



May 24, 2019

VIA ELECTRONIC FILING

Rosemary Chiavetta, Secretary
Pennsylvania Public Utilities Commission
Commonwealth Keystone Building
400 North Street, 2nd Floor North
P.O. Box 3265
Harrisburg, PA 17105-3265

Re: Implementation of the Alternative ENERGY Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2021 Update – Docket No. M-2019-3006867

Dear Secretary Chiavetta:

Pursuant to the Commission's April 11, 2019 Tentative Order in the above referenced proceeding, please see Performance Systems Development's comments enclosed for consideration.

Respectfully submitted,

A handwritten signature in blue ink that reads "Scott von Kleeck".

Scott von Kleeck, CEO
Performance Systems Development
40 W. Evergreen Avenue, Ste. 110
Philadelphia, PA 19119
(610) 908-5859
svonkleeck@psdconsulting.com

SvK/ad
Enclosures

cc: Regi Sam (via e-mail – rsam@pa.gov)
Kriss Brown (via e-mail – kribrown@pa.gov)

redlined version of the Proposed TRM is included here as Appendix A to demonstrate possible implementation of the suggested changes.

Comments on the Proposed 2021 TRM

Weather-Sensitive and Non-Weather-Sensitive Measures (2.7.1 Residential New Construction, 2.7.3 Low-Rise Multifamily New Construction, and 2.7.4 Manufactured Homes)

Per the Commission’s April 11 Tentative Order, the Commission “proposes allowing the option of estimating all savings [for measure 2.7.1 Residential New Construction and 2.7.4 Manufactured Homes] using energy modeling.”¹ PSD strongly supports this change and assumes its intent also applies to measure 2.7.3 Low-Rise Multifamily New Construction. As these measures are currently written, distinct algorithms for “weather-sensitive” and “non-weather-sensitive” measures persist from earlier versions of the TRM. Continuing this distinction in the Proposed TRM is unduly confusing, appears counter to the intent of the Tentative Order, and does not align with residential new construction or manufactured home industry standards for whole-building energy performance modeling. PSD recommends that the distinction between “weather-sensitive” and “non-weather-sensitive” measures be removed from the TRM for measures 2.7.1 Residential New Construction, 2.7.3 Low-Rise Multifamily New Construction, and 2.7.4 Manufactured Homes.

Additionally, as the Proposed TRM is currently written, peak demand savings for the above-mentioned sections of the TRM are only derived from “weather-sensitive” measures. PSD suggests calculating demand savings from all measures that impact peak demand.

¹ Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources — Technical Reference Manual 2021 Update, Docket No. M-2019-3006867 (Order Entered Apr. 11, 2019) (“TRM Tentative Order”)

2.7.1 Residential New Construction

PSD recommends updating the baseline value for Frame Wall U-Factor, IECC Climate Zone 6A from 0.060 to 0.045, per 2015 IECC standards.² This update should be made to Table 2-135: Baseline Insulation and Fenestration Requirements by Component (Equivalent U-Factors).

PSD recommends updating the Residential New Construction baseline to reflect an increase in infiltration requirements from 3.0 ACH50 to 5.0 ACH50, per Pennsylvania-specific amendments to the recently adopted 2015 International Energy Conservation Code (IECC).³ This update should be made to data point “Air Infiltration Rate” in Table 2-136: ENERGY STAR Homes – User Defined Reference Home.

