMY3 weather for Pennsylvania and the surrounding area to calculate EFLH. EFLH values are estimated using temperature-optimized linear change-point models. Using the ENERGY STAR connected thermostat Energy Saving Factor (ESF) values from the proposed Residential Thermostat protocol (2.2.12), the values are inflated to add-back the assumed runtime reduction achieved by connected thermostats. The EFLH and CF assumptions are intended to represent a blended average of programmable and non-programmable thermostats.

The Commission’s proposed values for the Air Conditioning CF are calculated using the aforementioned data. The SWE estimated separate CFs for each of nine weather reference cities by modeling the typical run time during the peak demand window with a fractional regression model. These runtime models, in conjunction with hourly TMY3 data, are used to predict compressor run time on non-holiday weekdays in June, July, and August from 2 pm to 6 pm. The CF is the average predicted runtime proportion for each weather station. The Commission’s proposed CF values are lower than the current CF values and vary by city with average outdoor temperature.

Proposed EFLH Cooling values are higher than the previous values in the 2016 TRM. Proposed EFLH Heating values for fossil fuel and electric furnaces are lower than current values. The SWE team modeled the compressor and auxiliary heat components of air source heat pumps separately and then calculated EFLH Heating assumptions for the full system by examining the frequency that the two components run independently and together. The proposed EFLH Heating values for air source heat pumps are higher than the values in the 2016 TRM. Appendix F of Volume 1 of the Proposed 2021 TRM contains all weather dependent lookup tables, like EFLH and CF, by city.

### Updated C&I Building Types

The Commission proposes adopting a common set of C&I building types across all C&I measures for which one or more of the inputs is a function of building type. In the 2016 TRM, the list of possible building types changes from measure to measure. The adoption of a common set of building types across measures should improve TRM usability by giving applicants choices that apply across the state. It will also provide consistency between the baseline and market potential studies, and the TRM.

The table below maps the proposed adjustments and consolidations to the building types listed in the 2016 TRM. The proposed standardization is largely drawn from the building types used in 3.1.1 Lighting Improvements. Simple averaging will be used to make the proposed consolidations. For example, the default CFs for the Office – Large and Office – Small building types will be averaged to produce the default CF for the Office building type.

| **2016 TRM Building Types** | **Proposed Building Type** |
| --- | --- |
| Assembly | Institutional / Public Service |
| Education – Community College | Education – College / University  |
| Education – University |
| Education – Primary School | Education – Other  |
| Education – Relocatable Classroom |
| Education – Secondary School |
| Grocery | Grocery |
| Health / Medical – Hospital | Health – Hospital |
| Health / Medical – Nursing Home | Health – Other |
| Lodging – Hotel | Lodging |
| Manufacturing – Bio Tech / High Tech | Industrial Manufacturing |
| Manufacturing – 1 Shift / Light Industrial |
| Multifamily (Common Areas) | Multifamily (Common Areas) |
| Office – Large | Office |
| Office – Small |
| Restaurant – Fast-Food | Restaurant |
| Restaurant – Sit-Down |
| Retail – Multi-story Large | Retail |
| Retail – Single-story Large |
| Retail – Small |
| Storage – Conditioned | Warehouse – Other |
| Warehouse – Refrigerated | Warehouse – Refrigerated |

 The measures affected by this change include the following:

* 3.2.1 – HVAC Systems;
* 3.2.2 – Electric Chillers;
* 3.2.4 – Ductless Mini-split Heat Pumps – Commercial < 5.4 Tons;
* 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas / Propane / Oil Heat;
* 3.2.6 – Small C/I HVAC Refrigerant Charge Correction;
* 3.2.7 – ENERGY STAR Room Air Conditioners;
* 3.3.1 – Premium Efficiency Motors; and
* 3.4.1 – Heat Pump Water Heaters.

### In-Service Date

Section 1 of the TRM provides an overview of how the Pennsylvania TRM is used by EDCs, their CSPs, and evaluation contractors to claim and verify energy and peak demand savings. The in-service-date of a project determines when savings are eligible to be claimed by an EDC. In Section 1.2.4 of the TRM, the Commission proposes to update the definition of in-service-date for efficient equipment installed in spaces that are not currently occupied to the date the equipment is energized. The intent of this change is to remove barriers to new construction programs and measures and reduce the amount of time between when building architects and owners select and purchase efficient equipment and when EDCs can provide incentives and claim savings.

### Definition of Peak and Off-peak Energy Periods

The monetary benefits of electric energy savings for Act 129 programs are time‑differentiated by season and on/off peak periods to account for differences in marginal costs in these periods. The Commission proposes to update the definition of the peak and off-peak hours to align with the definition used by PJM. The proposed peak hours are 7:00 am to 11:00 pm Monday through Friday. The proposed off-peak hours are 11:00 pm to 7:00 am Monday through Friday and all weekend and holiday hours. This change will align the TRM on/off peak hours with the PJM on/off peak hours, which is used by the EDCs to determine a measure’s avoided cost of supplying electricity for the total resource cost test.

### Line Loss Factors

The Commission is not proposing any changes to the line loss factors themselves in Table 1-4 of the TRM but is proposing to distinguish non-residential assumptions by Small C&I and Large C&I instead of Commercial and Industrial. This change will better align the TRM with the sector definitions used by the EDCs in EE&C program design and cost-recovery.

### Measure Applicability Based on Sector

In Section 1.18 of the TRM, the Commission proposes to clarify guidance regarding which set of TRM measures should be used for specific savings calculation. The intent of the changes is to provide clearer guidance for projects in multifamily buildings. Multifamily buildings can be individually metered as part of the residential rate class or master metered as part of a non-residential rate class. Either type of building may have common areas that operate more like a commercial building than a residential household.

## Additional Residential EE&C Measure Protocols

The Commission recognizes that the expansion of the residential section of the TRM is essential for the accurate and timely measurement and verification (M&V) of the EDCs’ Act 129 EE&C programs and is proposing to include 14 new residential EE&C measure protocols. The EDCs’ independent evaluators, in collaboration with the SWE, produced, reviewed, and edited these residential EE&C measure protocols. The 14 new residential EE&C measure protocols are as follows:

* Section 2.2.3 – Properly Sized Cooling;
* Section 2.2.4 – ECM Circulation Fans;
* Section 2.2.5 – GSHP Desuperheaters;
* Section 2.2.6 – Air Conditioner & Heat Pump Maintenance;
* Section 2.2.12 – ENERGY STAR Connected Thermostats;
* Section 2.2.13 – Furnace Maintenance;
* Section 2.4.6 – Heat Pump Clothes Dryers;
* Section 2.4.10 – Dehumidifier Retirement;
* Section 2.4.12 – ENERGY STAR Air Purifiers;
* Section 2.6.2 – Weather Stripping, Caulking, and Outlet Gaskets;
* Section 2.6.4 – Basement Wall Insulation;
* Section 2.6.7 – Residential Window Repair;
* Section 2.7.3 – Low-rise Multifamily New Construction; and
* Section 2.7.5 – Home Energy Reports.

## Additional C&I EE&C Measure Protocols

 As with residential measures, expansion of the C&I section of the TRM is also essential for the accurate and timely M&V of these EE&C programs. Based on collaborative discussions between the SWE and the EDCs, as well as a review of the available research, we propose the inclusion of the following 26 new C&I EE&C measures and associated protocols:

* Section 3.1.7 – Lighting Improvements for Midstream Delivery Programs;
* Section 3.2.10 – Computer Room Air Conditioner;
* Section 3.2.11 – Computer Room Air Conditioner / Handler Electronically Commutated Plug Fans;
* Section 3.2.12 – Computer Room Air Conditioner / Handler VSD on AC Fan Motors;
* Section 3.2.13 – Circulation Fan: High-volume Low-speed;
* Section 3.3.5 – ECM Circulator Pump;
* Section 3.3.6 – High-efficiency Pump;
* Section 3.5.16 – Air-cooled Refrigeration Condenser;
* Section 3.5.17 – Refrigerated Case Light Occupancy Sensor;
* Section 3.5.18 – Refrigeration Economizers;
* Section 3.6.2 – ENERGY STAR Bathroom Ventilation Fan in Commercial Applications;
* Section 3.7.4 – ENERGY STAR Electric Steak Cooker;
* Section 3.7.5 – ENERGY STAR Combination Oven;
* Section 3.7.6 – ENERGY STAR Commercial Convection Oven;
* Section 3.7.7 – ENERGY STAR Commercial Fryer;
* Section 3.7.8 – ENERGY STAR Commercial Hot Food Holding Cabinet;
* Section 3.7.9 – ENERGY STAR Commercial Dishwasher;
* Section 3.7.10 – ENERGY STAR Commercial Griddle;
* Section 3.9.5 – Server Virtualization;
* Section 3.10.5 – Variable-speed Drive Air Compressor;
* Section 3.10.6 – Compressed Air Controller;
* Section 3.10.7 – Compressed Air Low-pressure Drop Filters;
* Section 3.10.8 – Compressed Air Mist Eliminators;
* Section 3.11.1 – High-efficiency Transformer;
* Section 3.11.2 – Engine Block Heat Timer; and
* Section 3.11.3 – High-frequency Battery Chargers.

## Existing Residential EE&C Measure Protocols and Processes

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

### Section 2.1.1 – ENERGY STAR Lighting[[15]](#footnote-16)

#### Baseline Wattage

The Commission proposes replacing the table of tiered baseline wattages based on lumen ranges with a simple calculation based on the EISA standard of 45 lumens per watt.

#### Specialty Lamp Baselines Removed

The Commission proposes eliminating the separate table of baseline wattages for specialty lamps to reflect the broadened definition of general service lamps under the provisions of EISA. This recommendation is based on a U.S. Department of Energy (DOE) ruling in 2017 that would eliminate exemptions for the most common lamp types that had been exempted, such as reflectors and 3-way lamps, to take effect January 2020.[[16]](#footnote-17) The status of this ruling is currently in question as the DOE has proposed to take back the 2017 ruling and maintain the exemptions for reflectors and other specialty lamp types. The DOE held a public meeting on February 27, 2019 and is collecting comments through May 3, 2019 regarding this proposed rulemaking.[[17]](#footnote-18)

#### Default Values for Non-residential End-uses (Cross-Sector Sales)

The 2016 TRM provided limited guidance for estimating savings from cross‑sector sales (i.e., lamps sold through upstream programs where the installation location is unknown). EDCs were required to conduct research to estimate cross-sector sales in their service territories. The expected decline of savings available from lighting will reduce the resources available for evaluation research on this measure. To reduce the research required to claim savings from cross-sector sales, the Commission proposes including a default cross-sector sales value of 7.4% based on previous EDC evaluations, along with default values for other terms necessary to estimate savings for lamps assumed to have non-residential end-uses.

### Section 2.1.2 – Residential Occupancy Sensors[[18]](#footnote-19)

The Commission proposes amending the measure to include a deemed savings value for units sold through upstream buy-down or retail programs where Wattscontrolled is unknown. The proposed deemed savings value is 28.9 kWh/year per occupancy sensor, based on data from the Phase III Market Potential Study.[[19]](#footnote-20)

### Section 2.1.3 – Electroluminescent Nightlight and Section 2.1.4 – LED Nightlight[[20]](#footnote-21)

The Commission proposes consolidating these two similar measures into a single section named LED and Electroluminescent Nightlights. The Commission also proposes to update the default in-service rate (ISR) for these measures to 0.20 based on ISR values reported in FirstEnergy evaluations from PY9.

### Section 2.2.1 – Electric HVAC[[21]](#footnote-22)

#### Changes to Name and Section Structure

This measure in the 2016 TRM includes a variety of HVAC-related but dissimilar measures. The Commission proposes to limit this measure to new electric HVAC equipment, with the other measures separated into their own sections of the TRM. The Commission proposes renaming this measure High-efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP to clearly define the equipment covered under the measure. PTAC and PTHP systems had previously been included in Section 2.2.10 – Packaged Terminal Systems,[[22]](#footnote-23) though the savings algorithms are similar to other electric HVAC equipment. The measures that the Commission proposes removing from this section to separate measures are Properly Sized Cooling, ECM Circulation Fans, GSHP Desuperheaters, and Air Conditioner & Heat Pump Maintenance.

#### Updates to Default Values

The Commission proposes updating the default efficiencies for early replacement equipment using data from the Act 129 2018 Pennsylvania Residential Baseline Study and updating default efficiencies for replace on burnout or new construction installations based on applicable updates to federal standards. This measure is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.2.2 – Fuel Switching: Electric Heat to Gas / Propane / Oil Heat[[23]](#footnote-24)

The Commission proposes updating the minimum efficiency requirements due to ENERGY STAR specification updates for furnaces and boilers. The Commission also proposes updating the default baseline HSPF value used to calculate savings in heat pump scenarios with data from the Act 129 2018 Pennsylvania Residential Baseline Study. This measure is also affected by updates to climate‑dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment. The Commission proposes using these values in lieu of the Alternate Heating EFLH tables, which will be removed.

### Section 2.2.3 – Ductless Mini-split Heat Pumps[[24]](#footnote-25)

#### Add Midstream Delivery Option, Rename

The Commission proposes adding a midstream delivery option to this measure using baseline assumptions based on downstream program data from Phase III from PECO and PPL. The Commission proposes renaming the measure to High-efficiency Equipment: Ductless Heat Pumps with Midstream Delivery Option.

