Public Utility Commission of Texas

Texas Technical Reference Manual

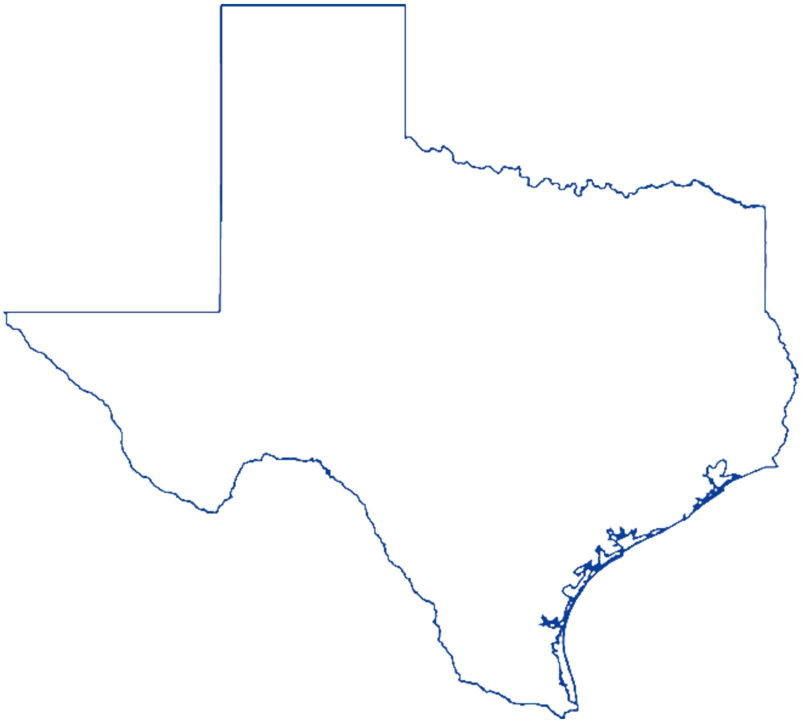
Version 10.0

Volume 2: Residential Measures

Program Year 2023

Last Revision Date:

November 2022



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Acknowledgments

The Texas Technical Reference Manual is maintained by the Public Utility Commission of Texas' independent evaluation, measurement, and verification (EM&V) team led by Tetra Tech. This version of the Texas Technical Reference Manual was primarily developed from program documentation and measure savings calculators used by the Texas Electric Utilities and their Energy Efficiency Services Providers (EESPs) to support their energy efficiency efforts, and original source material from petitions filed with the Public Utility Commission of Texas by the utilities, their consultants and EESPs such as Frontier Energy (TXu 1-904-705), ICF, CLEAResult, and Nexant. Portions of the Technical Reference Manual are copyrighted 2001-2017 by the Electric Utility Marketing Managers of Texas (EUMMOT), while other portions are copyrighted 2001-2018 by Frontier Energy. Certain technical content and updates were added by the EM&V team to provide further explanation and direction as well as a consistent structure and level of information.

TRM Technical Support

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1 INTRODUCTION

This volume of the TRM contains the deemed savings for residential measures that have been approved for use in Texas by the Public Utility Commission of Texas (PUCT). This volume includes instructions regarding various savings calculators and reference sources of the information. The TRM serves as a centralized source of deemed savings values. Where appropriate, measurement and verification (M&V) methods by measure category are noted for informational purposes only regarding the basis of projected and claimed savings.

Table 1 provides an overview of the residential measures contained within this program year (PY) 2023 TRM 10.0 Volume 2 and the types of deemed savings estimates available for each one. There are five types of deemed savings estimates identified:

- *Point estimates* that provided a single deemed savings value correspond to a single measure or type of technology.
- *Deemed saving tables* that provide energy and peak savings as a function of size, capacity, building type, efficiency level, or other inputs.
- *Savings algorithms* that require specified primary inputs that must be gathered on site and the identification of default inputs where primary data could not be collected. In many cases, these algorithms are provided as references to deemed savings tables, point estimates, or calculator explanations.
- *Calculators* are used by different utilities and implementers to calculate energy savings for different measures. In many cases, there are several different calculators available for a single measure. Sometimes their background calculators are similar, and in other cases, estimates can vary greatly between each calculator.
- *M&V methods* are also used for some measures to calculate savings in the event that standard equipment is not used, or the specified building types do not apply. For some of these measures, both a simplified M&V approach and a full M&V approach may be allowed by the utility. M&V methods as a source of claimed and projected savings are noted for informational purposes only.

Please consult Volume 1: Overview and User Guide, Section 5: Structure and Content, for details on the organization of the measure templates presented in this volume.

Table 1. Residential Deemed Savings by Measure Category

Measure category	Measure description	Point estimates	Deemed savings tables	Savings algorithm	Calculator	M&V	10.0 update
Lighting	ENERGY STAR® general service LED lamps	–	–	X	–	–	Updated for compliance with the new Department of Energy (DOE) general service lamp (GSL) definition and reinstatement of the Energy Independence Security Act (EISA) 45 lumens/watt backstop
	ENERGY STAR® specialty and directional LED lamps	–	–	X	–	–	Updated for compliance with the new DOE GSL definition. Several lamp types previously considered *specialty lamps* moved to *general service lamp* measure
	LED nightlights	–	–	X	–	–	New measure
HVAC	Air conditioner or heat pump tune-up	–	–	X	–	–	Updated coincidence factors
	Central heat pumps without SEER2 ratings	–	X	–	–	–	Restricted measure for use with central heat pumps (HP) without a SEER2 rating. Updated early retirement age eligibility
	Mini-split heat pumps without SEER2 ratings	–	X	–	–	–	Restricted measure for use with mini-split HPs without a SEER2 rating. Updated early retirement age eligibility
	Central mini-split air conditioners and heat pumps with SEER2 ratings	–	–	X	–	–	New measure
	Room air conditioners	–	–	X	–	–	Update minimum combined energy efficiency ratio (CEER) requirement for units with connected functionality. Updated coincidence factors, early retirement age eligibility, and documentation requirements
	Packed terminal heat pumps	–	–	X	–	–	Clarified electric resistance baseline. Updated coincidence factors and early retirement age eligibility

Measure category	Measure description	Point estimates	Deemed savings tables	Savings algorithm	Calculator	M&V	10.0 update
	Ground source heat pumps	–	X	X	–	–	Updated coincidence factors and estimated useful life (EUL)
	Large capacity split system and single-package air conditioners and heat pumps	–	–	X	–	–	Updated coincidence factors
	Evaporative Cooling	–	X	–	–	–	Updated cooling degree days (CDD) reference
	ENERGY STAR® connected thermostats	–	X	–	–	–	No revision
	Smart thermostat load management	–	X	–	–	–	No revision
	Duct sealing	–	–	X	–	X	Corrected typo in leakage categorization guide; added language for additional rater certification options
Building envelope	Air infiltration	–	X	–	–	X	No revision
	Ceiling insulation	–	X	–	–	–	No revision
	Attic encapsulation	–	X	–	–	–	No revision
	Wall insulation	–	X	–	–	–	No revision
	Floor insulation	–	X	–	–	–	No revision
	Radiant barriers	–	X	–	–	–	New measure
	Cool roofs	–	X	–	–	–	Addressed sunsetting of ENERGY STAR® Roof program
	Solar screens	–	X	–	–	–	No revision
	ENERGY STAR® windows	–	X	–	–	–	Added option for a weighted single-pane and double-pane baseline
	ENERGY STAR® low-e storm windows		X	–	–	–	Added option for a weighted single-pane and double-pane baseline

Measure category	Measure description	Point estimates	Deemed savings tables	Savings algorithm	Calculator	M&V	10.0 update
Domestic water heating	Water heater installation—electric tankless and fuel substitution	–	–	X	–	–	Verified compliance with ENERGY STAR® Final Version 4.0 Requirements. Updated documentation requirements
	Heat pump water heaters	–	X	–	–	–	Verified compliance with ENERGY STAR® Final Version 4.0 Requirements. Updated savings methodology to algorithm approach. Updated documentation requirements
	Solar water heaters	–	X	–	–	–	Verified compliance with ENERGY STAR® Final Version 4.0 Requirements. Updated documentation requirements
	Water heater tank insulation	–	–	X	–	–	Updated documentation requirements
	Water heater pipe insulation	–	–	X	–	–	Updated documentation requirements
	Faucet aerators	–	–	X	–	–	Updated number of occupants per home
	Low-flow showerheads	–	–	X	–	–	Updated number of occupants per home
	Showerhead temperature sensitive restrictor valves	–	–	X	–	–	Updated number of occupants per home
	Tub spout and showerhead temperature-sensitive restrictor valves	–	–	X	–	–	Updated number of occupants per home
	Water heater temperature setback	–	–	X	–	–	New measure

Measure category	Measure description	Point estimates	Deemed savings tables	Savings algorithm	Calculator	M&V	10.0 update
Appliances	ENERGY STAR® ceiling fans	–	–	X	–	–	Reduce baseline lighting wattage and resulting deemed energy savings for compliance with reinstated EISA 2007 45 lumens/watt baseline
	ENERGY STAR® clothes washers	–	X	–	–	–	No revision
	ENERGY STAR® clothes dryers	–	X	–	–	–	No revision
	ENERGY STAR® dishwashers	–	X	–	–	–	No revision
	ENERGY STAR® refrigerators	–	–	X	–	X	Updated early retirement age eligibility
	ENERGY STAR® freezers	–	X	–	–	–	Updated early retirement age eligibility
	Refrigerator/ freezer recycling	X	–	X	–	–	No revision
	ENERGY STAR® air purifiers	–	X	–	–	–	Verified compliance with ENERGY STAR® Final Version 2.0 Requirements. Updated dust clean air delivery rate (CADR) references to refer to smoke CADR. Updated deemed savings ranges and values
	ENERGY STAR® pool pumps	–	–	X	–	–	Verified compliance with ENERGY STAR® Final Version 3.1 Requirements. Updated savings coefficient definitions
	Advanced power strips	–	X	–	–	–	Corrected typos in deemed savings tables from TRM v9.0 update
	ENERGY STAR® electric vehicle supply equipment	–	X	–	–	–	Verified compliance with ENERGY STAR® Final Version 1.1 Requirements. Updated savings calculation assumptions, deemed savings, and documentation requirements
	Induction cooking	–	X	–	–	–	New measure

2 RESIDENTIAL MEASURES

2.1 RESIDENTIAL: LIGHTING

2.1.1 ENERGY STAR® General Service LED Lamps Measure Overview

TRM Measure ID: R-LT-GS

Market Sector: Residential

Measure Category: Lighting

Applicable Building Types: Single-family, multifamily; manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive and direct install

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure provides a method for calculating savings for the replacement of a standard-efficiency lamp with an ENERGY STAR-compliant LED general service lamp (GSL) in a residential application.[1] This measure applies to all lamps not included in the subsequent measure for *specialty LED* lamps.

Eligibility Criteria

These savings values rely on usage patterns specific to both indoor and outdoor applications. In lieu of collecting lamp location, a default weighting of 90.5 percent indoor and 9.5 percent outdoor may be assumed.[2]

New homes must exceed the lighting equipment requirements of the current state building code (IECC 2015) to be eligible for prescriptive lighting savings.

Fixtures with integrated LEDs may be eligible under this measure using a modified baseline.

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[1] DOE Final Rule: Definitions for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.

[2] 2015 US Lighting Market Characterization, Department of Energy. November 2017. Table 4.11. https://www.energy.gov/sites/prod/files/2017/12/f46/lmc2015_nov17.pdf.

Baseline Condition

On May 8, 2022, the Department of Energy (DOE) issued two final rules relating to GSLs:

- Energy Conservation Program: Definitions for General Service Lamps, effective July 8, 2022, which expanded the definition of GSLs.[3]
- Energy Conservation Program: Energy Conservation Standards for General Service Lamps, effective July 25, 2022, which shifted the baseline to 45 lumens/watt efficacy.[4]

The baseline is assumed to be the second-tier Energy Independence and Security Act of 2007 (EISA)-mandated efficiency for a GSL (see Table 2). The EISA regulations dictate that GSLs must comply with a 45 lumen/watt efficacy standard at time of sale beginning January 1, 2023. However, due to the DOE enforcement schedule, savings may be claimed against the first-tier EISA baseline through February 28, 2023, at the utility's discretion.[5]

For low-income and hard-to-reach direct install programs, utilities may claim additional savings for early retirement of incandescent and halogen lamps with LEDs when documentation requirements are met. It is assumed that the remaining useful life (RUL) of the existing lamps is two years. This is when the incandescent or halogen lamp baseline bulbs will be at the end of their useful life and need to be replaced. First year savings are weighted using the dual baseline methodology for the first-tier and second-tier baselines found in Table 2 and Table 3. The first-tier baseline may only be used in this scenario.

New construction applications use the same baselines; however, savings can only be claimed for efficient lighting installed above the minimum amount required by code. Current code dictates 75 percent high-efficacy lighting. Therefore, if 100 percent of installed lighting is high-efficacy, savings can be claimed for the remaining 25 percent of installed lamps.

Due to the variability among fixture types compared to screw-in lamps, qualified fixtures with integrated LEDs should use the rated installed wattage and equivalent wattage, or other approved custom methodology, in lieu of the deemed values outlined in Table 2 and Table 3. These wattages are available on the ENERGY STAR certificate and can be used in combination with the deemed savings methodologies provided in this measure.

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[3] DOE Final Rule: Definitions for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.

[4] DOE Final Rule: Energy Conservation Standards for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0005-0070.

[5] See TRM v9.0 for methodology and baseline.

Table 2. GSL LEDs—Baseline and Default Wattages for A-Shaped Lamps[6,7]

Minimum lumens	Maximum lumens	Incandescent equivalent wattage	1st tier EISA 2007 (W_{Base})[8]	2nd tier EISA 2007 (W_{Base})[9]	Default W_{Post} (if unknown)[10]
250	309	25	Exempt	Exempt	3.5
310	749	40	29	12	5.5
750	1,049	60	43	20	9.0
1,050	1,489	75	53	28	11.5
1,490	2,600	100	72	45	15.0
2,601	3,300	150	Exempt	66	22.5

Table 3. GSL LEDs—Baseline and Default Wattages for Other Lamp Shapes[11,12]

Minimum lumens	Maximum lumens	Incandescent equivalent wattage[13]	1st tier EISA 2007 (W_{Base})[14]	2nd tier EISA 2007 (W_{Base})[15]	W_{Post} (if unknown)[16]
250	309	Qualified Products List (QPL)	Exempt	Exempt	QPL
310	749	–	29	12	
750	1,049	–	43	20	
1,050	1,489	–	53	28	
1,490	2,600	–	72	45	
2,601	3,300	QPL	Exempt	66	

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[6] Federal standard for General Service Incandescent Lamps (GSIL): https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=20.

[7] If exempt, refer to the incandescent equivalent wattage.

[8] 1st tier baseline is only applicable to low-income and hard-to-reach direct install programs. This baseline is only applicable for two years, equivalent to the expected life of an incandescent lamp.

[9] Non-exempt baseline wattages are calculated by dividing the midpoint of the specified lumen range by the 45 lumens/watt efficacy standard.

[10] Average rated wattage from the ENERGY STAR QPL rounded to nearest half-watt: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

[11] Federal standard for General Service Incandescent Lamps (GSIL): https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=20.

[12] If exempt, refer to incandescent equivalent wattage.

[13] Due to large variation in lamp types, use rated value from the ENERGY STAR QPL: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

[14] 1st tier baseline is only applicable to low-income and hard-to-reach direct install programs. This baseline is only applicable for two years, equivalent to the expected life of an incandescent lamp.

[15] Non-exempt baseline wattages are calculated by dividing the midpoint of the specified lumen range by the 45 lumens/watt efficacy standard.

[16] Due to large variation in lamp types, use rated value from ENERGY STAR: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

High-Efficiency Condition

The high-efficiency condition is the wattage of the replacement lamp.

LEDs must be ENERGY STAR-compliant[17] for the relevant lamp shape being installed as outlined in the latest ENERGY STAR specification.[18] Using ANSI C79.1-2002 nomenclature, the applicable omni-directional LED lamp types are A, BT, P, PS, S, and T.

Alternatively, lab testing reports (e.g., LM-79, LM-80, TM-21, ISTMT) are also accepted as a method of certification.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Wattage reduction is defined as the difference between the wattage of a standard baseline lamp, according to EISA 2007 (see Table 2 and Table 3) and the wattage of a comparable GSL LED. An LED is considered comparable to the baseline lamp if they are aligned on the lumen output ranges set out in EISA 2007.

For new construction projects, programs should calculate savings using the methodology in this section for all efficient lamps installed in the home. The program should claim savings for the percentage of installed high-efficacy lamps that exceed the minimum required by code, which is currently 75 percent of lamps. For example, if a new home is built with high-efficacy lamps in 85 percent of the permanently installed fixtures, the program would claim 10 percent of the total calculated savings.

Energy Savings

Annual energy (kWh) savings are calculated as follows.

$$Energy\ Savings\ [\Delta kWh] = \frac{\left(W_{base} - W_{post}\right)}{1{,}000} \times Hours \times ISR \times IEF_E$$

Equation 1

Where:

W_{post} = *Baseline wattage corresponding with the lumen output of the purchased LED lamp for the year purchased/installed; reduced baselines are provided for EISA-compliant lamps in Table 2*

W_{post} = *Actual wattage of LED purchased/installed (if unknown, use default wattages from Table 2)*

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[17] ENERGY STAR QPL: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.
[18] http://www.energystar.gov/products/certified-products/detail/light-bulbs.

HOU	=	*Average hours of use per year = 803 hours (for interior/exterior applications calculated based on an average daily usage of 2.2 hours per day*[19]*)*
IEF_E	=	*Interactive effects factor to account for cooling energy savings and heating energy penalties associated with lighting power reductions (see Table 4)*
ISR	=	*In-service rate, the percentage of incentivized units that are installed and in use (rather than removed, stored, or burnout) to account for units incentivized but not operating*[20] *= 0.97*
1,000	=	*Constant to convert from W to kW*

Table 4. GSL LEDs—Interactive Effects for Cooling Energy Savings and Heating Energy Penalties[21]

IEF_E					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Gas heat with AC	1.06	1.13	1.17	1.15	1.12
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.91	1.00	1.05	1.11	0.97
Electric resistance heat with AC	0.65	0.80	0.90	1.00	0.75
Electric resistance heat with no AC	0.57	0.69	0.76	0.83	0.65

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[19] The average daily usage of 2.2 hours per day is a blended value for indoor and outdoor lamps. Source: Evaluation of 2008 Texas ‘Make Your Mark’ Statewide CFL Program Report. Frontier Energy. June 2009.

[20] Dimetrosky, S., Parkinson, K. and Lieb, N., “Residential Lighting Evaluation Protocol – The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.” January 2015. ISR for upstream programs, including storage lamps installed within four years of purchase. http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf.

[21] Extracted from BEopt energy models used to estimate savings for envelope measures. Referencing the EISA baseline table, the typical lumen output was determined by taking the midpoint for the 60-watt equivalent lamp (900 lumens), which was assumed to be the most typical installation. The resulting lumens were divided by the default wattage for incandescents (43 W), CFLs (13 W), and LEDs (10 W) resulting in an assumed efficacy for incandescents (21 lm/W), CFLs (70 lm/W), and LEDs (90 lm/W). IEF values were calculated using the following formula: $1 + HVAC_{savings}/Lighting_{savings}$.

IEF_E					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
No heat with AC	1.06	1.13	1.17	1.15	1.12
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[22]	0.88	0.98	1.04	1.07	0.95

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

Demand Savings

Summer and winter demand savings are determined by applying a coincidence factor associated with each season.

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_S \times ISR \times IEF_{D,S}$$

Equation 2

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_W \times ISR \times IEF_{D,W}$$

Equation 3

Where:

$CF_{S/W}$ = *Seasonal peak coincidence factor (see Table 5)*

IEF_D = *Interactive effects factor to account for cooling demand savings or heating demand penalties associated with lighting power reductions (see Table 6)*

Table 5. GSL LEDs—Coincidence Factors[23]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5 El Paso
Summer	0.060	0.053	0.063	0.059	0.032
Winter	0.275	0.232	0.199	0.263	0.358

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[22] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

[23] See Volume 1.

Table 6. GSL LEDs—Interactive Effects Factor for Cooling Demand Savings and Heating Demand Penalties[24]

$IEF_{D,S}$					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Gas heat with AC	1.45	1.33	1.68	1.23	1.44
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with AC	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with no AC	1.00	1.00	1.00	1.00	1.00
No heat with AC	1.45	1.33	1.68	1.23	1.44
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[25]	1.39	1.28	1.58	1.20	1.38
$IEF_{D,W}$					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4 Corpus Christi**	**Climate Zone 5 El Paso**
Gas heat with AC	0.98	0.98	0.98	0.98	0.98
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.71	0.67	0.65	0.74	0.81
Electric resistance heat with AC	0.44	0.36	0.38	0.42	0.52
Electric resistance heat with no AC	0.44	0.36	0.38	0.42	0.52
No heat with AC	0.98	0.98	0.98	0.98	0.98
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[26]	0.76	0.72	0.73	0.75	0.80

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

Low-Income and Hard-to-Reach Direct Install Programs

Annual energy (kilowatt-hours, kWh) and peak demand (kilowatts, kW) may be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed (incandescent or halogen lamp), designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL).

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[24] Refer to Table 4.
[25] Ibid.
[26] Ibid.

Annual energy and peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life = 2 years*

EUL = *Estimated useful life = 16 or 20 years (see Measure Life and Lifetime Savings section)*

Upstream/Midstream Program Assumptions

All GSLs with an equivalent wattage of 100 W or lower distributed though upstream or midstream programs should calculate savings using a combination of residential and non-residential savings methodologies with 95 percent of savings allocated to the residential sector and the remaining five percent of savings allocated to the commercial sector.[27] While only summer demand savings are specified for the commercial sector, winter demand savings are allowed for the portion of savings allocated to the residential sector.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

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[27] Weighting assumptions based on statewide evaluator review of LED purchasing behavior for similar program designs as referenced in the 2018 EM&V Upstream Lighting memo.

Measure Life and Lifetime Savings

Historically, the average measure life is based upon the rated lamp life of the LED. The measure life assumes an average use of 2.2 hours per day based on blended usage for indoor/outdoor applications and applies a 0.85 degradation factor to indoor/outdoor LEDs.

$$EUL_{Total} = \frac{Rated\ Life \times DF}{HOU \times 365.25}$$

Equation 4

Where:

Rated Life = *10,000 hours, 12,000 hours, 15,000 hours, or 20,000 hours, as specified by the manufacture; if unknown, assume a 10,000-hour lifetime* [28]

DF = *0.85 degradation factor*[29]

HOU = *2.2 hours per day*[30]

Table 7. GSL LEDs—Estimated Useful Life

Range of rated measure life (hours)	Assumed rated measure life (hours)	Rated product lifetime (years)
$\leq$ 17,500	15,000	16
> 17,500	20,000	20*

* Measure life capped at 20 years. EUL may be deemed at 16 years in lieu of documenting the customer baseline.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of LEDs installed
- Wattage of each replacement LED
- Lumen output of each replacement LED
    - Manufacturer-rated lifetime of each replacement LED in hours

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[28] Minimum lifetime requirement under ENERGY STAR® Lamps Specification V2.1, effective January 2, 2017. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf.

[29] ENERGY STAR® CFL Third Party Testing and Verification Off-the-Shelf CFL Performance: Batch 3. Figure 27, p. 47.

[30] The average daily usage of 2.2 hours per day is a blended value for indoor and outdoor lamps. Source: Evaluation of 2008 Texas ‘Make Your Mark’ Statewide CFL Program Report. Frontier Energy. June 2009.

- Heating system type (gas, electric resistance, heat pump, none, unknown)
- Cooling system type (air conditioner, evaporative, none, unknown)
- Location of replacement lamp (conditioned, unconditioned, or outdoor); only required when not assuming default weighting
- Proof of purchase – with date of purchase and quantity
    - Alternative: representative photos of replacement units or another pre-approved method of installation verification
- ENERGY STAR certificate matching replacement model number
    - Alternative: another pre-approved method of certification (e.g., LM-79, LM-80, TM-21 ISTMT lap reports)
- For low-income and hard-to-reach direct install programs, photo documentation clearly showing the lamp type and approximate quantity replaced or other pre-approved method of verification
- For new construction projects only, these data points must be gathered for all permanently installed fixtures in the home to document the percentage that are high-efficacy.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 8. GSL LEDs—Revision History

TRM version	Date	Description of change
v3.0	4/10/2015	TRM v3.0 origin.
v3.1	11/05/2015	TRM v3.1 update. Modification of in-service rate, revision of interactive effects factors to reflect indoor-specific values for additional heating and cooling equipment types. Provided default input assumptions for upstream lighting programs. Capped estimated measure life.
v3.1	3/28/2016	TRM v3.1 March revision. Updated summer and winter coincidence factors.
v4.0	10/10/2016	TRM v4.0 update. Updated IEF values and useful life estimates.
v5.0	10/2017	TRM v5.0 update. Updated EUL algorithm to account for baseline change beginning in 2021. Included language to deem EUL.
v6.0	11/2018	TRM v6.0 update. Updated useful life estimates. Updated interactive effects factors.
v7.0	10/2019	TRM v7.0 update. Removed dual baseline and updated useful life estimates. Added invoice and certificate requirements. Added option for new construction savings.
v8.0	10/2020	TRM v8.0 update. Defined midstream methodology and clarified default wattages by lumen range.
v9.0	10/2021	TRM v9.0 update. Updated midstream methodology and added path for fixtures.
v10.0	10/2022	TRM v10.0 update. Updated for compliance with new DOE GSL definition and reinstatement of EISA 45 lumens/watt backstop.

2.1.2 ENERGY STAR® Specialty LED Lamps Measure Overview

TRM Measure ID: R-LT-SP

Market Sector: Residential

Measure Category: Lighting

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive and direct install

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure provides a method for calculating savings for replacement of an incandescent or halogen reflector or decorative lamp with an ENERGY STAR-compliant LED specialty lamp in a residential application. These lamps are limited to the following lamp types, defined by the current federal standard[31] and further reduced to only include lamps that are common to utility rebate programs.

- G-shape lamps that have a first number symbol less than or equal to 12.5 (diameter less than or equal to 1.5625 inches)
- G-shape lamps with a diameter of 5 inches or more
- MR-shape lamps that have a first symbol equal to 16 (diameter equal to 2 inches) and have a lumen output greater than or equal to 800 lumens

Reflector lamps that have a first number symbol less than 16 (diameter less than 2 inches) and that do not have E26/E24, E26d, E26/50x39, E26/53x39, E29/28, E29/53x39, E39, E39d, EP39, or EX39 bases.

Eligibility Criteria

These savings values rely on usage patterns specific to both indoor and outdoor applications. In lieu of collecting lamp location, a default weighting of 90.5 percent indoor and 9.5 percent outdoor may be assumed.[32]

New homes must exceed the lighting equipment requirements of the current state building code (IECC 2015) to be eligible for prescriptive lighting savings.

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[31] DOE Final Rule: Definitions for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.

[32] 2015 US Lighting Market Characterization, Department of Energy. November 2017. Table 4.11. https://www.energy.gov/sites/prod/files/2017/12/f46/lmc2015_nov17.pdf.

Fixtures with integrated LEDs may be eligible under this measure using a modified baseline.

Baseline Condition

On May 8, 2022, the Department of Energy (DOE) issued two final rules relating to general service lamps:

- Energy Conservation Program: Definitions for General Service Lamps (GSL), effective July 8, 2022, which expanded the definition of general service lamp.[33]
- Energy Conservation Program: Energy Conservation Standards for General Service Lamps, effective July 25, 2022, which shifted the baseline to 45 lumens per watt efficacy.[34]

For all products not defined as GSLs, the baseline is assumed to be the incandescent equivalent wattage. The baseline wattage will be determined based on the bulb shape of the installed lamp, as outlined below. New construction applications use the same baselines; however, savings can only be claimed for efficient lighting installed above the minimum amount required by code. Current code dictates 75 percent high-efficacy lighting. Therefore, if 100 percent of installed lighting is high-efficacy, savings can be claimed for the remaining 25 percent of installed lamps.

Due to the variability among fixture types compared to screw-in lamps, qualified fixtures with integrated LEDs should use the rated installed wattage and equivalent wattage, or other approved custom methodology, in lieu of the deemed values outlined in this section. These wattages are available on the ENERGY STAR certificate and can be used in combination with the deemed savings methodologies provided in this measure.

Table 9. Specialty LEDs—Baseline and Default Wattages

Lamp type[36]	Minimum lumens	Maximum lumens	W_{Base}
G-shape with diameter $\geq$ 5 in.[37]	–	–	Qualified Products List (QPL)
G-shape with diameter $\geq$ 5 in.[38]	–	–	QPL
MR16/MRX16	800	–	75
R14	250	299	25

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[33] DOE Final Rule: Definitions for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.

[34] DOE Final Rule: Energy Conservation Standards for General Service Lamps. https://www.regulations.gov/document/EERE-2021-BT-STD-0005-0070.

[35] Due to large variation in lamp types, use rated value from ENERGY STAR QPL where not specified: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

[36] Lamp types excluded from this table were not included on the ENERGY STAR QPL. For missing lamp types, refer to the equivalent and rated wattages from the ENERGY STAR certification.

[37] G-shape lamps are not included because there were very few ENERGY STAR-qualified products with a diameter of 5 inches or more. For these products, use the equivalent and rated wattages from the ENERGY STAR certification.

[38] G-shape lamps are not included because there were very few ENERGY STAR-qualified products with a diameter of 5 inches or more. For these products, use the equivalent and rated wattages from the ENERGY STAR certification.

High- Efficiency Condition

The high-efficiency condition is the wattage of the replacement lamp.

LEDs must be ENERGY STAR-compliant[39] for the relevant lamp shape being removed as outlined in the latest ENERGY STAR specification.[40] These lamps include reflectors, G-shape lamps, T-shape lamps, B, BA, CA, F G16-1/2, G25, G30, S, or M14 lamps.

Alternatively, lab testing reports (e.g., LM-79, LM-80, TM-21, ISTMT) are also accepted as a method of certification.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Wattage reduction is defined as the difference between the wattage of a specialty baseline lamp and the wattage of a directional or specialty LED.

For new construction projects, programs should calculate savings using the methodology in this section for all efficient lamps installed in the home. The program should claim savings for the percentage of installed high-efficacy lamps that exceed the minimum required by code, which is currently 75 percent of lamps. For example, if a new home is built with high-efficacy lamps in 85 percent of the permanently installed fixtures, the program would claim 10 percent of the total calculated savings.

Energy Savings Algorithms

Annual energy (kWh) savings are calculated as follows:

$$Energy\ Savings\ [\Delta kWh] = \frac{(W_{base} - W_{post})}{1{,}000} \times HOU \times ISR \times IEF_E$$

Equation 5

Where:

W_{base} = *EISA-exempt specialty lamp or a DOE-ruling-exempt reflector (see Table 9)*

W_{post} = *Actual wattage of LED purchased/installed*

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[39] ENERGY STAR QPL: https://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

[40] ENERGY STAR specification: http://www.energystar.gov/products/certified-products/detail/light-bulbs.

HOU = *Average hours of use per year = 803 hours (for interior/exterior applications calculated based on an average daily usage of 2.2 hours per day*[41]*)*

IEF_E = *Interactive effects factor to account for cooling energy savings and heating energy penalties associated with lighting power reductions (see Table 10)*

ISR = *In-service rate, the percentage of incentivized units that are installed and in use (rather than removed, stored, or burnt out) to account for units incentivized but not operating*[42] *= 0.97*

1,000 = *Constant to convert from W to kW*

Table 10. Specialty LEDs—Interactive Effects for Cooling Energy Savings and Heating Energy Penalties[43]

IEF_E					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Gas heat with AC	1.06	1.13	1.17	1.15	1.12
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.91	1.00	1.05	1.11	0.97
Electric resistance heat with AC	0.65	0.80	0.90	1.00	0.75
Electric resistance heat with no AC	0.57	0.69	0.76	0.83	0.65
No heat with AC	1.06	1.13	1.17	1.15	1.12
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[44]	0.88	0.98	1.04	1.07	0.95

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

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[41] The average daily usage of 2.2 hours per day is a blended value for indoor and outdoor lamps. Source: Evaluation of 2008 Texas 'Make Your Mark' Statewide CFL Program Report. Frontier Energy (formerly Associates). June 2009.

[42] Dimetrosky, S., Parkinson, K. and Lieb, N. "Residential Lighting Evaluation Protocol – The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures." January 2015. ISR for upstream programs, including storage lamps installed within four years of purchase. http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf.

[43] Extracted from BEopt energy models used to estimate savings for envelope measures. Referencing the EISA baseline table, the typical lumen output was determined by taking the midpoint for the 60-watt equivalent lamp (900 lm), which was assumed to be the most typical installation. The resulting lumens were divided by the default wattage for incandescents (43 W), CFLs (13 W), and LEDs (10 W) resulting in an assumed efficacy for incandescents (21 lm/W), CFLs (70 lm/W), and LEDs (90 lm/W). IEF values were calculated using the following formula: $1 + HVAC_{savings}/Lighting_{savings}$.

[44] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

Demand Savings Algorithms

Summer and winter demand savings are determined by applying a coincidence factor associated with each season.