2.7.3 Low-Rise Multifamily New Construction

The Low-Rise Multifamily New Construction Measure does not include provisions for calculating or reporting savings from residentially-metered units in buildings greater than three stories. Many residential buildings above three stories are designed with individual residential meters and should be serviced by residential EE&C programs. While commercial building codes typically apply to buildings over three stories, an appropriate savings baseline can be accommodated in software reference homes and reference buildings to reflect the applicable building code. Additionally, industry standard whole-home and whole-building modeling tools, and associated standards, are not limited to buildings of a certain number of floors above grade. Building height limitations are also not in alignment with the EPA’s ENERGY STAR program,⁴ the most common certification for energy efficient residential new construction, referenced elsewhere in this measure and in the Residential New Construction measure. PSD is additionally

² https://codes.iccsafe.org/content/IECC2015?site_type=public

³ <https://www.dli.pa.gov/ucc/Documents/Official-Record-of-2015-Code-Review-Amended%2007232018.pdf>

⁴ https://www.energystar.gov/newhomes/homes_prog_reqs/multifamily_national_page

concerned that this restriction will limit participation of affordable housing developments, many of which are four stories or greater. PSD recommends removing height restrictions in the Low-Rise Multifamily New Construction Measure.

While the Low-Rise Multifamily New Construction Measure refers to a whole-building modeling approach, the specified modeling software is not capable of performing savings calculations on whole building residential spaces in multifamily buildings. Limiting software solutions to only those that model savings of individual townhouses and multifamily units, as opposed to whole-buildings, seems to be in contradiction to the measure’s intent and places an undue burden on participants developing multifamily projects, as modeling a whole building is often significantly more cost effective than modeling many individual units. PSD recommends that the TRM include reference to software capable of modeling whole-building savings, in addition to RESNET Accredited and Passive House modeling tools, such as approaches used in the IECC Total Building Performance pathway⁵ and ASHRAE 90.1 Appendix G.⁶

To reduce confusion and provide additional flexibility for program participants, the Commission should consider combining sections 2.7.1 and 2.7.3 into one Residential New Construction Measure offering both “per-unit” (RESNET accredited) and “whole-building” (ASHRAE compliant) modeling strategies. This format will be best aligned with industry practice and match ENERGY STAR guidelines for both single family and multifamily Residential New Construction.⁷

⁵ International Energy Conservation Code (2015) Section C407.6


⁶ ASHRAE 90.1-2013 Energy Standard for Buildings Except Low-Rise Residential Buildings, Appendix G, G2 Simulation General Requirements (<https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards>)

⁷ https://www.energystar.gov/newhomes/homes_prog_reqs/multifamily_national_page

Conclusion

PSD is appreciative of the opportunity to provide comment on the Commission's Proposed 2021 TRM. PSD sees the above-mentioned changes as broadly beneficial to the implementation of EE&C programs for Residential New Construction, Multifamily New Construction and Manufactured Homes. These changes will bring benefits to EDC customers and support clear and flexible programming that meets industry practice. PSD views its recommendations as supportive of the intent of the Commission's Tentative Order and hopes its comments can assist in development of the Proposed 2021 TRM.

Respectfully submitted,



Dated: May 24, 2019.

Scott von Kleeck, CEO
Performance Systems Development
40 W. Evergreen Avenue, Ste. 110
Philadelphia, PA 19119
(610) 908-5859
svonkleeck@psdconsulting.com

**BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMISSION**

Implementation of the Alternative Energy :
Portfolio Standards Act of 2004: Standards :
For the Participation of Demand Side : Docket No. M-2019-3006867
Management Resources – Technical :
Reference Manual 2021 Update :

**COMMENTS OF
PERFORMANCE SYSTEMS DEVELOPMENT**

APPENDIX A

2.7 WHOLE HOME

2.7.1 RESIDENTIAL NEW CONSTRUCTION

Target Sector	Residential Establishments
Measure Unit	Multiple
Measure Life	Varies
Vintage	New Construction

ELIGIBILITY

This protocol documents the energy savings attributed to improvements to the construction of residential homes above the baseline home as calculated by the appropriate energy modeling software or as determined by deemed savings values.

ALGORITHMS

Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment, Duct Sealing, Hot Water, Lighting, and Appliances;

Energy and peak demand savings in Residential New Construction programs will be an output of an energy modeling package that compares the as-designed unit or building to a minimally code-compliant baseline unit or building. The baseline building thermal envelope and/or system characteristics shall be based on the current state adopted International Energy Conservation Code (IECC), including Pennsylvania amendments⁸, or a SWE-approved baseline reflecting industry standard construction practices.⁹

Modeled energy and peak demand savings may be calculated using either a per-home approach or whole-building approach (for townhouses or multifamily buildings) as described in Methods 1 and 2 below.