#### Eligibility and Default Values

The Commission proposes that eligibility for efficient ductless heat pumps be limited to ENERGY STAR-qualified models. The Commission also proposes updating the default efficiencies for early replacement equipment using data from the Act 129 2018 Pennsylvania Residential Baseline Study and updating default efficiencies for replace on burnout or new construction installations based on applicable updates to Federal standards. This measure is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.2.4 – ENERGY STAR Room Air Conditioners[[25]](#footnote-26)

The Commission proposes using the Combined Energy Efficiency Ratio (CEER), the current Federal standard metric for room air conditioner efficiency, in the savings algorithms. The Commission also proposes updating the TRM default for average RAC capacity based on data from the Act 129 2018 Pennsylvania Residential Baseline Study. This measure is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.2.5 – Room AC (RAC) Retirement[[26]](#footnote-27)

The Commission proposes updating the TRM default for average RAC capacity based on data from the Act 129 2018 Pennsylvania Residential Baseline Study. The Commission also proposes updates to the location-based deemed savings values, including expanding the number of locations and updating the existing location-based values.

### Section 2.2.6 – Duct Sealing[[27]](#footnote-28)

#### Rename and Addition of Duct Insulation to Measure

The Commission proposes renaming this measure to Duct Sealing and Insulation to reflect the added option of duct insulation. The Commission also proposes amending the measure to include the installation of duct insulation in unconditioned or semi-conditioned spaces in addition to duct sealing with mastic or metal tape. Duct insulation provides sealing qualities that can be assessed using the Evaluation of Distribution Efficiency method already in use in the 2016 TRM. In cases where duct insulation is involved with the improvement, the Commission proposes that the TRM require the use of the Evaluation of Distribution Efficiency method for assessing the work as opposed to RESNET Test 380 4.4.2.

#### Measure Verification Methods

The Commission proposes removing the Modified Blower Door Subtraction method from the TRM as a means of measuring savings. It is the opinion of the Commission that this method does not provide appreciable benefit or accuracy beyond that provided by the RESNET Test 380 4.4.2, while being cumbersome to perform.

### Section 2.2.7 – Furnace Whistle[[28]](#footnote-29)

The Commission proposes to rename this measure Air Handler Filter Whistle to more accurately describe the measure. The Commission also proposes reducing the default in-service rate (ISR) from the current 47.4% to 15%. The proposed value is based on PY9 EDC data, which is both more current and more appropriate than the current value derived from a 2001 study of ISRs in a program targeting installations in schools. The Commission proposes a revised default kW value for the average motor full load demand of 0.377 for consistency with other measures. This measure is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.2.10 – Packaged Terminal Systems[[29]](#footnote-30)

The Commission proposes that this section be incorporated into Section 2.2.1.

### Section 2.3.1 – Heat Pump Water Heaters,[[30]](#footnote-31) Section 2.3.2 – Solar Water Heaters,[[31]](#footnote-32) Section 2.3.3 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater[[32]](#footnote-33)

The current DOE metric for efficiency of water heaters is the Uniform Energy Factor (UEF), which has superseded the prior metric, Energy Factor (EF). The Commission proposes updating this measure to specify baseline and efficient equipment by UEF. The Commission also proposes updating the table of minimum baseline UEF values to comply with current Federal standards for water heaters, which now incorporate a factor for draw pattern in addition to tank size. The Commission proposes revising the assumed cold water inlet temperature to 52F, and the assumed value for hot water used per day to 45.5 gallons, with these values to be applied across all measures that incorporate these factors. Section 2.3.1 – Heat Pump Water Heaters is also affected by updates to climate‑dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment (in relation to interactive heating / cooling effects).

### Section 2.3.5 – Water Heater Tank Wrap[[33]](#footnote-34)

The energy savings algorithm for this measure in the 2016 TRM requires inverting the tank wrap R-value to calculate a U-value. The Commission proposes reconfiguring the algorithm to use R-value only and eliminate this intermediary step. The Commission also proposes updating the default baseline R-value to 12, from 8.3, to better reflect expected baseline values of water heaters in use during Phase IV.

### Section 2.3.6 –Water Heater Temperature Setback[[34]](#footnote-35)

The Commission proposes adding a term for the assumed number of clothes washer cycles per year, which was missing from the 2016 TRM, though the algorithm includes a term for the volume of hot water used in each clothes washer cycle. In addition, the current DOE metric for efficiency of water heaters is the Uniform Energy Factor (UEF), which has superseded the prior metric, Energy Factor (EF). The Commission proposes updating this measure to specify baseline and efficient equipment by UEF.

### Section 2.3.7 –Water Heater Pipe Insulation[[35]](#footnote-36)

The Commission proposes updating the assumed energy use of an electric water heater to correspond with updated baseline values in Section 2.3.1 – Heat Pump Water Heaters. This results in a deemed savings of 8.82 kWh per year per foot of pipe insulation, versus the former value of 9.43 kWh per year per foot.

### Section 2.3.8 – Low-flow Faucet Aerators[[36]](#footnote-37) and Section 2.3.9 – Low‑Flow Showerheads[[37]](#footnote-38)

The Commission proposes revising the assumed cold water inlet temperature to 52F, as used in other updated domestic hot water measures. The Commission proposes updating values for persons per household, faucets per home, and share of homes with electric water heaters using results from the Act 129 2018 Pennsylvania Residential Baseline Study. The Commission proposes to include a default in-service rate of 28% for aerators and 35% for showerheads delivered in kits, based on evaluations of PY9 from FirstEnergy EDCs.

### Section 2.3.10 – Thermostatic Shower Restriction Valve[[38]](#footnote-39)

The Commission proposes updating default values to reflect findings from the Act 129 2018 Pennsylvania Residential Baseline Study. Updated data available from the study includes persons per household, showerheads per home, and the default percent of homes with electric heat. The Commission proposes revising the assumed cold water inlet temperature to 52F, as used in other updated domestic hot water measures. Default savings will change as with adjustments to these inputs. The Commission also proposes that the measure life for thermostatic shower restriction valves be increased from ten to the maximum of 15 years. This is based on the International Association of Plumbing and Mechanical Officials’ Uniform Plumbing Code (UPC) standards that require a device last 10,000 cycles without failure.[[39]](#footnote-40)

### Section 2.4.1 – ENERGY STAR Refrigerators[[40]](#footnote-41) and Section 2.4.2 – ENERGY STAR Freezers[[41]](#footnote-42)

The Commission proposes updating the equations for Adjusted Volume to correspond to the Federal definition of this term. In addition, for Section 2.4.1 only, the Commission proposes updating the criteria for determining the maximum energy use of refrigerators with top-mounted freezers to correspond to the ENERGY STAR Most Efficient specifications. Furthermore, the Commission proposes using an updated value for the Energy to Demand Factor (ETDF) term that matches the value found in the Mid-Atlantic, Illinois, and Wisconsin TRMs.

### Section 2.4.3 – Refrigerator / Freezer Recycling with and without Replacement[[42]](#footnote-43)

#### Remove Default UEC Values

The 2016 TRM provides a set of EDC-specific default coefficients for calculating the Unit Energy Consumption (UEC) of existing refrigerators. The Commission proposes removing these values and requiring the use of program data to calculate UEC vales. A recycling program, by its nature, provides EDCs the opportunity to collect the required information to calculate the actual UEC rather than using defaults.

#### Update Part Use Factor Default Values and Measure Life

The Commission proposes using default Part-Use Factor values of 72.8% for refrigerators and 84.5% for freezers, based on a PPL participant survey from PY8. The Commission also proposes measure lives of five years for refrigerators and four years for freezers recycled without replacement, based on the California Database for Energy Efficient Resources. For refrigerators and freezers recycled with replacement, the Commission proposes an adjusted measure life of six years for refrigerators and five years for freezers. This methodology accounts for findings from a San Diego Gas & Electric study showing longer Expected Useful Life values among low-income customers.

### Section 2.4.4 – ENERGY STAR Clothes Washers[[43]](#footnote-44)

The Commission proposes updating default values in this measure to reflect data from the Act 129 2018 Pennsylvania Residential Baseline Study, more recent market research on available ENERGY STAR-qualified products, data on frequency of clothes washer and dryer use from the DOE 2015 Residential Energy Consumption Survey, and updates to the ENERGY STAR specifications for clothes washers.

### Section 2.4.5 – ENERGY STAR Dryers[[44]](#footnote-45)

The Commission proposes changing the name of this section to ENERGY STAR Clothes Dryers to add specificity. In addition, the Commission proposes to introduce terms for baseline and efficient dryer cycle times in lieu of the single cycle time term in the current algorithm. Furthermore, the Commission proposes updating default values in this measure to reflect data on frequency of clothes dryer use from the DOE 2015 Residential Energy Consumption Survey. The Commission proposes to use the same Coincidence Factor value as used for ENERGY STAR Clothes Washers.

### Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer[[45]](#footnote-46)

The Commission proposes to update default values based on data from the Act 129 2018 Pennsylvania Residential Baseline Study and DOE 2015 Residential Energy Consumption Survey. The Commission proposes to use the same Coincidence Factor value as used for ENERGY STAR Clothes Washers.

### Section 2.4.7 – ENERGY STAR Dishwashers[[46]](#footnote-47)

The Commission proposes updating default values in this measure using data from the Act 129 2018 Pennsylvania Residential Baseline Study, research on efficiency of currently available equipment, and updates to the Federal standards and ENERGY STAR specifications for dishwashers.

### Section 2.4.8 – ENERGY STAR Dehumidifiers[[47]](#footnote-48)

The Commission proposes updating default baseline and efficient values to reflect updates to Federal standards, ENERGY STAR specifications, and the addition of an ENERGY STAR Most Efficient specification.

### Section 2.4.10 – ENERGY STAR Ceiling Fans[[48]](#footnote-49)

The Commission proposes a simplified algorithm with a default assumed wattage reduction table that depends on fan type and diameter. The default wattage reductions are based on currently available ENERGY STAR-qualified models and a weighted average fan airflow.

### Section 2.5.2 – ENERGY STAR Office Equipment[[49]](#footnote-50)

The default savings value for this measure come from the ENERGY STAR Office Equipment Calculator. This calculator does not reflect changes in the ENERGY STAR specifications V7.1 for computers, which went into effect in November 2018. The Commission proposes updating default savings for this measure once an updated calculator becomes available.

### Section 2.5.3 – Smart Strip Plug Outlets[[50]](#footnote-51)

The Commission proposes renaming this measure to Advanced Power Strips to better reflect market terminology. The Commission proposes to replace the existing algorithms with similar but simplified versions that use assumed values for particular end uses of advanced power strips (home office, entertainment center, unspecified), an Energy Reduction Percentage value that depends on end use and strip type (Tier 1 or Tier 2), an in-service rate, and a realization rate. The new algorithms and default values are based on recent research in Massachusetts by NMR Group, Inc. The default energy and demand savings increase for Tier 1 advanced power strips and decrease for Tier 2 strips compared to the 2016 TRM.

### Section 2.6.1 – Ceiling / Attic and Wall Insulation[[51]](#footnote-52)

The Commission proposes consolidating above-grade insulation measures in this section, to include the existing Ceiling / Attic and Wall insulation measures, as well as Rim Joist insulation (Section 2.6.8 of the 2016 TRM) and Floor Insulation (from a Phase III IMP).[[52]](#footnote-53) To reflect these changes, the Commission proposes renaming the section to Ceiling / Attic, Wall, Floor, and Rim Joist Insulation. In addition, the Commission proposes a similar but simplified and reduced set of algorithms for calculating savings using the same set of terms. Furthermore, the Commission proposes updating default baseline HVAC system efficiency values with data from the Act 129 2018 Pennsylvania Residential Baseline Study. This section is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.6.2 – ENERGY STAR Windows[[53]](#footnote-54)

Savings estimates under this section depend on an energy model of a representative prototype home. The Commission proposes replacing the current model with a new energy model created in BEopt v.2.8.0, a modelling tool developed by NREL.[[54]](#footnote-55) The characteristics of the prototype model are based on data from the Act 129 2018 Pennsylvania Residential Baseline Study. Results from running the model under varying climate reference locations and HVAC configurations are used to generate a table of Unit Energy Savings (UES) factors identifying the kWh savings per square foot of replaced window. These factors are used in a new algorithm, along with window area and the ratio of heating or cooling system efficiency in the actual baseline home to the assumed system efficiency in the prototype model.

### Section 2.6.3 – Residential New Construction[[55]](#footnote-56)

The 2016 TRM requires two methods to estimate savings under this measure. Climate-dependent savings, such as from insulation or HVAC systems, are estimated using the results of energy modelling comparing the as-designed home to a minimally code-compliant baseline building. Non-climate-dependent savings from measures such as lighting and appliances must be calculated using the specific measure algorithm from the appropriate section elsewhere in the TRM. The Commission proposes allowing the option of estimating all savings using energy modeling. The Commission also proposes expanding the range of energy modelling software approved for estimating savings under this measure to include any RESNET-accredited software as well as Passive House accreditation packages Passive House Planning Package and WUFI Passive. Furthermore, the Commission proposes updating the parameters of the baseline code-compliant home according to the requirements of the 2015 IECC and updated Federal standards.

### Section 2.6.5 – ENERGY STAR Manufactured Homes[[56]](#footnote-57)

The 2016 TRM requires two methods to estimate savings under this measure. Climate-dependent savings, such as from insulation or HVAC systems, are estimated using the results of energy modelling comparing the as-designed home to a minimally code-compliant baseline building. Non-climate-dependent savings from measures such as lighting and appliances must be calculated using the specific measure algorithm from the appropriate section elsewhere in the TRM. The Commission proposes allowing the option of estimating all savings using energy modelling. The Commission also proposes updating the parameters of the baseline manufactured home according to the requirements of updated Federal standards.

### Section 2.6.6 – Residential Air Sealing[[57]](#footnote-58)

Savings estimates under this section depend on an energy model of a representative prototype home. The Commission proposes replacing the current model with a new energy model created in BEopt v.2.8.0, a modelling tool developed by NREL.[[58]](#footnote-59) The characteristics of the prototype model are based on data from the Act 129 2018 Pennsylvania Residential Baseline Study. Results from running the model under varying climate reference locations and HVAC configurations were used to generate a quadratic regression model and a table of regression coefficients. Savings are calculated by selecting the appropriate coefficients for the location and HVAC configuration and applying them in the algorithm along with factors defining the ratio of duct efficiency and HVAC equipment efficiency in the air-sealed home versus the prototype model and the pre- and post-air sealing air infiltration measurements in the home.