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_S \times ISR \times IEF_{D,S}$$

Equation 6

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_W \times ISR \times IEF_{D,W}$$

Equation 7

Where:

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 11)*

IEF_D = *Interactive effects factor to account for cooling demand savings or heating demand penalties associated with lighting power reductions (see Table 12)*

Table 11. Specialty LEDs—Coincidence Factors[45]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.060	0.053	0.063	0.059	0.032
Winter	0.275	0.232	0.199	0.263	0.358

Table 12. Specialty LEDs—Interactive Effects Factor for Cooling Demand Savings and Heating Demand Penalties[46]

$IEF_{D,S}$					
Heating/cooling type*	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Gas heat with AC	1.45	1.33	1.68	1.23	1.44
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with AC	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with no AC	1.00	1.00	1.00	1.00	1.00

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[45] See Volume 1

[46] Refer to Table 10.

$IEF_{D,S}$					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
No heat with AC	1.45	1.33	1.68	1.23	1.44
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[47]	1.39	1.28	1.58	1.20	1.38
$IEF_{D,W}$					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Gas heat with AC	0.98	0.98	0.98	0.98	0.98
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.71	0.67	0.65	0.74	0.81
Electric resistance heat with AC	0.44	0.36	0.38	0.42	0.52
Electric resistance heat with no AC	0.44	0.36	0.38	0.42	0.52
No heat with AC	0.98	0.98	0.98	0.98	0.98
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[48]	0.76	0.72	0.73	0.75	0.80

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

Upstream/Midstream Program Assumptions

All general service, decorative, and reflector lamps with an equivalent wattage of 100 W or lower distributed though upstream or midstream programs should calculate savings using a combination of residential and non-residential savings methodologies with 95 percent of savings allocated to the residential sector and the remaining five percent of savings allocated to the commercial sector.[49] While only summer demand savings are specified for the commercial sector, winter demand savings are allowed for the portion of savings allocated to the residential sector.

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[47] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

[48] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

[49] Weighting assumptions based on statewide evaluator review of LED purchasing behavior for similar program designs as referenced in the 2018 EM&V upstream lighting memo.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

Historically, the average measure life is based upon rated lamp life of the LED. The measure life assumes an average use of 2.2 hours per day based on blended usage for indoor/outdoor applications and applies a 0.85 degradation factor to indoor/outdoor LEDs.

$$EUL_{Total} = \frac{Rated\ Life \times DF}{HOU \times 365.25}$$

Equation 8

Where:

Rated Life = *10,000 hours, 12,000 hours, 15,000 hours, or 20,000 hours, as specified by the manufacturer; if unknown, assume a 10,000-hour lifetime*[50]

DF = *0.85 degradation factor*[51]

HOU = *2.2 hours per day*[52]

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[50] Minimum lifetime requirement under ENERGY STAR® Lamps Specification V2.1, effective January 2, 2017. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf.

[51] ENERGY STAR® CFL Third Party Testing and Verification Off-the-Shelf CFL Performance: Batch 3. Figure 27, p. 47.

EISA Compliant Lamps

To account for a rapidly changing market, standard practice dictates that measure life assumptions be reduced to approximate the point at which the residential lighting market has been fully transformed to high-efficiency lamps. Due to market uncertainty in response to a recent rule issued by the Department of Energy, a simplified approach to claim half of the more conservative 16-year EUL will be implemented during the 2020 program year, resulting in an 8-year EUL. This assumption will be reviewed annually to account for current market trends.

Based on an expected delay in market adoption among certain customer bases, this measure life will be extended to 10 years for programs targeting low-income and hard-to-reach customers.

These reductions do not apply to specialty lamps.

Table 13. Specialty LEDs—Estimated Useful Life

Range of Rated Measure Life (Hours)	Assumed Rated Measure Life (Hours)	Specialty Measure Life (Years)
≤ 17,500	15,000	16
> 17,500	20,000	20*

* Measure life capped at 20 years. EUL may be deemed at 16 years in lieu of collecting manufacturer rated life or documenting customer baseline.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of LEDs installed
- ANSI C79.1-2002 nomenclature of LED installed (G40, PAR, etc.)
- Baseline and rated wattages of each replacement LED
- Lumen output of each replacement LED
- Manufacturer-rated lifetime of each replacement LED in hours
- Heating system type (gas, electric resistance, heat pump, none, unknown)
- Cooling system type (air conditioner, evaporative cooler, none, unknown)
- Location of installed lamp (conditioned, unconditioned, or outdoor); only required when not assuming default weighting
- Baseline calculation methodology (EISA-affected non-reflector, EISA-exempt non-reflector, DOE-ruling-affected reflector, DOE-ruling-exempt reflector,

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[52] The average daily usage of 2.2 hours per day is a blended value for indoor and outdoor lamps. Source: Evaluation of 2008 Texas ‘Make Your Mark’ Statewide CFL Program Report. Frontier Energy (formerly Associates). June 2009.

manufacturer-rated equivalent incandescent wattage, or default wattage)

- Proof of purchase – with date of purchase and quantity
    - Alternative: representative photos of installed units or other pre-approved method of installation verification
- ENERGY STAR certificate matching replacement model number
    - Alternative: other pre-approved method of certification (e.g., LM-79, LM-80, TM-21, ISTMT lap reports)
- For new construction projects only, these data points must be gathered for all permanently installed fixtures in the home to document the percentage that are high-efficacy.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 14. Specialty LEDs—Revision History

TRM version	Date	Description of change
v3.0	4/10/2015	TRM v3.0 origin.
v3.1	11/05/2015	TRM v3.1 update. Modification of in-service rate, revision of interactive effects factors to reflect indoor-specific values for additional heating and cooling equipment types. Consolidated default input assumptions for upstream lighting programs. Capped estimated measure life.
v3.1	3/28/2016	TRM v3.1 March revision. Updated summer and winter coincidence factors.
v4.0	10/10/2016	TRM v4.0 update. Updated IEF values.
v5.0	10/2017	TRM v5.0 update. Updated useful life estimates.
v6.0	11/2018	TRM v6.0 update. Updated useful life estimates. Updated interactive effects factors.
v7.0	10/2019	TRM v7.0 update. Removed dual baseline and updated useful life estimates. Added invoice and certificate requirements. Added option for new construction savings.
v8.0	10/2020	TRM v8.0 update. Defined midstream methodology and clarified default wattages by lumen range. Updated specialty lamps baselines.

TRM version	Date	Description of change
v9.0	10/2021	TRM v9.0 update. Updated midstream methodology and added path for fixtures.
v10.0	10/2022	TRM v10.0 update. Updated for compliance with new DOE GSL definition. Several lamp types previously considered *specialty lamps* moved to *general service lamp* measure.

2.1.3 LED Nightlights Measure Overview

TRM Measure ID: R-LT-NL

Market Sector: Residential

Measure Category: Lighting

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive and direct install

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure provides a method for calculating savings for the replacement of an incandescent nightlight with an LED or electroluminescent nightlight.

Eligibility Criteria

This measure applies to all LED nightlights installed in a residential application.

Baseline Condition

The baseline condition is assumed to be an incandescent/halogen nightlight.

High-Efficiency Condition

The high-efficiency condition is a qualified LED nightlight.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings

Annual energy (kilowatt-hours, kWh) savings are calculated as follows.

$$Energy\ Savings\ [\Delta kWh] = \frac{\left(W_{base} - W_{post}\right)}{1{,}000} \times Hours \times ISR \times IEF_E$$

Equation 9

Where:

W_{base} = *Baseline wattage. Use actual wattage if known (default = 7 W)*[53]

W_{post} = *Actual wattage of LED purchased/installed (default = 1 W for LED)*

HOU = *Average hours of use per year = 4,161 hours*[54]

IEF_E = *Interactive effects factor to account for cooling energy savings and heating energy penalties associated with lighting power reductions (see Table 15)*

ISR = *In-service rate, the percentage of incentivized units that are installed and in use (rather than removed, stored, or burnt out) to account for units incentivized but not operating (see Table 16)*

1,000 = *Constant to convert from W to kW*

Table 15. LED Nightlights—Interactive Effects for Cooling Energy Savings and Heating Energy Penalties[55]

IEF_E					
Heating/cooling type*	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Gas heat with AC	1.06	1.13	1.17	1.15	1.12
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.91	1.00	1.05	1.11	0.97
Electric resistance heat with AC	0.65	0.80	0.90	1.00	0.75
Electric resistance heat with no AC	0.57	0.69	0.76	0.83	0.65
No heat with AC	1.06	1.13	1.17	1.15	1.12

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[53] Mertz, Stanley. "LED Nightlights Energy Efficiency Retail products programs." March 2018.

[54] Southern California Edison Company, "LED, Electroluminescent & Fluorescent Night Lights," Work Paper WPSCRELG0029 Rev. 1, February 2009, p. 2 and 3.

[55] Extracted from BEopt energy models used to estimate savings for envelope measures. Referencing the EISA baseline table, the typical lumen output was determined by taking the midpoint for the 60-watt equivalent lamp (900 lm), which was assumed to be the most typical installation. The resulting lumens were divided by the default wattage for incandescents (43 W), CFLs (13 W), and LEDs (10 W) resulting in an assumed efficacy for incandescents (21 lm/W), CFLs (70 lm/W), and LEDs (90 lm/W). IEF values were calculated using the following formula: $1 + HVAC_{savings}/Lighting_{savings}$.

IEF_E					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[56]	0.88	0.98	1.04	1.07	0.95

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

Table 16. LED Nightlights—In-Service Rates by Program Type

Program type	ISR
Kit programs[57]	0.60
All other	0.97

Demand Savings

Summer and winter demand savings are determined by applying a coincidence factor associated with each season.

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_S \times ISR \times IEF_{D,S}$$

Equation 10

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{(W_{base} - W_{post})}{1{,}000} \times CF_W \times ISR \times IEF_{D,W}$$

Equation 11

Where:

$CF_{S/W}$ = *Seasonal peak coincidence factor (see* Table 17*)*

IEF_D = *Interactive effects factor to account for cooling demand savings or heating demand penalties associated with lighting power reductions (see* Table 18*)*

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[56] Calculated using IEFs from a Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

[57] From IL TRM v10 based on evaluation of ComEd PY9 Elementary Energy Education program. Representative of total installations within three years of delivery.

Table 17. LED Nightlights—Coincidence Factors[58]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.00	0.00	0.00	0.00	0.00
Winter	0.67	0.71	0.61	0.75	1.00

Table 18. LED Nightlights—Interactive Effects Factor for Cooling Demand Savings and Heating Demand Penalties[59]

$IEF_{D,S}$					
Heating/cooling type*	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Gas heat with AC	1.45	1.33	1.68	1.23	1.44
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with AC	1.45	1.33	1.68	1.23	1.44
Electric resistance heat with no AC	1.00	1.00	1.00	1.00	1.00
No heat with AC	1.45	1.33	1.68	1.23	1.44
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[60]	1.39	1.28	1.58	1.20	1.38

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[58] From TX TRM *commercial lamps & fixtures* measure for dusk-to-dawn operation.

[59] Refer to
Table 15.

[60] Ibid.

$IEF_{D,W}$					
Heating/cooling type*	**Climate Zone 1: Amarillo**	**Climate Zone 2: Dallas**	**Climate Zone 3: Houston**	**Climate Zone 4: Corpus Christi**	**Climate Zone 5: El Paso**
Gas heat with AC	0.98	0.98	0.98	0.98	0.98
Gas heat with no AC	1.00	1.00	1.00	1.00	1.00
Heat pump	0.71	0.67	0.65	0.74	0.81
Electric resistance heat with AC	0.44	0.36	0.38	0.42	0.52
Electric resistance heat with no AC	0.44	0.36	0.38	0.42	0.52
No heat with AC	0.98	0.98	0.98	0.98	0.98
Unconditioned space	1.00	1.00	1.00	1.00	1.00
Heating/cooling unknown[61]	0.76	0.72	0.73	0.75	0.80

* IEF for homes with no AC is most appropriate for customers with evaporative cooling or room air conditioners.

Upstream/Midstream Program Assumptions

All general service lamps with an equivalent wattage of 100 W or lower distributed though upstream or midstream programs should calculate savings using a combination of residential and non-residential savings methodologies with 95 percent of savings allocated to the residential sector and the remaining 5 percent of savings allocated to the commercial sector.[62] While only summer demand savings are specified for the commercial sector, winter demand savings are allowed for the portion of savings allocated to the residential sector.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[61] Ibid.

[62] Weighting assumptions based on statewide evaluator review of LED purchasing behavior for similar program designs as referenced in the 2018 EM&V upstream lighting memo.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for LED nightlights is 8 years.[63]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of LED nightlights installed
- LED nightlight wattage
- Heating system type (gas, electric resistance, heat pump, none, unknown)
- Cooling system type (air conditioner, evaporative, none, unknown)
- Proof of purchase – with date of purchase and quantity
    - Alternative: representative photos of replacement units or another pre-approved method of installation verification

References and Efficiency Standards

Not applicable.

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 19. LED Nightlights—Revision History

TRM version	Date	Description of change
v10.0	10/2022	TRM v10.0 origin.

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[63] Southern California Edison Company, "LED, Electroluminescent & Fluorescent Night Lights," Work Paper WPSCRELG0029 Rev. 1, February 2009, p. 2 and 3.

2.2 RESIDENTIAL: HEATING, VENTILATION, AND AIR CONDITIONING

2.2.1 Air Conditioner and Heat Pump Tune-Ups Measure Overview

TRM Measure ID: R-HV-TU

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure applies to central air conditioners (AC) and heat pumps (HP) of any configuration where all applicable actions from the checklist below are completed. An AC tune-up involves checking, cleaning, adjusting, and resetting the equipment to factory conditions to restore operating efficiencies, on average, closer to as-new performance. This measure applies to all residential applications.

For this measure, the service technician must complete the following tasks according to industry best practices. To properly assess and adjust the refrigerant charge level, the unit must be operating under significant (normal) cooling load conditions. Therefore, this measure may only be performed for energy savings reporting purposes when the outdoor ambient dry bulb temperature is above 75˚F, and the indoor return air dry bulb temperature is above 70˚F.

Air conditioner inspection and tune-up checklist:[64]

- Tighten all electrical connections, measure motor voltage and current
- Lubricate all moving parts, including motor and fan bearings
- Inspect and clean the condensate drain
- Inspect controls of the system to ensure proper and safe operation. Check the startup/shutdown cycle of the equipment to assure the system starts, operates, and shuts off properly.
- Clean evaporator and condenser coils

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[64] Based on ENERGY STAR® HVAC Maintenance Checklist. www.energystar.gov/index.cfm?c=heat_cool.pr_maintenance.

- Clean indoor blower fan components
- Inspect and clean or change air filters; replacement preferred best practice
- Measure airflow via static pressure across the cooling coil and adjust to manufacturers specifications
- Check refrigerant level and adjust to manufacturer specifications
- Check capacitor functionality and capacitance; compare to OEM specifications

Eligibility Criteria

All residential customers are eligible for this measure if they have refrigerated air conditioning 65,000 Btu/hr or less in cooling capacity that has not been serviced in the last 5 years.

Baseline Condition

The baseline is a system with some or all of the following issues:

- Dirty condenser coil
- Dirty evaporator coil
- Dirty blower wheel
- Dirty filter
- Improper airflow
- Incorrect refrigerant charge

The baseline system efficiency should be calculated using the following formulas:

$$EER_{pre} = (1 - EL) \times EER_{post}$$

Equation 12

$$HSPF_{pre} = (1 - EL) \times HSPF_{post}$$

Equation 13

Where:

EER_{pre} = *Efficiency of the cooling equipment before tune-up*

EL = *Efficiency loss due to dirty coils, blower, filter, improper airflow, and/or incorrect refrigerant charge = 0.05*

EER_{post} = *Deemed cooling efficiency of the equipment after tune-up = 11.2 EER*

$HSPF_{pre}$ = *Heating efficiency of the air source heat pump before tune-up*

$HSPF_{post}$ = *Deemed heating efficiency of air source heat pumps after tune-up = 7.7 HSPF*

High-Efficiency Condition

After the tune-up, the equipment must be clean with airflows and refrigerant charges adjusted as appropriate and set forth above, with the added specification that refrigerant charge adjustments must be within ±3 degrees of target sub-cooling for units with thermal expansion valves (TXV) and ±5 degrees of target super heat for units with fixed orifices or capillary tubes.

The efficiency standard, or efficiency after the tune-up, is deemed to be the manufacturer specified energy efficiency ratio (EER) of the existing central air conditioner or heat pump, which has been determined using the following logic and standards. The useful life of an AC unit is 19 years. The useful life of a heat pump is 16 years. Therefore, it is conservatively thought that the majority of existing, functioning units were installed under the federal standard in place between January 23, 2006, and January 1, 2015, which set a baseline of 13 SEER and 7.7 HSPF[65]. A 13 SEER is equivalent to approximately 11.2 EER[66] using the conversion developed by Lawrence Berkeley Lab and US DOE: EER = -0.02 x $SEER^2$ + 1.12 x SEER.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Savings are based on an assumed efficiency loss factor of 5 percent due to dirty coils, dirty filters, improper airflow, and/or incorrect refrigerant charge.[67]

Energy Savings Algorithms

Heating energy savings are only applicable to heat pumps.

$$Total\ Energy\ Savings\ [\Delta kWh] = kWh_C + kWh_H$$

Equation 14

$$Cooling\ Energy\ Savings\ [kWh_C] = Cap_C \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right) \times EFLH_C \times \frac{1\ kW}{1{,}000\ W}$$

Equation 15

$$Heating\ Energy\ Savings\ [kWh_H] = Cap_H \times \left(\frac{1}{HSPF_{pre}} - \frac{1}{HSPF_{post}}\right) \times EFLH_H \times \frac{1\ kW}{1{,}000\ W}$$

Equation 16

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[65] Code specified HSPF from federal standard effective January 23, 2006 through January 1, 2015.

[66] Code specified 13 SEER from federal standard effective January 23, 2006 through January 1, 2015, converted to EER using EER = -0.02 x $SEER^2$ + 1.12 x SEER. National Renewable Energy Laboratory (NREL). “Building America House Simulation Protocols.” US Department of Energy. Revised October 2010. http://www.nrel.gov/docs/fy11osti/49246.pdf.

[67] Energy Center of Wisconsin, May 2008; “Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research.”

Where:

Cap_C = *Rated cooling capacity of the equipment based on model number [Btuh] (1 ton = 12,000 Btuh)*

Cap_H = *Rated heating capacity of the equipment based on model number [Btuh] (1 ton = 12,000 Btuh)*

EER_{pre} = *Cooling efficiency of the equipment pre-tune-up using Equation 12 [Btuh/W]*

EER_{post} = *Cooling efficiency of the equipment after the tune-up [Btuh/W]; assume 11.2*

$HSPF_{pre}$ = *Heating efficiency of the equipment pre-tune-up using Equation 13 [Btuh/W]*

$HSPF_{post}$ = *Heating efficiency of the equipment after the tune-up [Btuh/W]; assume 7.7*

$EFLH_{C/H}$ = *Cooling/heating equivalent full-load hours for appropriate climate zone [hours]*

Table 20. AC/HP Tune-Ups—Equivalent Full Load Cooling/Heating Hours[68]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = Capacity \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right) \times DF_S \times \frac{1\ kW}{1{,}000\ W}$$

Equation 17

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = Capacity \times \left(\frac{1}{HSPF_{pre}} - \frac{1}{HSPF_{post}}\right) \times DF_W \times \frac{1\ kW}{1{,}000\ W}$$

Equation 18

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[68] ENERGY STAR® Central AC/HP Savings Calculator. April 2009 update. https://www.energystar.gov/sites/default/files/asset/document/ASHP_Sav_Calc.xls.

Summer and winter demand savings are determined by applying a coincidence factor for each season. Winter peak demand savings are only applicable to heat pumps.

Where:

$DF_{S/W}$ = *Summer/winter peak demand factor (see Table 21)*

Table 21. AC/HP Tune-Ups—Demand Factors[69]

Season	DF
Summer[70]	0.87
Winter[71]	0.83

Deemed Energy Savings Tables

Applying the above algorithms results in the deemed energy savings per ton in Table 22. Heating savings are only applicable for heat pumps.

Table 22. AC/HP Tune-Ups—Energy Savings (kWh/ton)

Climate zone	Cooling (kWh/ton)	Heating (kWh/ton)
Zone 1: Amarillo	64.4	154.2
Zone 2: Dallas	108.6	110.2
Zone 3: Houston	124.6	92.4
Zone 4: Corpus Christi	166.8	63.7
Zone 5: El Paso	85.9	127.9

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[69] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[70] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[71] ACCA Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and adjusting for the average ratio of heating-to-cooling capacity, the guideline leads to a demand factor of 0.96 / 1.15 = 0.83.

Deemed Summer Demand Savings Tables

Applying the above algorithms results in the deemed summer demand savings per ton in Table 23.

Table 23. AC/HP Tune-Ups—Summer Peak Demand Savings (kW/ton)

Climate zone	Summer kW/ton
Zone 1: Amarillo	0.036
Zone 2: Dallas	0.040
Zone 3: Houston	0.036
Zone 4: Corpus Christi	0.033
Zone 5: El Paso	0.044

Deemed Winter Demand Savings Tables

Applying the above algorithms results in the deemed winter demand savings per ton in Table 24. Winter peak demand savings are only applicable for heat pumps.

Table 24. AC/HP Tune-Ups—Peak Demand Savings (kW/ton)

Climate zone	Winter kW/ton
Zone 1: Amarillo	0.033
Zone 2: Dallas	0.025
Zone 3: Houston	0.028
Zone 4: Corpus Christi	0.024
Zone 5: El Paso	0.036

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for a tune-up is five years.[72]

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[72] GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group; Page 1-3, Table 1. https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone or county
- Manufacturer
- Model Number
- Cooling capacity of the installed unit (tons)
- Heating capacity of the installed unit (algorithm approach only)
- Type of unit (air conditioner, air source heat pump)
- Serial number
- Refrigerant type
- Target superheat or subcooling
- Post tune-up superheat or subcooling
- Amount of refrigerant added or removed
- Static pressures before and after tune-up
- Return and supply dry bulb and wet bulb temperatures
- Before and after tune-up pictures of components illustrating condition change due to cleanings (Note: pictures that include well-placed familiar objects like hand tools often provide a sense of scale and a reference for color/shading comparisons. Pictures of equipment name plates are useful).

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 25. AC/HP Tune-Ups—History

TRM version	Date	Description of change
v4.0	10/10/2015	TRM v4.0 origin.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.

TRM version	Date	Description of change
v8.0	10/2020	TRM v8.0 update. Updated coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated coincidence factors.

2.2.2 Central Heat Pumps Without SEER2 Ratings Measure Overview

TRM Measure ID: R-HV-CH

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive, direct install (early retirement)

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering spreadsheets and estimates

Measure Description

Residential replacement of existing heating and cooling equipment with a new central air-source heat pump (HP) without a SEER2 rating in an existing building, or the installation of a new central AC or HP in a new residential construction. Downsized systems that are right-sized per heat load calculation are also eligible. A new central system includes an entire packaged unit or a split system consisting of an indoor unit with a matching remote condensing unit. This measure also applies to the installation of dual-fuel HPs that meet all existing measure eligibility criteria.

This measure is a one-year allowance that will be retired for program year 2024. It is only applicable to HPs based on a sell-through allowance for units manufactured prior to January 1, 2023.

Eligibility Criteria

This measure only applies to HPs without a SEER2 rating. For units that do not have SEER2 ratings at the time of purchase but that have SEER2 ratings added to the Air Conditioning, Heating, and Refrigeration Institute (AHRI) prior to evaluation, the baselines in this measure will apply if project documentation can demonstrate that no SEER2 rating was available at the time of purchase. Appropriate documentation may include a copy of the AHRI certificate, manufacturer specification sheet, or other evaluator pre-approved documentation dated to match approximate installation or purchase date.

Newly-installed units must have a cooling capacity of less than 65,000 Btu/hour (5.4 tons) to be eligible for these deemed savings.

Equipment shall be properly sized to dwelling based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) or Air Conditioning Contractors of America Association, Inc. (ACCA) Manual J standards. Manufacturer datasheets for installed equipment or documentation of AHRI or the Department of Energy (DOE) Compliance

Certification Management System (CCMS) certification must be provided[73,74]. Savings should be calculated using rated capacities whenever possible. Reported system capacities and efficiencies should always match those verified by AHRI or DOE as tested under AHRI operating conditions for a specific combination of equipment, including condenser, coil, and furnace (or condenser only for packaged units). Savings should never be calculated using efficiency ratings for individual system components.

Customers should be advised against using the emergency heat (EM HEAT) setting on heat pump thermostats. This setting is meant only for use in emergency situations when the heat pump is damaged or malfunctioning. Supplemental heating automatically kicks on in below-freezing conditions using the regular HEAT setting. Contractors installing a new heat pump thermostat with equipment install shall advise customer of correct thermostat usage.

For early retirement projects, to receive savings, the unit to be replaced must be functioning at the time of removal with a maximum age of 20 years. Otherwise, claim savings for a replace-on-burnout project. Additional guidance for systems applying the default age is provided in the Savings Algorithms and Input Variables section.

The replacement of an evaporative cooler with a refrigerated system is eligible where the decision to change equipment types predates or is independent of the decision to install efficient equipment and should be claimed against the new construction baseline.

The replacement of a room AC with a central HP is eligible and should be claimed against the new construction baseline. Refer to the Replace-on-burnout or Early Retirement of an Electric Resistance Furnace section for guidance about the appropriate heating baseline for residences with electric resistance heat. Under this scenario, no savings should be awarded for rightsizing.

New construction projects are not eligible to receive deemed savings for system rightsizing.[75] For system upsizing, savings should generally be claimed against the new construction baseline; however, upsizing is allowed for the following scenarios outlined below. In these cases, savings may be claimed against the applicable replace-on-burnout or early retirement scenario if the specified conditions are met. For these scenarios, savings must be determined using the lower pre-tonnage.

- Replacing a single, larger-capacity system with multiple, smaller-capacity systems where the total pre- and post-tonnage are within one-half ton.[76] If the multiple installed units do not share the same efficiency value, savings should be determined using the most conservative efficiency value.
- Replacing a single-stage system with a multi-stage system operating at variable speeds where the total pre- and post-tonnage are within one-half ton.[77] This scenario does not apply to the replacement of a multi-stage unit with another multi-stage unit.

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[73] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.

[74] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

[75] For projects using a custom baseline, see TRM Volume 4.

[76] This exception is allowed to account for efficiency improvements due to zoning that are not reflected in the current savings methodology.

[77] This exception is allowed to account for efficiency improvements due to operating at variable speeds that are not reflected in the current savings methodology.

- If a Manual J load calculation is completed and included with project documentation, upsizing will be allowed where the total pre- and post-tonnage are within one ton.[78] This guidance is also extended to the previous scenarios when a Manual J load calculation is provided.

Additionally, low-income or hard-to-reach programs may use the electric resistance baseline for the following two scenarios:

- The electric resistance baseline may be used for systems upsized by no more than a half-ton in lieu of the new construction baseline. Under this scenario, cooling savings should be claimed against the new construction baseline using the installed (higher) capacity. Heating savings should be claimed against the electric resistance baseline using the existing (lower) capacity. Documentation should be aligned with the rightsizing and electric resistance baseline requirements outlined in this measure.
- The second scenario is for a major multifamily renovation when a centralized system, such as a boiler, is replaced with individual heat pumps. For this scenario, the electric resistance baseline may be claimed in lieu of new construction only if the building owner can document intent to install electric resistance furnaces without program intervention. The cooling savings should still be claimed against the new construction baseline. Documentation should follow early retirement and electric resistance baseline requirements.

When replacing a single unit with multiple units where the capacity is the same or has been downsized, savings should be looked up using the total system pre and post capacities. Again, if the multiple installed units do not share the same efficiency value, savings should be looked up using the most conservative efficiency value.

Baseline Condition

New Construction, Replace-on-Burnout, or Early Retirement of an Air-Source AC or HP

New construction baseline efficiency values for HPs are compliant with the previous federal standard,[79] effective January 1, 2015. The baseline is assumed to be a new system with an AHRI-listed SEER rating of 14.0. This baseline is also applicable to HP installations replacing ACs with central gas heat, evaporative coolers with central, space, or no heating, or room/window ACs with central, space, or no heating.

For replace-on-burnout (ROB) projects, the cooling baseline is reduced to 13.08 SEER. This value incorporates an adjustment to the baseline SEER value to reflect the percentage of current replacements that do not include the installation of an AHRI-matched system.[80]

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[78] This exception is allowed to account for efficiency improvements due to replacing a unit that was operating longer than designed to keep up with actual site load conditions.

[79] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

[80] Frontier Energy on behalf of the Electric Utility Marketing Managers of Texas (EUMMOT). “Petition to revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat

For early retirement projects, the cooling baseline is reduced to 10 SEER for systems installed before January 23, 2006. For systems installed on or after January 23, 2006, the ER baseline increases to 12.44 SEER. Systems manufactured as of January 1, 2015, are not eligible for early retirement.

For ROB projects, heating baseline efficiency values for HPs are compliant with the current federal minimum standard, effective January 1, 2015. These standards specify an HSPF of 8.2 for split systems and 8.0 for packaged systems. This baseline reflects updates to federal standards that take effect on January 1, 2015, as defined in the Department of Energy (DOE) energy efficiency standards (10 CFR Part 430).[81] For ER projects where the existing system was installed on or after January 23, 2006, the heating baseline efficiency is assumed to be an HSPF of 7.7 based on the federal minimum standard in effect from January 23, 2006, through December 31, 2014.[82] For ER projects where the existing system was installed before January 23, 2006, the heating baseline efficiency is reduced to 6.8 HSPF based on the federal minimum standard in effect prior to January 23, 2006.

Replace-on-Burnout or Early Retirement of an Electric Resistance Furnace

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[83] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[84] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters should calculate savings using a HP baseline.

By the nature of the technology, all electric resistance furnaces have the same efficiency with HSPF = 3.41.[85] Projects in which an electric resistance furnace is replaced, either in replace-on-burnout or early retirement scenarios, use this baseline for heating-side savings.

Table 26. Central HPs—Efficiencies

Project type	Cooling mode	Heating mode
New construction	14 SEER	8.2 HSPF
Replace-on-burnout, heat pump	13.08 SEER	8.2 HSPF
Replace-on-burnout, electric resistance furnace		3.41 HSPF
Early retirement, heat pump (manufactured as of 1/1/2015)	13.08 SEER	8.2 HSPF
Early retirement, heat pump (manufactured 1/23/2006 through 12/31/2014)	12.44 SEER	7.7 HSPF

Pump Systems: Docket No. 36780." Public Utility Commission of Texas. Approved August 27, 2009. https://interchange.puc.texas.gov/. Adapted for new 14 SEER baseline.

[81] *10 CFR Part 430.32(c)2. Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule*. Online. Available: http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

[82] Ibid.

[83] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[84] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[85] COP = HSPF × 1,055 J/BTU / 3,600 J/W-hr. For Electric Resistance, heating efficiency is 1 COP. Therefore, HSPF = 1 × 3,600 / 1,055 = 3.41.

Project type	Cooling mode	Heating mode
Early retirement, electric resistance furnace (manufactured 1/23/2006 through 12/31/2014)	12.44 SEER	3.41 HSPF
Early retirement, heat pump (when applying default age)		7.7 HSPF
Early retirement, electric resistance furnace (when applying default age)		3.41 HSPF
Early retirement, heat pump (manufactured before 1/23/2006)	10 SEER	6.8 HSPF
Early retirement, electric resistance furnace (manufactured before 1/23/2006)		3.41 HSPF

High-Efficiency Condition

Table 27 displays the Consortium for Energy Efficiency (CEE) requirements for eligible Tier 0 HPs as of January 1, 2015. Energy efficiency service providers are expected to at least comply with the latest CEE Tier 0 requirements.

Since there is no full-load efficiency requirement specified in the current federal standard, systems that comply with SEER and HSPF requirements but do not comply with the EER requirements outlined in Table 27 may still be eligible to claim savings. Systems with qualifying SEER and HSPF energy ratings are permitted to claim cooling energy savings, heating energy savings, and winter demand savings for systems, but not summer demand savings where the EER does not comply with the below requirement.

Table 27. Central HPs—Tier 0 Requirements[86]

SEER	EER	HSPF
14.5	12.0	8.5

Split system efficiencies are driven primarily by the efficiency of the condenser unit. If the paired outdoor and indoor units are not listed on the AHRI certification listing and only provide DOE CCMS testing results, then the capacity and efficiency of the high efficiency condition shall not exceed the average of the AHRI certification listing pairing for the matching condenser. The DOE CCMS listing provides documentation of the results that are on the AHRI certification listing and can be downloaded and filtered based on listing using a similar condenser and various indoor units.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy and demand savings algorithms and associated input variables are listed below.

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[86] CEE Residential High Efficiency Central Air Conditioners and Air Source Heat Pumps Specification, January 1, 2015. https://library.cee1.org/content/cee-residential-high-efficiency-central-air-conditioners-and-air-source-heat-pumps-specifica.

For early retirement or rightsizing projects, attempt to determine the rated capacity of the existing unit. The rated capacity may be found on the manufacturer specification sheet for the existing unit if the new system is not available on the AHRI or DOE CCMS directories. If the model number of the existing unit is unobtainable or if the manufacturer specification sheet cannot be found, use nominal tonnage for both the existing and new unit. Never use nominal tonnage for the existing unit in combination with rated tonnage for the new unit, which can lead to overstated savings. Additionally, never use nominal tonnage to determine savings for projects where no early retirement or rightsizing has occurred.