Method 1: Per-home calculations

Modeled energy and peak demand savings shall be produced by a RESNET accredited software program¹⁰ or by other models approved by the PA SWE, including but not limited to Passive House accreditation software packages.¹¹

Method 2: Whole-building calculations

Modeled energy and peak demand savings shall be produced by a software package having the capabilities required by the IECC Total Building Performance approach¹³ or ASHRAE 90.1-2013 Appendix G.¹⁴

The energy savings for residential new construction will be calculated from the software output using the following algorithm:

Energy savings of the qualified home or residential space (kWh)

⁸ <https://www.dli.pa.gov/ucc/Pages/UCC-Review-and-Advisory-Council.aspx>

⁹ International Code Council, Inc. (2015). 2015 International Energy Conservation Code. Retrieved from International Code Council: https://codes.iccsafe.org/content/IECC2015?site_type=public

¹⁰ See the RESNET National Registry of Accredited Rating Software Programs for a complete listing:

http://www.resnet.us/professional/programs/energy_rating_software

¹¹ <http://www.passivehouseacademy.com/index.php/shop-us>) and WUFI Passive (<http://www.phius.org/software-resources/wufi-passive-and-other-modeling-tools/wufi-passive-3-0>)

¹³ International Energy Conservation Code (2015) Section C407.6

¹⁴ ASHRAE 90.1-2013 Energy Standard for Buildings Except Low-Rise Residential Buildings, Appendix G, G2 Simulation General Requirements (<https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards>)

Deleted: and

Deleted: (Weather-Sensitive Measures)

Deleted: due to improvements in the above mentioned measures in Multifamily

Deleted: 2015

Formatted: Font: (Default) Arial, 10 pt, Bold

Deleted: . The latter include the

Deleted: (Passive House Planning Package

Deleted: and WUFI Passive¹²), though both tools require the user to separately model the code baseline reference design to calculate energy and demand savings.

Formatted: Font: (Default) Arial, 10 pt, Bold

Deleted: weather-sensitive measures

Field Code Changed

Formatted: Font: (Default) Arial

$$= (kWh_{base} - kWh_{ee})$$

The system peak electric demand savings for residential new construction will be calculated from the software output with the following algorithm:

Coincident system peak electric demand savings

$$= (\text{Peak demand of the baseline home or residential space} - \text{Peak demand of the qualifying home or residential space})$$

DEFINITION OF TERMS

A summary of the input values and their data sources follows:

Table Error! No text of specified style in document.-1: Terms, Values, and References for Residential New Construction

Term	Unit	Value	Sources
kWh_{base} , Annual energy consumption of the baseline home, or residential spaces of the baseline building, from software.	kWh	Software Calculated	1
kWh_{ee} , Annual energy consumption of the qualifying home, or residential spaces of the qualifying building, from software.	kWh	Software Calculated	2
PL_{base} , Estimated peak load of the baseline home, from software.	kBTU/hr	Software Calculated	3
PL_q , Estimated peak load for the qualifying home constructed, from software.	kBTU/hr	Software Calculated	5

The following table lists the building envelope characteristics of the baseline reference home based on 2015 IECC for the three climate zones in Pennsylvania.