### Section 2.6.7 – Crawl Space Wall Insulation[[59]](#footnote-60)

The Commission proposes updating default baseline HVAC system efficiency values with data from the Act 129 2018 Pennsylvania Residential Baseline Study. This section is also affected by updates to climate-dependent values, described in Section B.5 – Updated Equivalent Full Load Hours and Coincidence Factors for Residential HVAC Equipment.

### Section 2.6.8 – Rim Joist Insulation[[60]](#footnote-61)

The Commission proposes consolidating this measure with Section 2.6.1 – Ceiling / Attic and Wall Insulation and removing this section. Because of similarities in the nature of these above grade shell measures, the Commission sees the benefit of consolidation and simplifying the savings calculations under a single set of algorithms for heating / cooling savings attributed to similar shell components.

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

The Commission proposes eliminating the load shifting option from this measure as load shifting is a demand savings and not an energy savings tactic. While this measure in the 2016 TRM included default values for all terms needed to estimate savings, it did not state the default savings values. The Commission proposes including the default energy savings of 1,409 kWh and 0.3195 kW of demand savings.

### Measure Number Changes

The changes proposed herein will result in new measure numbers for several residential measures. The table below shows the current measure name and number and the new measure name and number (assuming all of the Commission’s proposed changes are made) for all affected measures. The table also shows measures that the Commission proposes removing – these measures are discussed in more detail later.

| **Current Measure Number** | **Current Measure Name** | **New Measure Number** | **New Measure Name** |
| --- | --- | --- | --- |
| 2.1.3 | Electroluminescent Nightlight | 2.1.3 | LED and Electroluminescent Nightlights |
| 2.1.4 | LED Nightlight | 2.1.3 | LED and Electroluminescent Nightlights |
| 2.1.5 | Holiday Lights | 2.1.4 | Holiday Lights |
| 2.2.1 | Electric HVAC | 2.2.1 | High-efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP |
| 2.2.2 | Fuel Switching: Electric Heat to Gas / Propane / Oil Heat | 2.2.7 | Fuel Switching: Electric Heat to Gas / Propane / Oil Heat |
| 2.2.3 | Ductless Mini-split Heat Pumps | 2.2.2 | High-efficiency Equipment: Ductless Heat Pumps with Midstream Delivery Option |
| 2.2.4 | ENERGY STAR Room Air Conditioners | 2.2.8 | ENERGY STAR Room Air Conditioners |
| 2.2.5 | Room AC (RAC) Retirement | 2.2.9 | Room AC (RAC) Retirement |
| 2.2.6 | Duct Sealing | 2.2.10 | Duct Sealing and Insulation |
| 2.2.7 | Furnace Whistle | 2.2.11 | Air Handler Filter Whistle |
| 2.2.8 | Programmable Thermostat | - | Deleted |
| 2.2.9 | Residential Whole House Fans | - | Deleted |
| 2.2.10 | Packaged Terminal Systems | 2.2.1 | High-efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP |
| 2.3.4 | Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater | - | Deleted |
| 2.3.5 | Water Heater Tank Wrap | 2.3.4 | Water Heater Tank Wrap |
| 2.3.6 | Water Heater Temperature Setback | 2.3.5 | Water Heater Temperature Setback |
| 2.3.7 | Water Heater Pipe Insulation | 2.3.6 | Water Heater Pipe Insulation |
| 2.3.8 | Low-flow Faucet Aerators | 2.3.7 | Low-flow Faucet Aerators |
| 2.3.9 | Low-flow Showerheads | 2.3.8 | Low-flow Showerheads |
| 2.3.10 | Thermostatic Shower Restriction Valve | 2.3.9 | Thermostatic Shower Restriction Valve |
| 2.4.5 | ENERGY STAR Dryers | 2.4.5 | ENERGY STAR Clothes Dryers |
| 2.4.6 | Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer | 2.4.7 | Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer |
| 2.4.7 | ENERGY STAR Dishwashers | 2.4.8 | ENERGY STAR Dishwashers |
| 2.4.8 | ENERGY STAR Dehumidifiers | 2.4.9 | ENERGY STAR Dehumidifiers |
| 2.4.9 | ENERGY STAR Water Coolers | 2.4.10 | ENERGY STAR Water Coolers |
| 2.4.10 | ENERGY STAR Ceiling Fans | 2.4.11 | ENERGY STAR Ceiling Fans |
| 2.5.1 | ENERGY STAR Televisions | - | Deleted |
| 2.5.2 | ENERGY STAR Office Equipment | 2.5.1 | ENERGY STAR Office Equipment |
| 2.5.3 | Smart Strip Plug Outlets | 2.5.2 | Advanced Power Strips |
| 2.6.1 | Ceiling / Attic and Wall Insulation | 2.6.3 | Ceiling / Attic, Wall, Floor, and Rim Joist Insulation |
| 2.6.2 | ENERGY STAR Windows | 2.6.6 | ENERGY STAR Windows |
| 2.6.3 | Residential New Construction | 2.7.1 | Residential New Construction |
| 2.6.4 | Home Performance with ENERGY STAR | 2.7.2 | Home Performance with ENERGY STAR |
| 2.6.5 | ENERGY STAR Manufactured Homes | 2.7.4 | ENERGY STAR Manufactured Homes |
| 2.6.6 | Residential Air Sealing | 2.6.1 | Residential Air Sealing |
| 2.6.7 | Crawl Space Wall Insulation | 2.6.5 | Crawl Space Wall Insulation |
| 2.6.8 | Rim Joist Insulation | 2.6.3 | Ceiling / Attic, Wall, Floor and Rim Joist Insulation |
| 2.7.1 | Pool Pump Load Shifting | - | Deleted |
| 2.7.2 | Variable Speed Pool Pumps (with Load Shifting Option) | 2.8.1 | Variable Speed Pool Pumps |
| 5.2 | Direct Load Control and Behavior-based Demand Response Programs | 2.9.1 | Direct Load Control and Behavior-based Demand Response Programs |

## Existing C&I EE&C Measure Protocols

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

### Section 3.1.1 – Lighting Improvements[[62]](#footnote-63)

#### Measure Life

The Commission proposes assuming different measure lives for Type A, Type B, and Type C linear LEDs. Type A linear LEDs use integrated drivers and are designed to work with a linear fluorescent lamp ballast. Type B linear LEDs also use integrated drivers but are designed to work directly on mains voltage. Type C linear LEDs operate off remote LED drivers, but the low-voltage outputs of the drivers are connected to sockets as opposed to the mains voltage, as is the case for Type B equipment. Because of these differences, Type A equipment is assumed to have diminished longevity due to the reliance on an existing (or new) linear fluorescent lamp ballast. Therefore, a measure life of five years is proposed for Type A equipment and a measure life of 15 years is proposed for Type B and Type C equipment.

#### Measure Consolidation

The Commission proposes updating this protocol to accommodate Permanent Fixture Removal and Permanent Lamp Removal. These measures share many characteristics with the Lighting Improvements measure protocol, and consolidation reduces redundancy.

#### General Service Lamp Baseline Adjustment

The Energy Independence and Security Act of 2007 (EISA) “backstop” provision introduced new efficacy standards for general service lamps (effective January 1, 2020) effectively requiring a minimum efficacy of 45 lm/W for most general service lamps. This will induce a shift in what a participant would have purchased in the absence of the program because standard and halogen incandescent lamps will no longer be viable options. Because of this, the Commission proposes the use of a generic general service lamp with an efficacy of 45 lm/W as the assumed baseline for screw-based lighting retrofit beginning in PY13. The comparable baseline for any removed incandescent lamps will be a generic general service lamp with similar lumen output. The assumed generic general service lamp baseline lamps / fixtures and wattages associated with the most common incandescent lamp / fixture configurations are presented in the new table titled Assumed Generic GSL Baseline Lamps / Fixtures for Removed Incandescent Lamps / Fixtures.

#### Hours of Use

The Commission proposes updating the hours of use (HOU) for Exterior (All Building Types) from 3,833 to 3,604 hours and Parking Garages from 6,552 to 8,678 hours in both the Lighting HOU and CF by Building Type for Screw-Based Bulbs and Lighting HOU and CF by Building Type for Other General Service Lighting tables based on more recent sources or newer versions of the current data sources.

#### Coincidence Factor

The Commission proposes updating the coincidence factors (CF) for Exterior (All Building Types) from 0.00 to 0.11; Industrial Manufacturing – 1 Shift, Industrial Manufacturing – 2 Shift, and Industrial Manufacturing – 3 Shift from 0.57 to 0.96; Multifamily Common Areas from 0.62 to 0.73; and Parking Garages from 0.62 to 0.98 in both the Lighting HOU and CF by Building Type for Screw-Based Bulbs and Lighting HOU and CF by Building Type for Other General Service Lighting tables based on more recent sources or newer versions of the current data sources.

#### T12 Linear Fluorescent Baseline Adjustment

The Act 129 2018 Pennsylvania Non-Residential Baseline Study found a surprising share of T12 linear fluorescent lighting, almost exclusively in the small C&I sector. To address this and help EDC programs overcome barriers and tap into potential in this hard‑to-reach segment, the Commission proposes to use as found baselines without overrides for codes and standards for small business direct install programs.

### Section 3.1.2 – New Construction Lighting[[63]](#footnote-64)

The Commission proposes updating the maximum lighting power densities and common space types presented in the Lighting Power Densities from ASHRAE 90.1‑2007 Building Area Method, Lighting Power Densities from ASHRAE 90.1-2007 Space-by-Space Method and Baseline Exterior Lighting Power Densities tables to reflect the requirements in the 2015 International Energy Conservation Code (IECC), the current statewide Pennsylvania energy code. The Commission also proposes updating the values in the Default Baseline Savings Control Factors Assumptions for New Construction Only table to reflect the fact that 2015 IECC requires lighting controls in additional space types relative to the previous code, 2009 IECC.

### Section 3.1.3 – Lighting Controls[[64]](#footnote-65)

See discussion in Section F.2 regarding baseline savings control factors.

### Section 3.1.6 – LED Channel Signage[[65]](#footnote-66)

The Commission proposes limiting the application of this measure to red LED systems. The referenced research suggests that savings are minimal for other LED lighting colors. The Commission also proposes changing the savings algorithm for this measure protocol to include sign length. As a result, the inputs for the kW of baseline (pre‑retrofit) lighting (kWbase) and kW of post-retrofit or energy-efficient lighting system (kWee) are expressed on a per linear foot of signage basis. This update is the result of using updated sources for the baseline and efficient case power consumption. Previously, the baseline and efficient lighting power consumption were expressed on a per letter basis and differentiated by two sign height categories.

### Section 3.1.7 – LED Refrigeration Display Case Lighting[[66]](#footnote-67)

The Commission proposes increasing the annual operating hours (HOURS) from 6,205 to 6,471 hours. The revised value is consistent with the assumed HOU for general service lighting in grocery settings presented in the Lighting Improvements measure protocol. The Commission also proposes increasing the coincidence factor from 0.92 to 0.99. The revised value is consistent with the coincidence factor from the Pennsylvania Statewide Act 129 2014 Commercial & Residential Lighting Metering Study for grocery stores.

### Section 3.2.1 – HVAC Systems[[67]](#footnote-68)

The Commission proposes updating the baseline equipment efficiencies (IEERbase, EERbase, SEERbase, COPbase, HSPFbase) to be consistent with current federal standards requirements or the 2015 IECC, whichever is more stringent. Federal standards and 2015 IECC do not establish post‑January 2, 2023 minimum EER requirements for air-source air conditioners and heat pumps. The Commission proposes establishing minimum EER requirements using the average EER of units meeting minimum IEER requirements, by type and size category, from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory of Certified Product Performance.

### Section 3.2.2 – Electric Chillers[[68]](#footnote-69)

The Commission proposes updating the baseline equipment efficiencies (kW/tonbase, EERbase, IPLVbase) to be consistent with 2015 International Energy Conservation Code requirements.

### Section 3.2.3 – Water Source and Geothermal Heat Pumps[[69]](#footnote-70)

The Commission proposes updating the baseline equipment efficiencies (SEERbase, IEERbase, EERbase, HSPFbase, COPbase) to be consistent with 2015 International Energy Conservation Code requirements.

### Section 3.2.4 – Ductless Mini-split Heat Pumps – Commercial < 5.4 Tons[[70]](#footnote-71)

The Commission proposes updating the baseline efficiencies (HSPFb, SEERb) for ductless mini-split heat pumps (DHP) for consistency with the available ductless mini-split heat pumps with the lowest efficiency listed in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory of Certified Product Performance. The Commission proposes updating the baseline efficiencies for air-source heat pumps (ASHP), packaged terminal heat pumps (PTHP), packaged terminal air conditioners (PTAC), and central air conditioners for consistency with 2015 IECC or federal standards, whichever is more stringent.

### Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas / Propane / Oil Heat[[71]](#footnote-72)

See discussion in Section F.6 regarding baseline efficiency changes.

### Section 3.2.6 – Small C&I HVAC Refrigerant Charge Correction[[72]](#footnote-73)

Previously, the algorithm for peak kW reduction (ΔkWpeak) for heat pumps omitted the RCF factor from the equation. The Commission proposes correcting the algorithm to include this factor. The Commission also proposes to change the baseline efficiency as discussed in Section F.6. above.