Replace-on-Burnout or New Construction

Energy, summer demand, and winter demand savings were estimated using AC and HP performance curves developed by the National Renewable Energy Laboratory[87] for typical units in each of the following SEER ranges:

- Baseline units
- 14.5–14.9
- 15.0–15.9
- 16.0–16.9
- 17.0–17.9
- 18.0–20.9
- 21.0 and above

14.5–16.9 SEER units were assumed to be single-stage. 17.0 and above SEER units were assumed to be multi-stage cooling units.

These performance curves provide the capacity and efficiency of HPs operating in cooling mode across a wide range of outside air temperatures. Unit loading was estimated as a function of outside air temperature, and hours of cooling mode operation under different loadings were estimated using bin weather data for each weather zone. In heating mode, predicted HVAC operation was limited to meeting 77 percent of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions. This approach accounts for the observation that heating systems are not always operated even when outdoor conditions indicate they should.

Summer and winter demand savings were estimated according to the expected unit performance under design conditions. For all weather zones, it is assumed that typical HVAC systems are sized to 115 percent of their design cooling load (oversized by 15 percent). Heating mode capacity was related to rated cooling capacity using the rated capacity in the cooling and heating mode of the residential market HP products of four major manufacturers according to data exported from AHRI. Data were exported from the AHRI directory, and the average ratio for each equipment size of heating capacity to cooling capacity was multiplied by the rated (cooling side) capacity to estimate the HP capacity. HP system output was then compared to its loading under design conditions.

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[87] D. Cutler et al. Improved Modeling of Residential Air Conditioners and Heat Pumps for Energy Calculations. National Renewable Energy Laboratory. NREL/TP-5500-56354. January 2013. Tables 12 and 13. http://www.nrel.gov/docs/fy13osti/56354.pdf.

The model used the following set of normalized performance curves to scale the rated performance values as a function of outdoor dry-bulb temperature ranging from 65 to 115 degrees Fahrenheit. The total capacity and energy input ratio (EIR = 1/COP) curves are a function of entering wet-bulb temperature (EWB) and outdoor dry-bulb temperature (ODB) and are both quadratic curve fits of the form:

$$y = a + b \times T_{EWB} + c \times T_{EWB}^2 + d \times T_{ODB} + e \times T_{ODB}^2 + f \times T_{EWB} \times T_{ODB}$$

Equation 19

Table 28. Central HPs—Curve Coefficients[88]

Coeff.	Cooling			Heating		
		Multi-stage/speed			Multi-stage/speed	
	Single-stage	Low	High	Single-stage	Low	High
a	3.670270705	3.940185508	3.109456535	0.566333415	0.335690634	0.306358843
b	-0.098652414	-0.104723455	-0.085520461	-0.000744164	0.002405123	0.005376987
c	0.000955906	0.001019298	0.000863238	-0.0000103	-0.0000464	-0.0000579
d	0.006552414	0.006471171	0.00863049	0.009414634	0.013498735	0.011645092
e	-0.0000156	-0.00000953	-0.000021	0.0000506	0.0000499	0.0000591
f	-0.000131877	-0.000161658	-0.000140186	-0.00000675	-0.00000725	-0.0000203

Table 29. Central HPs—Curve Coefficients[89]

Coeff.	Cooling			Heating		
		Multi-stage/speed			Multi-stage/speed	
	Single-stage	Low	High	Single-stage	Low	High
a	-3.302695861	-3.87752688	-1.990708931	0.718398423	0.36338171	0.981100941
b	0.137871531	0.164566276	0.093969249	0.003498178	0.013523725	-0.005158493
c	-0.001056996	-0.001272755	-0.00073335	0.000142202	0.000258872	0.000243416
d	-0.012573945	-0.019956043	-0.009062553	-0.005724331	-0.009450269	-0.005274352
e	0.000214638	0.000256512	0.000165099	0.00014085	0.000439519	0.000230742
f	-0.000145054	-0.000133539	-0.0000997	-0.000215321	-0.000653723	-0.000336954

To estimate the baseline SEER value for retrofit installations, Texas A&M’s Energy Systems Laboratory (ESL) surveyed dealers across the State to determine installation practices. The research found that in the event of a compressor failure out of warranty, dealers replaced the compressor 11.7 percent of the time, and replaced the condensing unit 88.3 percent of the time. Further, the condensing unit replacements consist of condensing unit-only replacements, replacements with mismatched evaporator coils, and replacements with matching evaporator coils. The percentages for these installations are as follows:

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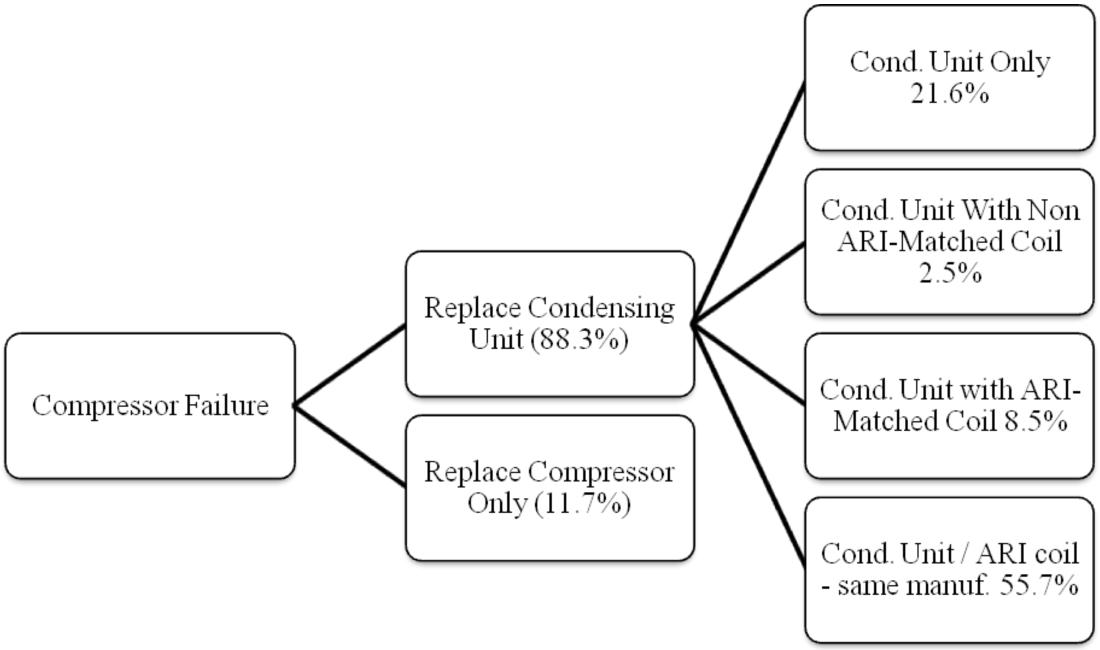
[88] Using air conditioner capacity curve coefficients for heat pump cooling savings.
[89] Using air conditioner capacity EIR coefficients for heat pump cooling savings.

Figure 1. Central HPs—Unit Replacement Percentages upon Compressor Failure



Source: Docket No. 36780

To calculate a weighted average SEER for these installations, ESL assumed that a compressor-only replacement resulted in no increase in SEER and that the SEER of a condensing unit installed without a matching coil would be 85 percent of the SEER value for a matched system. The ESL estimate of the baseline SEER for replacement AC units is given by the following equation:

$$\begin{aligned} SEER_{Base} = {} & \left(SEER_{Compressor\ Replacement}\right) \times (Actual\ \%\ Compressor\ Replacement) \\ & + \left(SEER_{Condenser\ Replacement}\right) \times (Actual\ \%\ Condenser\ Replacement) \\ & + \left(SEER_{System\ Replacement}\right) \times (Actual\ \%\ System\ Replacement) \end{aligned}$$

Equation 20

Substituting ESL SEER estimates and survey data provides the following baseline SEER estimate:

$$SEER_{Base} = (9.5) \times (11.7\%) + (11.05) \times (24.1\%) + (13.5) \times (64.2\%) = 12.44$$

Adjusting for the increased 14 SEER baseline:

$$SEER_{Base} = (10.5) \times (11.7\%) + (11.9) \times (24.1\%) + (14) \times (64.2\%) = 13.08$$

In new construction, there is no possibility of a partial system (e.g., condensing unit-only) change out, so the 13.08 baseline would not be appropriate. Therefore, the baseline for new construction installations is set at the federal government's minimum efficiency standard of 14 SEER.

Early Retirement

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL).

Annual energy and summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 30 or Table 31). If individual system components were installed at separate times, use the condenser age as a proxy for the entire system. For HPs replacing an AC with an electric resistance furnace, use the AC RUL table.*

EUL = *Estimated useful life = 15 years*

For early retirement, if age is unknown, assume a default age equal to the replaced unit EUL resulting in an RUL of 7 (ACs) or 6 years (HPs). Default age may be used exclusively if applied consistently for all early retirement projects. This is the only scenario where an early retirement baseline can be applied to systems older than 24 years for ACs and 20 years for HPs. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible. Default early retirement baselines are specified in Table 26 for use with the default age.

Table 30. Central HPs—RUL of Replaced AC[90]

Age of replaced unit (years)	Remaining useful life (years)	Age of replaced unit (years)	Remaining useful life (years)
1	16.8	14	8.6
2	15.8	15	8.2
3	14.9	16	7.9
4	14.1	17	7.6
5	13.3	18	7.0
6	12.6	19	6.0

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[90] Current federal standard effective date is 1/1/2015. Existing systems manufactured after this date are not eligible to use the early retirement baseline and should use the ROB baseline instead.

Age of replaced unit (years)	Remaining useful life (years)
7	11.9
8	11.3
9	10.8
10	10.3
11	9.8
12	9.4
13	9.0
20	5.0
21	4.0
22	3.0
23	2.0
24	1.0
25[91,92]	0.0

Table 31. Central HPs—RUL of Replaced HP[93]

Age of replaced unit (years)	Remaining useful life (years)
1	13.7
2	12.7
3	12.0
4	11.3
5	10.7
6	10.2
7	9.7
8	9.3
9	8.9
10	8.5
11	8.2
12	7.9
13	7.6
14	7.0
15	6.0
16	5.0
17	4.0
18	3.0
19	2.0
20	1.0
21[94,95]	0.0

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[91] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (see Figure 2). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for early replacement of residential equipment,” for further detail.

[92] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for early replacement of residential equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team’s SharePoint.

[93] Current federal standard effective date is 1/1/2015. Existing systems manufactured after this date are not eligible to use the early retirement baseline and should use the ROB baseline instead.

[94] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (Figure 3). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for early replacement of residential equipment,” for further detail.

[95] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for early replacement of residential equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team’s SharePoint.

Derivation of RULs

HPs have an estimated useful life of 15 years. This estimate is consistent with the age at which approximately 50 percent of HPs installed in a given year will no longer be in service, as described by the survival function in Figure 2 and Figure 3.

Figure 2. Central AC/HPs—AC Survival Function[96]

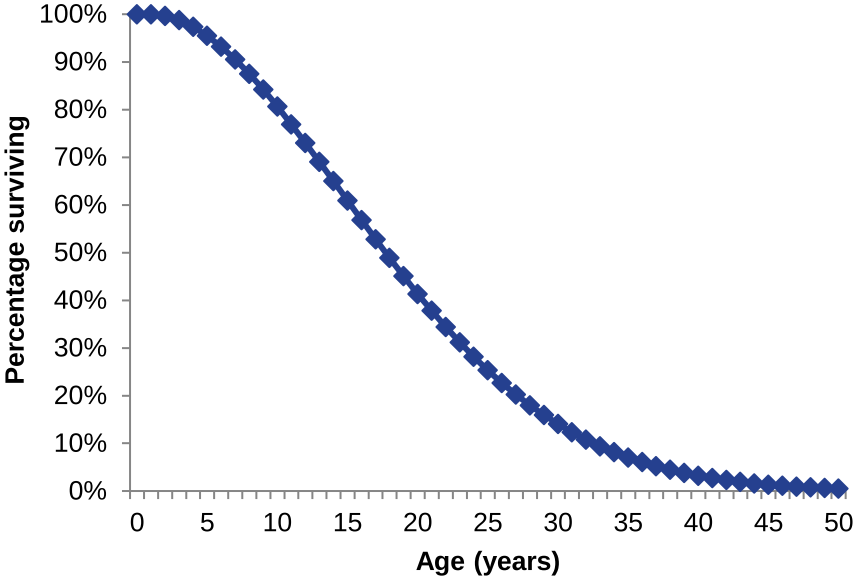
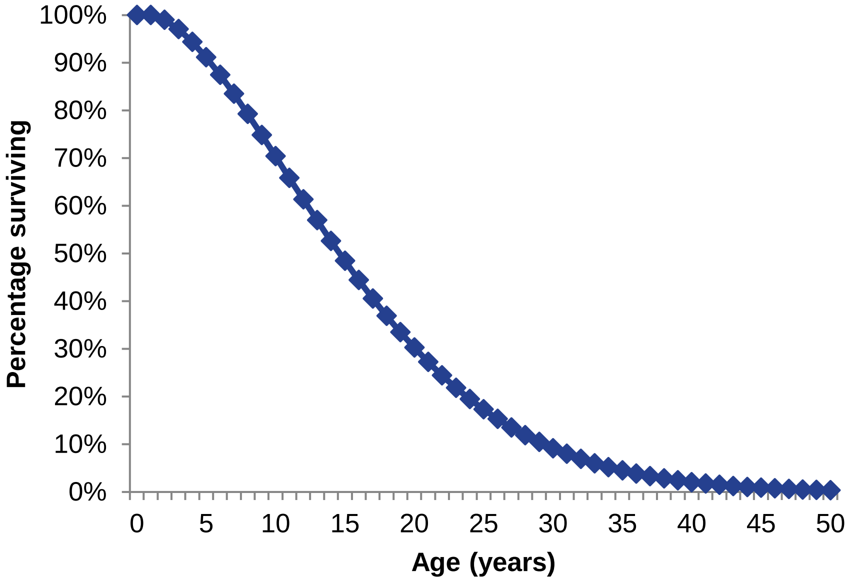


Figure 3. Central AC/HPs—HP Survival Function[97]



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[96] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: https://www.regulations.gov/document/EERE-2011-BT-STD-0011-0012.

[97] Ibid.

The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 3. The age of the system being replaced is found on the horizontal axis, and the corresponding percentage of surviving system is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. The age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

Deemed Energy Savings Tables[98]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[99] Both cooling and heating savings are specified according to AHRI-rated cooling capacity.

Deemed Summer Demand Savings Tables[100]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[101] Summer demand savings are specified according to AHRI-rated cooling capacity.

Deemed Winter Demand Savings Tables[102]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[103] Winter demand savings are specified according to AHRI-rated cooling capacity.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

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[98] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[99] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

[100] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[101] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

[102] Rated capacity ranges are specified with a 5 percent tolerance in accordance with AHRI Standard 210/240 to account for systems that are rated slightly below the applicable nominal capacity. AHRI Standard 210/240. Table J1. https://www.ahrinet.org/sites/default/files/2022-07/AHRI_Standard_210-240_2017.pdf.

[103] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 15 years for HPs based on the DOE 76 Final Rule 37408 Technical Support Document for Energy Conservation Standards for central ACs and HPs.[104]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Decision/action type (early retirement, replace-on-burnout, new construction)
- Cooling capacity of the newly installed unit (Btuh)
- Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ratio (EER) of the newly installed unit
- Heating Seasonal Performance Factor (HSPF) of the newly installed unit (HPs only)
- Type of unit replaced (AC with gas furnace, AC with electric resistance furnace, air source HP)
- Baseline equipment used for savings (if different from unit replaced)
- Type of unit installed (central HP or dual-fuel HP)
- Compressor type for newly-installed unit (single-stage, multi-stage, variable speed)
  - Recommended to assist with development of future deemed savings for multi-stage systems operating at variable speeds
- Age of the replaced unit (early retirement only unless default EUL is applied consistently across the program)
- Retired or replaced heating unit model number, serial number, manufacturer, and heating capacity (electric resistance only)
  - Photograph of retired heating unit nameplate, utility inspection, or other evaluator-approved approach. Sampling is allowed for multifamily complexes.
- Retired cooling unit model number, serial number, manufacturer, and cooling capacity (rightsizing or early retirement unless default EUL is applied consistently across the program)
- Manual J load calculation (when rightsizing upward by more than one-half tons). See Eligibility Criteria section for applicable scenarios
- Photograph of retired cooling unit nameplate (required for all rightsizing and early

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[104] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. https://www.regulations.gov/document/EERE-2011-BT-STD-0011-0012.

retirement projects unless default age is applied consistently across the program)

    - If a photograph of the retired unit nameplate is unavailable or not legible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (early retirement only)
    - If a photograph of the retired unit nameplate is unavailable or not legible, provide estimated square footage of conditioned area served by the retired unit (rightsizing only)

- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only). This requirement also applies to projects using the default age.
- If replacing an evaporative cooler, application should include a statement that the customer decision to change equipment types predates or is independent of the decision to install efficient equipment
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or other pre-approved method of installation verification
- Manufacturer, model, and serial number of newly installed unit
    - AHRI/DOE CCMS certificate or reference number matching manufacturer and model number
- AHRI certificate or manufacturer specification sheet with date corresponding to time of application or purchase demonstrating that the unit does not have a SEER2 efficiency rating.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 32. Central HPs—History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Low-income and hard-to-reach Market Transformation section merged with main measure as “early retirement” option. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. early retirement savings may be claimed through any appropriately designed program in accordance with EM&V team’s memo, “Considerations for early replacement of residential equipment.” Remaining useful lifetimes updated.
v3.1	11/05/2015	TRM v3.1 update. Revision of cooling savings to reflect heat-pump-specific performance curves. Extension of early retirement cooling savings tables to higher SEER values. Clarification around summer demand savings for single-stage and two-stage units.
v4.0	10/10/2016	TRM v4.0 update. Added RUL value for units with an age of one year. Added a default RUL value for when the age of the unit is unknown. Eliminated the eligibility requirement of the existing unit to have a minimum age of five years. Updated savings for 15.0-15.9 SEER range.
v5.0	10/2017	TRM v5.0 update. Switched to air conditioner capacity and EIR curve coefficients for estimated heat pump cooling savings. Updated energy savings to use TMY3 temperature bin hours. Updated demand savings for compliance with current peak definition. Added 12.44 SEER and 6.8 HSPF baseline savings tables previously referencing earlier version of TRM. Updated baseline to include replacing air conditioners with gas heat.
v6.0	11/2018	TRM v6.0 update. Updated baseline and eligibility requirements. Added rightsizing savings for replace on burnout in winter demand tables. Added language clarifying use of rated capacity vs nominal and updated the deemed savings tables to show rated Btuh. Clarified required documentation for early retirement.
v7.0	10/2019	TRM v7.0 update. Consolidated central air conditioner and heat pump measures. Moved deemed savings tables to Appendix A. Updated eligibility for low-income and hard-to-reach.
v8.0	10/2020	TRM v8.0 update. Clarified early retirement age eligibility. Updated electric resistance baseline documentation.
v9.0	10/2021	TRM v9.0 update. Updated early retirement age eligibility. Clarified eligibility for systems where EER does not meet CEE Tier 0 requirements.
v10.0	10/2022	TRM v10.0 update. Restricted measure for use with central HPs without a SEER2 rating. Updated early retirement age eligibility.

2.2.3 Mini-Split Heat Pumps Without SEER2 Ratings Measure Overview

TRM Measure ID: R-HV-MS

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive, direct Install (early retirement)

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering spreadsheets and estimates

Measure Description

Residential replacement of existing heating and cooling equipment with a new mini-split heat pump (HP) without a SEER2 rating in an existing building, or the installation of a new mini-split AC or HP in a new residential construction. Downsized systems that are right-sized per a heat load calculation are also eligible. This measure also applies to the installation of DC inverter systems that meet all existing measure eligibility criteria.

This measure is a one-year allowance that will be retired for program year 2024. It is only applicable to HPs based on a sell-through allowance for units manufactured prior to January 1, 2023.

Additional savings may be available for duct removal in combination with the installation of a ductless mini-split. In these cases, refer to the *duct sealing* measure and follow the savings methodology (standard approach) using a value of 0 CFM as the post-improvement duct leakage. Leakage testing must be performed on the existing ductwork to claim savings for duct removal.

Eligibility Criteria

This measure only applies to HPs without a SEER2 rating. For units that do not have SEER2 ratings at the time of purchase but that have SEER2 ratings added to the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) prior to evaluation, the baselines in this measure will apply if project documentation can demonstrate that no SEER2 rating was available at the time of purchase. Appropriate documentation may include a copy of the AHRI certificate, manufacturer specification sheet, or other evaluator pre-approved documentation dated to match approximate installation or purchase date.

Newly installed units must have a cooling capacity of less than 65,000 Btu/hour (5.4 tons) to be eligible for these deemed savings.

Equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards. Manufacturer datasheets for new equipment or documentation of AHRI or DOE CCMS certification must be provided[105,106]. Savings should be calculated using rated capacities whenever possible. Reported system capacities and efficiencies should always match those verified by AHRI or DOE as tested under AHRI operating conditions for a specific combination of equipment, including condenser, coil, and furnace (or condenser only for packaged units). Savings should never be calculated using efficiency ratings for individual system components.

Customers should be advised against using the emergency heat (EM HEAT) setting on heat pump thermostats. This setting is meant only for use in emergency situations when the heat pump is damaged or malfunctioning. Supplemental heating automatically kicks on in below-freezing conditions using the regular HEAT setting. Contractors installing a new heat pump thermostat with equipment install shall advise customer of correct thermostat usage.

For early retirement projects, to receive savings, the unit to be replaced must be functioning at the time of removal with a maximum age of 20 years. Otherwise, claim savings for a replace on burnout project. Additional guidance for systems applying the default age is provided in the Savings Algorithms and Input Variables section.

The replacement of a room AC with a mini-split HP is eligible and should be claimed against the new construction baseline. Refer to the Replace-on-burnout or Early Retirement of an Electric Resistance Furnace section for guidance about the appropriate heating baseline for residences with electric resistance heat. Under this scenario, no savings should be awarded for rightsizing.

Replacement of an evaporative cooler with a mini-split system is eligible where the decision to change equipment types predates or is independent of the decision to install efficient equipment and should be claimed against the new construction baseline.

New construction projects are not eligible to receive deemed savings for system rightsizing.[107] For system upsizing, savings should generally be claimed against the new construction baseline. However, upsizing is allowed for scenarios outlined below. In these cases, savings may be claimed against the applicable replace-on-burnout or early retirement scenario if the specified conditions are met. For these scenarios, savings must be determined using the lower pre-tonnage.

- Replacing a single larger-capacity system with multiple smaller-capacity systems where the total pre- and post-tonnage are within one-half ton.[108] If the multiple installed units do not share the same efficiency value, savings should be determined using the most conservative efficiency value.

- Replacing a single-stage system with a multi-stage system operating at variable

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[105] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.

[106] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

[107] For projects using a custom baseline, see TRM Volume 4.

[108] This exception is allowed to account for efficiency improvements due to zoning that are not reflected in the current savings methodology.

speeds where the total pre- and post-tonnage are within one-half ton.[109] This scenario does not apply to the replacement of a multi-stage unit with another multi-stage unit.

- If a Manual J load calculation is completed and included with project documentation, upsizing will be allowed where the total pre- and post-tonnage are within one ton.[110] This guidance is also extended to the previous scenarios when a Manual J load calculation is provided.

Additionally, low-income or hard-to-reach programs may use the electric resistance baseline for the following two scenarios. The electric resistance baseline may be used for systems upsized by no more than a half-ton in lieu of the new construction baseline. Under this scenario, cooling savings should be claimed against the new construction baseline using the installed (higher) capacity. Heating savings should be claimed against the electric resistance baseline using the existing (lower) capacity. Documentation should be aligned with the rightsizing and electric resistance baseline requirements outlined in this measure. The second scenario is for a major multifamily renovation when a centralized system, such as a boiler, is replaced with individual heat pumps. For this scenario, the electric resistance baseline may be claimed in lieu of new construction only if the building owner can document intent to install electric resistance furnaces without program intervention. The cooling savings should still be claimed against the new construction baseline. Documentation should follow early retirement and electric resistance baseline requirements.

When replacing a single unit with multiple units where the capacity is the same or has been downsized, savings should be looked up using the total system pre and post capacities. Again, if the multiple installed units do not share the same efficiency value, savings should be looked up using the most conservative efficiency value.

Baseline Condition

New Construction, Replace-on-Burnout, or Early Retirement of an Air-Source AC or HP

New construction baseline efficiency values for HPs are compliant with the previous federal standard,[111] effective January 1, 2015. The baseline is assumed to be a new system with an AHRI-listed SEER rating of 14.0. This baseline is also applicable to HP installations replacing ACs with central gas heat, evaporative coolers with central, space, or no heating, or room/window ACs with central, space, or no heating.

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[109] This exception is allowed to account for efficiency improvements due to operating at variable speeds that are not reflected in the current savings methodology.

[110] This exception is allowed to account for efficiency improvements due to replacing a unit that was operating longer than designed to keep up with actual site load conditions.

[111] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

For replace-on-burnout projects, the cooling baseline is reduced to 13.08 SEER. This value incorporates an adjustment to the baseline SEER value to reflect the percentage of current replacements that do not include the installation of an AHRI-matched system.[112]

For early retirement projects, the cooling baseline is reduced to 10 SEER for systems installed before January 23, 2006. For systems installed on or after January 23, 2006, the ER baseline increases to 12.44 SEER. Systems manufactured as of January 1, 2015, are not eligible for early retirement.

For ROB projects, heating baseline efficiency values for HPs are compliant with the current federal minimum standard, effective January 1, 2015. These standards specify an HSPF of 8.2 for split systems, or 8.0 for packaged systems. This baseline reflects updates to federal standards that took effect on January 1, 2015, as defined in the Department of Energy (DOE) energy efficiency standards (10 CFR Part 430).[113] For ER projects where the existing system was installed on or after January 23, 2006, the heating baseline efficiency is assumed to be an HSPF of 7.7 based on the federal minimum standard in effect from January 23, 2006, through December 31, 2014.[114] For ER projects where the existing system was installed before January 23, 2006, the heating baseline efficiency is reduced to 6.8 HSPF based on the federal minimum standard in effect prior to January 23, 2006.

Replace-on-Burnout or Early Retirement of an Electric Resistance Furnace

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[115] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[116] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters should calculate savings using a HP baseline.

By the nature of the technology, all electric resistance furnaces have the same efficiency with HSPF = 3.41.[117] Projects in which an electric resistance furnace is replaced, either in replace-on-burnout or early retirement scenarios, use this baseline for heating-side savings.

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[112] Frontier Energy on behalf of the Electric Utility Marketing Managers of Texas (EUMMOT). “Petition to revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems: Docket No. 36780.” Public Utility Commission of Texas. Approved August 27, 2009. https://interchange.puc.texas.gov/Documents/36780_41_624513.PDF. Adapted for new 14 SEER baseline.

[113] *10 CFR Part 430.32(c)2. Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule*. Online. Available: https://www.govinfo.gov/content/pkg/CFR-2016-title10-vol3/xml/CFR-2016-title10-vol3-part430.xml.

[114] Ibid.

[115] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[116] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[117] COP = HSPF × 1,055 J/BTU / 3,600 J/W-hr. For Electric Resistance, heating efficiency is 1 COP. Therefore, HSPF = 1 × 3,600 / 1,055 = 3.41.

Table 33. Mini-Split HPs—Baseline Efficiencies

Project type	Cooling mode	Heating mode
New construction	14 SEER	8.2 HSPF
Replace-on-burnout, heat pump	13.08 SEER	8.2 HSPF
Replace-on-burnout, electric resistance furnace		3.41 HSPF
Early retirement, heat pump (manufactured as of 1/1/2015)	13.08 SEER	8.2 HSPF
Early retirement, heat pump (manufactured 1/23/2006 through 12/31/2014)	12.44 SEER	7.7 HSPF
Early retirement, electric resistance furnace (manufactured 1/23/2006 through 12/31/2014)		3.41 HSPF
Early retirement, heat pump (when applying default age)	12.44 SEER	7.7 HSPF
Early retirement, electric resistance furnace (when applying default age		3.41 HSPF
Early retirement, heat pump (before 1/23/2006)	10 SEER	6.8 HSPF
Early retirement, electric resistance furnace (before 1/23/2006)		3.41 HSPF

High-Efficiency Condition

Table 27 displays the Consortium for Energy Efficiency (CEE) requirements for eligible Tier 0 systems as of January 1, 2015. Energy efficiency service providers are expected to at least comply with the latest CEE Tier 0 requirements.

Since there is no full-load efficiency requirement specified in the current federal standard, systems that comply with SEER and HSPF requirements but do not comply with the EER requirements outlined in Table 27 may still be eligible to claim savings. Systems with qualifying SEER and HSPF energy ratings are permitted to claim cooling energy savings, heating energy savings, and winter demand savings for systems, but not summer demand savings where the EER does not comply with the below requirement.

Table 34. Mini-Split HPs—System CEE Tier 0 Requirements[118]

SEER	EER	HSPF
14.5	12.0	8.5

Split system efficiencies are driven primarily by the efficiency of the condenser unit. If the paired outdoor and indoor units are not listed on the AHRI certification listing and only provide DOE CCMS testing results, then the capacity and efficiency of the high efficiency condition shall not exceed the average of the AHRI certification listing pairing for the matching condenser. The DOE CCMS listing provides documentation of the results that are on the AHRI certification listing and can be downloaded and filtered based on listing using a similar condenser and various indoor units.

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[118] CEE Residential High Efficiency Central Air Conditioners and Air Source Heat Pumps Specification, January 1, 2015. https://library.cee1.org/content/cee-residential-high-efficiency-central-air-conditioners-and-air-source-heat-pumps-specifica.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy and demand savings algorithms and associated input variables are listed below.

For early retirement or rightsizing projects, attempt to determine the rated capacity of the existing unit. The rated capacity may be found on the manufacturer specification sheet for the existing unit if the new system is not available on the AHRI or DOE CCMS directories. If the model number of the existing unit is unobtainable or if the manufacturer specification sheet cannot be found, use nominal tonnage for both the existing and new unit. Never use nominal tonnage for the existing unit in combination with rated tonnage for the new unit, which can lead to overstated savings. Additionally, never use nominal tonnage to determine savings for projects where no early retirement or rightsizing has occurred.

Replace-on-Burnout or New Construction

Energy, summer demand, and winter demand savings were estimated using the AC and HP performance curves developed by the National Renewable Energy Laboratory[119] for typical units in each of the following SEER ranges:

- Baseline units
- 14.5–14.9
- 15.0–15.9
- 16.0–16.9
- 17.0–17.9
- 18.0–20.9
- 21.0 and above

14.5–16.9 SEER units were assumed to be single-stage. 17.0 and above SEER units were assumed to be multi-stage cooling units.

These performance curves provide the capacity and efficiency of HPs operating in cooling mode across a wide range of outside air temperatures. Unit loading was estimated as a function of outside air temperature, and hours of cooling mode operation under different loadings were estimated using bin weather data for each weather zone. In heating mode, predicted HVAC operation was limited to meeting 77 percent of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions. This approach accounts for the observation that heating systems are not always operated even when outdoor conditions indicate they should.

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[119] D. Cutler et al. Improved Modeling of Residential Air Conditioners and Heat Pumps for Energy Calculations. National Renewable Energy Laboratory. NREL/TP-5500-56354. January 2013. Tables 12 and 13. http://www.nrel.gov/docs/fy13osti/56354.pdf.

Summer and winter demand savings were estimated according to the expected unit performance under design conditions. For all weather zones, it is assumed that typical HVAC systems are sized to 115 percent of their design cooling load (oversized by 15 percent). Heating mode capacity was related to rated cooling capacity using the rated capacity in the cooling and heating mode of the residential market HP products of four major manufacturers according to data exported from AHRI. Data was exported from the AHRI directory, and the average ratio for each equipment size of heating capacity to cooling capacity was multiplied by the rated (cooling side) capacity to estimate the HP capacity. HP system output was then compared to its loading under design conditions.