Table Error! No text of specified style in document.-2: Baseline Insulation and Fenestration Requirements by Component (Equivalent U-Factors) for Reference Homes or Reference Buildings for projects required to comply with the residential provisions of the 2015 International Energy Conservation Code (chapters marked with [RE])^{Source 12}

IECC Climate Zone	Fenestration U-Factor	Skylight U-Factor	Ceiling U-Factor	Frame Wall U-Factor	Mass Wall U-Factor	Floor U-Factor	Basement Wall U-Factor	Slab R-Value & Depth	Crawl Space Wall U-Factor
4A	0.35	0.55	0.026	0.060	0.098	0.047	0.059	10, 2 ft	0.065
5A	0.32	0.55	0.026	0.060	0.082	0.033	0.050	10, 2 ft	0.055
6A	0.32	0.55	0.026	0.045	0.060	0.033	0.050	10, 4 ft	0.055

Climate Region D and York County are CZ4, Climate Region A and G are CZ6, everything else is CZ5.

Table Error! No text of specified style in document.-3: User Defined Reference Home or Reference Building for projects required to comply with the residential provisions of the 2015 International Energy Conservation Code (chapters marked with [RE])

Data Point	Value	Source
Air Infiltration Rate	5 ACH ₅₀ for the whole house	7

- Deleted: Heating
- Deleted: Heating
- Deleted: +
- Deleted: (Cooling kWh_{base} - Cooling kWh_{ee})
- Commented [MT1]: Add comment: We suggest including all end uses that impact building peak demand (not limited to cooling) in line with the whole-home/whole-building approach.
- Deleted: weather-sensitive measures
- Deleted: , which is based on compliance and certification of the energy efficient home to the EPA's ENERGY STAR for New Homes' program standard
- Deleted: Peak demand of the baseline home =
- Deleted: PL_{base} / EER_{base}
- Deleted: ¶
¶
Peak demand of the qualifying home =
- Deleted: PL_{ee} / EER_{ee}
- Deleted: ¶
- Deleted: Hot Water, Lighting, and Appliances (Non-Weather-Sensitive Measures):¶
Quantification of additional energy and peak demand savings due to the installation of high-efficiency electric water heaters, lighting and other appliances may be done using the chosen modeling software or using the TRM algorithms presented for these measures elsewhere in this volume of the Manual.¶
¶
When using the TRM algorithms, and where the TRM algorithms involve deemed savings, e.g. lighting, the savings in the baseline and qualifying homes should (...)
- Deleted: Heating
- Deleted: heating
- Deleted: Heating
- Deleted: heating
- Deleted: Cooling kWh_{base}, Annual cooling energy (...)
- Formatted Table
- Deleted: cooling
- Deleted: EER_{base}, Energy Efficiency Ratio of the (...)
- Formatted Table
- Deleted: cooling
- Formatted Table
- Deleted: 0.060
- Deleted: Energy Star Homes -
- Commented [MT2]: Refer to PA amendments: (...)
- Deleted: 3

Data Point	Value	Source
Duct Leakage	4 CFM ₂₅ (4 cubic feet per minute per 100 square feet of conditioned space when tested at 25 pascals)	7
Duct Insulation	Supply and return ducts in attics shall be insulated to a minimum of R-8 where ≥3" in diameter and a minimum of R-6 where <3" in diameter. All other ducts not located completely inside the building thermal envelope shall be insulated to a minimum of R-6 where ≥3" in diameter and a minimum of R-4.2 where <3" in diameter.	7
Duct Location	50% in conditioned space, 50% unconditioned space	Program Design
Mechanical Ventilation	A continuous whole-house ventilation system with efficiency of 2.8 CFM/Watt and airflow defined by Table M1507.3.3(1) of 2015 IRC	11
Appliances	Use Default	
Thermostat Setback	Maintain zone temperature down to 55 °F (13 °C) or up to 85 °F (29 °C)	7
Temperature Set Points	Heating: 70°F Cooling: 78°F	7
Heating Efficiency		
Furnace	80% AFUE	8
Gas Fired Steam Boiler	82% AFUE	8
Gas Fired Hot Water Boiler	84% AFUE	8
Oil Fired Steam Boiler	85% AFUE	8
Oil Fired Hot Water Boiler	86% AFUE	8
Combo Water Heater	76% AFUE (recovery efficiency)	8
Air Source or Geothermal Heat Pump	8.2 HSPF	7
PTAC / PTHP	Use value for air source heat pump	7
Cooling Efficiency		
Central Air Conditioning	13.0 SEER	7
Air Source Heat Pump	14.0 SEER	7
Geothermal Heat Pump	14 SEER (12.2 EER)	7
PTAC / PTHP	Use value for central AC	7
Window Air Conditioners	Use value for central AC	7
Domestic WH Efficiency		
Electric	≥20 gal and ≤55 gal: EF = 0.9307 - 0.0002×(V _s) >55 gal and ≤120 gal: EF = 2.1171 - 0.0011×(V _s)	9
Natural Gas	≥20 gal and ≤55 gal: EF = 0.6483 - (0.0017×V _s) >55 gal and ≤100 gal: EF = 0.7897 - (0.0004× V _s) V _s : Rated Storage Volume – the water storage capacity of a water heater (in gallons)	7
Additional Water Heater Tank Insulation	None	