### Section 3.2.7 – ENERGY STAR Room Air Conditioner[[73]](#footnote-74)

The Commission proposes reducing the measure life from 12 years to nine years based on the most current EUL in the California Database for Energy Efficient Resources. The Commission also proposes using CEER as the exclusive efficiency metric in both energy and peak demand savings algorithms. Previously, EER could be used if CEER was not available. In addition, the Commission proposes introducing the EFLHRAC-CAC factor in the energy savings algorithm to account for the fact that room air conditioners are used far less frequently than the central systems the cooling equivalent full load hours were developed to represent. Furthermore, the federal standard CEER for units with louvered sides with capacity was changed from 25,000 to 27,999 Btu/h is stated in the 2016 TRM as 9.0; however, the correct value is 9.4. The Commission proposes correcting this to the actual value from the federal standard, 9.4.

### Section 3.2.9 – Controls: Economizer[[74]](#footnote-75)

See discussion in Section F.6 regarding baseline efficiency changes. The Commission proposes adding a second set of algorithms specifically for the retrofit measure vintage. The algorithm will remain unchanged for the replace-on-burnout and new construction measures. One of the inputs to the proposed algorithm for retrofit measures will be drawn from the Act 129 2018 Pennsylvania Non-Residential Baseline Study.

### Section 3.3.1 – Premium Efficiency Motors[[75]](#footnote-76)

 The Commission proposes to update the default load factor value of 0.75 for all HVAC motors to 0.76 for motors driving HVAC fans and 0.78 for motors driving HVAC pumps. These values were derived through a metering study that incorporated an array of different in-service HVAC motors. Increasing the load factor default values will increase the level of savings associated with these measures by the ratio of the proposed load factors to the original default load factor of 0.75. Under the Commission’s proposal, measure savings would increase by 1% for HVAC pumps and 4% for HVAC fans.

### Section 3.3.2 – Variable Frequency Drive (VFD) Improvements[[76]](#footnote-77)

#### Eligibility Criteria

Energy codes increasingly require variable frequency drive control for HVAC fans and pumps. The 2015 IECC, effective in Pennsylvania for work construction permits issued on October 1, 2018 or later, specifies motor control requirements that can only be satisfied by VFDs for several equipment types including fans serving multiple zones and hydronic system pumps with a combined motor capacity of 10hp or larger. The Commission proposes to update the eligibility criteria for this measure to specifically state that VFD equipment installed according to code requirement is not eligible for incentives.

#### Algorithm Revision

The Commission proposes a revision to the algorithm for energy and demand savings. The proposed algorithm no longer references Energy and Demand Savings Factors (ESF and DSF). Instead, the algorithm allows EDCs to input equipment load profiles and select the appropriate baseline control capability. The Commission believes that this added flexibility will support the generation of more accurate savings values. For projects with unknown equipment load profiles, the Commission proposes the inclusion of default HVAC fan and HVAC pump load profiles. The Commission also proposes to update the default load factor value of 0.75 for all HVAC motors to 0.76 for motors driving HVAC fans and 0.78 for motors driving HVAC pumps. These values were derived through a metering study that incorporated an array of different in-service HVAC motors. Increasing the load factor default values will increase the level of savings associated with these measures by the ratio of the proposed load factors to the original default load factor of 0.75.

#### Evaluation Protocols

The proposed algorithm revisions for this measure are accompanied by similarly proposed revisions to the Appendix D calculator. The Commission proposes to add text describing the usage of Appendix D to estimate savings for VFD projects including methods for determining baseline conditions and definition of custom load profiles.

### Section 3.3.3 – ECM Circulating Fan[[77]](#footnote-78)

#### Algorithm Revision – Interactive Factor

The Commission proposes to adjust the usage of interactive factors in the algorithm for ECM Circulating Fans in two ways. The Commission proposes to discontinue the usage of any interactive factor for heating season savings. Because this measure results in less waste heat generation by a more efficient fan motor, no interactive heating benefits are achieved. The Commission also proposes the addition of text specifying that interactive benefits during the cooling season can only be claimed for fans motors in the stream of conditioned air. The Commission also proposes to change the default interactive factor from an algorithm to a specified value of 26%. This shift will make the overall measure algorithm more user-friendly.

#### Algorithm Revision – Default Motor Watts

The Commission proposes to change the method for determining both baseline and energy-efficient motor wattages if unknown. The 2016 TRM specifies default motor wattages for three different motor sizes (1/2 hp, ¾ hp, 1 hp) in Table 3-67. In order to expand the TRM to more readily apply to other fractional-size motors, the Commission proposes to provide an algorithm for calculating unknown motor wattages using rated motor horsepower and default efficiency levels based on motor type (SP, PSC, or ECM).

### Section 3.3.4 – VSD on Kitchen Exhaust Fan[[78]](#footnote-79)

The Commission proposes to revise the energy savings and peak demand savings per total exhaust fan horsepower for this measure. The 2016 TRM incorporates values taken directly from a Pacific Gas & Electric (PG&E) work paper, which has since been updated and now incorporates reduced per unit savings values. The Commission proposes similarly update the TRM, reducing energy savings to 4,423 kWh per exhaust fan horsepower, a 1% reduction. The Commission also proposes to reduce the coincident peak demand savings to 0.55 kW per exhaust fan horsepower, a 27% reduction.

### Section 3.4.1 – Heat Pump Water Heaters[[79]](#footnote-80)

#### Load Shapes

The Commission proposes to update the load shapes for the entire Water Heating section. Proposed load shapes are created from building-type specific daily load schedules provided by the U.S. Department of Energy’s *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment*.[[80]](#footnote-81) From these load shapes, new Energy to Demand Factors are created based on the Act 129 peak demand definition.

#### Unknown Installation Location

The Commission proposes to provide an option for savings calculations when water heater installation location is unknown. We propose to provide default savings values for the unknown installation and allow the EDCs to calculate the building-type and install-location specific values when relevant.

#### Coefficient of Performance Adjustment Factors

The Commission proposes updating the COP Adjustment Factors based on a more current estimate of the ground temperature in Pennsylvania which indicates new wet bulb temperatures for the installation locations of interest. Unknown installation location is a new option proposed in this version.

#### Uniform Efficiency Factors

The Commission proposes to update the Uniform Efficiency Factors to meet current U.S. Federal Standards for Residential Water Heaters. New formulas are provided by tank size for both baseline and proposed units.

#### Algorithm Changes

The Commission proposes to adjust the calculation of gallons of water used per year. The proposed calculation is a simplified function of building type and square footage served by the water heating unit based on typical gallons of water used per unit by building type. The proposed list of building sites is consistent across all measures within the TRM. The Commission also proposes to remove the Resistive Discount Factor from the peak savings algorithm.

### Section 3.4.2 – Low-flow Pre-rinse Sprayers for Retrofit Programs[[81]](#footnote-82)

#### Merge of Low-flow Pre-rinse Sprayer Measures

The Commission proposes to combine Sections 3.4.2 and 3.4.3. These measures relate to the same product improvement but have minor differences relating to product application. To account for this merge, the proposed algorithms are simplified and generalized to allow for application specific inputs. The Commission proposes to provide an option for savings calculations when installation location is unknown.

#### Measure Life

The Commission proposes to update the Pre-rinse Sprayer measure life to reflect a more recent estimate as reported in DNV-GL’s *Impact Evaluation of Massachusetts Prescriptive Gas Pre-rinse Spray Valve Measure* from 2014.[[82]](#footnote-83) This impact study guides our recommendation of an eight-year measure life.

#### Load Shapes

The Commission proposes to update the load shapes for the entire Water Heating section. Proposed load shapes are created from building-type specific daily load schedules provided by the U.S. Department of Energy’s *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment*.[[83]](#footnote-84) From these load shapes, new Energy to Demand Factors are created based on Pennsylvania’s summer peak. The Commission proposes an adjustment of the applications of pre-rinse sprayers to include quick-service and full-service restaurants, retail locations such as grocery stores, and a default option for unknown application.

#### Uniform Energy Factor

The Commission proposes a standard Uniform Energy Factor for existing water heaters based on results from the Act 129 2018 Pennsylvania Non-Residential Baseline Study. The study suggests a UEF of 0.90 for existing C&I Water Heating units.

#### Flow Rate and Usage Duration

The existing TRM provides flow rate and usage by application in a disparate format. The Commission proposes a structured table that includes each of these values by program and application for the baseline and energy-efficient units. Proposed values for these inputs are standardized for a cleaner comparison between the Retrofit and Time of Sale programs.

### Section 3.4.4 – Fuel Switching: Electric Resistance Water Heaters to Gas / Oil / Propane[[84]](#footnote-85)

#### Load Shapes

The Commission proposes to update the load shapes for the entire Water Heating section. Proposed load shapes are created from building-type specific daily load schedules provided by the U.S. Department of Energy’s *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment*.[[85]](#footnote-86) From these load shapes, new Energy to Demand Factors are created based on Pennsylvania’s summer peak. The Commission also proposes to remove the Resistive Discount Factor from the peak savings algorithm.

#### Uniform Efficiency Factors

The Commission proposes to update the Uniform Efficiency Factors to meet current U.S. Federal Standards for Residential Water Heaters. For the new or proposed unit, UEF formulas are provided by tank size. For the baseline existing water heaters, the proposed UEF values originates from the Act 129 2018 Pennsylvania Non-Residential Baseline Study. The study suggests a UEF of 0.90 for existing C&I Water Heating units.

#### Algorithm Changes

The Commission proposes to adjust the calculation of gallons of water used per year. The proposed calculation is a simplified function of building type and square footage served by the water heating unit based on typical gallons of water used per unit by building type. The proposed list of building sites is consistent across all measures within the TRM. Additionally, we propose to simplify the Default Savings to only provide values for the unknown building type. All other building types can be evaluated by inputting the appropriate values into the provided algorithms.

### Section 3.5.1 – High-efficiency Refrigeration / Freezer Cases[[86]](#footnote-87)

The Commission proposes updating the ENERGY STAR Requirements and default efficient kWh values based on the ENERGY STAR Product Criteria for Commercial Refrigerators and Freezers version 4.0. The Commission also proposes updating the default baseline kWh values based on the Department of Energy’s (DOE) publishing of a final rule on March 28, 2014, adopting more stringent energy conservation standards for commercial refrigerator and freezers.

### Section 3.5.2 – High-efficiency Evaporator Fan Motors for Reach-in Refrigerated Cases[[87]](#footnote-88)

#### Merge of High-efficiency Evaporator Fan Motor Measures

The Commission proposes to combine Sections 3.5.2 and 3.5.3. These measures relate to the same product improvement (high-efficiency evaporator fan motors) but have minor differences relating to product application (reach-in and walk-in refrigerated cases). To account for this merge, the proposed algorithms are simplified and generalized to allow for application-specific inputs.

#### Algorithm Revision

The Commission proposes revising the annual energy savings and peak demand savings algorithms for this measure based on the Commercial Refrigeration Loadshape Project, a 2014 research effort from Northeast Energy Efficiency Partnership, Cadmus, and the Demand Management Institute.[[88]](#footnote-89) This research effort examined the annual energy and peak demand savings associated with the installation of evaporator fan motors for reach-in and walk-in refrigerated cases. The updated algorithms will allow for both electronically commutated motors or permanent magnet synchronous motors in the efficient case (rather than just electronically commutated motors). By virtue of revising the savings algorithms, the Commission proposes removing the default savings tables, as some values in the algorithms must be collected by EDCs.

### Section 3.5.3 – High-efficiency Evaporator Fan Motors For Walk-in Refrigerated Cases[[89]](#footnote-90)

The Commission proposes to combine Sections 3.5.2 and 3.5.3. These measures relate to the same product improvement (high-efficiency evaporator fan motors) but have minor differences relating to product application (reach-in and walk-in refrigerated cases). To account for this merge, the proposed algorithms are simplified and generalized to allow for application-specific inputs. Refer to Section F.22.b for a discussion on the algorithm revisions for this measure.

### Section 3.5.4 – Controls: Evaporator Fan Controllers[[90]](#footnote-91)

The Commission proposes updating the measure life of refrigeration evaporator fan controllers with the most current DEER EUL value of 15 years. The Commission also proposes revising the annual energy savings and peak demand savings algorithms for this measure based on the Commercial Refrigeration Loadshape Project, a 2014 research effort from NEEP, Cadmus, and the Demand Management Institute.[[91]](#footnote-92) This research effort examined the annual energy and peak demand savings associated with the installation of evaporator fan controllers for reach-in and walk-in refrigerated cases. The algorithms in the 2016 TRM cite the 2012 Massachusetts TRM, and the sources for many of the default values could not be found upon review in 2018. The default values in the proposed revision draw primarily from the NEEP research effort mentioned herein.

### Section 3.5.5 – Controls: Floating Head Pressure Controls[[92]](#footnote-93)

The Commission proposes updating the default values for the coefficient of performance (COP) for refrigerator / freezer condensing units and remote condensers based on an updated version of the Regional Technical Forum (RTF) measure upon which these defaults are currently sourced (Grocery Floating Head Pressure Controls for Single Compressor Systems).[[93]](#footnote-94) The most recent version of the RTF measure was updated in 2016; the 2016 TRM draws from a 2010 version of the RTF measure. For condensing units, the proposed COP values are slightly higher. For remote condensers, the proposed COP values are slightly lower. These proposed updates will flow through to the default savings tables included in this protocol.

### Section 3.5.6 – Controls: Anti-sweat Heater Controls[[94]](#footnote-95)

The Commission proposes revising the annual energy savings and peak demand savings algorithms for this measure based on the Commercial Refrigeration Loadshape Project, a 2014 research effort from NEEP, Cadmus, and the Demand Management Institute.[[95]](#footnote-96) This research effort examined the annual energy and peak demand savings associated with the installation of anti-sweat heater controls. The Commission proposes making this change for two reasons: (1) The NEEP study is more recent than the sources used in the 2016 TRM and (2) several of the default values in the 2016 TRM could not be verified in 2018. The default values in the proposed revision draw solely from the NEEP research effort mentioned herein.