The model uses the following set of normalized performance curves to scale the rated performance values as a function of outdoor dry-bulb temperature ranging from 65 to 115 degrees Fahrenheit. The total capacity and energy input ratio (EIR = 1/COP) curves are a function of entering wet-bulb temperature (EWB) and outdoor dry-bulb temperature (ODB) and are both quadratic curve fits of the form:

$$y = a + b \times T_{EWB} + c \times T_{EWB}^2 + d \times T_{ODB} + e \times T_{ODB}^2 + f \times T_{EWB} \times T_{ODB}$$

Equation 21

Table 35. Mini-Split HPs—Capacity Curve Coefficients[120]

Coeff.	Cooling			Heating		
	Single-stage	Multi-stage/speed		Single-stage	Multi-stage/speed	
		Low	High		Low	High
a	3.670270705	3.940185508	3.109456535	0.566333415	0.335690634	0.306358843
b	-0.098652414	-0.104723455	-0.085520461	-0.000744164	0.002405123	0.005376987
c	0.000955906	0.001019298	0.000863238	-0.0000103	-0.0000464	-0.0000579
d	0.006552414	0.006471171	0.00863049	0.009414634	0.013498735	0.011645092
e	-0.0000156	-0.00000953	-0.000021	0.0000506	0.0000499	0.0000591
f	-0.000131877	-0.000161658	-0.000140186	-0.00000675	-0.00000725	-0.0000203

Table 36. Mini-Split HPs—EIR Curve Coefficients[121]

Coeff.	Cooling			Heating		
	Single-stage	Multi-stage/speed		Single-stage	Multi-stage/speed	
		Low	High		Low	High
a	-3.302695861	-3.87752688	-1.990708931	0.718398423	0.36338171	0.981100941
b	0.137871531	0.164566276	0.093969249	0.003498178	0.013523725	-0.005158493
c	-0.001056996	-0.001272755	-0.00073335	0.000142202	0.000258872	0.000243416

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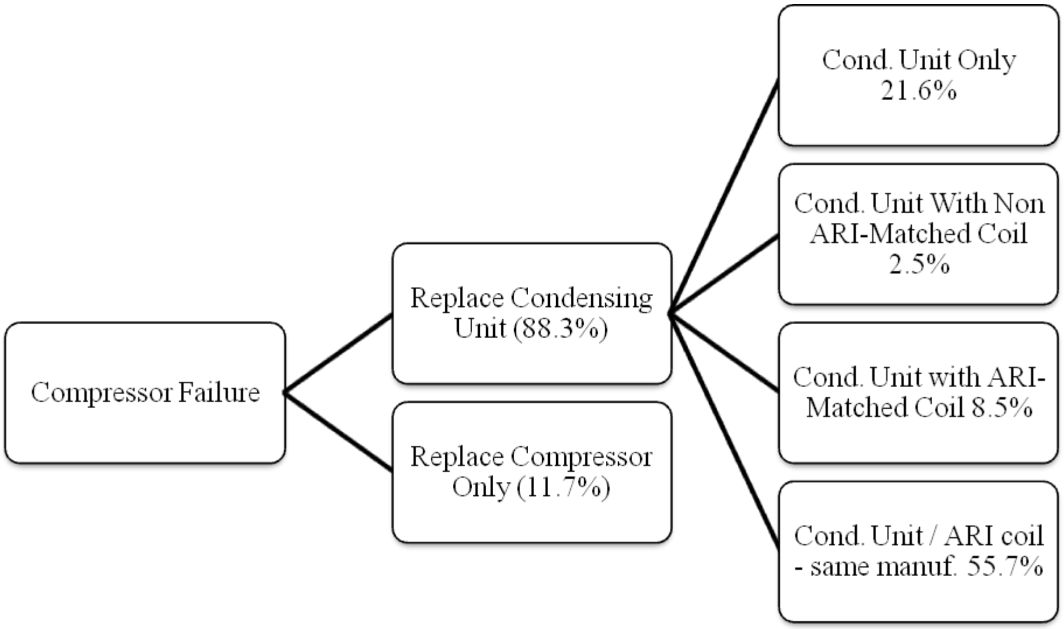
[120] Using air conditioner capacity curve coefficients for heat pump cooling savings.
[121] Using air conditioner capacity EIR coefficients for heat pump cooling savings.

	Cooling			Heating		
		Multi-stage/speed			Multi-stage/speed	
Coeff.	**Single-stage**	**Low**	**High**	**Single-stage**	**Low**	**High**
d	-0.012573945	-0.019956043	-0.009062553	-0.005724331	-0.009450269	-0.005274352
e	0.000214638	0.000256512	0.000165099	0.00014085	0.000439519	0.000230742
f	-0.000145054	-0.000133539	-0.0000997	-0.000215321	-0.000653723	-0.000336954

To estimate the baseline SEER value for retrofit installations, Texas A&M's Energy Systems Laboratory (ESL) surveyed dealers across the State to determine installation practices. The research found that in the event of a compressor failure out of warranty, dealers replaced the compressor 11.7 percent of the time, and replaced the condensing unit 88.3 percent of the time. Further, the condensing unit replacements consist of condensing unit-only replacements, replacements with mismatched evaporator coils, and replacements with matching evaporator coils. The percentages for these installations are as follows:

Figure 4. Mini-Split HPs—Unit Replacement Percentages upon Compressor Failure



Source: Docket No. 36780

To calculate a weighted average SEER for these installations, ESL assumed that a compressor-only replacement resulted in no increase in SEER and that the SEER of a condensing unit installed without a matching coil would be 85 percent of the SEER value for a matched system. The ESL estimate of the baseline SEER for replacement AC units is given using Equation 22.

$$\begin{aligned} SEER_{Base} = {} & \left(SEER_{Compressor\ Replacement}\right) \times (Actual\ \%\ Compressor\ Replacement) \\ & + \left(SEER_{Condenser\ Replacement}\right) \times (Actual\ \%\ Condenser\ Replacement) \\ & + \left(SEER_{System\ Replacement}\right) \times (Actual\ \%\ System\ Replacement) \end{aligned}$$

Equation 22

Substituting ESL SEER estimates and survey data provides the following baseline SEER estimate:

$$SEER_{Base} = (9.5) \times (11.7\%) + (11.05) \times (24.1\%) + (13.5) \times (64.2\%) = 12.44$$

Adjusting for the increased 14 SEER baseline:

$$SEER_{Base} = (10.5) \times (11.7\%) + (11.9) \times (24.1\%) + (14) \times (64.2\%) = 13.08$$

In new construction, there is no possibility of a partial system (e.g., condensing unit-only) change out, so the 13.08 baseline would not be appropriate. Therefore, the baseline for new construction installations is set at the federal government's minimum efficiency standard of 14 SEER.

Early Retirement

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL)

Annual energy and summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 37 or Table 38). If individual system components were installed at separate times, use the condenser age as a proxy for the entire system. For HPs replacing an AC with an electric resistance furnace, use the AC RUL table.*

EUL = *Estimated useful life = 15 years*

For early retirement, if age is unknown, assume a default age equal to the replaced unit EUL resulting in an RUL of 7 (ACs) or 6 years (HPs). Default age may be used exclusively if applied consistently for all early retirement projects. This is the only scenario where an early retirement baseline can be applied to systems older than 24 years for ACs and 20 years for HPs. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible. Default early retirement baselines are specified in Table 33 for use with the default age.

Table 37. Mini-Split HPs—Remaining Useful Life of Replaced ACs[122]

Age of replaced unit (years)	Remaining useful life (years)
1	16.8
2	15.8
3	14.9
4	14.1
5	13.3
6	12.6
7	11.9
8	11.3
9	10.8
10	10.3
11	9.8
12	9.4
13	9.0
14	8.6
15	8.2
16	7.9
17	7.6
18	7.0
19	6.0
20	5.0
21	4.0
22	3.0
23	2.0
24	1.0
25[123,124]	0.0

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[122] Current federal standard effective date is 1/1/2015. Existing systems manufactured after this date are not eligible to use the early retirement baseline and instead should use ROB baseline.

[123] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (see Figure 5). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for early replacement of residential equipment,” for further detail.

[124] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for early replacement of residential equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team’s SharePoint.

Table 38. Mini-Split HPs—Remaining Useful Life of Replaced HPs[125]

Age of replaced unit (years)	Remaining useful life (years)
1	13.7
2	12.7
3	12.0
4	11.3
5	10.7
6	10.2
7	9.7
8	9.3
9	8.9
10	8.5
11	8.2
12	7.9
13	7.6
14	7.0
15	6.0
16	5.0
17	4.0
18	3.0
19	2.0
20	1.0
21[126,127]	0.0

Derivation of RULs

HPs have an estimated useful life of 15 years. This estimate is consistent with the age at which approximately 50 percent of HPs installed in a given year will no longer be in service, as described by the survival function in Figure 5 and Figure 6.

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[125] Current federal standard effective date is 1/1/2015. Existing systems manufactured after this date are not eligible to use the early retirement baseline and should use ROB baseline instead.

[126] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (Figure 6). Systems older than this age should use the ROB baseline. See the January 2015 memo, "Considerations for early replacement of residential equipment," for further detail.

[127] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. "Considerations for early replacement of residential equipment." Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team's SharePoint.

Figure 5. Mini-Split HPs—AC Survival Function[128]

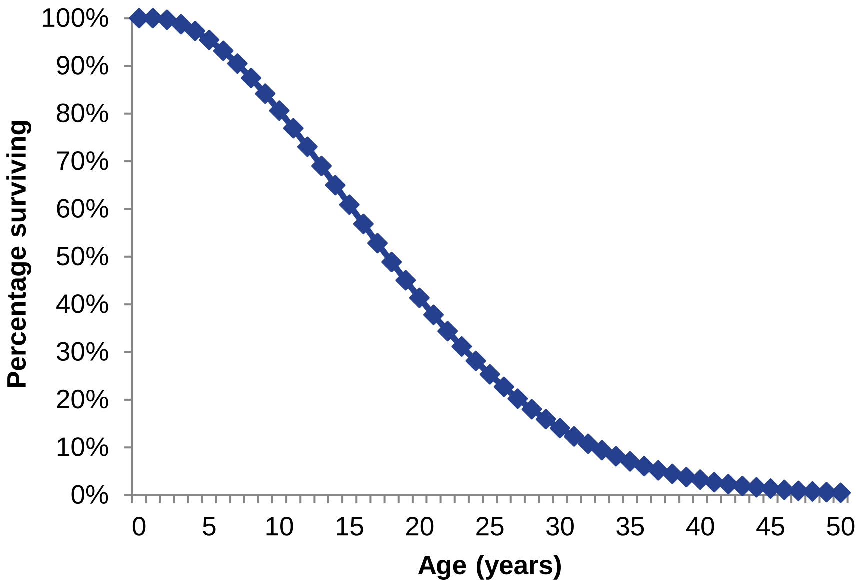
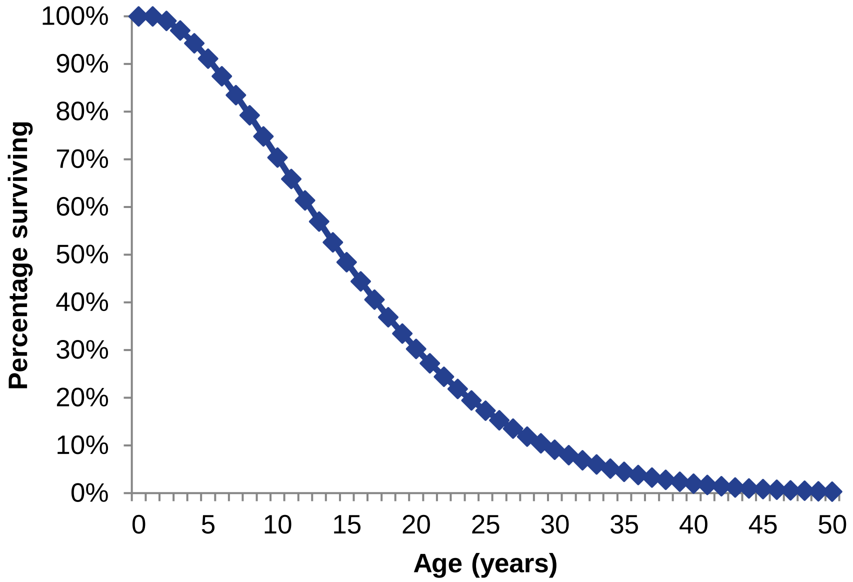


Figure 6. Mini-Split HPs—HP Survival Function [129]



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[128] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: https://www.regulations.gov/document/EERE-2011-BT-STD-0011-0012.

[129] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: https://www.regulations.gov/document/EERE-2011-BT-STD-0011-0012.

The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 5 and Figure 6. The age of the system being replaced is found on the horizontal axis, and the corresponding percentage of surviving systems is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. The age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

Deemed Energy Savings Tables[130]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[131] Both cooling and heating savings are specified for AHRI-rated cooling capacity.

Deemed Summer Demand Savings Tables[132]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[133] Summer demand savings are specified according to AHRI-rated cooling capacity.

Deemed Winter Demand Savings Tables[134]

Due to the high volume of tables associated with this measure, deemed savings tables are provided in an appendix at the end of this volume.[135] Winter demand savings are specified according to AHRI-rated cooling capacity.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

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[130] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[131] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

[132] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[133] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

[134] Rated capacity ranges are specified with a 5 percent tolerance in accordance with AHRI Standard 210/240 to account for systems that are rated slightly below the applicable nominal capacity. AHRI Standard 210/240. Table J1. https://www.ahrinet.org/sites/default/files/2022-07/AHRI_Standard_210-240_2017.pdf.

[135] Savings tables are also provided in Excel format at the Texas Efficiency website. http://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 15 years for HPs based on the DOE 76 Final Rule 37408 technical support document for energy conservation standards for central ACs and HPs.[136]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Decision/action type (early retirement, replace-on-burnout, new construction)
- Cooling capacity of the installed unit (Btuh)
- Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ratio (EER) of the installed unit
- Heating Seasonal Performance Factor (HSPF) of the installed unit (HPs only)
- Type of unit replaced (AC with gas furnace, AC with electric resistance furnace, air source HP)
    - Baseline equipment used for savings (if different from unit replaced)
- Type of unit installed (mini-split HP or DC inverter HP)
- Compressor type for newly installed unit (single-stage, multi-stage, variable speed)
    - Recommended to assist with development of future deemed savings for multi-stage systems operating at variable speeds
- Age of the replaced unit (early retirement only unless default EUL is applied consistently across the program)
- Retired or replaced heating unit model number, serial number, manufacturer, and heating capacity (electric resistance only)
    - Photograph of retired heating unit nameplate, utility inspection, or other evaluator-approved approach. Sampling is allowed for multifamily complexes.
- Retired unit model number, serial number, manufacturer, and cooling capacity (rightsizing or early retirement unless default EUL is applied consistently across the program)
- Manual J load calculation (when rightsizing upward by more than one-half tons). See Eligibility Criteria section for applicable scenarios.
- Photograph of retired cooling unit nameplate (required for all rightsizing and early retirement projects unless default age is applied consistently across the program)

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[136] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. https://www.regulations.gov/document/EERE-2011-BT-STD-0011-0012.

  - If a photograph of the retired unit nameplate is unavailable or not legible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (early retirement only)
  - If a photograph of the retired unit nameplate is unavailable or not legible, provide estimated square footage of conditioned area served by the retired unit (rightsizing only)
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only). This requirement also applies to projects using the default age.
- If replacing an evaporative cooler, application should include a statement that the customer decision to change equipment types predates or is independent of the decision to install efficient equipment
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or other pre-approved method of installation verification
- Manufacturer, model, and serial number of newly installed unit
  - AHRI/DOE CCMS certificate or reference number matching manufacturer and model number
- AHRI certificate or manufacturer specification sheet with date corresponding to time of application or purchase demonstrating that the unit does not have a SEER2 efficiency rating.
- When claiming savings for duct removal in combination with the installation of a ductless mini-split:
  - Pre-improvement duct leakage at 25 Pa (cu. ft./min)
  - Pre and post photos demonstrating removal of existing ductwork

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 39. Mini-Split HPs—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. Clarified early retirement age eligibility. Updated electric resistance baseline documentation.
v9.0	10/2021	TRM v9.0 update. Updated early retirement age eligibility. Clarified eligibility for systems where EER does not meet CEE Tier 0 requirements.
v10.0	10/2022	TRM v10.0 update. Restricted measure for use with mini-split HPs without a SEER2 rating. Updated early retirement age eligibility.

2.2.4 Central and Mini-Split Air Conditioners and Heat Pumps with SEER2 Ratings Measure Overview

TRM Measure ID: R-HV-CM

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

Residential replacement of existing heating and cooling equipment with a new central or mini-split air-source air conditioner (AC) or heat pump (HP) in an existing building, or the installation of a new central AC or HP in a new residential construction. Downsized systems that are rightsized per heat-load calculation are also eligible. A new central system includes an entire packaged unit or a split system consisting of an indoor unit with a matching remote condensing unit. This measure also applies to the installation of dual-fuel HPs and DC inverter systems that meet all existing measure eligibility criteria.

Additional savings may be available for duct removal in combination with the installation of a ductless mini-split. In these cases, refer to the *duct sealing* measure and follow the savings methodology (standard approach) using a value of 0 cubic feet per minute (CFM) as the post-improvement duct leakage. Leakage testing must be performed on the existing ductwork to claim savings for duct removal.

Eligibility Criteria

The deemed savings apply to units with a capacity of ≤ 65,000 Btu/hour (5.4 tons).

Equipment shall be properly sized to the dwelling based on ASHRAE or ACCA Manual J standards. Manufacturer datasheets for installed equipment or documentation of AHRI or DOE CCMS certification must be provided.[137,138] Savings should be calculated using rated capacities whenever possible. Reported system capacities and efficiencies should always match those verified by AHRI or DOE as tested under AHRI operating conditions for a specific combination

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[137] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.

[138] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

of equipment, including condenser, coil, and furnace (or condenser only for packaged units). Savings should never be calculated using efficiency ratings for individual system components.

Customers should be advised against using the emergency heat (EM HEAT) setting on heat pump thermostats. This setting is meant only for use in emergency situations when the heat pump is damaged or malfunctioning. Supplemental heating automatically kicks on in below-freezing conditions using the regular HEAT setting. Contractors installing a new heat pump thermostat with equipment install shall advise the customer of correct thermostat usage.

For early retirement projects, to receive savings, the unit to be replaced must be functioning at the time of removal with a maximum age of 24 years for ACs and 20 years for HPs. Otherwise, claim savings for a replace-on-burnout project. Additional guidance for systems applying the default age is provided in the Savings Algorithms and Input Variables section.

The replacement of an evaporative cooler with a refrigerated system is eligible where the decision to change equipment types predates or is independent of the decision to install efficient equipment and should be claimed against the new construction baseline.

The replacement of a room AC with a central or mini-split AC or HP is eligible and should be claimed against the new construction baseline. Refer to the Replace-on-Burnout or Early Retirement of an Electric Resistance Furnace section for guidance about the appropriate heating baseline for residences with electric resistance heat. Under this scenario, no savings should be awarded for rightsizing.

New construction projects are not eligible to receive deemed savings for system rightsizing.[139]

For system upsizing, savings should generally be claimed against the new construction baseline. However, upsizing is allowed for the scenarios outlined below. In these cases, savings may be claimed against the applicable replace-on-burnout or early retirement scenario if the specified conditions are met. For these scenarios, savings must be determined using the lower pre-tonnage.

- Replacing a single larger capacity system with multiple smaller capacity systems where the total pre and post tonnage are within one-half ton.[140] If the multiple installed units do not share the same efficiency value, savings should be determined using the most conservative efficiency value.
- Replacing a single-stage system with a multi-stage system operating at variable speeds where the total pre and post tonnage are within one-half ton.[141] This scenario does not apply to the replacement of a multi-stage unit with another multi-stage unit.
- If a Manual J load calculation is completed and included with project documentation, upsizing will be allowed where the total pre- and post-tonnage

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[139] For projects using a custom baseline, see TRM Volume 4.

[140] This exception is allowed to account for efficiency improvements due to zoning that are not reflected in the current savings methodology.

[141] This exception is allowed to account for efficiency improvements due to operating at variable speeds that are not reflected in the current savings methodology.

are within one ton.[142] This guidance is also extended to the previous scenarios when a Manual J load calculation is provided.

Additionally, low-income or hard-to-reach programs may use the electric resistance baseline for the following two scenarios:

- The electric resistance baseline may be used for systems upsized by no more than a half-ton in lieu of the new construction baseline. Under this scenario, cooling savings should be claimed against the new construction baseline using the installed (higher) capacity. Heating savings should be claimed against the electric resistance baseline using the existing (lower) capacity. Documentation should be aligned with the rightsizing and electric resistance baseline requirements outlined in this measure.
- The second scenario is for a major multifamily renovation when a centralized system, such as a boiler, is replaced with individual heat pumps. For this scenario, the electric resistance baseline may be claimed in lieu of new construction only if the building owner can document intent to install electric-resistance furnaces without program intervention. The cooling savings should still be claimed against the new construction baseline. Documentation should follow early retirement and electric-resistance baseline requirements.

When replacing a single unit with multiple units where the capacity is the same or has been downsized, savings should be calculated using the total system pre- and post-capacity. Again, if the multiple installed units do not share the same efficiency value, savings should be looked up using the most conservative efficiency value.

Baseline Condition

New Construction, Replace-on-Burnout, or Early Retirement of an Air-Source AC or HP

New construction baseline efficiency values for ACs or HPs are compliant with the current federal standard,[143,144] effective January 1, 2023. The baseline is assumed to be a new system with an AHRI-listed SEER2 rating consistent with the values listed in Table 40 and Table 41. These baselines are also applicable to HP installations replacing ACs with central gas heat; evaporative coolers with central, space, or no heating; or room/window ACs with central, space, or no heating.

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[142] This exception is allowed to account for efficiency improvements due to replacing a unit that was operating longer than designed to keep up with actual site load conditions.

[143] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

[144] Walter-Terrinoni, Helen, “New US Energy Efficiency Standards and Refrigerants for Residential ACs and Heat Pumps.” Air-Conditioning, Heating, & Refrigeration Institute (AHRI). February 1, 2022.

For replace-on-burnout projects, the cooling baselines are reduced by 4.3 percent. This value is based on Energy Systems Laboratory (ESL) survey data and incorporates an adjustment to the baseline SEER2/EER2 value to reflect the percentage of current replacements that do not include the installation of an AHRI-matched system.[145,146] Heating baselines were not included in original ESL survey data and are not adjusted.

For early retirement projects, baselines are defined in Table 40 and Table 41 based on the applicable federal standard base on manufacture year. These baselines have been converted to SEER2, EER2, and HSPF2 by extrapolating from known values referenced in the current federal standard. Systems manufactured as of January 1, 2023, are not eligible for early retirement.

For all systems with a part-load efficiency rating of 15.2 SEER2 or higher, the full-load efficiency baseline is reduced to 9.8 EER2, consistent with the EER2 federal standard specified for the Southwest region. While this standard does not directly apply to Texas, it is used here to recognize a reduced full-load allowance for systems achieving higher part-load efficiency ratings. This value is not reduced based on ESL survey data. Where applicable, the reduced 9.8 EER2 baseline should be applied in lieu of the EER2 baseline value presented in Table 40 and Table 41 except where the specified baseline EER2 value is lower than 9.8 EER2.

Replace-on-Burnout or Early Retirement of an Electric Resistance Furnace

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[147] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[148] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters should calculate savings using a HP baseline.

By the nature of the technology, all electric resistance furnaces have the same efficiency with HSPF = 3.412.[149] Projects in which an electric resistance furnace is replaced, either in replace-on-burnout or early retirement scenarios, use this baseline for heating-side savings.

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[145] Frontier Energy on behalf of the Electric Utility Marketing Managers of Texas (EUMMOT). “Petition to revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems: Docket No. 36780.” Public Utility Commission of Texas. Approved August 27, 2009. https://interchange.puc.texas.gov/. Adapted for new 14 SEER baseline.

[146] The original petition defines the reduced baseline as 12.44 SEER compared to a 13 SEER federal standard. This deemed value was converted to a percentage reduction to accommodate a transition from SEER to SEER2. No EER adjustment is discussed in the original petition because the previous deemed savings structure only awarded savings based on SEER ratings. However, supporting documentation of the original filing makes it clear that the adjustment is appropriate for both part- and full-load cooling efficiency values. Therefore, the deemed percentage reduction is applied to both SEER2 and EER2 ROB baselines.

[147] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[148] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[149] COP = HSPF × 1,055 J/BTU / 3,600 J/W-hr. For Electric Resistance, heating efficiency is 1 COP. Therefore, HSPF = 1 × 3,600 / 1,055 = 3.412.

Table 40. Central and Mini-Split ACs—Baseline Efficiencies

Project type	Capacity (Btu/hr)	Cooling mode
New construction, split air conditioners	< 45,000	14.3 SEER2 11.7 EER2
	≥ 45,000	13.8 SEER2 11.2 EER2
New construction, packaged air conditioners	All	13.4 SEER2 10.9 EER2
Replace-on-burnout, split air conditioners	< 45,000	13.7 SEER2 11.2 EER2
	≥ 45,000	13.2 SEER2 10.7 EER2
Replace-on-burnout, packaged air conditioners	All	12.8 SEER2 10.4 EER2
Early retirement, air conditioners (manufactured 1/1/2015 through 12/31/2022)	All	12.8 SEER2 10.4 EER2
Early retirement, air conditioners (when applying default age)[150]	All	12.3 SEER2 10.0 EER2
Early retirement, air conditioners (manufactured 1/23/2006 through 12/31/2014)	All	11.9 SEER2 9.7 EER2
Early retirement, air conditioners (manufactured before 1/23/2006)	All	9.1 SEER2 7.4 EER2
All systems rated at 15.2 SEER2 or higher[151]	All	9.8 EER2

Table 41. Central and Mini-Split HPs—Baseline Efficiencies

Project type	Cooling mode	Heating mode
New construction, split heat pumps	14.3 SEER2 11.7 EER2	7.5 HSPF2
New construction, packaged heat pumps	13.4 SEER2 10.9 EER2	6.7 HSPF2
Replace-on-burnout, split heat pumps	13.7 SEER2 11.2 EER2	7.5 HSPF2
Replace-on-burnout, packaged heat pumps	12.8 SEER2 10.4 EER2	6.7 HSPF2

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[150] Baseline efficiencies are calculated by taking the average the early retirement categories for 2006-2014 and 2015-2022.

[151] When installing any system with a part-load efficiency rating of 15.2 SEER2 or higher, the reduced 9.8 EER2 full-load efficiency baseline should be applied in lieu of the applicable value presented earlier in the table except where the specified baseline EER2 value is lower than 9.8 EER2.

Project type	Cooling mode	Heating mode
Early retirement, split heat pumps (manufactured 1/1/2015 through 12/31/2022)	12.8 SEER2 10.4 EER2	6.9 HSPF2
Early retirement, packaged heat pumps (manufactured 1/1/2015 through 12/31/2022)	12.8 SEER2 10.4 EER2	6.7 HSPF2
Early retirement, split heat pumps (when applying default age)[152]	12.3 SEER2 10.0 EER2	6.7 HSPF2
Early retirement, packaged heat pumps (when applying default age)[153]	12.3 SEER2 10.0 EER2	6.6 HSPF2
Early retirement, heat pumps (manufactured 1/23/2006 through 12/31/2014)	11.9 SEER2 9.7 EER2	6.5 HSPF2
Early retirement, heat pumps (manufactured before 1/23/2006)	9.1 SEER2 7.4 EER2	5.7 HSPF2
All systems rated at 15.2 SEER2 or higher[154]	9.8 EER2	–
Replace-on-burnout or early retirement, electric resistance furnace[155]	–	3.412 HSPF2

High-Efficiency Condition

Since there is no full-load efficiency requirement specified in the current federal standard, systems that comply with SEER2 and HSPF2 requirements but do not comply with the EER2 requirements outlined in Table 40 and Table 41 may still be eligible to claim savings. Systems with qualifying SEER2 and HSPF2 energy ratings are permitted to claim cooling energy savings, heating energy savings, and winter demand savings for systems, but not summer demand savings where the EER2 rating does not comply with the minimum requirement.

Rated system cooling and heating efficiencies must exceed the minimum efficiencies specified in Table 40 and Table 41. Split system efficiencies are driven primarily by the efficiency of the condenser unit. If the paired outdoor and indoor units are not listed on the AHRI certification listing and only provide DOE CCMS testing results, then the capacity and efficiency of the high-efficiency condition shall not exceed the average of the AHRI certification listing pairing for the matching condenser. The DOE CCMS listing provides documentation of the results that are on the AHRI certification listing and can be downloaded and filtered based on listing using a similar condenser and various indoor units.

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[152] Baseline efficiencies are calculated by taking the average the early retirement categories for 2006–2014 and 2015–2022.

[153] Ibid.

[154] When installing any system with a part-load efficiency rating of 15.2 SEER2 or higher, the reduced 9.8 EER2 full-load efficiency baseline should be applied in lieu of the applicable value presented earlier in the table except where the specified baseline EER2 value is lower than 9.8 EER2.

[155] When installing a heat pump replacing a split air conditioner with an electric resistance furnace, the reduced 3.412 HSPF2 heating baseline efficiency should be applied in lieu of the applicable value presented earlier in the table.

For reference, both ENERGY STAR[156] and the Consortium for Energy Efficiency (CEE)[157] offer suggested guidelines for high-efficiency equipment.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy and demand savings algorithms and associated input variables are listed below.

For early retirement or rightsizing projects, attempt to determine the rated capacity of the existing unit. The rated capacity may be found on the manufacturer specification sheet for the existing unit if the new system is not available on the AHRI or DOE CCMS directories. If the model number of the existing unit is unobtainable or if the manufacturer specification sheet cannot be found, use nominal tonnage for both the existing and new unit. Never use nominal tonnage for the existing unit in combination with rated tonnage for the new unit, which can lead to overstated savings. Additionally, never use nominal tonnage to determine savings for projects where no early retirement or rightsizing has occurred.

For early retirement, if age is unknown, assume a default age equal to the replaced unit estimated useful life (EUL) resulting in a remaining useful life (RUL) of 7 (ACs) or 6 years (HPs). Default age may be used exclusively if applied consistently for all early retirement projects. This is the only scenario where an early retirement baseline can be applied to systems older than 24 years for ACs and 20 years for HPs. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible. Default early retirement baselines are specified in Table 40 and Table 41 for use with the default age.

Energy Savings Algorithms

$$Total\ Energy\ Savings\ [\Delta kWh] = kWh_C + kWh_H$$

Equation 23

$$Cooling\ Energy\ Savings\ [kWh_C] = \left(\frac{Cap_{C,pre}}{\eta_{baseline,C}} - \frac{Cap_{C,post}}{\eta_{installed,C}}\right) \times EFLH_C \times \frac{1\ kW}{1{,}000\ W}$$

Equation 24

$$Heating\ Energy\ Savings\ [kWh_H] = \left(\frac{Cap_{H,pre}}{\eta_{baseline,H}} - \frac{Cap_{H,post}}{\eta_{installed,H}}\right) \times EFLH_H \times \frac{1\ kW}{1{,}000\ W}$$

Equation 25

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[156] ENERGY STAR® Heating & Cooling, https://www.energystar.gov/products/products_list.
[157] CEE Program Resources, http://www.cee1.org/content/cee-program-resources.

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \left(\frac{Cap_{C,pre}}{\eta_{baseline,C}} - \frac{Cap_{C,post}}{\eta_{installed,C}}\right) \times DF_S \times \frac{1\ kW}{1{,}000\ W}$$

Equation 26

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = \left(\frac{Cap_{H,pre}}{\eta_{baseline,H}} - \frac{Cap_{H,post}}{\eta_{installed,H}}\right) \times DF_W \times \frac{1\ kW}{1{,}000\ W}$$

Equation 27

Where:

$Cap_{C/H,pre}$ = *For early retirement (ER), rated equipment cooling/heating capacity of the existing equipment at AHRI-standard conditions; for replace-on-burnout (ROB) and new construction (NC), rated equipment cooling/heating capacity of the new equipment at AHRI-standard conditions [Btuh]; 1 ton = 12,000 Btuh*

$Cap_{C/H,post}$ = *Rated equipment cooling/heating capacity of the newly installed equipment at AHRI-standard conditions [Btuh]; 1 ton = 12,000 Btuh*

$\eta_{baseline,C}$ = *Baseline cooling efficiency of existing equipment (ER) or standard equipment (ROB/NC) [Btuh/W]*

$\eta_{installed,C}$ = *Rated cooling efficiency of the newly installed equipment (must exceed ROB/NC baseline efficiency standards in Table 40 and Table 41) [Btuh/W]*

$\eta_{baseline,H}$ = *Baseline heating efficiency of existing equipment (ER) or standard equipment (ROB/NC) [Btuh/W]*

$\eta_{installed,H}$ = *Rated heating efficiency of the newly installed equipment (must exceed baseline efficiency standards in Table 41) [Btuh/W]*

Note: Use EER2 for kW savings calculations and SEER2/HSPF2 kWh savings calculations.

$EFLH_{C/H}$ = *Cooling/heating equivalent full-load hours (Table 61)*

$DF_{S/W}$ = *Summer/winter seasonal peak demand factor (Table 43)*

Table 42. Central and Mini-Split AC/HPs—Equivalent Full Load Cooling/Heating Hours[158]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

Table 43. Central and Mini-Split AC/HPs—Demand Factors[159]

Season	DF
Summer[160]	0.87
Winter[161]	0.83

Early Retirement

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL)

Annual energy and summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

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[158] ENERGY STAR® Central AC/HP Savings Calculator.

[159] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[160] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[161] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and adjusting for the average ratio of heating to cooling capacity, the guideline leads to a demand factor of 0.96 / 1.15 = 0.83.

Where:

RUL = *Remaining useful life (see Table 44 or Table 45). If individual system components were installed at separate times, use the condenser age as a proxy for the entire system. For HPs replacing an AC with an electric resistance furnace, use the AC RUL table.*

EUL = *Estimated useful life = 18 years (AC); 15 years (HP)*

Table 44. Central and Mini-Split AC/HPs—RUL of Replaced AC

Age of replaced unit (years)	Remaining useful life (years)
1	16.8
2	15.8
3	14.9
4	14.1
5	13.3
6	12.6
7	11.9
8	11.3
9	10.8
10	10.3
11	9.8
12	9.4
13	9.0
14	8.6
15	8.2
16	7.9
17	7.6
18	7.0
19	6.0
20	5.0
21	4.0
22	3.0
23	2.0
24	1.0
25[162,163]	0.0

Table 45. Central and Mini-Split AC/HPs—RUL of Replaced HP

Age of replaced unit (years)	Remaining useful life (years)
1	13.7
2	12.7
3	12.0
4	11.3
5	10.7
6	10.2
7	9.7
12	7.9
13	7.6
14	7.0
15	6.0
16	5.0
17	4.0
18	3.0

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[162] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (see Figure 2Figure 7). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for Early Replacement of Residential Equipment,” for further detail.