Table Error! No text of specified style in document.-47: Baseline Insulation and Fenestration Requirements by Component (Equivalent U-Factors) for Reference Homes or Reference Buildings for projects required to comply with the commercial provisions of the 2015 International Energy Conservation Code (chapters marked with [CE])

Formatted: Normal, Justified, Space After: 6 pt, Keep with next, Don't allow hanging punctuation, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

Commented [MT3]: Insert U-factors from IECC Table C402.1.4.

Table Error! No text of specified style in document.-238: User Defined Reference Building for projects required to comply with the residential provisions of the 2015 International Energy Conservation Code (chapters marked with [RE])

Commented [MT4]: Insert the Standard Reference Design values from IECC Table C407.5.1. Also, refer to ASHRAE 90.1-2013 Appendix G as an alternative approach.

EVALUATION PROTOCOLS

For most projects, the appropriate evaluation protocol is to verify installation and proper selection of default values. For projects using customer specific data for open variables, the appropriate evaluation protocol is to verify installation and proper application of TRM protocol along with verification of open variables. The Pennsylvania Evaluation Framework provides specific guidelines and requirements for evaluation procedures.

SOURCES

- 1) Calculation of annual energy consumption of a baseline home from the home energy rating tool based on the reference home energy characteristics.
- 2) Calculation of annual energy consumption of an energy efficient home from the home energy rating tool based on the qualifying home energy characteristics
- 3) Calculation of peak load of baseline home from the home energy rating tool based on the reference home energy characteristics.
- 4) "Methodology for Calculating Cooling and Heating Energy Input-Ratio (EIR) from the Rated Seasonal Performance Efficiency (SEER OR HSPF)" (Kim, Baltazar, Haberl). April 2013 Accessed December 2018. <http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/152118/ESL-TR-13-04-01.pdf>
- 5) Calculation of peak load of energy efficient home from the home energy rating tool based on the qualifying home energy characteristics.
- 6) SEER of HVAC unit in energy efficient qualifying home.
- 7) 2015 International Energy Conservation Code §R401-R404. <https://codes.iccsafe.org/content/IECC2015/chapter-4-re-residential-energy-efficiency>
- 8) Electronic Code of Federal Regulations, 10 CFR Part 430, Subpart C, §430.32, "Energy Conservation Program for Consumer Products: Energy and Water Conservation Standards." https://www.ecfr.gov/cgi-bin/retrieveECFR?n=pt10.3.430#se10.3.430_132. Current as of November 13, 2018.
- 9) US Federal Standards for Residential Water Heaters. Effective April 16, 2015. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27
- 10) 2015 International Energy Conservation Code Table R402.1.4 Equivalent U-Factors presents the R-Value requirements of Table R402.1.2 in an equivalent U-Factor format. Users may choose to follow Table R402.1.2 instead. 2015 IECC supersedes this table in case of discrepancy. Additional requirements per §R402 of 2015 IECC must be followed even if not listed here. <https://codes.iccsafe.org/content/IECC2015/chapter-4-re-residential-energy-efficiency>