### Section 3.5.8 – Variable Speed Refrigeration Compressor[[96]](#footnote-97)

#### Algorithm Revision

The Commission proposes revising the annual energy savings and peak demand savings algorithms for this measure such that the conversion factor to convert HP to ton does not include a coefficient of performance (COP). Under this proposed change, the COP will be removed from the conversion and inserted into the algorithms directly. This change is proposed for two reasons: (1) Greater transparency into what values affect the savings estimates and (2) this allows for EDCs to use equipment-specific COPs rather than the default.

#### Default Values

The Commission proposes changing the default COP value based on 2009 commercial refrigeration research by the U.S. Department of Energy (DOE)[[97]](#footnote-98) and also based on the Act 129 2018 Pennsylvania Non-Residential Baseline Study. The COP value used in the 2016 TRM is based on a 1996 DOE publication. Additionally, the Commission proposed providing EDCs with a “Data Gathering” option for COP since the default is a blend of reach-in coolers and reach-in freezers.

### Section 3.5.9 – Strip Curtains for Walk-in Freezers and Coolers[[98]](#footnote-99)

The Commission proposes changing the baseline condition to a walk-in cooler or freezer with no strip curtains rather than a walk-in cooler or freezer with no strip curtains or old strip curtains. Several of the default values used in the 2016 TRM could not be verified either because the source could not be found, or the value could not be found within the source. For this reason, the Commission proposes aligning this protocol with a strip curtains measure maintained by the RTF and updated as recently as 2016.[[99]](#footnote-100) The strip curtains measure maintained by the RTF uses a baseline condition of no strip curtains.

In making this change, the Commission proposes adopting defaults (and default savings per square foot of doorway area) based on the RTF measure.

### Section 3.5.11 – Auto Closers[[100]](#footnote-101)

The Commission proposes updating the default savings values associated with the measure. The default savings values in the 2016 TRM are drawn from auto closer research done in California. The California research provides annual energy savings estimates for each of California’s 16 climate zones. The default savings values in the 2016 TRM are based on savings estimates for California’s climate zone four, which differs substantially from the Pennsylvania climate. (The reference city for climate zone four is San Jose.) Rather than use California climate zone four as a proxy for Pennsylvania’s climate, the Commission proposes using the savings estimates for each climate zone, along with average annual CDD and HDD for each climate zone, to develop a regression model. This model, which predicts energy savings based on annual CDD and HDD, can be used to estimate annual energy savings specific to Pennsylvania’s climate.

### Section 3.5.12 – Door Gaskets for Walk-in and Reach-in Coolers and Freezers[[101]](#footnote-102)

The default savings values in the 2016 TRM are drawn from door gasket research done in California in 2005. These values were based on savings observed in California climate zone four (San Jose area), which shows little resemblance with Pennsylvania in terms of climate. The Commission proposes aligning this protocol with a door gasket measure maintained by the RTF and updated in 2016. In aligning this protocol with the RTF measure, the Commission proposes adopting the annual energy and peak demand savings values developed therein. The savings values in the RTF measure are expressed per gasket door rather than per linear foot of gasket. As such, the savings algorithms would also be adjusted under this proposition.

### Section 3.5.13 – Special Doors with Low or No Anti-sweat Heat for Low Temp Cases[[102]](#footnote-103)

#### Measure Life and Algorithm Revision

The Commission proposes updating the measure life of this measure with the most current DEER EUL value of 12 years. The Commission proposes revising the annual energy savings and peak demand savings algorithms for this measure. The algorithms in the 2016 TRM are adopted from a San Diego Gas & Electric (SDG&E) work paper that cannot be found. Additionally, several of the default values could not be verified. For this reason, the Commission proposes aligning this measure with a similar measure in the Wisconsin Focus on Energy 2018 TRM. The proposed algorithms also serve to simplify the calculations, as the total number of relevant algorithms reduces from five to two.

#### Eligibility

As noted in Section 15.b, the Commission proposes aligning this protocol with a similar measure in the Wisconsin Focus on Energy 2018 TRM rather than a dated SDG&E work paper that cannot be found. Under this proposition, the eligibility requirements for the measure will change. The SDG&E work paper concerned low temperature cases, but the measure in the Wisconsin Focus on Energy 2018 TRM applies to both freezers and coolers. The proposed baseline condition would simply be standard energy doors.

### Section 3.5.14 – Suction Pipe Insulation for Walk-in Coolers and Freezers[[103]](#footnote-104)

The default savings values in the 2016 TRM are drawn from suction pipe insulation research done in California. These values were based on savings observed in California climate zone four (San Jose area), which shows little resemblance with Pennsylvania in terms of climate. Rather than use California climate zone four as a proxy for Pennsylvania’s climate, the Commission proposes using the savings estimates for each climate zone, along with average annual CDD and HDD for each climate zone, to develop a regression model. This model, which predicts energy savings based on annual CDD and HDD, can be used to estimate annual energy savings specific to Pennsylvania’s climate. This results in an increase in annual energy and peak demand savings.

### Section 3.5.15 – Refrigerated Display Cases with Doors Replacing Open Cases[[104]](#footnote-105)

#### Default Values

The Commission proposes updating the default values associated with this measure. The 2016 TRM references a CLEAResult work paper that is not publicly available. As such, the default values drawn from this source cannot be checked for accuracy. The Commission proposes aligning this measure with a 2010 paper submitted to the International Refrigeration and Air Conditioning Conference comparing the energy use of doored and open refrigeration display cases.[[105]](#footnote-106) This proposition would result in slightly lower annual energy savings and slightly higher peak demand savings.

#### Algorithm Revision

As noted in Section 33.a, the Commission proposes aligning this protocol with a research effort that compared energy use in doored display cases and open display cases. This research effort solely looked into energy consumption, not peak demand savings. In aligning this protocol with the referenced study, the Commission proposes adjusting the peak demand savings algorithm. The proposed algorithm assumes flat energy savings throughout the 8,760 hours of the year.

### Section 3.5.16 – Adding Doors to Existing Refrigerated Display Cases[[106]](#footnote-107)

#### Default Values

The Commission proposes updating the default values associated with this measure. The 2016 TRM references a CLEAResult work paper that is not publicly available. As such, the default values drawn from this source cannot be checked for accuracy. The Commission proposes aligning this measure with a 2010 paper submitted to the International Refrigeration and Air Conditioning Conference comparing the energy use of doored and open refrigeration display cases.[[107]](#footnote-108) This proposition would result in slightly higher annual energy and peak demand savings.

#### Algorithm Revision

As noted in Section 34.a, the Commission proposes aligning this protocol with a research effort that compared energy use in doored display cases and open display cases. This research effort solely looked into energy consumption, not peak demand savings. In aligning this protocol with the referenced study, the Commission proposes adjusting the peak demand savings algorithm. The proposed algorithm assumes flat energy savings throughout the 8,760 hours of the year.

### Section 3.6.1 – ENERGY STAR Clothes Washer[[108]](#footnote-109)

#### Testing Procedure

The U.S. DOE test procedures for clothes washers are codified at title 10 of the Code of Federal Regulations part 430, subpart B. The modified energy factor (MEF) for the previous standard was calculated using appendix J1; whereas the new federal standards use MEF J2. This new standard is calculated according to the test procedures of Appendix J2. Since the current federal standard, ENERGY STAR standard, and many of the default values now refer to the J2 testing procedure, the Commission proposes updating the algorithms in the TRM to use Appendix J2 MEFs. Adopting the new test procedure changes the federal efficiency standard for both top and front-loading washers. In conjunction with adopting the new testing procedures as described above, the Commission proposes updating the ENERGY STAR Requirements and integrated modified energy factor (MEFJ2) values with the ENERGY STAR Product Criteria for Commercial Clothes Washers Version 8 for both top loading and front-loading washers.

#### Default Values

The Commission proposes updating the default values for number of loads, maximum load weight, capacity, and dryer usage factor to reflect the new testing procedures. The Commission also proposes changing the measure life to reflect the values in the current federal standard. Finally, the Commission proposes updating default values for water heater fuel shares to reflect Pennsylvania-specific findings from the Act 129 2018 Pennsylvania Non-Residential Baseline Study.

### Section 3.7.1 – High-efficiency Ice Machines[[109]](#footnote-110)

#### Measure Life

The Commission proposes a change in the measure life for Ice Machines. The change in measure life from ten years to eight years is proposed to reflect the current measure life utilized by ENERGY STAR.

#### Baseline Efficiencies

The Commission proposes changes to the baseline efficiencies for the batch-type and continuous-type ice machines. The changes reflect the most recent updates to baseline efficiencies made as part of the Federal Register Final Rule (Energy Conservation Program: Energy Conservation Standards for Automatic Commercial Ice Makers; Final Rule. Federal Register / Vol. 80, No. 18. January 28, 2015). The changes include the revision of and addition of categories for the ice harvest rates for both batch-type and continuous-type ice machines and associated revisions and additions the algorithms and values for the baseline energy use for these categories.

#### Minimum Efficiency Requirements

The Commission proposes changes to the minimum efficiency requirements for the batch-type and continuous-type ice machines. The changes reflect the most recent updates to ENERGY STAR Commercial Ice Maker Key Product Criteria Version 3.0. The changes include the revision of and addition of categories for the ice harvest rates for both batch-type and continuous-type ice machines and associated revisions and additions to the algorithms and values for the efficient-case energy use for these categories.

#### Duty Cycle

 The Commission proposes a change in the duty cycle of ice machines (expressed as a percentage of time machine produces ice). The proposed change from 40% to 57% reflects the value used in the 2019 version of the Illinois Statewide Technical Reference Manual v7.0.

#### Coincidence Factor

The Commission proposes a change in the coincidence factor for ice machines (expressed as a percentage of time machine produces ice). The proposed change from 0.77 to 0.97 reflects the value used in the 2019 version of the Illinois Statewide Technical Reference Manual v7.0.

### Section 3.7.2 – Controls: Beverage Machine Controls [[110]](#footnote-111)

#### Eligibility

The Commission proposes the addition of the following eligibility requirement to the Beverage Machine Controls measure: This measure should not be applied to ENERGY STAR qualified vending machines, as they already have built-in controls. This proposed change aligns with the Illinois Statewide Technical Reference Manual v7.0 and is an acceptable eligibility requirement based on the nature of the measure.

#### Energy Savings Algorithm

 The Commission proposes a revision to the algorithm used to calculate energy savings for the Beverage Machine Controls measure to account for more specific characteristics of the machine. The change incorporates the use of the wattage of the beverage machine, the annual hours of operation of the machine and the energy savings factor of the machine. Based on this change in the algorithm, the Commission proposes that the EDC gathers data for the components of the savings algorithm or uses default values provided. Default values are provided for two types of machines; refrigerated beverage vending machine and glass front refrigerated cooler. Default values for wattage and energy savings factors are all proposed based on the Illinois Statewide Technical Reference Manual v7.0.

#### Default Savings

The Commission proposes the addition of the default energy savings values for Beverage Machine Controls. The addition of the default values aligns with the updated energy savings algorithm noted above and the use of the default terms noted for the two types of machines wherein the controls have been installed. Default values for wattage and energy savings factors are all proposed based on the Illinois Statewide Technical Reference Manual v7.0.

### Section 3.7.3 – Controls: Snack Machine Controls [[111]](#footnote-112)

The Commission proposes the addition of the default energy savings value of 342.5 kWh for Snack Machine Controls. The addition of the default value aligns with the energy savings algorithm for the measure and the use of the default terms noted for a machine where the controls have been installed.

### Section 3.7.4 – ENERGY STAR Electric Steam Cooker [[112]](#footnote-113)

#### Coincidence Factor

The Commission proposes a change in the coincidence factor for the electric steam cooker measure. The proposed change from 0.84 to 0.90 reflects the value used in the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs v6, effective date January 1, 2019.[[113]](#footnote-114) The Commission believes the New York Standard for coincidence factor is a reasonable comparison for use in Pennsylvania.

#### Demand Default Savings

In response to the FirstEnergy comments of the 2016 TRM Tentative Order,[[114]](#footnote-115) the Commission proposes an update to the default values for peak demand saving for the electric steam cooker measure. The update is made based on the change in coincidence factor noted in the section above and the following changes to the default parameters utilized for energy savings. The proposed revisions result in a decrease in the default peak demand savings values.

#### Default Values for Efficient Model Parameters

In response to the FirstEnergy comments of the 2016 TRM Tentative Order,[[115]](#footnote-116) the Commission proposes a change to three default parameters for the electric steam cooker measure. The proposed changes are for the following default parameters; Power Idle (kW), Capacity (lb/hr), and Cooking Energy Efficiency (%). The proposed changes align with the most current version of ENERGY STAR’s Commercial Kitchen Equipment Calculator.

#### Default Energy Savings

In response to the FirstEnergy comments of the 2016 TRM Tentative Order,[[116]](#footnote-117) the Commission proposes an update to the default values for energy saving for the electric steam cooker measure. The update is made based on the changes in the efficient model parameters noted in the section above. The proposed revisions result in a decrease in the default energy savings values.

### Section 3.8.1 – Wall and Ceiling Insulation[[117]](#footnote-118)

The Commission proposes updating the default initial R values for ceilings and walls in new construction settings from IECC 2009 to IECC 2015. The Commission also proposes removing default initial R values for existing premises since these parameters are collected by the EDCs. Using actual R values rather than default R values will result in more accurate savings calculations.