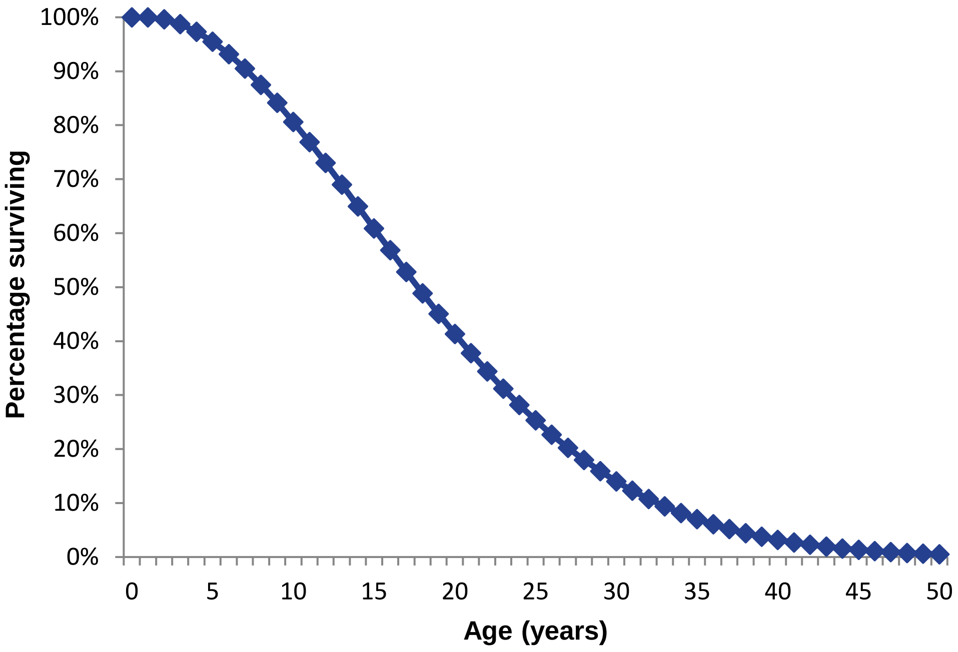
[163] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for Early Replacement of Residential Equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team’s SharePoint.

Age of replaced unit (years)	Remaining useful life (years)
8	9.3
9	8.9
10	8.5
11	8.2
19	2.0
20	1.0
21[164]	0.0

Derivation of RULs

ACs have an estimated useful life of 18 years, and HPs have an estimated useful life of 15 years. This estimate is consistent with the age at which approximately 50 percent of ACs and HPs installed in a given year will no longer be in service, as described by the survival function in Figure 7 and Figure 8.

Figure 7. Central and Mini-Split AC/HPs—AC Survival Function[165]



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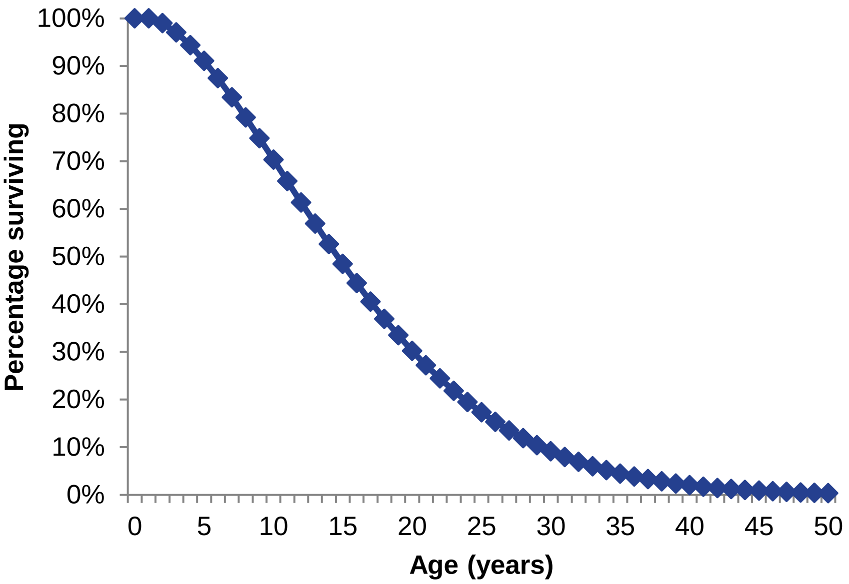
[164] See footnotes on default age from previous table.

[165] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012.

Figure 8. Central and Mini-Split AC/HPs—HP Survival Function[166]



The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 7 and Figure 8. The age of the system being replaced is found on the horizontal axis, and the corresponding percentage of surviving system is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. The age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

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[166] Ibid.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 18 years for an AC and 15 years for a HP unit based on the current DOE Final Rule standards for ACs and HPs.[167]

This value is consistent with the EUL reported in the Department of Energy 76 Final Rule 37408 Technical Support Document for Energy Conservation Standards for Air Conditioners and Heat Pumps.[168]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Decision/action type (early retirement, replace-on-burnout, new construction)
- Cooling capacity of the newly installed unit (Btuh)
- Heating capacity of the newly installed unit (Btuh) (HPs only)
- Seasonal energy efficiency ratio (SEER2) and energy efficiency ratio (EER2) of the newly installed unit
- Heating seasonal performance factor (HSPF2) of the newly installed unit (HPs only)
- Type of unit replaced (AC with gas furnace, AC with electric resistance furnace, air-source HP)
    - Baseline equipment used for savings (if different from unit replaced)
- Type of unit installed (central AC, central HP, dual-fuel HP, mini-split AC, mini-split HP, DC inverter AC, DC inverter HP)
- Unit type subcategory (split, packaged)
- Compressor type for newly installed unit (single-stage, multi-stage, variable speed)
    - Recommended to assist with development of future deemed savings for multi-stage systems operating at variable speeds
- Age of the replaced unit (early retirement only unless default EUL is applied

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[167] Final Rule: Standards, Federal Register, 76 FR 37408 (June 27, 2011) and associated Technical Support Document. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012.

[168] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011.

consistently across the program)

- Retired or replaced heating unit model number, serial number, manufacturer, and heating capacity (electric resistance only)
  - Photograph of retired heating unit nameplate, utility inspection, or other evaluator-approved approach. Sampling is allowed for multifamily complexes.
- Retired cooling unit model number, serial number, manufacturer, and cooling capacity (rightsizing or early retirement unless default EUL is applied consistently across the program)
- Manual J load calculation (when rightsizing upward by more than one-half tons). See the Eligibility Criteria section for applicable scenarios.
- Photograph of retired cooling unit nameplate (required for all rightsizing projects and early retirement projects unless default age is applied consistently across the program)
  - If a photograph of the retired unit nameplate is unavailable or not legible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (early retirement only)
  - If a photograph of the retired unit nameplate is unavailable or not legible, provide estimated square footage of conditioned area served by the retired unit (rightsizing only)
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only). This requirement also applies to projects using the default age.
- If replacing an evaporative cooler, application should include a statement that the customer decision to change equipment types predates or is independent of the decision to install efficient equipment
- Proof of purchase with date of purchase and quantity
  - Alternative: photo of unit installed or other pre-approved method of installation verification
- Manufacturer, model, and serial number of newly installed unit
  - AHRI/DOE CCMS certificate or reference number matching manufacturer and model number

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 46. Central and Mini-Split AC/HPs—Revision History

TRM version	Date	Description of change
v10.0	10/2022	TRM v10.0 origin.

2.2.5 ENERGY STAR® Room Air Conditioners Measure Overview

TRM Measure ID: R-HV-RA

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

The following deemed savings values are applicable to the installation of a high-efficiency room air conditioner.

Eligibility Criteria

Installed room air conditioners (RACs) must be compliant with the current ENERGY STAR specification for RACs.

To claim early retirement savings, the replaced unit must be functioning at the time of removal with a maximum age of 12 years.

Baseline Condition

For new construction and replace-on-burnout, the baseline is assumed to be a new room air conditioning unit that is compliant with the current federal standard,[169] effective June 1, 2014. The standard refers to a revised efficiency rating, Combined Energy Efficiency Ratio (CEER), which accounts for standby/off-mode energy usage.

For early retirement, the baseline efficiency is assumed to match the minimum federal standard efficiencies in place prior to June 1, 2014. Since the effective date occurred mid-year, existing systems manufactured as of 2015 are not eligible for early retirement.

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[169] DOE minimum efficiency standard for residential room air conditioners. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=52.

Table 47. RACs—Baseline Efficiencies for ER, ROB, and NC

Reverse cycle (yes/no)	Louvered sides (yes/no)	Capacity (Btu/hr)	Federal standard prior to June 1, 2014	Federal standard as of June 1, 2014
			ER baseline EER	ROB/NC baseline CEER
No	Yes	< 8,000	9.7	11.0
		≥ 8,000 and < 14,000	9.8	10.9
		≥ 14,000 and < 20,000	9.7	10.7
		≥ 20,000 and < 28,000	8.5	9.4
		≥ 28,000	8.5	9.0
No	No	< 8,000	9.0	10.0
		≥ 8,000 and < 11,000	8.5	9.6
		≥ 11,000 and < 14,000	8.5	9.5
		≥ 14,000 and < 20,000	8.5	9.3
		≥ 20,000	8.5	9.4
Yes	Yes	< 20,000	9.0	9.8
		≥ 20,000	8.5	9.3
Yes	No	< 14,000	8.5	9.3
		≥ 14,000	8.0	8.7
Casement-only		All capacities	8.7	9.5
Casement-slider		All capacities	9.5	10.4

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 4.2 Requirements for eligible room air conditioners effective December 20, 2020.[170] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[170] ENERGY STAR® Room Air Conditioners Final Version 4.2 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%204.2%20Room%20Air%20Conditioners%20Specification_0.pdf.

Table 48. RACs—Efficient Condition Requirements

Reverse cycle (Yes/No)	Louvered sides (Yes/No)	Capacity (Btu/hr)	Minimum CEER for units with connected functionality[171]	Minimum CEER for units without connected functionality
No	Yes	< 8,000	11.5	12.1
		≥ 8,000 and < 14,000	11.4	12.0
		≥ 14,000 and < 20,000	11.3	11.8
		≥ 20,000 and < 28,000	9.8	10.3
		≥ 28,000	9.5	9.9
No	No	< 8,000	10.5	11.0
		≥ 8,000 and < 11,000	10.1	10.6
		≥ 11,000 and < 14,000	10.0	10.5
		≥ 14,000 and < 20,000	9.7	10.2
		≥ 20,000	9.8	10.3
Yes	Yes	< 20,000	10.3	10.8
		≥ 20,000	9.7	10.2
Yes	No	< 14,000	9.7	10.2
		≥ 14,000	9.2	9.6
Casement-only		All capacities	10.0	10.5
Casement-slider		All capacities	10.9	11.4

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy and demand savings algorithms and associated input variables are listed below.

New Construction or Replace-on-Burnout

Energy Savings Algorithms

$$Energy\ Savings\ [\Delta kWh] = Cap \times \frac{1\ kW}{1{,}000\ W} \times AOH_C \times \left(\frac{1}{CEER_{Base}} - \frac{1}{CEER_{RAC}}\right)$$

Equation 28

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[171] Connected functionality refers to units that have been tested for demand response capabilities. These units receive a five percent credit toward ENERGY STAR certification. This means they must only achieve a five percent improvement over the federal standard compared to ten percent for standard units. This is calculated as 0.95 x CEER for units without connected functionality.

Where:

Cap = *Rated equipment cooling capacity of the installed (Btu/hr)*

AOH_C = *Annual operating hours for cooling (Table 49)*

$CEER_{Base}$ = *Combined energy efficiency ratio of the baseline cooling equipment (Table 47)*

$CEER_{RAC}$ = *Combined energy efficiency ratio of the installed RAC*

Table 49. RACs—Annual Operating Hours for Cooling[172]

Climate Zone	AOH_C
Zone 1: Amarillo	820
Zone 2: Dallas	1,374
Zone 3: Houston	1,308
Zone 4: Corpus Christi	2,150
Zone 5: El Paso	1,204

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = Cap \times \frac{1\ kW}{1{,}000\ W} \times \left(\frac{1}{CEER_{Base}} - \frac{1}{CEER_{RAC}}\right) \times DF_S$$

Equation 29

Where:

DF_S = *Summer peak demand factor (Table 50)*

Table 50. RACs—Demand Factor[173]

Season	DF
Summer[174]	0.87

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[172] Association of Home Appliance Manufacturers (AHAM) Room Air Conditioner Cooling Calculator.

[173] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[174] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

Early Retirement

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL).

Annual energy (kWh) savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 51); if unknown, assume the age of the replaced unit is equal to the EUL resulting in a default RUL of 5 years*

EUL = *Estimated useful life = 10 years*

Table 51. RACs—RUL of Replaced Unit[175]

Age of replaced unit (years)	RUL (years)
1	8.0
2	7.2
3	6.2
4	5.2
5	5.2
6	5.2
7	5.2
8	5.0
9	4.0
10	3.0
11	2.0
12	1.0
13[176,177]	0.0

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[175] Current federal standard effective date is 6/1/2014. Since the effective date occurred mid-year, existing systems installed as of 2015 are not eligible to use the early retirement baseline and should instead use the ROB baseline.

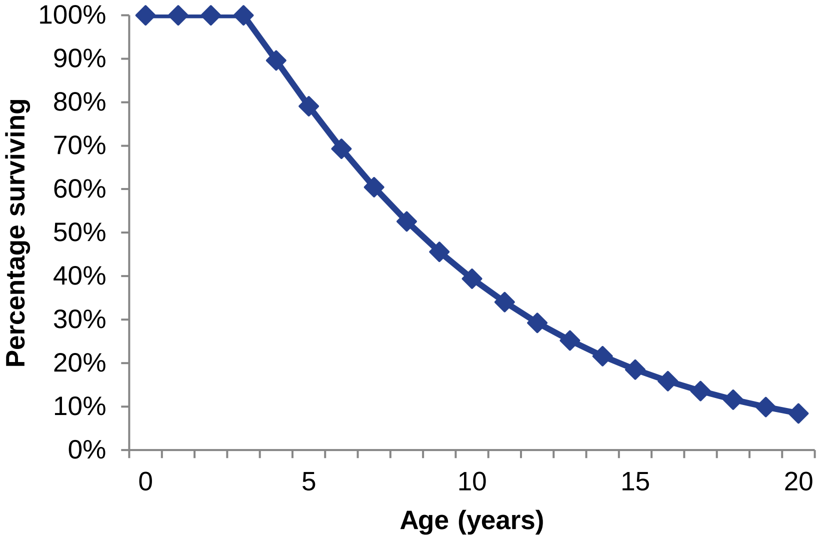
[176] RULs are capped at the seventy-fifth percentile of equipment age as determined based on DOE survival curves (see Figure 9). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for Early Replacement of Residential Equipment,” for further detail.

[177] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for Early Replacement of Residential Equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to all Texas investor-owned utilities through the EM&V team’s SharePoint.

Derivation of RULs

RACs have an estimated useful life of 10 years. This estimate is consistent with the age at which approximately 50 percent of the RACs installed in a given year will no longer be in service, as described by the survival function in Figure 9.

Figure 9. RACs—Survival Function[178]



The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 3. The age of the system being replaced is found on the horizontal axis, and the corresponding percentage of surviving system is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. The age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 9. The age of the room air conditioner being replaced is found on the horizontal axis, and the corresponding percentage of surviving RACs is determined from the chart. The surviving percentage value is then divided in half, creating a new percentage. Then, the age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

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[178] Department of Energy, Federal Register, 76 FR 22454, Technical Support Document: 8.2.2.6 Product Lifetime. April 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/41. Download TSD at: https://www.regulations.gov/document/EERE-2007-BT-STD-0010-0053.

Energy Savings Algorithms

For the RUL time period:

$$kWh_{savings,ER} = CAP \times \frac{1\,kW}{1{,}000\,W} \times AOH_C \times \left(\frac{1}{EER_{ER}} - \frac{1}{CEER_{RAC}}\right)$$

Equation 30

For the remaining time in the EUL period, calculate annual savings as you would for a replace-on-burnout project:

$$kWh_{savings,ROB} = Cap \times \frac{1\,kW}{1{,}000\,W} \times AOH_C \times \left(\frac{1}{CEER_{ROB}} - \frac{1}{CEER_{RAC}}\right)$$

Equation 31

Where:

EER_{ER} = *Energy efficiency ratio of the early retirement baseline cooling equipment (Table 47)*

Summer Demand Savings Algorithms

To calculate demand savings for the early retirement of a RAC, a similar methodology is used as for replace-on-burnout installations, with separate savings calculated for the remaining useful life of the unit, and the remainder of the EUL as outlined in the section above.

For the RUL time period:

$$kW_{Savings,ER} = CAP \times \frac{1\,kW}{1{,}000\,W} \times \left(\frac{1}{EER_{ER}} - \frac{1}{CEER_{RAC}}\right) \times DF_S$$

Equation 32

For the remaining time in the EUL period, calculate annual savings as you would for a replace-on-burnout project:

$$kW_{Savings,ROB} = CAP \times \frac{1\,kW}{1{,}000\,W} \times \left(\frac{1}{CEER_{ROB}} - \frac{1}{CEER_{RAC}}\right) \times DF_S$$

Equation 33

Where:

DF_S = *Summer peak demand factor (Table 50)*

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4, for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a room air conditioning unit is 10 years based on the Technical Support Document for the current DOE Final Rule standards for RACs.

This value is consistent with the EUL reported in the DOE Technical Support Document for RACs.[179]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Decision/action type (early retirement, replace-on-burnout, new construction)
- Cooling capacity of the installed unit (Btu/hr)
- Combined energy efficiency ratio (CEER) of the new unit
- Age of the replaced unit (early retirement only)
- Photograph of retired unit nameplate (early retirement)
    - If a photograph of the retired unit nameplate is unavailable or not legible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (early retirement only)
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit

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[179] Technical Support Document: Room Air Conditioners, June 2020, p. ES-14. https://www.regulations.gov/document/EERE-2014-BT-STD-0059-0013.

and their motivation for measure replacement for early retirement eligibility determination (early retirement only)

- Proof of purchase with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.
- New unit manufacturer, model, capacity, and serial number
    - AHRI certificate or equivalent matching manufacturer and model number
- Connected functionality status (yes, no)

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 52. RACs—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Low-income and hard-to-reach Market Transformation section merged with main measure as "early retirement" option. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. early retirement savings may be claimed through any appropriately designed program in accordance with EM&V team's memo, "Considerations for early replacement of residential equipment." Remaining useful lifetimes updated. Updated EUL to align with median lifetime. New construction permitted to claim savings. New ENERGY STAR standards incorporated.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v4.0	10/10/2016	TRM v4.0 update. Added RUL values for units with an age of one to three years. Added a default RUL value for when the age of the unit is unknown. Eliminated the eligibility requirement of the existing unit to have a minimum age of five years.
v5.0	10/2017	TRM v5.0 update. Updated peak coincidence factors for compliance with current Texas peak definition. Single coincidence factor replaced with individual factors for each climate zone.
v6.0	11/2018	TRM v6.0 update. No revision.

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 update. Update to documentation requirements.
v8.0	10/2020	TRM v8.0 update. Clarified early retirement age eligibility.
v9.0	10/2021	TRM v9.0 update. Updated early retirement age eligibility. Clarified eligibility for units with connected functionality.
v10.0	10/2022	TRM v10.0 update. Update minimum CEER requirement for units with connected functionality. Updated coincidence factors, early retirement age eligibility, and documentation requirements.

2.2.6 Packaged Terminal Heat Pumps Measure Overview

TRM Measure ID: R-HV-PT

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Multifamily

Fuels Affected: Electricity

Decision/Action Type: Replace-on-burnout, early retirement

Program Delivery Type: Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This section presents the deemed savings methodology for the installation of packaged terminal heat pumps (PTHP) replacing packaged terminal air conditioners (PTAC) with electric resistance heat. This document covers assumptions made for baseline equipment efficiencies for early retirement (ER) and replace-on-burnout (ROB), based current and previous on efficiency standards. For ER, the actual age of the baseline system should be determined from the equipment nameplate or other physical documentation whenever possible. Default values are provided for when the actual age of the unit is unknown.

Applicable efficient measure types are restricted to packaged terminal heat pumps. Both standard and non-standard size equipment types are covered. *Standard size* refers to equipment with wall sleeve dimensions having an external wall opening greater than, equal to 16 inches high or greater than, or equal to 42 inches wide and a cross-sectional area greater than 670 in^2. *Non-standard size* refers to equipment with existing wall sleeve dimensions having an external wall opening of fewer than 16 inches high or fewer than 42 inches wide and a cross-sectional area less than 670 in^2.

Eligibility Criteria

Existing PTAC and installed PTHP must be the primary cooling source in the residence. Installed PTHPs must be compliant with the current commercial code.

ER projects must involve the replacement of a working system before natural burnout. Additionally, the ER approach cannot be used for projects involving a simultaneous renovation where a major structural change or internal space remodel has occurred. A ROB approach should be used for these scenarios.

Manufacturer datasheets for new equipment or documentation of AHRI or DOE CCMS certification must be provided.[180,181]

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[180] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.

[181] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

Baseline Condition

Early Retirement

Two baseline condition efficiency values are required for an ER scenario, one for the ER (RUL) period and one for the ROB (EUL – RUL) period. For the ROB period, the baseline efficiency is the same as for a ROB scenario. For the ER period, the baseline efficiency should be estimated according to the capacity, system type (PTAC), and age (based on year of manufacture) of the replaced system.[182] When the system age can be determined (from a nameplate, building prints, equipment inventory list, etc.), the baseline efficiency levels provided in Table 53, reflecting ASHRAE Standard 90.1-2001 through 90.1-2007, should be used. PTHPs replacing PTACs with built-in electric resistance heat should use a baseline heating efficiency of 1.0 COP.

When the system age is unknown, assume 15 years.[183] A default RUL may be used exclusively if applied consistently for all eligible early retirement projects. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible.

Existing systems manufactured as of February 2013 are not eligible for early retirement.

Table 53. PTHPs—ER Baseline Efficiency Levels for Standard Size PTACs[184]

Equipment	Cooling capacity (Btuh)	Baseline cooling efficiency (EER)	Baseline heating efficiency (COP) (no built-in resistance heat)	Baseline heating efficiency (COP) (replacing built-in resistance heat)
PTAC	< 7,000	11.0	–	1.0
	7,000-15,000	12.5 – (0.213 x Cap/1,000)		
	> 15,000	9.3		

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[182] The actual age should be determined from the nameplate, building prints, equipment inventory list, etc. and whenever possible the actual source used should be identified in the project documentation.

[183] As noted in Docket 40885, page 14-15: Failure probability weights are established by assuming that systems for which age information will be unavailable are likely to be older, setting a minimum age threshold, and using the survival functions for the relevant system type to estimate the likelihood that an operational system is of a given age beyond that threshold. Baseline efficiency for each year of system age is established relative to program year. Baseline efficiency levels can be estimated for the next ten program years, considering increments in efficiency standards that took place in the historical period.

[184] ER only applies to standard size units because the minimum efficiency requirements for non-standard systems have never changed, making the ER baseline efficiency the same as for ROB.

Replace-on-Burnout

Table 54 provides minimum efficiency standards for PTAC/PTHP units and reflects the federal standards for packaged terminal air-conditioners and heat pumps effective February 2013 and reflected in 10 CFR 431.

Table 54. PTHPs—ROB Minimum Efficiency Levels[185,186]

Equipment	Category	Cooling capacity (Btuh)	Minimum cooling efficiency (EER)	Minimum heating efficiency (COP)	Baseline heating efficiency (COP) (replacing built-in resistance heat)
PTHP	Standard size	< 7,000	11.9	3.3	1.0
		7,000-15,000	14.0 – (0.300 x Cap/1,000)	3.7 – (0.052 x Cap/1,000)	
		>15,000	9.5	2.9	
	Non-standard size	<7,000	9.3	2.7	
		7,000-15,000	10.8 – (0.213 x Cap/1,000)	2.9 – (0.026 x Cap/1,000)	
		>15,000	7.6	2.5	

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[185] IECC 2015 Table C403.2.3(3).

[186] Cap refers to the rated cooling capacity in Btuh. If the capacity is less than 7,000 Btuh, use 7,000 Btuh in the calculation. If the capacity is greater than 15,000 Btuh, use 15,000 Btuh in the calculation.

High-Efficiency Condition

The high-efficiency retrofits must exceed the minimum federal standards found in Table 54.

The high-efficiency retrofits must also meet the following criteria:[187]

- For ER projects only, the installed equipment cooling capacity must be within 80 percent to 120 percent of the replaced electric cooling capacity.
- No additional measures are being installed that directly affect the operation of the cooling equipment (i.e., control sequences).

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

$$Summer\ Peak\ Demand\ Savings\ [kW] = \left(\frac{Cap_{C,pre}}{\eta_{baseline,C}} - \frac{Cap_{C,post}}{\eta_{installed,C}}\right) \times DF_S \times \frac{1\ kW}{1{,}000\ W}$$

Equation 34

$$Winter\ Peak\ Demand\ Savings\ [kW] = \left(\frac{Cap_{H,pre}}{\eta_{baseline,H}} - \frac{Cap_{H,post}}{\eta_{installed,H}}\right) \times DF_W \times \frac{1\ kW}{3{,}412\ Btuh}$$

Equation 35

$$Total\ Energy\ Savings\ [kWh] = kWh_C + kWh_H$$

Equation 36

$$Cooling\ Energy\ Savings\ [kWh_C] = \left(\frac{Cap_{C,pre}}{\eta_{baseline,C}} - \frac{Cap_{C,post}}{\eta_{installed,C}}\right) \times EFLH_C \times \frac{1\ kW}{1{,}000\ W}$$

Equation 37

$$Heating\ Energy\ Savings\ [kWh_H] = \left(\frac{Cap_{H,pre}}{\eta_{baseline,H}} - \frac{Cap_{H,post}}{\eta_{installed,H}}\right) \times EFLH_H \times \frac{1\ kWh}{3{,}412\ Btu}$$

Equation 38

---

[187] Modified from PUCT Docket #41070 for TRMv3 to limit replacement of only smaller-sized units and extend early retirement to cover PTAC/PTHP.

Where:

$Cap_{C/H,pre}$ = *For ER, rated equipment cooling/heating*[188] *capacity of the existing equipment at AHRI standard conditions*; for ROB & NC, rated equipment cooling/heating capacity of the new equipment at AHRI standard conditions *[BTUH]; 1 ton = 12,000 Btuh*

$Cap_{C/H,post}$ = *Rated equipment cooling/heating capacity of the newly installed equipment at AHRI standard conditions [Btuh]; 1 ton = 12,000 Btuh*

$\eta_{baseline,C}$ = *Cooling efficiency of existing (ER) or standard (ROB/NC) equipment [EER, Btu/W-h] (Table 53 through Table 54)*

$\eta_{installed,C}$ = *Rated cooling efficiency of the newly installed equipment [EER, Btu/W-h] (must exceed minimum requirements from Table 54)*[189]

$\eta_{baseline,H}$ = *Heating efficiency of existing (ER) or standard (ROB/NC) equipment [COP] (Table 53 through Table 54)*

$\eta_{installed,H}$ = *Rated heating efficiency of the newly installed equipment [COP] (must exceed minimum requirements from Table 54)*[190]

$DF_{S/W}$ = *Summer/winter seasonal peak demand factor (Table 55)*

$EFLH_{C/H}$ = *Cooling/heating equivalent full-load hours for newly installed equipment based on appropriate climate zone, building type, and equipment type [hours] (Table 56)*

Table 55. PTHPs—Demand Factors[191]

Season	DF
Summer[192]	0.87
Winter[193]	0.83

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[188] Baseline cooling capacity refers to the rated cooling capacity of the existing PTAC. Assume baseline heating capacity is equal to rated heating capacity for newly installed PTHP.

[189] Rated efficiency is commonly reported at both 230 V and 208 V. Savings calculations should reference efficiency at 230 V, as AHRI rating conditions specify that voltage.

[190] Ibid.

[191] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[192] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[193] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and

Table 56. PTHPs—Cooling/Heating EFLHs[194]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

The first-year savings algorithms in the above equations are used for all HVAC projects, across ROB and ER projects. However, ER projects require weighted savings calculated over both the ER and ROB periods taking the EUL and RUL into account. The ER savings are applied over the remaining useful life (RUL) period, and the ROB savings are applied over the remaining period (EUL – RUL). The final reported savings for ER projects are not actually a "first-year" savings, but an "average annual savings over the lifetime (EUL) of the measure." These savings calculations are explained in Volume 3, Appendix A.

Claimed Peak Demand Savings

A summer peak period value is used for this measure. Refer to Volume 1, Section 4for further details on peak demand savings and methodology.

Deemed Energy and Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Measure Life and Lifetime Savings

Estimated Useful Life (EUL)

The EUL is 15 years, as specified in as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID HVAC-PTHP.[195]

Remaining Useful Life (RUL) for PTHP Systems

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL).

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adjusting for the average ratio of heating to cooling capacity, the guideline leads to a demand factor of 0.96 / 1.15 = 0.83.

[194] ENERGY STAR® Central AC/HP Savings Calculator. April 2009 update. https://www.energystar.gov/sites/default/files/asset/document/ASHP_Sav_Calc.xls.

[195] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Annual energy (kWh) savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 57); if unknown, assume the age of the replaced unit is equal to the EUL resulting in a default RUL of 2.8 years*

EUL = *Estimated useful life = 15 years*

Default RUL may be used exclusively if applied consistently for all projects. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible.

Table 57. PTHPs—RUL of Replaced PTAC[196,197]

Age of replaced system (years)	PTAC RUL (Years)
1	14.0
2	13.0
3	12.0
4	11.0
5	10.0
6	9.1
7	8.2
8	7.3
9	6.5
10	5.7
11	5.0
12	4.4
13	3.8
14	3.3
15	2.8
16	2.0
17	1.0
18[198]	0.0

Program Tracking Data and Evaluation Requirements

The below list of primary inputs and contextual data is recommended to be specified and tracked by the program database to inform the evaluation and apply the savings properly.

- Decision/action type: ROB or ER
- Climate zone
- Equipment configuration category: standard/non-standard

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[196] PUCT Docket No. 40083, Attachment A describes the process in which the RUL of replaced systems has been calculated.

[197] Current federal standard effective date is 2/2013. Existing systems manufactured after this date are not eligible to use the early retirement baseline and should instead use the ROB baseline.

[198] RULs are capped at the seventy-fifth percentile of equipment age as determined based on DOE survival curves. Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for Early Replacement of Residential Equipment,” for further detail.

- Baseline equipment rated cooling capacity (Btuh)
- Baseline number of units
- Installed equipment rated cooling and heating capacities
- Installed number of units
- Installed cooling and heating efficiency rating
- Installed make and model
- AHRI/DOE CCMS certificate or reference number matching manufacturer and model number
- Baseline age and method of determination (e.g., nameplate, blueprints, customer reported, not available) (early retirement only)
- A representative sample of photographs of retired unit nameplate demonstrating model number, serial number, and manufacturer if blueprints are not provided (early retirement only)
    - If a photograph of the nameplate is unavailable or not legible, provide documentation demonstrating reason why the nameplate photo was unobtainable, including but not limited to a photo or description documenting the reason why the nameplate photo was unobtainable (alternate forms of documentation can be approved at the evaluator’s discretion)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Documentation demonstrating the functionality of existing equipment, including but not limited to photograph demonstrating the functionality of existing equipment or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only)

References and Efficiency Standards

Petitions and Rulings

- PUCT Docket 36779—Provides EUL for HVAC equipment.
- PUCT Docket 40083—Provides incorporation of early retirement savings for existing commercial HVAC SOP designs and updates for baseline equipment efficiency levels for ROB and new construction projects involving package and split systems.
- PUCT Docket 40885—Provides a petition to revise deemed savings values for commercial HVAC replacement measures. This petition updated demand and energy coefficients for all commercial HVAC systems.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 58. PTHPs—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. Clarified early retirement age eligibility. Added winter demand algorithm. Updated coincidence factors and documentation requirements
v9.0	10/2021	TRM v9.0 update. Clarified early retirement age eligibility. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Clarified electric resistance baseline. Updated coincidence factors and early retirement age eligibility.

2.2.7 ENERGY STAR® Ground Source Heat Pumps Measure Overview

TRM Measure ID: R-HV-GH

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure requires the installation of a ground-source heat pump (GSHP) meeting the minimum requirements of ENERGY STAR geothermal heat pump key product criteria. The deemed savings are dependent upon the energy efficiency rating (EER) and coefficient of performance (COP) of the installed equipment. Savings calculations are presented for systems with and without desuperheaters.

Eligibility Criteria

The deemed savings apply to units with a capacity of ≤ 65,000 Btu/hour.

Energy savings for desuperheaters only apply if the desuperheater is attached to an electric storage water heater. The electric storage water heating cannot replace a gas water heater in a retrofit installation.

Baseline Condition

The baseline unit is assumed to be an air-source heat pump (ASHP) for new construction, and either an ASHP or an air conditioner with an electric resistance furnace for replace-on-burnout projects. New construction baseline efficiency values for ASHPs are compliant with the current federal minimum standard,[199] effective January 1, 2015.