11) 2015 International Residential Code, Table M1507.3.3(1): Continuous Whole-House Mechanical Ventilation System Airflow Rate Requirements. <https://codes.iccsafe.org/content/IRC2015/chapter-15-exhaust-systems>

Deleted: <#>Low-Rise Multifamily New Construction¶
<#>Target Sector

2.7.4 ENERGY STAR MANUFACTURED HOMES

Target Sector	Manufactured homes
Measure Unit	Variable
Measure Life	15 Years ^{Source 14}
Vintage	New Construction

ELIGIBILITY

This measure applies to ENERGY STAR Manufactured Homes.

ALGORITHMS

Insulation Upgrades, Efficient Windows, Air Sealing, Efficient HVAC Equipment, Duct Sealing, Hot Water, Lighting, and Appliances;

Energy and peak demand savings in ENERGY STAR Manufactured Homes programs will be a direct output of an energy model package that compare the as-designed home to a minimally code-compliant baseline home. The baseline building and system characteristics shall be based on the current Manufactured Homes Construction and Safety Standards (HUD Code). For this measure a manufactured home “means a structure, transportable in one or more sections, which in the traveling mode, is eight body feet or more in width or forty body feet or more in length, or, when erected on site, is three hundred twenty or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein.”^{Source 14}

Modeled energy and peak demand savings shall be produced by a RESNET accredited software program²⁰ or by other models approved by the PA SWE.²¹

The energy savings for weather-sensitive measures will be calculated from the software output using the following algorithm:

$$\text{Energy savings of the qualified home (kWh/yr)}$$

$$\Delta \text{kWh} = (\text{kWh}_{\text{base}} - \text{kWh}_{\text{ee}})$$

The system peak electric demand savings for ENERGY STAR Manufactured Homes will be calculated from the software output with the following algorithm, which is based on compliance and certification of the energy efficient home to the EPA’s ENERGY STAR Manufactured Home’ program standard:

Coincident system peak electric demand savings (kW)

$$\Delta \text{kW}_{\text{peak}} = (\text{Peak demand of the baseline home} - \text{Peak demand of the qualifying home})$$

DEFINITION OF TERMS

²⁰ See the RESNET’s National Registry of Accredited Rating Software Programs for a complete list: http://www.resnet.us/professional/programs/energy_rating_software.

²¹ No other modeling software is currently approved.

Deleted: and

Deleted: (Weather-Sensitive Measures)

Deleted: due to improvements in the above measures

Deleted: accredited Home Energy Ratings (HERS) software that meets the applicable Mortgage Industry National Home Energy Rating System Standards. REM/Rate¹⁹ is cited here as an example of an accredited software which can be used to estimate savings for this program. REM/Rate has a module that compares the energy characteristics of the energy efficient home to the baseline/reference home and calculates savings. For ENERGY STAR Manufactured Homes, the baseline building thermal envelope and/or system characteristics shall be based on the current Manufactured Homes Construction and Safety Standards (HUD Code).

Commented [MT5]: Reference is not included.

Formatted: Font: (Default) Arial, 10 pt, Not Superscript/ Subscript

Deleted: Heating

Deleted: Heating

Deleted: weather-sensitive measures

Deleted: Peak demand of the baseline home =

Deleted: $\frac{PL_b}{EER_b}$

Deleted: ¶
¶
Peak demand of the qualifying home =

Deleted: $\frac{PL_q}{EER_q}$

Deleted: ¶

Deleted: Hot Water, Lighting, and Appliances (Non-Weather-Sensitive Measures):¶

Quantification of additional energy and peak demand savings due to the installation of high-efficiency electric water heaters, lighting and other appliances may be based either on direct output of accredited Home Energy Ratings (HERS) software that meets the applicable Mortgage Industry National Home Energy Rating System Standards or on the algorithms presented for these measures in Volume 2 (Residential Measures) of this Manual. Where the TRM algorithms involve deemed savings, e.g. lighting, the savings in the baseline and qualifying homes should be compared to determine the actual savings of the qualifying home above the baseline. ¶

¶
In instances where REM/Rate calculated parameters or model inputs do not match TRM algorithm inputs, additional data collection is necessary to use the TRM algorithms. One such example is lighting. REM/Rate requires an input of percent of lighting fixtures that are energy efficient whereas the TRM requires an exact ...