### Section 3.9.1 – ENERGY STAR Office Equipment[[118]](#footnote-119)

#### ENERGY STAR Office Equipment-Computers Measure Update

In response to comments of the 2016 TRM Tentative Order,[[119]](#footnote-120) the Commission proposes to update the ENERGY STAR Office Equipment with the addition of measure permutations to include ENERGY STAR Desktop Computer and ENERGY STAR Laptop Computer. Consequently, the prior measure permutation of ENERGY STAR Computer will be removed. The update provides greater measure resolution that allows the user to apply technology-specific deemed savings and reflects equipment options listed in the October 2016 ENERGY STAR calculator.

#### Fax Machine Deemed Savings Value and Measure Life

In response to comments of the 2016 TRM Tentative Order,[[120]](#footnote-121) the Commission proposes to update the deemed energy and demand savings for the Fax Machine measure permutation. These updates reflect changes made in the most recently released ENERGY STAR calculator for Office Equipment. The Fax Machine deemed savings values are based on ENERGY STAR Imaging Equipment version 2.0. The Commission proposes to update the Fax Machine EUL assumption from four to six years. This updated measure life value is based on ENERGY STAR Imaging Equipment version 2.0.

#### Monitor Deemed Savings and Measure Life

In response to comments of the 2016 TRM Tentative Order,[[121]](#footnote-122) the Commission proposes to update the deemed energy and demand savings and the EUL for the Monitor measure permutation. Specifically, additional savings values will be included in the TRM to represent savings impacts for different monitor sizes. These updates reflect changes made in the most recently released ENERGY STAR calculator for Office Equipment. The Monitor deemed savings values are based on ENERGY STAR Displays version 6.0. The Commission proposes to update the Monitor EUL assumption from four to seven years. This updated EUL value is based on ENERGY STAR Displays version 6.0.

### Section 3.9.2 – Office Equipment – Network Power Management[[122]](#footnote-123)

The Commission proposes to update the deemed energy and demand savings and the EUL source for Network Power Management. The previous deemed savings were sourced from RTF workbook, which has since been retired by the RTF. The updated deemed savings are sourced from the ENERGY STAR Computer Power Management Savings Calculator.

### Section 3.9.3 – Advanced Power Strips[[123]](#footnote-124)

#### Measure Name Change and Algorithm Update

The Commission proposes updating the measure name to better reflect current market products. The Commission also proposes to update the algorithm for Advanced Power Strips to provide a simpler calculation approach requiring fewer parameter inputs relative to the prior algorithm. The new algorithm is based on recent research from Massachusetts[[124]](#footnote-125) and relies on total energy consumption and an energy reduction percentage factor to estimate energy savings.

#### Measure Permutation

The Commission proposes to add two measure permutations to the Advanced Power Strips measure – Tier 1 and Tier 2 strips. Savings for each permutation vary based on their respective energy reduction percentage factor. The update provides greater measure resolution that allows the user to apply technology-specific deemed savings.

### Section 3.10.1 – Compressed Air Cycling Refrigerated Thermal Mass Dryer[[125]](#footnote-126)

#### Measure Life and Hours of Operation

The Commission proposes updating the measure life of compressed air cycling refrigerated thermal mass dryer to 15 years based on a measure life study for Wisconsin Focus on Energy, 2009. The Commission also proposes to revise the hours of compressor operation of compressed air cycling refrigerated thermal mass dryers for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

#### Coincidence Factor

The Commission proposes to revise the coincidence factors of compressed air cycling refrigerated thermal mass dryers for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

#### Default Savings

The Commission proposes to provide default per horsepower energy and demand savings of compressed air cycling refrigerated thermal mass dryers based on proposed updates of the hours of compressor operations and coincidence factors to account for holidays and scheduled.

### Section 3.10.2 – Compressed Air-entraining Air Nozzle[[126]](#footnote-127)

#### Hours of Operation

The Commission proposes to revise the hours of compressor operation of compressed air entraining sir nozzle for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

#### Coincidence Factor

The Commission proposes to revise the coincidence factors of compressed air entraining sir nozzle for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

### Section 3.10.3 – Compressed Air-no-loss Condensate Drains[[127]](#footnote-128)

The Commission proposes to revise the hours of compressor operation of compressed air no loss condensate drains for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual. The Commission also proposes to revise the coincidence factors of compressed air no loss condensate drains for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

### Section 3.10.4 – Compressed Air-tanks for Loads / No Load Compressors[[128]](#footnote-129)

The Commission proposes to revise the hours of compressor operation of compressed air tanks for loads / no load compressors for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual. The Commission also proposes to revise the coincidence factors of compressed air tanks for loads / no load compressors for a multiple shift conditions at the facility. The commission proposes making this change to account for holidays and scheduled downtime as supported by more recent sources, including the Efficiency Vermont Technical Reference User Manual.

### Section 3.11.1 – ENERGY STAR Servers[[129]](#footnote-130)

The Commission proposes to update the ENERGY STAR Servers measure with additional background content to provide further understanding and explanation for how the measure performs and how savings may be achieved. The Commission also proposes to relocate the measure from the Miscellaneous C&I section (3.11.1) to the Consumer Electronics C&I section of the TRM (3.9.4) due to its relationship with ENERGY STAR computer-based measures in the Consumer Electronics section.

### Section 4.1.1 – Automatic Milker Takeoffs[[130]](#footnote-131)

The Commission proposes updating the default value for ESC (energy savings per cow) based on updated assumptions related to the average herd size in Pennsylvania and the average dairy vacuum pump operating hours. Additionally, based on a review of the source data, the Commission proposes updating the energy-to-demand factor used in calculating peak demand savings.

### Section 4.1.2 – Dairy Scroll Compressors[[131]](#footnote-132)

Based on a review of the source data, the Commission proposes updating the energy-to-demand factor used in calculating peak demand savings.

### Section 4.1.3 – High-efficiency Ventilation Fans with and without Thermostats[[132]](#footnote-133)

The Commission proposes condensing the three formulas that feed into annual energy savings into one formula. The 2016 TRM provides separate algorithms based on whether thermostats are installed with the ventilation fans. However, the presence of thermostats can be handled by adjusting one of the inputs in a single, combined algorithm. The Commission also proposes adding two cities to the tables containing default annual operating run hours. Additionally, the Commission proposed removing any ambiguity around Table 4-6. In the 2016 TRM, it was unclear if this table contained default annual operating run hours for facilities that installed thermostats along with the ventilation fan, or if this table contained the reduction in operating hours due to the installation of a thermostat along with the ventilation fan. The Commission proposes updating the table such that it represents the former, default hours when a thermostat is present.

### Section 4.1.4 – Heat Reclaimers[[133]](#footnote-134)

Based on a review of the source data, the Commission proposes updating the energy-to-demand factor used in calculating peak demand savings. The Commission also proposes updating the default electric tank water heater efficiency value based on findings from the Act 129 2018 Pennsylvania Non-Residential Baseline Study. The efficiency value in the 2016 TRM is based on the code minimum in IECC 2009.

### Measure Number Changes

The changes proposed herein will result in new measure numbers for several C&I measures. The table below shows the current measure number and the new measure number (assuming all of the Commission’s proposed changes are made) for all affected measures. The table also shows measures that the Commission proposes removing – these measures are discussed in more detail later.

| **Measure** | **Current Measure Number** | **New Measure Number** |
| --- | --- | --- |
| Traffic Lights | 3.1.4 | Deleted |
| LED Exit Signs | 3.1.5 | 3.1.4 |
| LED Channel Signage | 3.1.6 | 3.1.5 |
| LED Refrigeration Display Case Lighting | 3.1.7 | 3.1.6 |
| Fuel Switching: Electric Resistance Water Heaters to Gas / Oil / Propane | 3.4.4 | 3.4.3 |
| Fuel Switching: Heat Pump Water Heaters to Gas / Oil / Propane | 3.4.5 | Deleted |
| Controls: Evaporator Fan Controllers | 3.5.4 | 3.5.3 |
| Controls: Floating Head Pressure Controls | 3.5.5 | 3.5.4 |
| Controls: Anti-sweat Heater Controls | 3.5.6 | 3.5.5 |
| Controls: Evaporator Coil Defrost Control | 3.5.7 | 3.5.6 |
| Variable Speed Refrigeration Compressor | 3.5.8 | 3.5.7 |
| Strip Curtains for Walk-in Freezers and Coolers | 3.5.9 | 3.5.8 |
| Night Covers for Display Cases | 3.5.10 | 3.5.9 |
| Auto Closers | 3.5.11 | 3.5.10 |
| Door Gaskets for Walk-in and Reach-in Coolers and Freezers | 3.5.12 | 3.5.11 |
| Special Doors with Low or No Anti-sweat Heat for Low Temp Case | 3.5.13 | 3.5.12 |
| Suction Pipe Insulation for Walk-in Coolers and Freezers | 3.5.14 | 3.5.13 |
| Refrigerated Display Cases with Doors Replacing Open Cases | 3.5.15 | 3.5.14 |
| Adding Doors to Existing Refrigerated Display Cases | 3.5.16 | 3.5.15 |
| ENERGY STAR Refrigerated Beverage Machine | 3.7.5 | Deleted |
| ENERGY STAR Servers | 3.11.1 | 3.9.4 |
| Load Curtailment for Commercial and Industrial Programs | 5.1 | 3.12.1 |

## Removed Residential EE&C Protocols

Based on a review of the available research, the Commission proposes removing six residential EE&C measures and associated protocols. These measures are discussed below.

### 1. Section 2.2.8 – Programmable Thermostats[[134]](#footnote-135)

The Commission proposes removing this measure since it has been superseded by the new ENERGY STAR Connected Thermostats measure.

### 2. Section 2.2.9 – Residential Whole House Fans[[135]](#footnote-136)

The Commission proposes removing this measure from the TRM. No EDCs have claimed savings under this measure to date in Phase III. Whole house fans are a common source of air infiltration in the heating season, leading to losses rather than savings. The potential cooling savings are more easily realized in cooling-dominated, low-humidity climates.

### 3. Section 2.3.4 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater[[136]](#footnote-137)

The Commission proposes removing this measure from the updated TRM. Heat pump water heaters are a new, efficient technology. It is unlikely that a customer with an existing heat pump water heater would look to replace what will be a relatively new water heater during the timeline of Phase IV. Heat pump water heaters are the most efficient water heating technology currently available, so while it is technically true that replacing one with a fossil fuel water heater would reduce electricity use, this would also reduce the overall energy efficiency of a home.

### 4. Section 2.4.9 – ENERGY STAR Water Coolers[[137]](#footnote-138)

The Commission proposes removing this measure. No EDCs have claimed savings under this measure to date in Phase III and they are relatively uncommon appliances in residential settings.

### 5. Section 2.5.1 – ENERGY STAR Televisions[[138]](#footnote-139)

The Commission proposes removing this measure. The practice in earlier phases of Act 129 has been to update this measure as ENERGY STAR specifications change, using the values of the previous version of the specification as the baseline for the updated version. The version 7.0 ENERGY STAR specifications for televisions do not offer substantial savings over version 6.0, so savings opportunities would be limited. The Commission believes that this is a market that has largely transformed to efficient technologies.

### 6. Section 2.7.1 – Pool Pump Load Shifting[[139]](#footnote-140)

 The Commission proposes removing this measure. Load shifting is a demand savings strategy and does not generate kWh savings.

## Removed C&I EE&C Measure Protocols

Based on a review of the available research, the Commission proposes removing three C&I EE&C measures and associated protocols. These measures are discussed below.

### 1. Section 3.1.4 – Traffic Lights[[140]](#footnote-141)

The efficient case for this measure is an LED traffic signal that complies with ENERGY STAR requirements. However, ENERGY STAR traffic light specifications have been discontinued since 2007 because EPACT 2005 essentially made the ENERGY STAR specification the baseline. Accordingly, any non-LED traffic lights that exist in 2021 will be at least 15 years old, exceeding their estimated useful life, and can only be replaced by the new LED traffic lights. For this reason, the Commission proposes eliminating this measure from the TRM.

### 2. Section 3.4.5 – Fuel Switching: Heat Pump Water Heaters to Gas / Oil / Propane[[141]](#footnote-142)

The Commission proposes removing this measure from the 2021 TRM. Heat pump water heaters are a new, efficient technology. It is unlikely that a customer with an existing heat pump water heater would look to replace what will be a relatively new water heater during the timeline of Phase IV. Heat pump water heaters are the most efficient water heating technology currently available, so while it is technically true that replacing one with a fossil fuel water heater would reduce electricity use, this would also reduce the overall energy efficiency of a business.

### 3. Section 3.7.5 – ENERGY STAR Refrigerated Beverage Machine[[142]](#footnote-143)

New federal codes for refrigerated beverage machines took effect on January 8, 2019.[[143]](#footnote-144) Under the new federal standards, ENERGY STAR specifications will result in zero energy and demand savings. For this reason, the Commission proposes eliminating this measure from the TRM.

## Section 6.3 – Appendix C: Lighting Audit and Design Tool

The Commission proposes several revisions to the 2016 TRM Appendix C in an attempt to increase customer usability while allowing for increased customization. These proposed changes include the following:

* Adjusting custom hours of use and coincidence factor module to accommodate dusk-to-dawn lighting;
* Adding an active link on Lighting Inventory tab to configure custom SVG values;
* Decrementing baseline incandescent lamp wattages for non-specialty lamps to be in compliance with EISA backstop;
* Correcting an error in which certain columns in the Lighting Inventory tab did not populate for new construction projects utilizing the Whole Building Method;
* Adding 36" and 96" linear LED options to the LED Fixture Builder;
* Expanding functionality to allow for multiple deemed space types (i.e., interior, exterior, refrigeration, and exit). This is facilitated by using either the Deemed or Mixed modes in General Information cell I26;
* Adjusting energy savings algorithm to ignore baseline SVG factor in the event that both the pre-retrofit and post-retrofit cases both employ either method of Daylighting controls. This proposed adjustment was made in order to correct the issue through which known photocell operating hours were further discounted by the Photocell SVG factor;
* Revising and expanding LED\_Codes named range to include LED Linear Fluorescent Tube Replacement Type in the Description and revising Code for same fixtures to append Type to the end of the Code (i.e., LTA, LTB, LTC);
* Adjusting LPD baseline values to be consistent with 2015 IECC;
* Revising hours of use and coincidence factors for consistency with the proposed updates to Section 3.1.1;
* Revising New Construction SVG Accountability % Req. assumptions for consistency with 2015 IECC 2015, as discussed in Section F.2.b; and
* Adding a Small Business Direct Install radio button input on the General Information worksheet. When Yes is selected, the T12 baseline adjustment will be disabled.