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[199] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

For replace-on-burnout (ROB) projects, the cooling baseline is reduced to 13.08 SEER. This value incorporates an adjustment to the baseline SEER value to reflect the percentage of current replacements that do not include the installation of an AHRI-matched system.[200] The heating baseline for replace-on-burnout projects is dependent on the heating type of the baseline equipment.

Table 59. GSHPs—Baseline Efficiencies

Project type	Cooling mode[201]	Heating mode[202]
New construction	11.8 EER (14 SEER)	2.4 COP (8.2 HSPF)
ROB—air source heat pump baseline	11.2 EER (13.08 SEER)	2.4 COP (8.2 HSPF)
ROB—air conditioner with electric resistance furnace baseline		1 COP (3.412 HSPF)

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 3.2 requirements for eligible geothermal heat pumps effective January 1, 2012.[203] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 60. GSHPs—ENERGY STAR Requirements

Product type	Cooling mode (EER)	Heating mode (COP)
Closed loop water-to-air	17.1	3.6
Open loop water-to-air	21.1	4.1
Closed loop water-to-water	16.1	3.1
Open loop water-to-water	20.1	3.5
Direct geoexchange (DGX)	16.0	3.6

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[200] Frontier Energy on behalf of the Electric Utility Marketing Managers of Texas (EUMMOT). “Petition to revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems: Docket No. 36780.” Public Utility Commission of Texas. Approved August 27, 2009. https://interchange.puc.texas.gov/. Adapted for new 14 SEER baseline.

[201] Code specified EER value converted to SEER using EER = -0.02 x SEER^2 + 1.12 x SEER. National Renewable Energy Laboratory (NREL). “Building America House Simulation Protocols.” US Department of Energy. Revised October 2010. http://www.nrel.gov/docs/fy11osti/49246.pdf.

[202] Code specified HSPF value converted to COP using COP = HSPF x 1,055 J/Btu ÷ 3,600 J/W-h = HSPF ÷ 3.412.

[203] ENERGY STAR® Program Requirements Product Specification for Geothermal Heat Pumps, v3.2. https://www.energystar.gov/sites/default/files/Geothermal%20Heat%20Pump%20Version%203.2%20Final%20Specification.pdf.

The specifications in the charts above apply to single-stage models. Multi-stage models may be qualified based on:[204]

$$EER = (highest\,rated\,capacity\,EER + lowest\,rated\,capacity\,EER) / 2$$

Equation 39

$$COP = (highest\,rated\,capacity\,COP + lowest\,rated\,capacity\,COP) / 2$$

Equation 40

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Peak demand and annual energy savings for GSHP systems should be calculated, as shown below. Where a desuperheater is also installed, please see the Deemed Energy Savings Tables section for additional energy savings and the Deemed Summer Demand Savings Tables for additional demand savings.

Energy and demand savings for desuperheaters were adapted from a 2001 study conducted by Oak Ridge National Laboratory (ORNL) on GSHPs in Texas.[205] Desuperheater savings were calculated for each climate zone by taking the difference in savings between GSHPs with and without desuperheaters and averaging the savings between low and high-efficiency units. Savings for GSHP systems with desuperheaters should be calculated using the algorithms below with an additional energy credit based on the system capacity and efficiency.

The ORNL study draws from a 1998 analysis based on a study conducted at the Fort Polk Joint Readiness Training Center in Leesville, Louisiana. The Fort Polk study used calibrated simulations of 200 multifamily residences in the complex to estimate energy savings attributable to the replacement of air source heat pumps with GSHPs. These estimates were found to be within 5 percent of actual post-retrofit savings. Building models were developed using TRNSYS.[206]

Using the Fort Polk models, the ORNL study assumed a baseline of a 1.5-ton, 10-SEER air source heat pump. Simulations of low-, medium-, and high-efficiency GSHPs with and without desuperheaters were compared against the baseline unit. The models were run using TMY-2 weather profiles for Climate Zones 1-4. Energy and demand differences between the pre- and post-retrofit models were used to estimate average savings per ton of cooling capacity.

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[204] Geothermal Heat Pumps Key Product Criteria, https://www.energystar.gov/products/heating_cooling/heat_pumps_geothermal/key_product_criteria.

[205] Shonder, J. A., Hughes, P., and Thornton, J. Development of Deemed Energy and Demand Savings for Residential Ground Source Heat Pump Retrofits in the State of Texas. Transactions-American Society of Heating, Refrigerating, and Air Conditioning Engineers. 108, no. 1: 953-961, 2001.

[206] Klein, S. A. TRNSYS Manual: A Transient Simulation Program. Solar Engineering Laboratory, University of Wisconsin-Madison, Version 14.2 for Windows, September 1996.

In the 1998 analysis, low-efficiency GSHPs were assumed to be units with an EER of 12.4 and capacity of 19 kBtuh, while medium-efficiency units had an EER of 16.8 and capacity of 21 kBtuh. High-efficiency units had an EER or 18.3, with a capacity of 22 kBtuh.

These models were used to derive the energy and demand savings associated with installation of a desuperheater along with a GSHP, as shown in Table 63 and Table 64, respectively.

Energy Savings Algorithms

$$Total\ Energy\ Savings\ [\Delta kWh] = kWh_{Savings,C} + kWh_{Savings,H} + kWh_{DSH}$$

Equation 41

$$Cooling\ Energy\ Savings\ [kWh_C] = Cap_C \times \frac{1\ kW}{1{,}000\ W} \times EFLH_C \times \left(\frac{1}{SEER_{Base}} - \frac{1}{EER_{GSHP}}\right)$$

Equation 42

$$Heating\ Energy\ Savings\ [kWh_H] = Cap_H \times \frac{1\ kWh}{3{,}412\ Btu} \times EFLH_H \times \left(\frac{1}{COP_{Base}} - \frac{1}{COP_{GSHP}}\right)$$

Equation 43

Where:

kWh_{DSH} = *Energy savings (kWh) associated with installation of a desuperheater (see Table 63); these savings should only be added if a desuperheater is installed*

$Cap_{C/H}$ = *Rated equipment cooling/heating capacity of the installed GSHP (Btu/hr)*

$EFLH_{C/H}$ = *Equivalent full load hours for cooling/heating (Table 61)*

$SEER_{Base}$ = *Energy efficiency ratio of the baseline cooling equipment (Table 59)*

EER_{GSHP} = *Energy efficiency ratio of the installed GSHP*

COP_{Base} = *Coefficient of performance of the baseline heating equipment (Table 59)*

COP_{GSHP} = *Coefficient of performance of the installed GSHP*

Table 61. GSHPs—Equivalent Full Load Cooling/Heating Hours[207]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = Cap_C \times \frac{1\ kW}{1{,}000\ W} \times \left(\frac{1}{EER_{Base}} - \frac{1}{EER_{GSHP}}\right) \times DF_S + kW_{DSH}$$

Equation 44

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = Cap_H \times \frac{1\ kWh}{3{,}412\ Btu} \times \left(\frac{1}{COP_{Base}} - \frac{1}{COP_{GSHP}}\right) \times DF_W$$

Equation 45

Where:

EER_{Base} = *Energy efficiency ratio of the baseline cooling equipment (see Table 59)*$DF_{S/W}$

= *Summer/winter peak demand factor (see Table 62)*

kW_{DSH} = *Summer demand savings (kW) associated with installation of a desuperheater (see Table 64); these savings should only be added if a desuperheater is installed*

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[207] ENERGY STAR® Central AC/HP Savings Calculator.

Table 62. GSHPs—Demand Factors[208]

Season	DF
Summer[209]	0.87
Winter[210]	0.83

Deemed Energy Savings Tables

Table 63. GSHPs—Energy Savings for Desuperheaters per Cooling Tonnage

Climate zone	kWh/ton
Zone 1: Amarillo	612
Zone 2: Dallas	791
Zone 3: Houston	802
Zone 4: Corpus Christi	847
Zone 5: El Paso	791

Deemed Summer Demand Savings Tables

Table 64. GSHPs—Summer Peak Demand Savings for Desuperheaters per Cooling Tonnage

Climate zone	kW/ton
Zone 1: Amarillo	0.440
Zone 2: Dallas	0.405
Zone 3: Houston	0.405
Zone 4: Corpus Christi	0.410
Zone 5: El Paso	0.405

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[208] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[209] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[210] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and adjusting for the average ratio of heating to cooling capacity, the guideline leads to a demand factor of 0.96 / 1.15 = 0.83.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Refer to Volume 1, Section 4 for further details on winter peak demand savings and methodology.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a GSHP unit is 24 years.

This value is consistent with the life expectancy of the heat pump components reported in multiple Department of Energy GSHP guides. Underground ground-loop infrastructure is expected to last 25–50 years. [211,212]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Decision/action type (new construction, replace-on-burnout)
- Replaced unit heating type (heat pump, electric resistance furnace)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Installed GSHP type (closed loop water-to-air, open loop water-to-air, closed loop water-to-water, open loop water-to-water, direct geoexchange)
- Rated cooling and heating capacity of the new unit (Btu/hr)
- Energy efficiency ratio (EER) of the new unit
- Coefficient of performance (COP) of the new unit

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[211] Department of Energy. Geothermal Heat Pump Energy Saver article. https://www.energy.gov/energysaver/geothermal-heat-pumps.

[212] Department of Energy. “Guide to Geothermal Heat Pumps. February 2011. http://www.energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf.

- Whether a desuperheater was also installed or present
- Proof of purchase with date of purchase and quantity
  - Alternative: photo of unit installed or other pre-approved method of installation verification
- Manufacturer, model, and serial number
  - AHRI certificate matching model number

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 65. GSHPs—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Updated by Frontier Energy, March 2014, based on new federal standards and alternative methodology.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. Updated peak coincidence factors for compliance with current Texas peak definition. Single coincidence factor replaced with individual factors for each climate zone.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Updates to tracking requirements.
v8.0	10/2020	TRM v8.0 update. Updated algorithms to make units consistent.
v9.0	10/2021	TRM v9.0 update. Added clarifying language and updated algorithm units.
v10.0	10/2022	TRM v10.0 update. Updated coincidence factors and EUL.

2.2.8 Large Capacity Split and Packaged Air Conditioners and Heat Pumps Measure Overview

TRM Measure ID: R-HV-LC

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure applies to the installation of a split/packaged air conditioner (AC) or heat pump (HP) with a capacity exceeding that of a typical residential system (greater than or equal to 65,000 Btu/hr) in a retrofit or new construction application. This measure also applies to the installation of ground-source heat pumps (GSHP) with a capacity exceeding 65,000 Btu/hr.

Eligibility Criteria

- The deemed savings apply to central AC/HPs with a capacity of 65,000-240,000 Btu/hr (5.4-20 tons) and GSHPs with a capacity of 65,000-135,000 Btu/hr (5.4-11.3 tons).
- Equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards.
- Manufacturer datasheets for new equipment or documentation of AHRI or DOE CCMS certification must be provided.[213,214]

Baseline Condition

New construction and replace-on-burnout baseline efficiency levels are provided in Table 66 and Table 67. These baseline efficiency levels reflect the latest minimum efficiency requirements from the current federal manufacturing standard, IECC 2015, and ASHRAE 90.1-2013.

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[213] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.

[214] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

Table 66. Large Capacity AC/HPs—NC/ROB Baseline Efficiency Levels for AC/HPs[215]

System type	Capacity (tons)	Heating section type	Baseline efficiencies	Source[216]
Air conditioners	> 5.4 to < 11.3	None or Electric resistance	11.2 EER 12.8 IEER	DOE Standards/ IECC 2015
		All Other	11.0 EER 12.6 IEER	
	≥ 11.3 to ≤ 20	None or Electric resistance	11.0 EER 12.4 IEER	
		All other	10.8 EER 12.2 IEER	
Heat pump (cooling)[217]	5.4 to < 11.3	Heat pump	11.0 EER 12.0 IEER	DOE Standards/ IECC 2015
	≥ 11.3 to ≤ 20		10.6 EER 11.6 IEER	
Heat pump (heating)[218]	5.4 to < 11.3	Heat pump	3.3 COP	DOE Standards/ IECC 2015
	≥ 11.3 to ≤ 20		3.2 COP	

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[215] IECC 2015 Table C403.2.3(1) and C403.2.3(2).

[216] These baseline efficiency standards noted as "DOE Standards" are cited in the Code of Federal Regulations, 10 CFR 431.97. http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec431-97.pdf.

[217] ASHRAE 90.1-2010 Table 6.8.1B. These systems larger than 5.4 tons, the minimum efficiency levels provided in this table are based on systems with heating type "No Heating or Electric Resistance Heating", excluding systems with "All Other Types of Heating".

[218] Heat pump retrofits must also exceed the baseline efficiency levels for heating efficiencies.

Table 67. Large Capacity AC/HPs—NC/ROB Baseline Efficiency Levels for GSHPs[219]

System type	Capacity (Btuh)	Cooling EWT rating condition	Minimum cooling EER	Heating EWT rating condition	Minimum heating COP
Water-to-air (water loop)	≥ 65,000 and < 135,000	86°F	13.0	68°F	4.3
Water-to-air (groundwater)		59°F	18.0	50°F	3.7
Brine-to-air (ground loop)		77°F	14.1	32°F	3.2
Water-to-water (water loop)		86°F	10.6	68°F	3.7
Water-to-water (groundwater)		59°F	16.3	50°F	3.1
Brine-to-water (ground loop)		77°F	12.1	32°F	2.5

High-Efficiency Condition

Split and packaged systems must exceed the minimum efficiencies specified in Table 66 and Table 67.

For reference, both ENERGY STAR and the Consortium for Energy Efficiency (CEE) offer suggested guidelines for high-efficiency equipment.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

$$Total\ Energy\ Savings\ [\Delta kWh] = kWh_C + kWh_H$$

Equation 46

$$Cooling\ Energy\ Savings\ [kWh_C] = Cap_C \times \left(\frac{1}{\eta_{baseline,C}} - \frac{1}{\eta_{installed,C}}\right) \times EFLH_C \times \frac{1\ kW}{1{,}000\ W}$$

Equation 47

$$Heating\ Energy\ Savings\ [kWh_H] = Cap_H \times \left(\frac{1}{\eta_{baseline,H}} - \frac{1}{\eta_{installed,H}}\right) \times EFLH_H \times \frac{1\ kWh}{3{,}412\ Btu}$$

Equation 48

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[219] Values from ASHRAE 90.1-2013.

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = Cap_C \times \left(\frac{1}{\eta_{baseline,C}} - \frac{1}{\eta_{installed,C}}\right) \times DF_S \times \frac{1\ kW}{1{,}000\ W}$$

Equation 49

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = Cap_H \times \left(\frac{1}{\eta_{baseline,H}} - \frac{1}{\eta_{installed,H}}\right) \times DF_W \times \frac{1\ kW}{3{,}412\ Btuh}$$

Equation 50

Where:

$Cap_{C/H}$ = *Rated equipment cooling/heating capacity of the installed equipment at AHRI standard conditions (Btu/hr); 1 ton = 12,000 Btu/hr*

$\eta_{baseline,C}$ = *Cooling efficiency of standard equipment (Btuh/W)*

$\eta_{installed,C}$ = *Rated cooling efficiency of the newly installed equipment (Btuh/W)*

$\eta_{baseline,H}$ = *Heating efficiency of standard equipment (Btuh/W or COP)*

$\eta_{installed,H}$ = *Rated heating efficiency of the newly installed equipment (Btuh/W or COP)*

Note: Use EER for cooling kW and COP for heating kW and kWh savings calculations. SEER/IEER should be used to calculate cooling kWh for central ACs and HPs. EER should be used to calculate cooling kWh for GSHPs. Heating efficiencies expressed as HSPF will be approximated as a seasonal COP and should be converted using the following equation:

$$COP = \frac{HSPF}{3.412}$$

Equation 51

$DF_{S/W}$ = *Summer/winter peak demand factor (Table 68)*

$EFLH_{C/H}$ = *Cooling/heating equivalent full-load hours (Table 69)*

Table 68. Large Capacity AC/HPs—Demand Factors[220]

Season	DF
Summer[221]	0.87
Winter[222]	0.83

Table 69. Large Capacity AC/HPs—Equivalent Full Load Cooling/Heating Hours[223]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[220] Demand factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the demand factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[221] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[222] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and adjusting for the average ratio of heating to cooling capacity, the guideline leads to a demand factor of 0.96 / 1.15 = 0.83.

[223] ENERGY STAR® Central AC/HP Savings Calculator. April 2009 update. https://www.energystar.gov/sites/default/files/asset/document/ASHP_Sav_Calc.xls.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 18 years for a large-capacity air conditioner and 15 years for a large capacity heat pump based on the current DOE Final Rule standards for central heat pumps.[224] The EUL of a high-efficiency ground source heat pump unit is 20 years, consistent with the EUL reported in the DOE GSHP guide.[225]

These values are consistent with the EULs reported in the Department of Energy 76 Final Rule 37408 Technical Support Document for Energy Conservation Standards for Air conditioners and Heat Pumps.[226]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Decision/action type (new construction, retrofit)
- Cooling and heating capacities (Btu/hr)
- Full-load efficiency rating (EER) of the installed unit
- Part-load efficiency rating (SEER/IEER) of the installed unit (if applicable)
- Coefficient of Performance (COP) of the unit installed (heat pumps and GSHPs only)
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or other pre-approved method of installation verification
- Manufacturer, model, capacity, and serial number
- AHRI/DOE CCMS certificate or reference number matching manufacturer and model number

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[224] Final Rule: Standards, Federal Register, 76 FR 37408 (June 27, 2011) and associated Technical Support Document. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=75.

[225] Department of Energy. "Guide to Geothermal Heat Pumps. February 2011. http://www.energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf.

[226] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 70. Large Capacity AC/HPs—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Measure removed from TRM.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. Consolidated AC and HP measures and reintroduced to TRM. Extended measure applicability to GSHPs. Updated from deemed savings to algorithm approach.
v7.0	10/2019	TRM v7.0 update. Updated documentation requirements.
v8.0	10/2020	TRM v8.0 update. Updated coincidence factors
v9.0	10/2021	TRM v9.0 update. Updated baseline efficiency table to remove categories applicable to larger capacity ranges. Added GSHP coincidence factors.
v10.0	10/2022	TRM v10.0 update. Updated coincidence factors.

2.2.9 Evaporative Cooling Measure Overview

TRM Measure ID: R-HV-EC

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculations

Savings Methodology: Engineering algorithms and estimates

Measure Description

The following deemed savings values are applicable in calculating an incentive for the installation of a direct evaporative cooler instead of a refrigerated air system in an existing or new construction home in a dwelling occupied by a residential energy consumer.

Eligibility Criteria

Direct whole-house evaporative cooling systems with a saturation efficiency of 0.85 or greater are eligible for this measure. Portable, window, indirect, and hybrid systems are not eligible.

Baseline Condition

The baseline condition is a new refrigerated air conditioner with a rated efficiency at 14 SEER, the federal minimum standard.[227] The system being replaced is likely to be a less efficient evaporative cooling system, but the alternative to the new evaporative cooling unit is a minimally efficient refrigerated air conditioning system.

High-Efficiency Condition

The high efficiency condition is a direct evaporative cooling system with a saturation efficiency of at least 0.85.

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[227] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Deemed savings for this measure were derived using a reference metering study of evaporative cooling projects for Xcel Energy.[228] The energy savings from the Xcel study are adjusted for climate using a cooling degree day (CDD) ratio derived from TMY 2020 weather data.[229] Demand savings are calculated using the coincidence factor for the room air conditioner measure and an EFLH estimation simulated in a calibrated BEopt model that is used for other modeled measures in the Texas TRM.

Energy Savings Algorithms

$$kWh_{Savings} = kWh_{Ref} \times \left(\frac{CDD_{Site}}{CDD_{Ref}}\right)$$

Equation 52

Where:

kWh_{Ref} = *Reference kWh savings from Xcel Energy metering evaluation of evaporative cooling project in Grand Junction, CO: 2,041*

CDD_{Ref} = *Cooling degree days for the reference location of Grand Junction, CO: 1,452*

CDD_{Site} = *Cooling degree days for the project site location, El Paso, TX: 2,446*

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{kWh_{Savings}}{EFLH_{Site}} \times CF_S$$

Equation 53

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[228] Evaporative Cooling Rebate Program Evaluation by The Cadmus Group, Inc., January 2010, Page 64, Table 23, Savings kWh value for Grand Junction Tier 2. https://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/EvaporativeCoolingProgramEvaluation.pdf.

[229] NSRDB Viewer: https://nsrdb.nrel.gov/.

Where:

$EFLH_{Site}$ = *Equivalent full-load hours of an evaporative cooling system for the project site location, El Paso, TX: 1,288*[230]

CF_S = *Summer coincidence factor*[231] *= 0.87*

Deemed Savings Tables

Table 71. Evaporative Cooling—Deemed Savings per System

Climate zone	kWh savings	Summer kW savings	Winter kW savings
5	3,438	2.46	0

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 15 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID HV-Evap.[232]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Retired system model number and serial number (if applicable)
- Installed evaporative cooler model number and serial number
- Installed evaporative cooler saturation effectiveness
- Proof of purchase with date of purchase and quantity
    - Alternative: photo of unit installed or other pre-approved method of installation verification

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[230] EFLH are calculated as the total annual kilowatt-hours divided by the max kilowatt value output by the BEopt model.

[231] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a demand factor of 1 / 1.15 = 0.87.

[232] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 72. Evaporative Cooling—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. No revision
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated CDD reference.

2.2.10 ENERGY STAR® Connected Thermostats Measure Overview

TRM Measure ID: R-HV-CT

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering spreadsheets and estimates

Measure Description

Deemed savings are provided for the replacement of a standard or programmable thermostat with an ENERGY STAR connected thermostat.

Eligibility Criteria

All residential customers with refrigerated air conditioning are eligible to claim cooling savings for this measure. Customers must have electric central heating (either an electric resistance furnace or a heat pump) to claim heating savings.

The connected thermostats measure is primarily a residential retrofit measure; savings are presented for the average efficiency ratings of installed HVAC systems. Deemed savings are also presented for new construction efficiency ratings (minimum efficiency set by Federal standards).

Customers should be advised against using the emergency heat (EM HEAT) setting on heat pump thermostats. This setting is meant only for use in emergency situations when the heat pump is damaged or malfunctioning. Supplemental heating automatically kicks on in below-freezing conditions using the regular HEAT setting. Contractors installing a new heat pump thermostat with equipment install shall advise customer of correct thermostat usage.

Customers that receive incentives for purchasing a thermostat device through an energy efficiency program may be able to enroll in the load management program offered by the utility at the point of purchase. Deemed demand savings can only be claimed for those customers if they participate in the peak demand events. Otherwise, these devices are only eligible for the deemed energy efficiency savings.

Baseline Condition

The baseline condition is a residential central HVAC system controlled by a thermostat that does not meet the criteria for a connected thermostat (see high efficiency condition). For connected thermostats installed in conjunction with an existing HVAC unit, the baseline condition is an HVAC unit controlled by a manual or programmable thermostat with an average efficiency for existing HVAC units in Texas estimated as shown in Table 73.

Table 73. Connected Thermostats—Baseline Efficiency of Existing HVAC Systems

Application	Rating type	Efficiency value
Air conditioner/heat pump cooling mode	SEER	12.2
Heat pump heating mode	HSPF	7.6
Electric resistance heat	COP	3.41

For connected thermostats installed in conjunction with a new HVAC unit (for both retrofit and new construction applications), the baseline condition is an HVAC unit controlled by a manual or programmable thermostat with the baseline HVAC unit efficiency being equal to the efficiency of the installed system. The efficiency ratings of newly installed HVAC units should meet or exceed minimum values set by the federal manufacturing standards in effect at the time of the installation.

High-Efficiency Condition

The high-efficiency condition is an HVAC unit being controlled by a connected thermostat compliant with the ENERGY STAR Final Version 1.0 requirements for eligible connected thermostats effective December3, 2016.[233] A list of eligible thermostats is available on the ENERGY STAR website.[234] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Energy and Demand Savings Methodology

Energy savings are estimated according to the program requirements established by the ENERGY STAR program for thermostat service providers seeking certification. In addition to a series of other technical and programmatic requirements, providers must demonstrate that their thermostat services result in significant run-time reductions for the controlled cooling and heating equipment. Specifically, ENERGY STAR provides the runtime reduction criteria reproduced in Table 74.

- The ENERGY STAR runtime reductions are translated to energy savings estimates using the following information:

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[233] ENERGY STAR® Program Requirements Product Specification for Connected Thermostats, v1.0. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf.

[234] ENERGY STAR Certified Products: ENERGY STAR Certified Smart Thermostats. Online. Available: https://www.energystar.gov/productfinder/product/certified-connected-thermostats/results.

- Capacity and efficiency curves for HVAC performance under different temperature conditions
- Outdoor dry bulb temperature data (binned TMY3 data) for each TRM climate zone
- Annual HVAC consumption extracted from Central Air Conditioners and Heat Pumps measure savings spreadsheets

Energy use under the range of temperature conditions is estimated for each bin in each climate zone. The base case total energy use for a system of given nominal capacity (and efficiency) is estimated by multiplying each bin's energy use estimate by the number of hours of estimated operation in that bin. Energy savings are estimated by applying the runtime reductions in Table 74 uniformly to each bin's energy use.

Demand (kW) savings are not estimated for the connected thermostats measure.

Table 74. Connected Thermostats—Runtime Reduction Criteria for ENERGY STAR Certification

Metric	Statistical measure	Performance requirement
Annual percent run time reduction, heating (HS)	Lower 95 percent confidence limit of weighted national average	$\geq$ 8 percent
	Weighted national average of 20th percentiles	$\geq$ 4 percent
Annual percent run time reduction, cooling (CS)	Lower 95 percent confidence limit of weighted national average	$\geq$ 10 percent
	Weighted national average of 20th percentiles	$\geq$ 5 percent
Average resistance heat utilization for heat pump installations (RU)	National Mean in 5°F Outdoor Temperature Bins from 0 to 60°F	Reporting requirement

Savings Algorithms and Input Variables

Deemed Energy Savings Tables

Savings are presented in kWh per ton of HVAC system capacity. For projects where tonnage is unknown, assume a default of 3.7 tons.[235]

Table 75 presents the annual energy savings for installations in which the connected thermostat is not installed in conjunction with the installation of a new HVAC unit.

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[235] Based on review of average reported cooling capacity for central air conditioners and heat pumps installed in Texas utility programs in previous program years.

Table 75. Connected Thermostats—Energy Savings for Thermostats Installed with Existing HVAC Unit (kWh/ton)

Climate zone	Cooling savings	Heating savings	
		Electric resistance heat	Heat pump
Zone 1: Amarillo	121	485	199
Zone 2: Dallas	196	273	99
Zone 3: Houston	229	178	62
Zone 4: Corpus Christi	254	120	41
Zone 5: El Paso	167	283	98

When a connected thermostat is installed in conjunction with the installation of a new HVAC unit, the deemed savings are a function of the efficiency of the installed system. The deemed savings for connected thermostats installed on new HVAC units are provided in Table 76 and Table 77. The following savings are eligible to be claimed in both new construction programs and retrofit programs where a new HVAC system is installed.

Table 76. Connected Thermostats—Cooling Energy Savings for Thermostats Installed with New HVAC Unit (kWh/ton)

Climate zone	SEER						
	14	14.5	15	16	17	18	21
Zone 1: Amarillo	108	103	99	92	81	77	66
Zone 2: Dallas	174	167	161	150	131	124	107
Zone 3: Houston	204	196	189	175	154	146	126
Zone 4: Corpus Christi	226	217	209	194	169	160	138
Zone 5: El Paso	149	143	138	128	112	106	91

Table 77. Connected Thermostats—Heating Energy Savings (HP ONLY) for Thermostats Installed with New HVAC Unit (kWh/ton)

Climate zone	Heat pump HSPF							
	8.2	8.5	8.6	8.7	9.0	9.3	9.5	9.7
Zone 1: Amarillo	188	181	177	177	170	163	159	156
Zone 2: Dallas	93	89	87	87	82	78	77	75
Zone 3: Houston	57	55	53	53	51	48	47	46
Zone 4: Corpus Christi	38	37	36	36	34	32	31	31
Zone 5: El Paso	91	87	85	85	80	76	75	73

The following table describes various equipment replacement scenarios that may be encountered and specifies which baseline should be used in each case. “Existing” corresponds to the savings from Table 75. “New” corresponds to the savings from Table 76 for cooling equipment and Table 77 for heating equipment.

Table 78. Connected Thermostats—Baseline for Various Equipment Replacement Scenarios

Equipment replacement scenario	Baseline	
	Cooling	Heating
No HVAC equipment replacement	Existing	Existing
Non-condenser replacements (e.g., coil or furnace ONLY)	Existing	Existing
Air conditioner condenser replacement with gas furnace	New	No savings
Air conditioner condenser replacement with electric heat	New	Existing
Heat pump condenser replacement	New	New

For upstream programs, assume a heating type weighting of 41.8 percent gas, 49.3 percent electric resistance, and 9.0 percent heat pump heat.[236]

Table 79. Connected Thermostats—Upstream and Midstream Program Energy Savings[237] (kWh/thermostat)

Climate zone	Total energy savings
Zone 1: Amarillo	1,397
Zone 2: Dallas	1,256
Zone 3: Houston	1,192
Zone 4: Corpus Christi	1,172
Zone 5: El Paso	1,166

Deemed Summer Demand Savings Tables

Summer demand savings shall not be claimed for the connected thermostats measure.

Deemed Winter Demand Savings Tables

Winter demand savings shall not be claimed for the connected thermostats measure.

Claimed Peak Demand Savings

Not applicable.

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[236] Residential Energy Consumption Survey (RECS) 2015: Space heating in homes in the South and West Regions (HC6.8), February 27, 2017. https://www.eia.gov/consumption/residential/data/2015/.

[237] Assuming smart thermostat is installed in conjunction with an existing 3.7-ton HVAC unit.

Example Deemed Savings Calculation

Example 1. A connected thermostat is installed on an existing 3.5-ton heat pump in Climate Zone 2.

$$Cooling\ Energy\ Savings\ = 196\frac{kWh}{ton} \times 3.5tons = 686\ kWh$$

$$Heating\ Energy\ Savings\ = 99\frac{kWh}{ton} \times 3.5tons = 347\ kWh$$

$$Total\ kWh\ Savings = 686 + 347 = 1{,}033\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 0\ kW$$

$$Winter\ Peak\ Demand\ Savings = 0\ kW$$

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 11 years as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID HV-ProgTstat.[238]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

All program types:

- Climate zone
- Number of smart thermostats sold/installed
- Smart thermostat manufacturer and model number

Additional requirements for all program types other than upstream/midstream:

- HVAC system type (AC/HP)
- Determine whether HVAC condenser was replaced in conjunction with the thermostat
- HVAC capacity (tons)
- HVAC cooling efficiency (SEER) – only if installed with a new HVAC system
- HVAC heating efficiency (HSPF) – only if installed with a new heat pump

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[238] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

- Heating type (gas, electric resistance, heat pump, none)
- Proof of purchase with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

- Docket No. 48265. Petition of AEP Texas Inc., CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company. Petition to Approve Deemed Savings for New Nonresidential Door Air Infiltration, Nonresidential Door Gaskets, and Residential ENERGY STAR Connected Thermostats. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 80. Connected Thermostats—Revision History

TRM version	Date	Description of change
v6.0	11/2018	TRM v6.0 origin.
v7.0	10/2019	TRM v7.0 revision. Updated documentation requirement.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. Provided guidance about emergency heat settings and updated EUL reference. Added clarification to prevent double counting of savings with smart thermostat load management measure.
v10.0	10/2022	TRM v10.0 update. No revision.

2.2.11 Smart Thermostat Load Management Measure Overview

TRM Measure ID: R-HV-TD

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Measurement and verification

Measure Description

Deemed demand savings are provided for calling load management events on smart thermostats[239] in summer afternoons. A load management event is a process through which a utility may optimize available resources by sending a signal to customers' smart thermostats. The signal modifies the smart thermostats temperature setting to reduce overall load demand from central refrigerated air conditioning.

Eligibility Criteria

All Texas residential customers with smart thermostats participating in Climate Zone 5 load management events are eligible to claim demand savings for this measure.

Customers that receive incentives for purchasing a thermostat device through an energy efficiency program may be able to enroll in the load management program offered by the utility at the point of purchase. Deemed demand savings can only be claimed for those customers if they participate in the peak demand events. Otherwise, these devices are only eligible for the deemed energy efficiency savings.

Baseline Condition

The baseline condition is a heating, ventilation, and air conditioning (HVAC) unit operating in the absence of the load management event and subsequent load management activities.

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[239] In this case, smart thermostats are internet-enabled devices that control a home's heating and air conditioning and can be remotely controlled by El Paso Electric Company for load management events.

High-Efficiency Condition

The high-efficiency condition is an HVAC unit being controlled by a smart thermostat and participating in a load management event.

Energy and Demand Savings Methodology

Demand savings were calculated using the “High 3 of 5 Baseline with Day-of Adjustment” method adopted in the Texas Technical Reference Manual Version 5.0 (TRM 5.0). This method considered the five most recent non-event non-holiday weekdays preceding an event and used data from the three days with the highest load within those five days to establish the baseline. “Day-of” adjustments were used to scale the baseline load estimate to the load conditions on the day of the event using data from the two hours prior to the time on the event day when participants were notified of the pending call for curtailment. In this specific program, customers were likely to experience a pre-cool period lasting up to one hour prior to the event. Therefore, the adjustment period was set as the two-hour period three hours prior to the event.