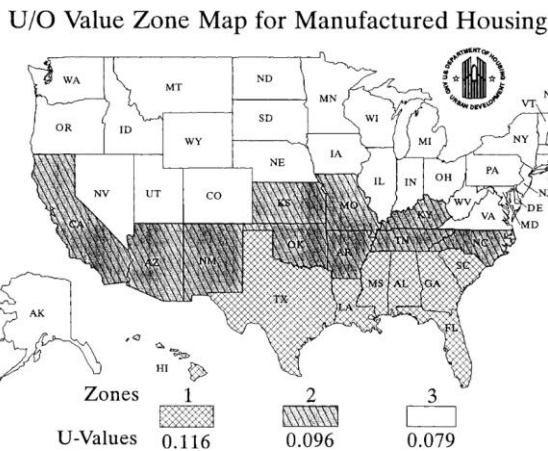
Table Error! No text of specified style in document.-5: ENERGY STAR Manufactured Homes– References

Term	Unit	Value	Sources
kWh_{base} , Annual energy consumption of the baseline home	kWh	Software Calculated	1
kWh_{res} , Annual energy consumption of the qualifying home	kWh	Software Calculated	1
PL_b , Estimated peak load of the baseline home	$kBTU/h$	Software Calculated	1
PL_q , Estimated peak load for the qualifying home constructed, in kBTU/hr, from software.	$kBTU/h$	Software Calculated	1

- Deleted: Heating
- Deleted: heating
- Deleted: Heating
- Deleted: heating
- Deleted: Cooling kWh_{base} , Annual cooling energy consumption of the baseline home
- Formatted Table
- Deleted: cooling
- Deleted: EER_b , Energy Efficiency Ratio of the baseline unit.
- Formatted Table
- Deleted: cooling

The HUD Code defines required insulation levels as an average envelope U_0 factor per zone. In Pennsylvania zone 3 requirements apply with a required U_0 -factor of 0.079. This value cannot be directly used to define a baseline envelope R-values because the U_0 -factor is dependent on both the size of the manufactured homes and insulating levels together. However, because manufactured homes are typically built to standard dimensions baseline U-factors can be estimated with reasonable accuracy.

Figure Error! No text of specified style in document.-1: Uo Baseline Requirements²²



The HUD Code required insulation levels can be expressed as a set of estimated envelope parameters to be used in REM/Rate’s user defined reference home function. Using typical manufactured home sizes these values are expressed below along with federal standard baseline parameters below in **Table Error! No text of specified style in document.-6.**

Table Error! No text of specified style in document.-6: ENERGY STAR Manufactured Homes - User Defined Reference Home

Data Point	Value ²³	Source
Walls	U-factor 0.090	6, 7
Ceilings	U-factor 0.045	6, 7

²² 24 CFR Part 3280-MANUFACTURED HOMES CONSTRUCTION AND SAFETY STANDARD (<http://www.gpo.gov/fdsys/pkg/CFR-2013-title24-vol5/pdf/CFR-2013-title24-vol5-part3280.pdf>)

²³ Single and multiple family as noted.