## Section 6.4 – Appendix D: Motors and VFD Audit and Design Tool

The Commission proposes several updates to the 2016 TRM Appendix D calculator to increase usability and to align with the proposed algorithm revisions for VFD improvement measures. The 2016 TRM Appendix D calculator houses general project information on both the Summary tab and the measure-specific Motor Form and VFD Form. The Commission proposes consolidating all general project information including Facility Type and Weather Location, fields that are critical for populating default coincidence factors and hours of operation according to the TRM, onto a new General Information tab. The proposed format of this new tab aligns this calculator with the Appendix C Lighting Calculator.

 The Commission also proposes to reformat the Motor Form tab, which houses the algorithms for Measure 3.3.1 Premium Efficiency Motors. The proposed formatting was designed to streamline the user experience and maintain consistency with TRM algorithms. In the 2016 TRM Appendix D calculator, baseline and post-retrofit motor information were entered in separate parts of the Motor Form worksheet. The proposed format provides a single worksheet row for each upgraded motor type. Formulas on this tab were modified to include the Commission’s proposed revision to default load factor values and to allow for the entry of custom hours of operation in accordance with the algorithm outlined in the TRM for this measure. Additionally, the Commission proposes to rename this form to 3.3.1 Premium Efficiency Motors to further clarify the relationship between the calculator and the TRM.

The Commission similarly proposes that the Appendix D VFD Form be renamed to 3.3.2 VFD Improvements and to further revise the calculator formulas for alignment with the proposed algorithms for Measure 3.3.2 Variable Frequency Drive (VFD) Improvements. To facilitate this alignment, the Commission proposes the addition of a new tab to the calculator, VFD Custom Load Profile, where users can review the Default HVAC Fan and HVAC Pump load profiles and define up to ten custom load profiles. Formulas on this tab were also modified to include the Commission’s proposed revisions to the default motor load factor value and to allow for the entry of custom hours of operation, in accordance with the algorithm outlined in the 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 2021 Technical Reference Manual update be issued for comment.

2. That a copy of this Tentative Order shall be served upon all electric distribution companies, 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 2016 Technical Reference Manual update.

3. That the Law Bureau shall deposit a notice of this Tentative Order and proposed 2021 version of the Technical Reference Manual with the Legislative Reference Bureau for publication in the *Pennsylvania Bulletin*.

4. That interested parties shall have 30 days from the date the notice of this Tentative Order is published in the *Pennsylvania Bulletin* to file written comments referencing Docket Number M-2019-3006867 with the Pennsylvania Public Utility Commission, Attn: Secretary Rosemary Chiavetta, Pennsylvania Public Utility Commission, Commonwealth Keystone Building, Second Floor, 400 North Street, Harrisburg, Pennsylvania 17120. Comments may also be filed electronically through the Commission’s e‑file System.

5. That interested parties shall have 50 days from the date the notice of this Tentative Order is published in the *Pennsylvania Bulletin* to file written reply comments referencing Docket Number M-2019-3006867 with the Pennsylvania Public Utility Commission, Attn: Secretary Rosemary Chiavetta, Pennsylvania Public Utility Commission, Commonwealth Keystone Building, Second Floor, 400 North Street, Harrisburg, Pennsylvania 17120. Comments may also be filed electronically through the Commission’s e‑file System.

6. That a Word formatted copy of all comments and reply comments shall be electronically mailed to Regi Sam at rsam@pa.gov and Kriss Brown at kribrown@pa.gov. Attachments may not exceed three megabytes.

7. That this Tentative Order, the proposed 2021 version of the Technical Reference Manual, 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 2021 version of the Technical Reference Manual is Regi Sam, Bureau of Technical Utility Services, 717-772-2151 or rsam@pa.gov. The contact person for legal and process issues related to this Tentative Order and the proposed 2021 version of the Technical Reference Manual is Kriss Brown, Law Bureau, 717-787-4518 or kribrown@pa.gov.

**BY THE COMMISSION**

Rosemary Chiavetta

Secretary

(SEAL)