Interval metering devices were installed on a sample of households to record 15-minute interval kW demand of each house. Consumption data were recorded for a total of 50 homes in Texas. Among these 50 homes, 43 have un-anonymized thermostat run-time data, which allow linking interval consumption data with run-time data for each home. Data for customers in the sample was recorded beginning June 23, 2017. The deemed demand savings presented below were derived from these 43 homes in the summer 2018 data.

Event-level savings are calculated by multiplying kW savings per device by the number of participating devices for each event. Devices that participated no less than 50 percent of the total event duration are identified as participating devices. The average of the events’ savings represents the program year savings.

Energy savings are not estimated through this specific measure.

Savings Algorithms and Input Variables

The demand algorithms and associated input variables are listed below:

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = Baseline\ Period\ kW - Curtailment\ kW$$

Equation 54

Where:

Baseline Period kW = *Baseline average demand calculated according to the High 3 of 5 Baseline Method*

Curtailment kW = *Average demand measured during the curtailment period*

Deemed Energy Savings Tables

Energy savings shall not be claimed using the methodology described in this measure.

Deemed Summer Demand Savings Tables

Table 81. Smart Thermostat Load Management—Deemed kW Savings per Device

Climate zone	kW/device
5	1.45

Deemed Winter Demand Savings Tables

Winter demand savings shall not be claimed using the methodology described in this measure.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4, for further details on peak demand savings and methodology.

Example Deemed Savings Calculation

Example 1. A smart thermostat is installed in a home participating in summer load management events:

$$Summer\ kWsavings = 1.45\ kW$$

$$Winter\ kW\ savings = 0\ kW$$

$$kWh\ savings = 0\ kWh$$

Example 2. Suppose ten events were called in an entire summer with participation counts listed in the table below. The total program year demand savings would be the average of the event-level savings.

Table 82. Smart Thermostat Load Management—Example Total Program Year Savings Calculation

Event number	Texas		Event-level demand savings (kW)
	Deemed savings per device (kW)	Participating device number	
Event 1	1.45	600	870
Event 2	1.45	671	973
Event 3	1.45	744	1,079
Event 4	1.45	819	1,188
Event 5	1.45	868	1,259
Event 6	1.45	975	1,414
Event 7	1.45	826	1,198
Event 8	1.45	910	1,320
Event 9	1.45	804	1,166
Event 10	1.45	704	1,021
Total program year demand savings (kW):			1,149

Measure Life and Lifetime Savings

The estimated useful life (EUL) is one year for smart thermostat load management.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- A list of all load management events affecting residential participants, describing their date, the time the event started, and the time the event ended.
- List of targeted smart thermostats in each event and unique identifier for each device.
- Participation status for targeted thermostats (e.g., participant and non-participant as described below), runtime data, or other information to assign participation status (e.g., duration of participation, offline, opted-out).
    - Participants are smart thermostats that participated no less than 50 percent of the total event duration.
    - Devices that opted out after participating for no less than 50 percent of the total event duration may be included in the participants list for that specific event.
    - All other devices that participated for less than 50 percent of the total event duration or were offline are considered non-participants and should be excluded from the participants list and savings calculation for that event.
- Summary of savings calculations and rounding practices.
    - Data rounding to the nearest whole number should only occur at the event and program levels for residential load management programs (NOT at the customer level). Utilities that prefer not to round the savings should document that in their calculations and inform the EM&V team (see Volume 5 section 3.1 for more details).

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 83. Smart Thermostat Load Management—Revision History

TRM version	Date	Description of change
v6.0	11/2018	TRM v6.0 origin.
v7.0	10/2019	TRM v7.0 update. Updates to calculated savings.
v8.0	10/2020	TRM v8.0 update. Updated description and tracking requirements.
v9.0	10/2021	TRM v9.0 update. Added clarification to prevent double counting of savings with smart thermostat load management measure.
v10.0	10/2022	TRM v10.0 update. No revision.

2.2.12 Duct Sealing Measure Overview

TRM Measure ID: R-HV-DS

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

This measure involves sealing leaks in supply and return ducts of the HVAC distribution systems in homes or converted residences with central air conditioning. The standard approach to estimate savings in this measure is based on the results obtained via pre- and post-leakage testing as defined in this measure. In lieu of leakage testing, savings for eligible duct sealing projects may be claimed using the alternate approach specified in this measure.

Eligibility Criteria

All single-family customers with ducted central refrigerated air conditioning or evaporative cooling are eligible to claim cooling savings for this measure. Customers must have ducted central heating with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. The specified deemed savings are not applicable to multifamily customers or to residences with space (non-central or ducted) air conditioning or heating.

For the standard approach with leakage testing, duct leakage should be assessed following the Building Performance Institute (BPI) standards. Duct leakage testing should not be conducted in homes where either evidence of asbestos or mold is present or suspected due to the age of the home.[240]

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[240] "Technical Standards for the Building Analyst Professional", Building Performance Institute (BPI), v1/4/12, Page 1 of 17, states:
"Health and Safety: Where the presence of asbestos, lead, mold and/or other potentially hazardous material is known or suspected, all relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety. Blower door depressurization tests may not be performed in homes *where there is a risk of asbestos becoming airborne and being drawn into the dwelling."* http://www.bpi.org/sites/default/files/Technical%20Standards%20for%20the%20Building%20Analyst%20Professional.pdf.

Utility program manuals should be consulted for health and safety considerations related to the implementation of duct efficiency measures and/or testing procedures.

Duct sealing is a residential retrofit measure only and does not apply to new construction.

Baseline Condition

The savings calculation methods for this measure (when implemented with duct leakage testing) are valid up to a maximum pre-installation leakage rate of 35 percent of total fan flow.[241] For homes with an initial leakage rate greater than 35 percent of total fan flow, savings will be awarded with respect to this cap rather than the initial leakage. Data from nearly 28,000 single-family and mobile home duct blaster tests conducted for duct efficiency improvements in Texas between 2003 and 2006 show that more than 70 percent of all pre-retrofit leakage rates fall below 38 percent total leakage.[242]

Engineering calculations show that the interior temperature in those settings that exceed 38 percent total leakage would be above the thermally acceptable comfort levels published by ASHRAE in its 2009 Fundamentals publication. The proposed pre-installation leakage limits will help ensure that the deemed savings are an accurate reflection of the program's impacts and that the program focuses its efforts on scenarios where leakage conditions are likely to persist if unaddressed for several years.

Low-income customers[243] are exempt from the cap limiting the maximum pre-installation leakage rate to 35 percent of total fan flow.

While these baseline criteria were applied in deriving the deemed savings for the alternate approach (without duct leakage testing), it is not necessary to determine the pre-installation leakage rate for projects claiming the alternate deemed savings.

High-Efficiency Condition

Materials used should be long-lasting materials, such as mastics, UL 181A or UL 181B approved foil tape or aerosol-based sealants. Fabric-based duct tape is not allowed.

The selected methodology for estimating duct sealing deemed savings according to the standard approach requires duct leakage-to-outside testing using a combination duct pressurization and house pressurization.

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[241] Total Fan Flow = Cooling Capacity (tons) x 400 cfm/ton.

[242] Based on data collected by Frontier Energy for investor-owned utilities in Texas.

[243] Low-income customers are income-eligible customers served through a targeted low-income energy efficiency program as described in 25.181(r). This may also apply to income-eligible customers served through a hard-to-reach program that is also delivered following the guidelines in 25.181(r). https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.181/25.181.pdf.

Duct Leakage Testing (Standard Approach)

Measurements to determine pre-installation and post-installation leakage rates must be performed in accordance with utility-approved procedures. For this measure, leakage-to-outside must be directly measured. The project sponsor shall use the Combination Duct Blaster^{TM} (or equivalent) and blower door method. Prior to beginning any installations, the project sponsor must submit the intended method(s) and may be required to provide the utility with evidence of competency, such as RESNET certification, North American Technician Excellence (NATE) certification, or other certification by evaluator approved EPA-recognized ENERGY STAR Home Certification Organization (HCO). Leakage rates must be measured and reported at the average air distribution system operating pressure (25 Pa).[244]

Categorizing Achieved Duct Leakage Reduction (Absent Leakage Testing)

Participating energy efficiency service providers (EESPs) electing not to perform leakage testing should nevertheless provide an estimate of the expected outcome of the leakage reduction work performed: projects should be characterized according to contractor estimation of whether the work required should result in a ***low***, ***average***, or ***high reduction*** in duct system leakage. EESPs should take the following considerations into account in assessing the likely leakage reduction achieved in a given project:

- The number and size of repaired leaks
- Leak location: a leak in an attic joint will cause more energy loss than a joint that leaks to conditioned space
- Supply/return: supply-side leaks, particularly in the return air plenum and near the air handling unit can be especially problematic, as they tend to draw additional unconditioned air into the system.

Systems that were not initially very leaky and in which few joints and supply vents were sealed should be characterized as low reduction. Jobs with a typical number of supply vents and joints sealed, and in which the supply air return or the return air plenum were sealed, should be characterized as average reduction. Jobs requiring significant interventions to eliminate large or numerous leaks should be considered high reduction.

The following table provides a guideline for selecting an appropriate leakage category. How the category is determined may fluctuate on a per-home basis.

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[244] See ANSI/RESNET/ICC 380, Chapter 4 Procedure for Measuring Airtightness of Building or Dwelling Unit Enclosure and Chapter 5 Procedure for Measuring Airtightness of Duct Systems.

Table 84. Duct Sealing—Leakage Categorization Guide[245]

Category	Duct location	Duct insulation value	Leakage characteristics[246]
Low	> 90 percent conditioned	> R7	Some observable leaks
			Substantial leaks
		R4 - R7	Some observable leaks
			Substantial leaks
		< R4	Some observable leaks
			Substantial leaks
	50-90 percent conditioned	> R7	Some observable leaks
		R4 - R7	Some observable leaks
		< R4	Some observable leaks
Average	> 90 percent conditioned	> R7	Catastrophic leaks
		R4 - R7	Catastrophic leaks
		< R4	Catastrophic leaks
	50-90 percent conditioned	> R7	Substantial leaks
			Catastrophic leaks
		R4 - R7	Substantial leaks
		< R4	Substantial leaks
	< 50 percent conditioned	> R7	Some observable leaks
		R4 - R7	Some observable leaks
		< R4	Some observable leaks
High	50-90 percent conditioned	R4 - R7	Catastrophic leaks
		< R4	Catastrophic leaks
	< 50 percent conditioned	> R7	Substantial leaks
			Catastrophic leaks
		R4 - R7	Substantial leaks
			Catastrophic leaks
		< R4	Substantial leaks
			Catastrophic leaks

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[245] Based on typical distribution efficiency assumptions from the Building Performance Institute (BPI) Technical Standards for the Heating Professional, November 20, 2007, page 7. http://www.bpi.org/sites/default/files/Technical%20Standards%20for%20the%20Heating%20Professional.pdf.

[246] Catastrophic leaks are defined by BPI as disconnected ducts, missing end-caps, and other catastrophic holes.

Energy and Demand Savings Methodology

Savings may be claimed according to either the standard approach (with duct leakage testing) or the alternate approach, according to the following sections.

Standard Approach (with Duct Leakage Testing)

The annual energy and summer and winter peak demand savings to be claimed according to the standard approach for this measure shall be calculated as a function of the reduction in duct leakage achieved, using the energy and demand savings coefficients from Table 85 through Table 87 for the climate zone in which the project was implemented and the type of heating equipment in the project home.

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings, which are expressed as linear functions of the reduction in duct leakage achieved (in CFM_{25}). Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows: the base case duct leakage rate was set to 8 CFM_{25} per 100 square feet. Results from running the base case model provide estimated hourly energy use for the prototypical home prior to treatment. Post-treatment conditions were simulated by setting the leakage rate to 6 CFM_{25} per 100 square feet. Results from running the change case model provide estimated hourly energy use for the prototypical home after treatment. A comparison of these two runs provides the deemed savings estimates.

Deemed savings are presented as a function of the CFM_{25} reduction achieved, as demonstrated by leakage to outside testing using the Combination Duct Blaster^{TM} (or equivalent) and Blower Door method. The kWh and kW per CFM_{50} values represented by the V_E, V_S, and V_W coefficients are derived by taking the difference between annual energy use and summer and winter peak demand, as estimated by the two model runs and normalizing to the CFM_{25} reduction achieved.

Deemed Energy Savings Tables

Table 85 presents the annual energy savings per CFM_{25} reduction for a residential duct sealing project. The following formula shall be used to calculate annual energy savings for duct leakage reduction:

$$Energy\ Savings\ [\Delta kWh] = \left(DL_{pre} - DL_{post}\right) \times V_E$$

Equation 55

Where:

DL_{pre} = *Pre-improvement duct leakage at 25 Pa (cu. ft./min)*

DL_{post} = *Post-improvement duct leakage at 25 Pa (cu. ft./min)*

$V_{E,C}$ = *Cooling Energy Savings Coefficient in Table 85*

$V_{E,H}$ = *Heating Energy Savings Coefficient in Table 85*

Table 85. Duct Sealing—Energy Savings V_E per CFM_{25} Reduction

	$V_{E,C}$: Cooling savings		$V_{E,H}$: Heating savings		
Climate zone	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	0.82	0.21	0.07	2.75	0.71
Zone 2: Dallas	1.05	–	0.03	1.19	0.31
Zone 3: Houston	1.23	–	0.02	0.85	0.26
Zone 4: Corpus Christi	1.46	–	0.01	0.61	0.19
Zone 5: El Paso	1.20	0.38	0.03	1.44	0.37

Deemed Summer Demand Savings Tables

Table 86 presents the summer peak demand savings per CFM_{25} reduction for a residential duct sealing project. The following formula shall be used to calculate deemed summer demand savings for duct leakage reduction:

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \left(DL_{pre} - DL_{post}\right) \times V_S$$

Equation 56

Where:

V_S = *Summer Demand Savings Coefficient (see Table 86)*

Table 86. Duct Sealing—Summer Demand Savings V_S per CFM_{25} Reduction

	Summer kW impact per CFM_{25} reduction	
Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	9.28E-04	2.29E-04
Zone 2: Dallas	8.47E-04	–
Zone 3: Houston	1.06E-03	–
Zone 4: Corpus Christi	6.72E-04	–
Zone 5: El Paso	7.66E-04	1.86E-04

Deemed Winter Demand Savings Tables

Table 87 presents the winter peak demand savings per CFM_{25} reduction for a residential duct sealing project. The following formula shall be used to calculate deemed winter demand savings for duct leakage reduction:

$$Deemed\ Winter\ Demand\ Savings\ (kW) = \left(DL_{pre} - DL_{post}\right) \times V_W$$

Equation 57

Where:

V_W = *Winter Demand Savings Coefficient (see Table 87)*

Table 87. Duct Sealing—Winter Demand Savings V_W per CFM_{25} Reduction

Climate zone	kWh impact per CFM_{25} reduction		
	Gas	Resistance	Heat pump
Zone 1: Amarillo	4.38E-06	8.49E-04	1.46E-04
Zone 2: Dallas	1.22E-06	9.96E-04	6.98E-04
Zone 3: Houston	8.60E-06	8.61E-04	5.02E-04
Zone 4: Corpus Christi	1.18E-05	6.71E-04	4.06E-04
Zone 5: El Paso	6.68E-06	2.81E-04	6.69E-05

Alternate Approach (No Duct Leakage Testing)

The following savings tables are provided for projects implemented without performing leakage testing, accounting for the application of pre-retrofit leakage caps to not hard-to-reach (HTR) projects. The annual energy and summer and winter peak demand savings to be claimed according to the alternate approach for this measure shall be taken from Table 85 through Table 87 for the climate zone in which the project was implemented and the type of heating equipment in the project home.

While savings for multiple duct systems are additive for the standard approach, the following savings are specified per home when using the alternate approach and should not be multiplied by the number of treated duct systems.

NOTE: This approach is only available to programs with an incentive structure that varies by leakage category. Additionally, energy efficiency service providers (EESPs) should not alternate between the standard and alternative approaches during the same program year. Utilities should either restrict all participants within an individual program to one approach or the other, or they should restrict individual EESPs to one approach or the other across all program types.

Hard-to-Reach (HTR) and Targeted Low-Income Programs

Deemed Energy Savings Tables (Alternate Approach)

Table 88. Duct Sealing—Climate Zone 1: Amarillo—Energy Savings (kWh), HTR Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	204	52	17	685	177
2	Average	323	83	28	1,083	280
3	High	514	132	44	1,725	445

Table 89. Duct Sealing—Climate Zone 2: Dallas—Energy Savings (kWh), HTR Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	262	–	7	297	77
2	Average	413	–	12	468	122
3	High	659	–	19	746	194

Table 90. Duct Sealing—Climate Zone 3: Houston—Energy Savings (kWh), HTR Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	307	–	5	212	65
2	Average	484	–	8	335	102
3	High	771	–	13	533	163

Table 91. Duct Sealing—Climate Zone 4: Corpus Christi—Energy Savings (kWh), HTR Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	364	–	2	152	47
2	Average	575	–	4	240	75
3	High	916	–	6	383	119

Table 92. Duct Sealing—Climate Zone 5: El Paso—Energy Savings (kWh), HTR Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	299	95	7	359	92
2	Average	472	150	12	567	146
3	High	753	238	19	903	232

Deemed Summer Demand Savings Tables (Alternate Approach)

Table 93. Duct Sealing—Climate Zone 1: Amarillo—Summer Peak Demand Savings (kW), HTR Alternate Approach

Category	Refrigerated	Evaporative
Low	0.23	0.06
Average	0.37	0.09
High	0.58	0.14

Table 94. Duct Sealing—Climate Zone 2: Dallas—Summer Peak Demand Savings (kW), HTR Alternate Approach

Category	Refrigerated	Evaporative
Low	0.21	–
Average	0.33	–
High	0.53	–

Table 95. Duct Sealing—Climate Zone 3: Houston—Summer Peak Demand Savings (kW), HTR Alternate Approach

Category	Refrigerated	Evaporative
Low	0.26	–
Average	0.42	–
High	0.66	–

Table 96. Duct Sealing—Climate Zone 4: Corpus Christi—Summer Peak Demand Savings (kW), HTR Alternate Approach

Category	Refrigerated	Evaporative
Low	0.17	–
Average	0.26	–
High	0.42	–

Table 97. Duct Sealing—Climate Zone 5: El Paso—Summer Peak Demand Savings (kW), HTR Alternate Approach

Category	Refrigerated	Evaporative
Low	0.19	0.05
Average	0.30	0.07
High	0.48	0.12

Deemed Winter Demand Savings Tables (Alternate Approach)

Table 98. Duct Sealing—Climate Zone 1: Amarillo—Winter Peak Demand Savings (kW), HTR Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.21	0.04
Average	0.00	0.33	0.06
High	0.00	0.53	0.09

Table 99. Duct Sealing—Climate Zone 2: Dallas—Winter Peak Demand Savings (kW), HTR Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.25	0.17
Average	0.00	0.39	0.27
High	0.00	0.62	0.44

Table 100. Duct Sealing—Climate Zone 3: Houston—Winter Peak Demand Savings (kW), HTR Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.21	0.13
Average	0.00	0.34	0.20
High	0.01	0.54	0.31

Table 101. Duct Sealing—Climate Zone 4: Corpus Christi—Winter Peak Demand Savings (kW), HTR Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.17	0.10
Average	0.00	0.26	0.16
High	0.01	0.42	0.25

Table 102. Duct Sealing—Climate Zone 5: El Paso—Winter Peak Demand Savings (kW), HTR Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.07	0.02
Average	0.00	0.11	0.03
High	0.00	0.18	0.04

All Other Programs

Deemed Energy Savings Tables (Alternate Approach)

Table 103. Duct Sealing—Climate Zone 1: Amarillo—Energy Savings (kWh), Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	187	48	16	628	162
2	Average	300	77	26	1,005	259
3	High	428	110	37	1,437	371

Table 104. Duct Sealing—Climate Zone 2: Dallas—Energy Savings (kWh), Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	240	–	7	272	71
2	Average	384	–	11	435	113
3	High	549	–	16	622	162

Table 105. Duct Sealing—Climate Zone 3: Houston—Energy Savings (kWh), Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	281	–	5	194	59
2	Average	449	–	7	310	95
3	High	643	–	10	444	136

Table 106. Duct Sealing—Climate Zone 4: Corpus Christi—Energy Savings (kWh), Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	333	–	2	139	43
2	Average	533	–	4	223	69
3	High	763	–	5	319	99

Table 107. Duct Sealing—Climate Zone 5: El Paso—Energy Savings (kWh), Alternate Approach

Category	Assessed leakiness	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
1	Low	274	87	7	329	84
2	Average	438	139	11	526	135
3	High	627	199	16	752	193

Deemed Summer Demand Savings Tables (Alternate Approach)

Table 108. Duct Sealing—Climate Zone 1: Amarillo—Summer Peak Demand Savings (kW), Alternate Approach

Category	Refrigerated	Evaporative
Low	0.21	0.05
Average	0.34	0.08
High	0.48	0.12

Table 109. Duct Sealing—Climate Zone 2: Dallas—Summer Peak Demand Savings (kW), Alternate Approach

Category	Refrigerated	Evaporative
Low	0.19	–
Average	0.31	–
High	0.44	–

Table 110. Duct Sealing—Climate Zone 3: Houston—Summer Peak Demand Savings (kW), Alternate Approach

Category	Refrigerated	Evaporative
Low	0.24	–
Average	0.39	–
High	0.55	–

Table 111. Duct Sealing—Climate Zone 4: Corpus Christi—Summer Peak Demand Savings (kW), Alternate Approach

Category	Refrigerated	Evaporative
Low	0.15	–
Average	0.25	–
High	0.35	–

Table 112. Duct Sealing—Climate Zone 5: El Paso—Summer Peak Demand Savings (kW), Alternate Approach

Category	Refrigerated	Evaporative
Low	0.17	0.04
Average	0.28	0.07
High	0.40	0.10

Deemed Winter Demand Savings Tables (Alternate Approach)

Table 113. Duct Sealing—Climate Zone 1: Amarillo—Winter Peak Demand Savings (kW), Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.19	0.03
Average	0.00	0.31	0.05
High	0.00	0.44	0.08

Table 114. Duct Sealing—Climate Zone 2: Dallas—Winter Peak Demand Savings (kW), Alternate Approach

Category	Heating system type		
	Gas	Electric resistance	Heat pump
Low	0.00	0.23	0.16
Average	0.00	0.36	0.25
High	0.00	0.52	0.36

Table 115. Duct Sealing—Climate Zone 3: Houston—Winter Peak Demand Savings (kW), Alternate Approach

	Heating system type		
Category	Gas	Electric resistance	Heat pump
Low	0.00	0.20	0.11
Average	0.00	0.31	0.18
High	0.00	0.45	0.26

Table 116. Duct Sealing—Climate Zone 4: Corpus Christi—Winter Peak Demand Savings (kW), Alternate Approach

	Heating system type		
Category	Gas	Electric resistance	Heat pump
Low	0.00	0.15	0.09
Average	0.00	0.25	0.15
High	0.01	0.35	0.21

Table 117. Duct Sealing—Climate Zone 5: El Paso—Winter Peak Demand Savings (kW), Alternate Approach

	Heating system type		
Category	Gas	Electric resistance	Heat pump
Low	0.00	0.06	0.02
Average	0.00	0.10	0.02
High	0.00	0.15	0.03

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Example Deemed Savings Calculation

Example 1. Using the **standard approach**, a 1,700 square foot home with a 3.5-ton central air conditioner and a gas furnace in Climate Zone 3 is found to have a pre-retrofit duct leakage rate of 600 CFM_{25}. After sealing leaks, duct leakage is estimated at 100 CFM_{25}. The project is completed in a non-HTR program.

$$Max\ Initial\ Leakage\ Rate\ = \left(400\frac{CFM}{ton} \times\ 3.5tons\right) \times\ 35\% = 490\ CFM_{25}$$

$$Reported\ Initial\ Leakage\ = Min\ (600, 490) = 490\ CFM_{25}$$

$$DL_{pre} - DL_{post} = (490 - 100) = 390\,CFM_{25}$$

$$kWh\ savings = (1.23 + 0.02) \times 390 = 488\ kWh$$

$$Summer\ kW\ savings = 1.06 \times 10^{-3} \times 390 = 0.41\ kW$$

$$Winter\ kW\ savings = 8.60 \times 10^{-6} \times 390 = 0.003\ kW$$

Example 2. Using the **alternate approach**, a duct sealing project is completed on a home of any square footage with a central heat pump of any tonnage in Climate Zone 3. The duct system is categorized as 50-90 percent in conditioned space with an existing duct insulation value of R4-R7 and substantial leaks. Therefore, that home is categorized as an average leakage home. No leakage testing is performed. The project is completed in an HTR program. All savings are taken directly from deemed savings lookup tables.

$$kWh\ savings = 484 + 102 = 586\ kWh$$

$$Summer\ kW\ savings = 0.42\ kW$$

$$Winter\ kW\ savings = 0.20\ kW$$

Additional Calculators and Tools

There is a calculator to estimate the energy and demand savings associated with this measure using the algorithms described in the previous subsection.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for a duct sealing measure is 18 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID HV-DuctSeal-BW.[247]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Cooling Type (central refrigerated, evaporative cooling, none)
- Heating type (central gas furnace, central electric resistance furnace, heat pump, none)
- Additional documentation is required to validate resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach)
- Cooling capacity of home HVAC units (tons)

EESPs claiming savings according to duct leakage testing:

- Pre-improvement duct leakage at 25 Pa (cu. ft./min)

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[247] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

- Post-improvement duct leakage at 25 Pa (cu. ft./min)
- Pre- and post-photos of leakage test readings

EESPs claiming savings without performing leakage testing should provide:

- Description of the leakage severity in the home (low, average, or high)
- Description of location and condition of ducts:
    - Duct location (>90 percent conditioned, 50-90 percent conditioned, <50 percent conditioned)
    - Existing duct insulation value (>R7, R4-R7, <R4)
- Leakage characteristics (some observable leaks, substantial leaks, catastrophic leaks)
- Other relevant details that may assist with validating claimed leakage category (recommended)
- Description and photos of interventions taken (both pre and post condition), such as newly sealed joints, supply vents, and other relevant leaks sealed
- Incentive rate structure: incentive should be paid per home and should not vary by leakage category to avoid providing an incentive to overstate the existing leakage category.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 118. Duct Sealing—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor formatting changes, and language introduced to provide further direction for low-income customers and testing procedure. Contractors now required to track cooling capacity of HVAC equipment. Language added to reflect updates to federal standards for central heat pumps

TRM version	Date	Description of change
		and central air conditioners.
v2.1	1/30/2015	TRM v2.1 update. Addition of language referring contractors to program manuals for information regarding health and safety precautions.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. Update of reference sources for air temperatures and densities, heating degree-days. Cooling demand savings required to be claimed.
v4.0	10/10/2016	TRM v4.0 update. Approach changed from algorithm-based to deemed savings coefficients estimated using building simulation models. Updated energy and demand savings. Added separate savings for homes with evaporative cooling. Updated measure description to eliminate eligibility for homes without a central AC, but with a ducted heating system.
v5.0	10/2017	TRM v5.0 update. Remove PY 2017 option to use energy and demand adjustment factors in combination with algorithm methodology from TRM v3.1.
v6.0	11/2018	TRM v6.0 update. Added alternative approach to bypass the need to complete leakage testing based on preceding guidance memo.
v7.0	10/2019	TRM v8.0 update. Added clarifying language on incentive rate per home.
v8.0	10/2020	TRM v8.0 update. Updated eligibility and documentation requirements for electric resistance heat.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Corrected typo in leakage categorization guide.

2.3 RESIDENTIAL: BUILDING ENVELOPE

2.3.1 Air Infiltration Measure Overview

TRM Measure ID: R-BE-AI

Market Sector: Residential Low-Income and Hard-to-Reach

Measure Category: Building Envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

This measure involves the implementation of interventions to reduce the rate of air infiltration into residences. Pre- and post-treatment blower door air pressure readings are required to confirm air leakage reduction. The standard approach for estimating savings in this measure is based on the results obtained via pre- and post-leakage testing as defined in this measure.

Eligibility Criteria

Savings in this measure apply to low-income (LI) and hard-to-reach (HTR) customers only. Cooling savings apply to customers with central or mini-split electric refrigerated air conditioning in their homes. Heating savings apply to customers with a central furnace (gas or electric resistance) or a heat pump in their homes. Customers who participate in HTR or LI programs are also eligible to claim heating or cooling savings for homes heated with gas or electric resistance space heaters and/or cooled by one or more room air conditioners by applying an adjustment to deemed savings for the specified system.

There is an upper limit of 4.6 CFM_{50} per square foot of house floor area for the pre-retrofit infiltration rate on eligible projects. For homes where the pre-retrofit leakage exceeds this limit, savings will be awarded against the leakage cap.

Utilities may require certification or competency testing of personnel who will perform the blower door tests Air leakage should be assessed through testing following Building Performance Institute (BPI) standards. In some limited cases, where testing is not possible or unsafe (e.g., due to potential presence of asbestos), a visual assessment may be satisfactory. The air leakage testing should not be conducted in homes where either evidence of asbestos or mold is present or suspected due to the age of the home.[248] Utilities' program manuals should be consulted for health and safety considerations related to the implementation of air sealing measures.

Only structures with electric refrigerated air conditioning systems are eligible.

Baseline Condition

The baseline for this measure is the existing leakage rate of the treated residence. The existing leakage rate should be capped to account for the fact that the deemed savings values per CFM_{50} leakage reduction are only applicable up to a point where the existing HVAC equipment would run continuously. Beyond that point, energy use will no longer increase linearly with an increase in leakage.

Baseline assumptions used in the development of these deemed savings are based on a conversion from $ACH_{Natural}$. ASHRAE Handbook: Fundamentals specifies that more than 80 percent of sampled low-income housing had a pre-leakage rate at or below 1.75 $ACH_{Natural}$.[249] $ACH_{Natural}$ was converted to CFM_{50}/sq. ft. using Equation 58.

$$CFM_{50,pre} = \frac{ACH_{Natural,pre} \times h \times N}{60}$$

Equation 58

Where:

$ACH_{Natural,pre}$ = *1.75 representing greater than 80 percent of sampled homes*

h = *Ceiling height (ft.) = 8.5 (default)*[250]

N = *N factor for single story normal shielding (Table 119) = 18.5*

Using the above approach, the maximum per-square-foot pre-installation infiltration rate is 4.6 CFM_{50}/sq. ft.. Therefore, to avoid incentivizing homes with envelope problems not easily remedied through typical weatherization procedures, or where blower door tests were improperly conducted, these savings should only be applied starting at a baseline CFM_{50}/sq. ft. of 4.6 or lower.

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[248] The Building Performance Institute, Inc. (BPI) Standard Reference: Building Performance Institute Technical Standards for the Building Analyst Professional, v2/28/05mda, Page 1 of 17, states: "Health and Safety*:* Where the presence of asbestos, lead, mold and/or other potentially hazardous material is known or suspected, all relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety. Blower door depressurization tests may not be performed in homes *where there is a risk of asbestos becoming airborne and being drawn into the dwelling."*

[249] 2017 ASHRAE Handbook: Fundamentals, Chapter 16, p. 16.19, Fig. 12.

[250] Typical ceiling height of 8 feet adjusted to account for greater ceiling heights in some areas of a typical residence.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[251] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[252] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

Blower door air pressure measurements must also be used to ensure that post-treatment air infiltration rates are not less than those set forth by the standard in Equation 59, based on floor area and the number of bedrooms.[253] These calculated minimum CFM_{50} values assume two occupants for a one-bedroom dwelling unit and an additional person for each additional bedroom. At the utility's discretion, this minimum CFM_{50} requirement may be enforced as an eligibility requirement. Otherwise, savings may be claimed for projects where the measured final infiltration rate is less than the minimum allowable ventilation rate if the following conditions are met:

- Mechanical ventilation is present or introduced in compliance with ASHRAE 62.2-2019
- Post-treatment infiltration rate is reported as the actual measured CFM50 result
- Savings are calculated using the TRM minimum allowable ventilation rate with no additional savings claimed for CFM reduction below this amount

Where higher occupant densities are known, the minimum rate shall be increased by 7.5 CFM_{Nat} for each additional person. A CFM_{Nat} value can be converted to CFM_{50} by multiplying by the appropriate N factor (Table 119).

$$Min\ CFM_{50} = [0.03 \times A_{Floor} + 7.5 \times OCC] \times N$$

Equation 59

Where:

$Min\ CFM_{50}$ = *Minimum final ventilation rate (CFM_{50})*

A_{Floor} = *Floor area (sq. ft.)*

OCC = *BR + 1, where BR is the number of bedrooms; if number of home occupants is known to exceed BR + 1, occupancy should be used instead*

N = *N factor (Table 119)*

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[251] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[252] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[253] ASHRAE 62.2-2013. CFM_{Nat} values converted to CFM_{50} values by multiplying by appropriate N factor.

Table 119. Air Infiltration—N Factors[254]

Shielding	Number of stories		
	1 story	2 story	3+ stories
Well shielded	22.2	17.8	15.5
Normal	18.5	14.8	13.0
Exposed	16.7	13.3	11.7

The maximum CFM reduction percentage[255] is capped at 30 percent. It is important to note that the minimum ventilation rate specified earlier in this section still applies for cases where the maximum 30 percent CFM reduction cannot be achieved due to the post CFM value being limited by the minimum allowable post CFM value provisioned for safety reasons.