Data Point	Value ²³	Source
Floor	U-factor 0.045	6, 7
Windows	U-factor 0.59	6, 7
Doors	U-factor 0.33	6, 7
Air Infiltration Rate	10 ACH50	6
Duct Leakage	RESNET/HERS default	6
Duct Insulation	RESNET/HERS default	6
Duct Location	Supply 100% manufactured home belly, Return 100% conditioned space	8
Mechanical Ventilation	0.035 CFM/ft ² Exhaust	7
Lighting Systems	0% CFL 10% pin based (Default assumption)	9
Appliances	Use Default	6
Thermostat Setback	Non-Programmable thermostat	6
Temperature Set Points	Heating: 70°F Cooling: 78°F	10
Heating Efficiency		
Furnace	80% AFUE	3
Gas Fired Steam Boiler	82% AFUE	3
Gas Fired Hot Water Boiler	84% AFUE	3
Oil Fired Steam Boiler	85% AFUE	3
Oil Fired Hot Water Boiler	86% AFUE	3
Combo Water Heater	76% AFUE (recovery efficiency)	3
Electric Resistance	3.412 HSPF	7
Cooling Efficiency		
Central Air Conditioning	13.0 SEER	3
Air Source Heat Pump	14.0 SEER	3
Geothermal Heat Pump	14 SEER (12.2 EER)	3
PTAC / PTHP	Use value for central AC	3
Window Air Conditioners	Use value for central AC	3
Domestic WH Efficiency		
Electric	≥20 gal and ≤55 gal: EF = 0.9307 - 0.0002x(V _s) >55 gal and ≤120 gal: EF = 2.1171 - 0.0011x(V _s)	11
Natural Gas	≥20 gal and ≤55 gal: EF = 0.6483 - (0.0017xV _s) >55 gal and ≤100 gal: EF = 0.7897 - (0.0004x V _s) V _s : Rated Storage Volume – the water storage capacity of a water heater (in gallons)	12

Data Point	Value ²³	Source
Additional Water Heater Tank Insulation	None	13

EVALUATION PROTOCOLS

The most appropriate evaluation protocol for this measure is verification of installation coupled with EDC data gathering.

SOURCES

- 1) Calculation of annual energy and peak load consumption of a baseline home from the home energy rating tool based on the reference home energy characteristics.
- 2) "Methodology for Calculating Cooling and Heating Energy Input-Ratio (EIR) from the Rated Seasonal Performance Efficiency (SEER OR HSPF)" (Kim, Baltazar, Haberl). April 2013 Accessed December 2018. <http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/152118/ESL-TR-13-04-01.pdf>
- 3) Electronic Code of Federal Regulations, 10 CFR Part 430, Subpart C, §430.32, "Energy Conservation Program for Consumer Products: Energy and Water Conservation Standards." https://www.ecfr.gov/cgi-bin/retrieveECFR?&n=pt10.3.430#se10.3.430_132. Current as of November 13, 2018.
- 4) SEER of HVAC unit in energy efficient qualifying home.
- 5) Straub, Mary and Switzer, Sheldon. "Using Available Information for Efficient Evaluation of Demand Side Management Programs". Study by BG&E. The Electricity Journal. Aug/Sept, 2011. p. 95. <http://www.sciencedirect.com/science/article/pii/S1040619011001941>
- 6) ENERGY STAR QUALIFIED MANUFACTURED HOMES-Guide for Retailers with instructions for installers and HVAC contractors / June 2007 / (http://www.research-alliance.org/pages/es_retail.htm)
- 7) Electronic Code of Federal Regulations, 24 CFR Part 3280, Manufactured Home Construction and Safety Standards. <https://www.ecfr.gov/cgi-bin/retrieveECFR?&n=pt24.5.3280> Accessed November 16, 2018.
- 8) Standard manufactured home construction
- 9) Not a requirement of the HUD Code.
- 10) 2015 International Energy Conservation Code §R401-R404.
- 11) US Federal Standards for Residential Water Heaters. Effective April 16, 2015. For a 40-gallon tank this is 0.948. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27
- 12) US Federal Standards for Residential Water Heaters. Effective April 16, 2015. For a 40-gallon tank this is 0.615 http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27
- 13) No requirement in code or federal regulation.
- 14) NREL, Northwest Energy Efficient Manufactured Housing Program Specification Development, T.Huges, B. Peeks February 2013. <http://www.nrel.gov/docs/fy13osti/56761.pdf>