ORDER ADOPTED: April 11, 2019

ORDER ENTERED: April 11, 2019

1. Order entered on October 3, 2005, at Docket No. M-00051865 (October 3, 2005 Order). [↑](#footnote-ref-2)
2. As of August 11, 2011, the Bureau of CEEP was eliminated and its functions and staff transferred to the newly created Bureau of Technical Utility Services (TUS). *See Implementation of Act 129 of 2008; Organization of Bureaus and Offices*, Final Procedural Order, entered August 11, 2011, at Docket No. M‑2008-2071852, at 4. [↑](#footnote-ref-3)
3. *See* October 3, 2005 Order at 13. [↑](#footnote-ref-4)
4. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M‑2008‑2069887, entered January 16, 2009 (Phase I Implementation Order), at 13. [↑](#footnote-ref-5)
5. *Id*. [↑](#footnote-ref-6)
6. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual* Update Order, at Docket No. M‑00051865, entered June 1, 2009 (2009 TRM). [↑](#footnote-ref-7)
7. *Id*. at 17 and 18. [↑](#footnote-ref-8)
8. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M‑2012‑2289411, entered August 3, 2012 (*Phase II Implementation Order*), at 71. [↑](#footnote-ref-9)
9. *Id*. at 75. [↑](#footnote-ref-10)
10. *See Energy Efficiency and Conservation Program* Implementation Order, at Docket No. M‑2014‑2424864, entered June 19, 2015 (Phase III Implementation Order), at 95. [↑](#footnote-ref-11)
11. *Id.* at 97 and 98. [↑](#footnote-ref-12)
12. The PEG is chaired by staff of the Commission’s Bureau of Technical Utility Services and is comprised of representatives from the EDCs and the SWE for the purpose of encouraging discussion of EDC program-specific issues and associated evaluation, measurement and verification. [↑](#footnote-ref-13)
13. National Solar Radiation Data Base. 1991 – 2005 Update: Typical Meteorological Year 3. Available at <https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html>. [↑](#footnote-ref-14)
14. <https://www.ecobee.com/donateyourdata/>. [↑](#footnote-ref-15)
15. *See* Section 2.1.1 – ENERGY STAR Lighting of the 2016 TRM, page 17. [↑](#footnote-ref-16)
16. Reflector and other specialty lamp types were found in 42% of sockets in the Act 129 2018 Pennsylvania Residential Baseline Study. [↑](#footnote-ref-17)
17. DOE Appliance and Equipment Standards Rulemakings and Notices, <https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4>. [↑](#footnote-ref-18)
18. *See* Section 2.1.2 – Residential Occupancy Sensors of the 2016 TRM, page 25. [↑](#footnote-ref-19)
19. Statewide Evaluation Team (GDS Associates, Inc, Nexant, Research into Action, Apex Analytics LLC), “2015 Energy Efficiency Potential Study for Pennsylvania,” February 27, 2015. <http://www.puc.pa.gov/pcdocs/1345079.pdf>. [↑](#footnote-ref-20)
20. *See* Section 2.1.3 – Electroluminescent Nightlight and Section 2.1.4 – LED Nightlight of the 2016 TRM, pages 27 and 29, respectively. [↑](#footnote-ref-21)
21. *See* Section 2.2.1 – Electric HVAC of the 2016 TRM, page 34. [↑](#footnote-ref-22)
22. *See* Section 2.2.10 – Packaged Terminal Systems of the 2016 TRM, page 83. [↑](#footnote-ref-23)
23. *See* Section 2.2.2 – Fuel Switching: Electric Heat to Gas / Propane / Oil Heat of the 2016 TRM, page 45. [↑](#footnote-ref-24)
24. *See* Section 2.2.3 – Ductless Mini-split Heat Pumps of the 2016 TRM, page 51. [↑](#footnote-ref-25)
25. *See* Section 2.2.4 – ENERGY STAR Room Air Conditioners of the 2016 TRM, page 57. [↑](#footnote-ref-26)
26. *See* Section 2.2.5 – Room AC (RAC) Retirement of the 2016 TRM, page 61. [↑](#footnote-ref-27)
27. *See* Section 2.2.6 – Duct Sealing of the 2016 TRM, page 67. [↑](#footnote-ref-28)
28. *See* Section 2.2.7 – Furnace Whistle of the 2016 TRM, page 73. [↑](#footnote-ref-29)
29. *See* Section 2.2.10 – Packaged Terminal Systems of the 2016 TRM, page 83. [↑](#footnote-ref-30)
30. *See* Section 2.3.1 – Heat Pump Water Heaters of the 2016 TRM, page 87. [↑](#footnote-ref-31)
31. *See* Section 2.3.2 – Solar Water Heaters of the 2016 TRM, page 93. [↑](#footnote-ref-32)
32. *See* Section 2.3.3 – Fuel Switching: Electric Resistance to Fossil Fuel Water Heater of the 2016 TRM, page 96. [↑](#footnote-ref-33)
33. *See* Section 2.3.5 – Water Heater Tank Wrap of the 2016 TRM, page 106. [↑](#footnote-ref-34)
34. *See* Section 2.3.6 – Water Heater Temperature Setback of the 2016 TRM, page 109. [↑](#footnote-ref-35)
35. *See* Section 2.3.7 – Water Heater Pipe Insulation of the 2016 TRM, page 112. [↑](#footnote-ref-36)
36. *See* Section 2.3.8 – Low-flow Faucet Aerators of the 2016 TRM, page 114. [↑](#footnote-ref-37)
37. *See* Section 2.3.9 – Low-flow Showerheads of the 2016 TRM, page 120. [↑](#footnote-ref-38)
38. *See* Section 2.3.10 – Thermostatic Shower Restriction Valve of the 2016 TRM, page 125. [↑](#footnote-ref-39)
39. Using the associated algorithm this would actually equate to 18 years, though Act 129 savings can only be claimed for 15. [↑](#footnote-ref-40)
40. *See* Section 2.4.1 – ENERGY STAR Refrigerators of the 2016 TRM, page 129. [↑](#footnote-ref-41)
41. *See* Section 2.4.2 – ENERGY STAR Freezers of the 2016 TRM, page 137. [↑](#footnote-ref-42)
42. *See* Section 2.4.3 – Refrigerator / Freezer Recycling with and without Replacement of the 2016 TRM, page 141. [↑](#footnote-ref-43)
43. *See* Section 2.4.4 – ENERGY STAR Clothes Washers of the 2016 TRM, page 147. [↑](#footnote-ref-44)
44. *See* Section 2.4.5 – ENERGY STAR Dryers of the 2016 TRM, page 152. [↑](#footnote-ref-45)
45. *See* Section 2.4.6 – Fuel Switching: Electric Clothes Dryer to Gas Clothes Dryer of the 2016 TRM, page 155. [↑](#footnote-ref-46)
46. *See* Section 2.4.7 – ENERGY STAR Dishwashers of the 2016 TRM, page 158. [↑](#footnote-ref-47)
47. *See* Section 2.4.8 – ENERGY STAR Dehumidifiers of the 2016 TRM, page 161. [↑](#footnote-ref-48)
48. *See* Section 2.4.10 – ENERGY STAR Ceiling Fans of the 2016 TRM, page 166. [↑](#footnote-ref-49)
49. *See* Section 2.5.2 – ENERGY STAR Office Equipment of the 2016 TRM, page 173. [↑](#footnote-ref-50)
50. *See* Section 2.5.3 – Smart Strip Plug Outlets of the 2016 TRM, page 176. [↑](#footnote-ref-51)
51. *See* Section 2.6.1 – Ceiling / Attic and Wall Insulation of the 2016 TRM, page 180. [↑](#footnote-ref-52)
52. *See* Section 2.6.8 – Rim Joist Insulation of the 2016 TRM, page 212, and the approved Floor Insulation IMP. [↑](#footnote-ref-53)
53. *See* Section 2.6.2 – ENERGY STAR Windows of the 2016 TRM, page 187. [↑](#footnote-ref-54)
54. *See* <https://beopt.nrel.gov/home>. [↑](#footnote-ref-55)
55. *See* Section 2.6.3 – Residential New Construction of the 2016 TRM, page 190. [↑](#footnote-ref-56)
56. *See* Section 2.6.5 – ENERGY STAR Manufactured Homes of the 2016 TRM, page 198. [↑](#footnote-ref-57)
57. *See* Section 2.6.6 – Residential Air Sealing of the 2016 TRM, page 204. [↑](#footnote-ref-58)
58. *See* <https://beopt.nrel.gov/home>. [↑](#footnote-ref-59)
59. *See* Section 2.6.7 – Crawl Space Wall Insulation of the 2016 TRM, page 207. [↑](#footnote-ref-60)
60. *See* Section 2.6.8 – Rim Joist Insulation of the 2016 TRM, page 212. [↑](#footnote-ref-61)
61. *See* Section 2.7.2 – Variable Speed Pool Pumps (with Load Shifting Option) of the 2016 TRM, page 220. [↑](#footnote-ref-62)
62. *See* Section 3.1.1 – Lighting Improvements of the 2016 TRM, page 225. [↑](#footnote-ref-63)
63. *See* Section 3.1.2 – New Construction Lighting of the 2016 TRM, page 235. [↑](#footnote-ref-64)
64. *See* Section 3.1.3 – Lighting Controls of the 2016 TRM, page 245. [↑](#footnote-ref-65)
65. *See* Section 3.1.6 – LED Channel Signage of the 2016 TRM, page 254. [↑](#footnote-ref-66)
66. *See* Section 3.1.7 – LED Refrigeration Display Case Lighting of the 2016 TRM, page 257. [↑](#footnote-ref-67)
67. *See* Section 3.2.1 – HVAC Systems of the 2016 TRM, page 260. [↑](#footnote-ref-68)
68. *See* Section 3.2.2 – Electric Chillers of the 2016 TRM, page 270. [↑](#footnote-ref-69)
69. *See* Section 3.2.3 – Water Source and Geothermal Heat Pumps of the 2016 TRM, page 275. [↑](#footnote-ref-70)
70. *See* Section 3.2.4 – Ductless Mini-split Heat Pumps – Commercial < 5.4 Tons of the 2016 TRM, page 284. [↑](#footnote-ref-71)
71. *See* Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas / Propane / Oil Heat of the 2016 TRM, page 289. [↑](#footnote-ref-72)
72. *See* Section 3.2.6 – Small C&I HVAC Refrigerant Charge Correction of the 2016 TRM, page 294. [↑](#footnote-ref-73)
73. *See* Section 3.2.7 – ENERGY STAR Room Air Conditioner of the 2016 TRM, page 300. [↑](#footnote-ref-74)
74. See Section 3.2.9 – Controls: Economizer of the 2016 TRM, page 308. [↑](#footnote-ref-75)
75. See Section 3.3.1 – Premium Efficiency Motors of the 2016 TRM, page 313. [↑](#footnote-ref-76)
76. *See* Section 3.3.2 – Variable Frequency Drive (VFD) Improvements of the 2016 TRM, page 325. [↑](#footnote-ref-77)
77. *See* Section 3.3.3 – ECM Circulating Fan of the 2016 TRM, page 328. [↑](#footnote-ref-78)
78. *See* Section 3.3.4 – VSD on Kitchen Exhaust Fan of the 2016 TRM, page 332. [↑](#footnote-ref-79)
79. *See* Section 3.4.1 – Heat Pump Water Heaters of the 2016 TRM, page 335. [↑](#footnote-ref-80)
80. Department of Energy. Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment. April 2016. Table 7B.2.3, page 230. <https://www.regulations.gov/document?D=EERE-2014-BT-STD-0042-0016>. [↑](#footnote-ref-81)
81. *See* Section 3.4.2 – Low-flow Pre-Rinse Sprayers for Retrofit Programs and Section 3.4.3 Low-flow Pre-Rinse Sprayers for Time of Sale / Retail Programs of the 2016 TRM, pages 344 and 349, respectively. [↑](#footnote-ref-82)
82. Impact Evaluation of Massachusetts Prescriptive Gas Pre-Rinse Spray Valve Measure, DNV-GL, 2014. Table 24. Page 6-12. <http://ma-eeac.org/wordpress/wp-content/uploads/Prescriptive-Gas-Pre-Rinse-Spray-Valve-Measure-Impact-Evaluation.pdf>. [↑](#footnote-ref-83)
83. Department of Energy. Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment. April 2016. Table 7B.2.3, page 230. <https://www.regulations.gov/document?D=EERE-2014-BT-STD-0042-0016>. [↑](#footnote-ref-84)
84. *See* Section 3.4.4 – Fuel Switching: Electric Resistance Water Heaters to Gas / Oil / Propane of the 2016 TRM, page 354. [↑](#footnote-ref-85)
85. Department of Energy. Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment. April 2016. Table 7B.2.3, page 230. <https://www.regulations.gov/document?D=EERE-2014-BT-STD-0042-0016>. [↑](#footnote-ref-86)
86. *See* Section 3.5.1 – High-efficiency Refrigeration / Freezer Cases of the 2016 TRM, page 369. [↑](#footnote-ref-87)
87. *See* Section 3.5.2 – High-efficiency Evaporator Fan Motors for Reach-in Refrigerated Cases of the 2016 TRM, page 373. [↑](#footnote-ref-88)
88. Commercial Refrigeration Loadshape Project, Northeast Energy Efficiency Partnerships, October 2015. Pages 71-72. <https://neep.org/commercial-refrigeration-loadshape-report-10-2015-0>. [↑](#footnote-ref-89)
89. *See* Section 3.5.3 – High-efficiency Evaporator Fan Motors For Walk-in Refrigerated Cases of the 2016 TRM, page 377. [↑](#footnote-ref-90)
90. *See* Section 3.5.4 – Controls: Evaporator Fan Controllers of the 2016 TRM, page 382. [↑](#footnote-ref-91)
91. Commercial Refrigeration Loadshape Project, Northeast Energy Efficiency Partnerships, October 2015. Pages 73-74. <https://neep.org/commercial-refrigeration-loadshape-report-10-2015-0>. [↑](#footnote-ref-92)
92. *See* Section 3.5.5 – Controls: Floating Head Pressure Controls of the 2016 TRM, page 385. [↑](#footnote-ref-93)
93. Database for UES Measures, Regional Technical Forum. Grocery Floating Head Pressure Controls for Single Compressor Systems, December 2016, V1.6. <https://rtf.nwcouncil.org/measure/floating-head-pressure-controls-single-compressor-systems>. [↑](#footnote-ref-94)
94. *See* Section 3.5.6 – Controls: Anti-sweat Heater Controls of the 2016 TRM, page 389. [↑](#footnote-ref-95)
95. Commercial Refrigeration Loadshape Project, Northeast Energy Efficiency Partnerships, October 2015. Pages 74-75. <https://neep.org/commercial-refrigeration-loadshape-report-10-2015-0>. [↑](#footnote-ref-96)
96. *See* Section 3.5.8 – Variable Speed Refrigeration Compressor of the 2016 TRM, page 396. [↑](#footnote-ref-97)
97. Navigant Consulting Inc., “*Energy Savings Potential and R&D Opportunities for Commercial Refrigeration*,” U.S. Department of Energy, September 2009. Table 4-4. <https://www1.eere.energy.gov/buildings/pdfs/commercial_refrigeration_equipment_research_opportunities.pdf>. [↑](#footnote-ref-98)
98. *See* Section 3.5.9 – Strip Curtains for Walk-in Freezers and Coolers of the 2016 TRM, page 398. [↑](#footnote-ref-99)
99. Database for UES Measures, Regional Technical Forum. Strip Curtains, version 1.7. December 2016. <https://rtf.nwcouncil.org/measure/strip-curtains> [↑](#footnote-ref-100)
100. *See* Section 3.5.11 – Auto Closers of the 2016 TRM, page 410. [↑](#footnote-ref-101)
101. *See* Section 3.5.12 – Door Gaskets for Walk-in and Reach-in Coolers and Freezers of the 2016 TRM, page 413. [↑](#footnote-ref-102)
102. *See* Section 3.5.13 – Special Doors with Low or No Anti-sweat Heat for Low Temp Case of the 2016 TRM, page 415. [↑](#footnote-ref-103)
103. *See* Section 3.5.14 – Suction Pipe Insulation for Walk-in Coolers and Freezers of the 2016 TRM, page 418. [↑](#footnote-ref-104)
104. *See* Section 3.5.15 – Refrigerated Display Cases with Doors Replacing Open Cases of the 2016 TRM, page 420. [↑](#footnote-ref-105)
105. Fricke, Brian and Becker, Bryan, “Energy Use of Doored and Open Vertical Refrigerated Display Cases” (2010). International Refrigeration and Air Conditioning Conference. Paper 1154. <http://docs.lib.purdue.edu/iracc/1154> [↑](#footnote-ref-106)
106. *See* Section 3.5.16 – Adding Doors to Existing Refrigerated Display Cases of the 2016 TRM, page 422. [↑](#footnote-ref-107)
107. Fricke, Brian and Becker, Bryan, “Energy Use of Doored and Open Vertical Refrigerated Display Cases” (2010). International Refrigeration and Air Conditioning Conference. Paper 1154. <http://docs.lib.purdue.edu/iracc/1154>. [↑](#footnote-ref-108)
108. *See* Section 3.6.1 – ENERGY STAR Clothes Washer of the 2016 TRM, page 424. [↑](#footnote-ref-109)
109. *See* Section 3.7.1 – High-efficiency Ice Machines of the 2016 TRM, page 432. [↑](#footnote-ref-110)
110. *See* Section 3.7.2 – Controls: Beverage Machine Controls of the 2016 TRM, page 437. [↑](#footnote-ref-111)
111. *See* Section 3.7.3 – Controls: Snack Machine Controls of the 2016 TRM, page 440. [↑](#footnote-ref-112)
112. *See* Section 3.7.4 – ENERGY STAR Electric Steam Cooker of the 2016 TRM, page 442. [↑](#footnote-ref-113)
113. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 6, April 2018. Page 190. [http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/TRM%20Version%206%20-%20January%202019.pdf](http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/%24FILE/TRM%20Version%206%20-%20January%202019.pdf). [↑](#footnote-ref-114)
114. *See* FirstEnergy Comments at page 7 found at: <http://www.puc.pa.gov/pcdocs/1359168.pdf>. [↑](#footnote-ref-115)
115. *See* FirstEnergy Comments at page 6 found at: <http://www.puc.pa.gov/pcdocs/1359168.pdf>. [↑](#footnote-ref-116)
116. *See* FirstEnergy Comments at page 6 found at: <http://www.puc.pa.gov/pcdocs/1359168.pdf>. [↑](#footnote-ref-117)
117. *See* Section 3.8.1 – Wall and Ceiling Insulation of the 2016 TRM, page 450. [↑](#footnote-ref-118)
118. *See* Section 3.9.1 – ENERGY STAR Office Equipment of the 2016 TRM, page 455. [↑](#footnote-ref-119)
119. 2016 TRM Update Final Order. Docket No. M-2015-2469311. §F, ¶12.b, p. 72 [↑](#footnote-ref-120)
120. 2016 TRM Update Final Order. Docket No. M-2015-2469311. §F, ¶12.b, p. 72 [↑](#footnote-ref-121)
121. 2016 TRM Update Final Order. Docket No. M-2015-2469311. §F, ¶12.b, p. 72 [↑](#footnote-ref-122)
122. *See* Section 3.9.2 – Office Equipment – Network Power Management Enabling of the 2016 TRM, page 460. [↑](#footnote-ref-123)
123. *See* Section 3.9.3 – Advanced Power Strips of the 2016 TRM, page 463. [↑](#footnote-ref-124)
124. “RLPNC 17-3: Advanced Power Strip Metering Study,” Massachusetts Programs Administrators and Other Plug-EEAC (Oct. 2018), <http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_173_APSMeteringReport_5OCT2018_Finalv2.pdf>. [↑](#footnote-ref-125)
125. *See* Section 3.10.1 – Compressed Air Cycling Refrigerated Thermal Mass Dryer of the 2016 TRM, page 465. [↑](#footnote-ref-126)
126. *See* Section 3.10.2 – Compressed Air-entraining Air Nozzle of the 2016 TRM, page 468. [↑](#footnote-ref-127)
127. *See* Section 3.10.3 – No-loss Condensate Drains of the 2016 TRM, page 472. [↑](#footnote-ref-128)
128. *See* Section 3.10.4 – Compressed Air-tanks for Loads / No Load Compressors of the 2016 TRM, page 477. [↑](#footnote-ref-129)
129. *See* Section 3.11.1 – ENERGY STAR Servers of the 2016 TRM, page 480. [↑](#footnote-ref-130)
130. *See* Section 4.1.1 – Automatic Milker Takeoffs of the 2016 TRM, page 485. [↑](#footnote-ref-131)
131. *See* Section 4.1.2 – Dairy Scroll Compressors of the 2016 TRM, page 488. [↑](#footnote-ref-132)
132. *See* Section 4.1.3 – High-efficiency Ventilation Fans with and without Thermostats of the 2016 TRM, page 491. [↑](#footnote-ref-133)
133. *See* Section 4.1.4 – Heat Reclaimers of the 2016 TRM, page 495. [↑](#footnote-ref-134)
134. *See* Section 2.2.8 – Programmable Thermostats of the 2016 TRM, page 78. [↑](#footnote-ref-135)
135. *See* Section 2.2.9 – Residential Whole House Fans of the 2016 TRM, page 81. [↑](#footnote-ref-136)
136. *See* Section 2.3.4 – Fuel Switching: Heat Pump Water Heater to Fossil Fuel Water Heater of the 2016 TRM, page 100. [↑](#footnote-ref-137)
137. *See* Section 2.4.9 – ENERGY STAR Water Coolers of the 2016 TRM, page 164. [↑](#footnote-ref-138)
138. *See* Section 2.5.1 – ENERGY STAR Televisions of the 2016 TRM, page 169. [↑](#footnote-ref-139)
139. *See* Section 2.7.1 – Pool Pump Load Shifting of the 2016 TRM, page 217. [↑](#footnote-ref-140)
140. *See* Section 3.1.4 – Traffic Lights of the 2016 TRM, page 248. [↑](#footnote-ref-141)
141. *See* Section 3.4.5 – Fuel Switching: Heat Pump Water Heaters to Gas / Oil / Propane of the 2016 TRM, page 360. [↑](#footnote-ref-142)
142. *See* Section 3.7.5 – ENERGY STAR Refrigerated Beverage Machine of the 2016 TRM, page 447. [↑](#footnote-ref-143)
143. Electronic Code of Federal Regulations. Energy conservation standards for refrigerated bottled or canned beverage vending machines. Available at <https://www.ecfr.gov/cgi-bin/text-idx?SID=e039793352d10c6ab6a2f36d45f5960b&mc=true&node=se10.3.431_1296&rgn=div8>. [↑](#footnote-ref-144)