The TRM stipulates an upper limit of 4.6 CFM_{50} per square foot of house floor area for the pre-retrofit infiltration rate as part of eligibility criteria. For homes where the pre-retrofit leakage exceeds this limit, energy and demand savings must be calculated using the pre-measure-installation leakage cap. Therefore, when the pre-retrofit leakage is capped, energy and demand savings can only be claimed for a 30 percent reduction in CFM compared to the capped pre-CFM value. When the pre-retrofit leakage is not capped, energy and demand savings can only be claimed for a 30 percent reduction in CFM compared to the tested, actual pre-retrofit infiltration rate of the home.

The TRM requires all contractors to provide sufficient evidence (e.g., pictures capturing the scope/type of retrofit implemented and blower door test readings) for all homes.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings, which are expressed as linear functions of the leakage reduction achieved (in CFM_{50}).[256] Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows: the base case air infiltration rate was set to 20 ACH_{50}. Results from running the base case model provide estimated hourly energy use for the prototypical home prior to treatment. Post-treatment conditions were simulated by setting the leakage rate to 3 ACH_{50}.

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[254] Krigger, J. and Dorsi, C.,"Residential Energy: Cost Savings and Comfort for Existing Buildings". A-11 Building Tightness Limits, p. 284. Use Zone 2 for Texas climate.

[255] CFM reduction percentage is calculated as: (pre-CFM value – post-CFM value) / pre-CFM value

[256] Model testing indicates a straight-line relationship between demand and energy savings achieved and CFM50 reductions is appropriate with beginning and ending leakage rates within the ranges permitted by the measure.

Deemed savings are presented as a function of the CFM_{50} reduction achieved, as demonstrated by blower door testing. The kWh and kW per CFM_{50} values represented by the V_E, V_S, and V_W coefficients are derived by taking the difference between annual energy use and summer and winter peak demand as estimated by the two model runs and normalizing to the CFM_{50} reduction achieved. The pre- and post-treatment ACH_{50} values (20 and 3, respectively) are converted to CFM_{50} by multiplying the pressurized air-change rate by the volume of the model home and dividing by 60 (minutes/hour).

Deemed Energy Savings Tables

Table 120 presents the energy savings per CFM_{50} reduction for a residential air sealing project. The following formula shall be used to calculate deemed energy savings for infiltration efficiency improvements.

$$Energy\ Savings\ [\Delta \mathrm{kWh}] = \Delta CFM_{50} \times \left(V_{E,C} \times CAF + V_{E,H} \times HAF\right)$$

Equation 60

Where:

ΔCFM_{50} = Air infiltration reduction in cubic feet per minute at 50 Pascal

$V_{E,C}$ = Cooling energy savings coefficient (Table 120)

CAF = Cooling savings adjustment factor for homes with room air conditioners; set to 1.0 for homes with refrigerated air or set to 0.6 for homes with one or more room air conditioners

$V_{E,H}$ = Heating energy savings coefficient (Table 120)

HAF = Heating savings adjustment factor for homes with electric resistance space heaters; set to 1.0 for homes with central heating with supplemental space heating or set to 0.24 for homes with primary electric resistance space heating

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 120 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 120 by a factor of 0.24.[257]

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[257] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 120. Air Infiltration—Energy Savings V_E per CFM_{50} Reduction

	$V_{E,C}$: Cooling savings	$V_{E,H}$: Heating savings		
Climate zone	Refrigerated air	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	0.12	0.09	1.92	0.78
Zone 2: Dallas	0.27	0.04	1.10	0.45
Zone 3: Houston	0.22	0.02	0.63	0.25
Zone 4: Corpus Christi	0.39	0.02	0.55	0.21
Zone 5: El Paso	0.07	0.03	0.88	0.34

Deemed Summer Demand Savings Tables

Table 121 presents the summer peak demand savings per CFM_{50} reduction for a residential air sealing project. The following formula shall be used to calculate deemed summer demand savings for air infiltration improvements.

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \Delta CFM_{50} \times V_S \times CAF$$

Equation 61

Where:

V_S = *Summer demand savings coefficient (Table 121)*

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 121 by a factor of 0.6.

Table 121. Air Infiltration—Peak Summer Demand Savings V_S per CFM_{50} Reduction

Climate zone	Summer kW impact per CFM_{50} reduction
Zone 1: Amarillo	1.64E-04
Zone 2: Dallas	2.10E-04
Zone 3: Houston	1.90E-04
Zone 4: Corpus Christi	2.24E-04
Zone 5: El Paso	9.40E-05

Deemed Winter Demand Savings Tables

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 122 by a factor of 0.24. For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 122 by a factor of 0.24.

Table 122 presents the summer peak demand savings per CFM_{50} reduction for a residential air sealing project. The following formula shall be used to calculate deemed winter demand savings for air infiltration improvement:

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = \Delta CFM_{50} \times V_W \times HAF$$

Equation 62

Where:

V_W = *Winter demand savings coefficient (Table 122)*

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 122 by a factor of 0.24.[258]

Table 122. Air Infiltration—Peak Winter Demand Savings V_W per CFM_{50} Reduction

	Winter kW impact per CFM_{50} reduction	
Climate zone	Electric resistance	Heat pump
Zone 1: Amarillo	9.42E-04	5.48E-04
Zone 2: Dallas	1.25E-03	6.93E-04
Zone 3: Houston	8.61E-04	4.41E-04
Zone 4: Corpus Christi	7.81E-04	3.60E-04
Zone 5: El Paso	2.92E-04	1.19E-04

Claimed Peak Demand Savings

Refer to Volume 1, Section 4.

Example Deemed Savings Calculation

Example 1. A contractor uses a blower door test to estimate 12,000 CFM_{50} of pre-retrofit air leakage in a 2,200 square foot, 2-story, 3-bedroom home in Climate Zone 4 with a heat pump. The home is located in a normally shielded area. After identifying and sealing leaks, she performs another blower door test and measures 8,000 CFM_{50} of air leakage.

$$Max\ Initial\ Leakage\ Rate\ = 4.6\ \times\ 2{,}200 = 10{,}120\ CFM_{50}$$

$$Reported\ Initial\ Leakage\ = Min\ (12{,}000, 10{,}120) = 10{,}120 CFM_{50}$$

$$Capped\ Post\ Retrofit\ Leakage\ = 10{,}120\ \times\ (1 -\ 0.3) = 7{,}084\ CFM_{50}$$

$$Reported\ Post\ Retrofit\ Leakage\ = Max\ (8{,}000, 7{,}084) = 8{,}000\ CFM_{50}$$

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[258] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

$$Min. Post\ Retrofit\ Leakage\ (safety) = [0.03\ \times\ 2{,}200 + 7.5 \times 4]\ \times\ 14.8 = 1{,}421\ CFM_{50}$$

$$\Delta CFM_{50} = (10{,}120 - 8{,}000) = \mathit{2{,}120}$$

$$Energy\ Savings = (0.39 + 0.21)\ \times\ 2{,}120 = \mathit{1{,}272\ kWh}$$

$$Summer\ Peak\ Demand\ Savings = 2.24\ \times\ 10^{-4}\ \times\ 2{,}120 = 0.47\ kW$$

$$Winter\ Peak\ Demand\ Savings = 3.60\ \times\ 10^{-4}\ \times\ 2{,}120 = 0.76\ kW$$

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 11 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID BS-Wthr.[259]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Pre-retrofit air infiltration in cubic feet per minute at 50 Pascal
- Post-retrofit air infiltration in cubic feet per minute at 50 Pascal
- Cooling type (central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); representative sampling is allowed for multifamily complexes
- Square footage of the house
- Shielding level (well shielded, normal, exposed)
- Number of bedrooms
- Number of stories
- Number of occupants
- Pre- and post-photos of blower door test readings
- Representative photos of leak repairs

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[259] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 27903. Order Adopting New §25.184 as Approved at the August 21, 2003, Open Meeting and Submitted to the Secretary of State. Public Utility Commission of Texas.
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.
- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 123. Air Infiltration—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language. Added detail on methodology and model characteristics.
v2.1	1/30/2015	TRM v2.1 update. Addition of language referring contractors to program manuals for information regarding health and safety precautions.
v3.0	4/10/2015	TRM v3.0 update. Revision of minimum ventilation requirements, pre-retrofit cap on infiltration levels, Climate Zone 5 savings values for homes with heat pumps, and tracking number of bedrooms and occupants in a house.
v3.1	11/05/2015	TRM v3.1 update. Provided clarification around effects of occupancy on minimum final ventilation.
v4.0	10/10/2016	TRM v4.0 update. Updated energy and demand savings per new prototype energy simulation models. Introduced new protocols related to maximum CFM reduction percentage and its associated documentation requirements. Added a new example for calculating savings.

TRM version	Date	Description of change
v5.0	10/2017	TRM v5.0 update. Added alternative approach to bypass the need to complete leakage testing in guidance memo to follow.
v6.0	11/2018	TRM v6.0 update. Removed alternative approach allowance at this time. Clarified the eligibility of projects where CFM_{post} falls below the minimum ventilation rate requirement.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Reduced leakage cap and updated documentation requirements. Updated eligibility to only LI/HTR. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. Updated savings calculation example and EUL reference.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.2 Ceiling Insulation Measure Overview

TRM Measure ID: R-BE-CI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Savings are estimated for insulation improvements to the ceiling area above a conditioned space in a residence.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Baseline Condition

Ceiling insulation levels encountered in existing homes can vary significantly, depending on factors such as the age of the home, type of insulation installed, and level of attic use (equipment, storage, etc.). Deemed savings have been developed based on different levels of encountered (existing) ceiling insulation in participating homes, ranging from sparsely insulated (R-5) to the equivalent of about 6 inches of fiberglass batt insulation (R-22). The current average ceiling insulation level at participating homes is to be determined and documented by the insulation installer. Degradation due to age and density of the existing insulation should be taken into account.

In the event that existing insulation is or has been removed during measure implementation, the existing R-value for claiming savings shall be based upon the R-value of the existing insulation prior to removal.

In the event there are varying levels of existing insulation, an area-weighted U-factor can be used to find the effective R-value across the treated area. The U-factor should be taken from the existing insulation only. This approach can be used in single attic spaces, and savings should be estimated separately for independent spaces where there are separate heating or cooling methods (e.g., additions).

Area-Weighted U-Factor Calculation Method

$$U_A = [U_1 \times Area_1 + \mathrm{U}_2 \times \mathrm{Area}_2 + \ldots] / [\mathrm{Area}_1 + \mathrm{Area}_2 + \ldots]$$

$$Effective\ Rvalue = \frac{1}{U_A}$$

Equation 63

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[260] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[261] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

A minimum ceiling insulation level of R-30 is recommended throughout Texas as prescribed by the Department of Energy. Accordingly, deemed savings are provided for insulating to R-30. Adjustment factors are provided to allow contractors to estimate savings for installation of higher or lower levels of post-retrofit insulation. Contractors should estimate post-retrofit R-values according to the average insulation depth achieved across the area treated and the R per-inch of the insulation material installed.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings values. Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone was modified as follows: the default R-value of ceiling insulation (R-15 in most zones) was set at different levels, ranging from R-0 (no ceiling insulation) to R-22. These modifications are shown in Table 124.

The model runs are used to estimate peak demand and energy use in the modeled home at each of the base case ceiling insulation levels. The change-case models were run with the ceiling insulated to R-30.

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[260] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[261] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

Table 124. Ceiling Insulation—Prototypical Home Characteristics

Shell characteristic	Value	Source
Base ceiling insulation	< R5 R5-R8 R9-R14 R15-R22	Existing insulation level
Change ceiling insulation	R-30	R-30 retrofit insulation level consistent with DOE recommendations

Deemed Energy Savings Tables

Table 125 through Table 129, present the energy savings (kWh) associated with ceiling insulation for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 125 through Table 131 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 125 through Table 131 by a factor of 0.24.[262]

Table 125. Ceiling Insulation—Climate Zone 1: Amarillo, R-30 Energy Savings (kWh/sq. ft.)

Ceiling insulation base R-value	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
< R-5	0.41	0.12	0.12	3.07	1.31
R-5 to R-8	0.28	0.08	0.08	2.16	0.92
R-9 to R-14	0.15	0.04	0.05	1.17	0.50
R-15 to R-22	0.06	0.02	0.02	0.51	0.22

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[262] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 126. Ceiling Insulation—Climate Zone 2: Dallas, R-30 Energy Savings (kWh/sq. ft.)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
< R-5	0.67	0.07	1.90	0.79
R-5 to R-8	0.46	0.05	1.34	0.55
R-9 to R-14	0.25	0.03	0.72	0.30
R-15 to R-22	0.11	0.01	0.32	0.13

Table 127. Ceiling Insulation—Climate Zone 3: Houston, R-30 Energy Savings (kWh/sq. ft.)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
< R-5	0.68	0.05	1.30	0.53
R-5 to R-8	0.46	0.03	0.92	0.37
R-9 to R-14	0.24	0.02	0.50	0.20
R-15 to R-22	0.10	0.01	0.22	0.09

Table 128. Ceiling Insulation—Climate Zone 4: Corpus Christi, R-30 Energy (kWh/sq. ft.)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
R-5	0.52	0.03	0.89	0.34
R-5 to R-8	0.35	0.02	0.62	0.24
R-9 to R-14	0.18	0.01	0.33	0.13
R-15 to R-22	0.08	0.00	0.14	0.06

Table 129. Ceiling Insulation—Climate Zone 5: El Paso, R-30 Energy Savings (kWh/sq. ft.)

Ceiling insulation base R-value	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
< R-5	0.63	0.21	0.07	1.96	0.81
R-5 to R-8	0.43	0.15	0.05	1.40	0.57
R-9 to R-14	0.23	0.08	0.03	0.75	0.31
R-15 to R-22	0.10	0.03	0.01	0.33	0.13

Scale-Down/Up Factors for Energy Savings: Insulation to Below or Above R-30

The factors presented in this section are to be used when the average post-retrofit insulation depth is providing more or less than R-30 insulation. Scale-down factors are provided for the case when average post-retrofit insulation depth is not sufficient to achieve R-30; scale-up factors are provided for the case when insulating to a level greater than R-30. In either case, the following equation should be applied to scale down or scale up the energy savings.

$$Energy\ Savings\ [\Delta kWh] = \left\{R30\ Savings/ft^2 + \left[S_{D/U} \times (R_{Achieved} - 30)\right]\right\} \times A$$

Equation 64

Where:

$R30\ Savings/ft^2$ = *Sum of project-appropriate deemed cooling and heating energy savings per square feet taken from Table 125 through Table 129*

$S_{D/U}$ = *Project-appropriate scale-down or scale-up factor from either Table 130 or Table 131*

$R_{Achieved}$ = *Achieved R-value of installed insulation (e.g., for R-28, $R_{Achieved}$ = 28)*

A = *Treated area (sq. ft.)*

If the ceiling is insulated to a level less than R-30, the following factors shall be applied to scale down the achieved energy savings per square foot of treated ceiling area.

Table 130. Ceiling Insulation—Energy Scale-Down Factors for Insulating to Less than R-30 (kWh/sq. ft./ΔR)

Climate zone	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	4.00E-03	1.16E-03	1.27E-03	3.26E-02	1.38E-02
Zone 2: Dallas	6.66E-03	–	7.11E-04	2.00E-02	8.20E-03
Zone 3: Houston	6.22E-03	–	4.67E-04	1.38E-02	5.47E-03
Zone 4: Corpus Christi	4.92E-03	–	2.44E-04	9.04E-03	3.47E-03
Zone 5: El Paso	4.00E-03	1.16E-03	1.27E-03	3.26E-02	1.38E-02

If the ceiling is insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved energy savings per square foot of treated ceiling area.

Table 131. Ceiling Insulation—Energy Scale-Up Factors for Insulating to Greater than R-30 (kWh/sq. ft./ΔR)

Climate zone	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.66E-03	7.63E-04	8.45E-04	2.18E-02	9.18E-03
Zone 2: Dallas	4.45E-03	–	4.82E-04	1.33E-02	5.47E-03
Zone 3: Houston	4.00E-03	–	2.97E-04	9.19E-03	3.66E-03
Zone 4: Corpus Christi	3.24E-03	–	1.62E-04	5.99E-03	2.30E-03
Zone 5: El Paso	2.66E-03	7.63E-04	8.45E-04	2.18E-02	9.18E-03

Deemed Summer Demand Savings Tables

Table 132 through Table 136 present the summer demand savings (kW/sq. ft.) associated with ceiling insulation for the five Texas climate zones.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in the refrigerated air column in Table 132 through Table 138 by a factor of 0.6.

Table 132. Ceiling Insulation—Climate Zone 1: Amarillo, R-30 Summer Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Refrigerated	Evaporative
< R-5	8.00E-04	2.25E-04
R-5 to R-8	4.50E-04	1.47E-04
R-9 to R-14	2.33E-04	7.16E-05
R-15 to R-22	1.02E-04	2.87E-05

Table 133. Ceiling Insulation—Climate Zone 2: Dallas, R-30 Summer Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings (kW/sq. ft.)
< R-5	9.00E-04
R-5 to R-8	5.17E-04
R-9 to R-14	2.67E-04
R-15 to R-22	1.15E-04

Table 134. Ceiling Insulation—Climate Zone 3: Houston, R-30 Summer Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings (kW/sq. ft.)
< R-5	6.25E-04
R-5 to R-8	5.51E-04
R-9 to R-14	2.87E-04
R-15 to R-22	1.22E-04

Table 135. Ceiling Insulation—Climate Zone 4: Corpus Christi, R-30 Summer Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings (kW/sq. ft.)
< R-5	4.75E-04
R-5 to R-8	3.40E-04
R-9 to R-14	1.79E-04
R-15 to R-22	7.95E-05

Table 136. Ceiling Insulation—Climate Zone 5: El Paso, R-30 Summer Peak Demand Savings (kW/sq. ft)

Ceiling insulation base R-value	Refrigerated	Evaporative
< R-5	8.00E-04	2.23E-04
R-5 to R-8	4.72E-04	1.53E-04
R-9 to R-14	2.38E-04	6.25E-05
R-15 to R-22	1.03E-04	2.09E-05

Scale-Down/Up Factors: Insulation to Below or Above R-30

If the ceiling is insulated to a level less than R-30, the following factors shall be applied to scale down the achieved summer peak demand savings per square foot of treated ceiling area.

Table 137. Ceiling Insulation—Summer Peak Demand Scale-Down Factors for Insulating to Less than R-30 (kW/sq. ft./ΔR)

Climate zone	Refrigerated air	Evaporative cooling
Zone 1: Amarillo	6.41E-06	1.97E-06
Zone 2: Dallas	7.30E-06	–
Zone 3: Houston	7.91E-06	–
Zone 4: Corpus Christi	5.20E-06	–
Zone 5: El Paso	6.41E-06	1.97E-06

If the ceiling is insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved summer peak demand savings per square foot of treated ceiling area.

Table 138. Ceiling Insulation—Summer Peak Demand Scale-Up Factors for Insulating to Greater than R-30 (kW/sq. ft./ΔR)

Climate zone	Refrigerated air	Evaporative cooling
Zone 1: Amarillo	4.22E-06	1.89E-06
Zone 2: Dallas	4.92E-06	–
Zone 3: Houston	5.92E-06	–
Zone 4: Corpus Christi	3.47E-06	–
Zone 5: El Paso	4.22E-06	1.89E-06

Deemed Winter Demand Savings Tables

Table 139 through Table 143 present the winter demand savings associated with ceiling insulation for the five Texas climate zones.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 139 through Table 145 by a factor of 0.24.[263]

Table 139. Ceiling Insulation—Climate Zone 1: Amarillo, R-30 Winter Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	4.25E-05	9.75E-04	8.00E-04
R-5 to R-8	2.51E-05	8.74E-04	4.53E-04
R-9 to R-14	1.37E-05	4.56E-04	2.38E-04
R-15 to R-22	4.72E-06	1.95E-04	1.01E-04

Table 140. Ceiling Insulation—Climate Zone 2: Dallas, R-30 Winter Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	3.50E-05	1.30E-03	8.25E-04
R-5 to R-8	2.79E-05	9.84E-04	6.60E-04
R-9 to R-14	1.45E-05	5.13E-04	3.51E-04
R-15 to R-22	6.42E-06	2.23E-04	1.52E-04

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[263] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 141. Ceiling Insulation—Climate Zone 3: Houston, R-30 Winter Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	4.25E-05	1.15E-03	6.75E-04
R-5 to R-8	2.91E-05	7.71E-04	4.49E-04
R-9 to R-14	1.39E-05	4.01E-04	2.35E-04
R-15 to R-22	5.36E-06	1.74E-04	1.03E-04

Table 142. Ceiling Insulation—Climate Zone 4: Corpus Christi, R-30 Winter Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	2.50E-05	8.25E-04	4.50E-04
R-5 to R-8	2.18E-05	6.31E-04	3.03E-04
R-9 to R-14	1.13E-05	3.28E-04	1.57E-04
R-15 to R-22	5.71E-06	1.44E-04	6.95E-05

Table 143. Ceiling Insulation—Climate Zone 5: El Paso, R-30 Winter Peak Demand Savings (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	2.25E-05	5.75E-04	2.25E-04
R-5 to R-8	1.14E-05	3.72E-04	1.57E-04
R-9 to R-14	5.38E-06	1.79E-04	7.54E-05
R-15 to R-22	2.26E-06	7.41E-05	3.11E-05

Scale-Down/Up Factors for Demand Reduction: Insulation to Below or Above R-30

The factors presented in this section are to be used when the average post-retrofit insulation depth is providing more or less than R-30 insulation. Scale-down factors are provided for the case when average post-retrofit insulation depth is not sufficient to achieve R-30; scale-up factors are provided for the case when insulating to a level greater than R-30. In either case, the following equation should be applied to scale down or scale up the summer peak demand savings.

$$Peak\ Demand\ Savings\ [\Delta kW] = \left\{R30\ Savings/ft^2 + \left[S_{D/U} \times (R_{Achieved} - 30)\right]\right\} \times A$$

Equation 65

Where:

R30 Savings/ft^2	=	*Sum of project-appropriate deemed cooling and heating energy savings per square feet taken from Table 132 through Table 136 or Table 139 through Table 143*
$S_{D/U}$	=	*Project-appropriate scale-down or scale-up factor from either Table 137 and Table 138 (Summer) or Table 144 and Table 145 (Winter)*

If the ceiling is insulated to a level less than R-30, the following factors shall be applied to scale down the achieved winter peak demand savings per square foot of treated ceiling area.

Table 144. Ceiling Insulation—Winter Peak Demand Scale-down Factors for Insulating to Less than R-30 (kW/sq. ft./ΔR)

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	4.29E-07	1.21E-05	6.30E-06
Zone 2: Dallas	3.97E-07	1.40E-05	9.55E-06
Zone 3: Houston	3.05E-07	1.10E-05	6.53E-06
Zone 4: Corpus Christi	3.19E-07	9.18E-06	4.32E-06
Zone 5: El Paso	4.29E-07	1.21E-05	6.30E-06

If the ceiling is insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved winter peak demand savings per square foot of treated ceiling area.

Table 145. Ceiling Insulation—Winter Peak Demand Scale-up Factors for Insulating to Greater than R-30(kW/sq. ft./ ΔR)

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.76E-07	7.85E-06	4.19E-06
Zone 2: Dallas	2.57E-07	8.33E-06	4.80E-06
Zone 3: Houston	2.19E-07	7.33E-06	4.46E-06
Zone 4: Corpus Christi	1.72E-07	5.79E-06	2.72E-06
Zone 5: El Paso	2.76E-07	7.85E-06	4.19E-06

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Example Deemed Savings Calculation

Example 1 (Scale-Up). A home in Climate Zone 5 with evaporative cooling and an electric resistance furnace insulates 400 square feet from a baseline of R-1 to an efficient condition of R-38.

$$Cooling\ kWh\ savings\ per\ sq.ft. = 0.21 + 7.63x10^{-4} \times (38 - 30) = \mathit{0.22\ kWh/sq.ft.}$$

$$Heating\ kWh\ savings\ per\ sq.ft. = 1.96 + 2.18x10^{-2} \times (38 - 30) = \mathit{2.13\ kWh/sq.ft.}$$

$$Energy\ Savings = (0.22 + 2.13) \times 400 = \mathit{940\ kWh}$$

$$Summer\ kW\ savings\ per\ sq.ft. = 2.23 \times 10^{-4} + 1.89 \times 10^{-6} \times (38 - 30) = \mathit{2.38} \times 10^{-4}\ kW/sq.ft.$$

$$Summer\ Peak\ Demand\ Savings = 2.38 \times 10^{-4} \times 400 = 0.10\ kW$$

$$Winter\ kWsavings\ per\ sq.ft\ = 5.75 \times 10^{-4} + 7.85 \times 10^{-5} \times (38 - 30) = \mathit{1.20} \times 10^{-3}\ kW/sq.ft.$$

$$Winter\ Peak\ Demand\ Savings = 1.20 \times 10^{-3} \times 400 = 0.48\ kW$$

Example 2 (Scale-Down). A home in Climate Zone 3 with an air-source heat pump insulates 550 square feet from a baseline of R-5 to an efficient condition of R-28.

$$Cooling\ kWh\ savings\ per\ sq.ft. = 0.46 + 5.47 \times 10^{-3} \times (28 - 30) = 0.45\ kWh/sq.ft.$$

$$Heating\ kWh\ savings\ per\ sq.ft. = 0.37 + 3.66 \times 10^{-3} \times (28 - 30) = 0.36\ kWh/sq.ft.$$

$$Energy\ Savings = (0.45 + 0.36) \times 550 = 446.4\ kWh$$

$$Summer\ kW\ savings\ per\ sq.ft. = 5.51 \times 10^{-4} + 7.91 \times 10^{-6} \times (28 - 30) = 5.35 \times 10^{-4}\ kW/sq.ft.$$

$$Summer\ Peak\ Demand\ Savings = 5.35 \times 10^{-4} \times 550 = 0.29\ kW$$

$$Winter\ kW\ savings\ per\ sq.ft. = 4.49 \times 10^{-4} + 6.53 \times 10^{-6} \times (28 - 30) = 4.36 \times 10^{-4}\ kW/sq.ft.$$

$$Winter\ Peak\ Demand\ Savings = 4.36 \times 10^{-4} \times 550 = 0.24\ kW$$

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007),[264] the estimated useful life is 25 years for ceiling insulation.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Base R-value of original insulation
- R-value of installed insulation
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Square footage of ceiling insulation installed above a conditioned space
- Only for homes with a reported baseline R-value that is less than R-5:
    - Two pictures: (1) a picture showing the entire attic floor, and (2) a close-up picture of a ruler that shows the measurement of the depth of the insulation.

      Note: The second photo type is required for each area of insulation where there are varying R-values less than R-5. Additionally, both photo types are required for all separate attic/ceiling areas, even when the installed R-value is the same.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.

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[264] GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007). http://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLightsandHVACGDS_1Jun2007.pdf.

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 146. Ceiling Insulation—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Added detail on methodology and model characteristics.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. Provided savings tables for installation of insulation up to R-38. Multiplier provided to adjust cooling side savings for homes with evaporative cooling due to lower energy usage and demand associated with evaporative coolers relative to refrigerated air conditioning. Climate Zone 2 savings values awarded for Climate Zone 5 homes with heat pumps.
v3.1	11/05/2015	TRM v3.1 update. Provided example savings calculations. Clarified that no heating demand savings are to be claimed for homes with a gas furnace.
v4.0	10/10/2016	TRM v4.0 update. Updated energy and demand savings per new prototype simulation models and introduced new protocols for baseline and post-retrofit R-values, their associated savings estimations and documentation requirements.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Added clarifying language for U-factor methodology.
v8.0	10/2020	TRM v8.0 update. Updated savings tables. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. Updated savings tables for < R-5 baseline category.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.3 Attic Encapsulation Measure Overview

TRM Measure ID: R-BE-AE

Market Sector: Residential

Measure Category: Building envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Savings are estimated for bringing the attic into conditioned space by insulating and sealing the attic walls and roofs, eliminating leakage (to outside) and removing ceiling insulation, if present, to enhance airflow between the attic and the conditioned space directly below. Savings are presented according to Insulation Improvement and Infiltration Reduction components. Participants are expected to claim the sum of component savings.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Baseline Condition

The baseline condition is a vented, unfinished attic with some level of ceiling insulation. Ceiling insulation levels in existing construction can vary significantly, depending on the age of the home, type of insulation installed, and activity in the attic (such as using the attic for storage and HVAC equipment). Deemed savings have been developed based on different levels of encountered (existing) ceiling insulation in participating homes, ranging from sparsely insulated (< R-5) to the equivalent of about 6 inches of fiberglass batt insulation (R-22). The average ceiling insulation level prior to the retrofit for at participating homes is to be determined and documented by the contractor. Degradation due to age and density of the existing insulation should be taken into account.

Because existing ceiling insulation must be removed during measure implementation, the existing R-value will be based upon the R-value of the existing insulation prior to removal.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[265] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[266] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

A minimum ceiling insulation level of R-30 is recommended throughout Texas as prescribed by the Department of Energy[267]. Accordingly, deemed savings are provided for insulating to R-30. Adjustment factors are provided to allow contractors to estimate savings for installation of higher or lower levels of post-retrofit insulation. Contractors should estimate post-retrofit R-value according to the average insulation depth achieved across the area treated and the R per-inch of the insulation material installed.

Vents, obvious leaks, are to be sealed. Ceiling insulation between the attic and the conditioned space is removed.

Energy and Demand Savings Methodology

The energy and demand savings produced by the attic encapsulation measures have two components: 1) reduced heat transfer into the attic from the insulation improvement, and 2) reduced leakage of conditioned air to outside by closing off vents and sealing of leaks. Accordingly, deemed energy and demand savings are presented by their insulation and air infiltration components. Both insulation improvement component and infiltration reduction component savings should be claimed for all projects. Insulation improvement component savings shall be claimed using deemed savings derived for the ceiling insulation measure, as explained below. There are two paths for claiming infiltration reduction component savings depending on whether pre- and post-retrofit blower door testing is undertaken when implementing the attic encapsulation measure. If blower door testing is performed, savings for the infiltration reduction component can be estimated according to the Residential Air Infiltration measure (Measure 2.3.1). If blower door testing is not undertaken, savings for the Infiltration Reduction component shall be claimed as presented in the air infiltration reduction component savings presented in this measure (below).

In previous versions of the TRM, energy and demand savings for the attic encapsulation measure have been presented according to the results achieved by directly modeling the attic encapsulation measure according to the best interpretation of how the measure should be represented. The expectation is that this measure should, at a minimum, provide savings commensurate with those obtained from the installation of ceiling insulation. In general, the

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[265] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[266] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[267] Department of Energy Insulation R-value recommendations for zone 2/3, https://www.energy.gov/energysaver/weatherize/insulation.

measure is expected to out-perform ceiling insulation. However, modeling results have not reflected this expectation due to complications accounting for reduced infiltration, resulting in lower deemed savings for the attic encapsulation measure than those estimated for ceiling insulation. To encourage implementation of the measure and begin to develop information about the outcomes, the savings presented in this measure for the insulation improvement component of the Attic Encapsulation Measure are equivalent to the ceiling insulation measure savings. After adding air infiltration reduction component savings to the insulation improvement component savings, attic encapsulation measure savings will exceed those of the ceiling insulation measure.

Insulation Component Savings

Savings Algorithms and Input Variables (Insulation Component)

Calibrated simulation modeling was used to develop these deemed savings values. Specifically, these deemed savings estimates were developed by modeling the ceiling insulation measure using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. For details on the derivation of these savings, refer to the Residential Ceiling Insulation Measure (Measure 2.3.2).

Deemed Energy Savings Tables (Insulation Component)

Table 148 through Table 152 present the energy savings (kWh) associated with attic encapsulation for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types. Savings are specified per square foot of conditioned space directly below the treated attic.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling energy savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling savings value from Table 148 through Table 154 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 148 through Table 154 by a factor of 0.24.[268]

Table 147. Attic Encapsulation—Prototypical Home Characteristics

Shell characteristic	Value	Source
Base attic encapsulation	Vented attic < R5 R5-R8 R9-R14 R15-R22	Typical construction practice throughout the state
Change attic encapsulation with blower door test	Sealed attic with no ceiling insulation and R-30 roof deck insulation	R-30 retrofit insulation level consistent with DOE recommendations

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[268] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Shell characteristic	Value	Source
Change attic encapsulation without blower door test	Sealed attic with no ceiling insulation and R-30 roof deck insulation 18 percent leakage reduction	Insulation: R-30 retrofit insulation level consistent with DOE recommendations Leakage Reduction: mean reduction achieved via attic encapsulation according to ACCA Manual J, 8th Edition, Section 21-14[269]

Table 148. Attic Encapsulation—Climate Zone 1: Amarillo, R-30 Energy Savings for Insulation Component (kWh/sq. ft)

Ceiling insulation base R-value	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
< R-5	0.41	0.12	0.12	3.07	1.31
R-5 to R-8	0.28	0.08	0.08	2.16	0.92
R-9 to R-14	0.15	0.04	0.05	1.17	0.50
R-15 to R-22	0.06	0.02	0.02	0.51	0.22

Table 149. Attic Encapsulation—Climate Zone 2: Dallas, R-30 Energy Savings for Insulation Component (kWh/sq. ft)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
< R-5	0.67	0.07	1.90	0.79
R-5 to R-8	0.46	0.05	1.34	0.55
R-9 to R-14	0.25	0.03	0.72	0.30
R-15 to R-22	0.11	0.01	0.32	0.13

Table 150. Attic Encapsulation—Climate Zone 3: Houston, R-30 Energy Savings for Insulation Component (kWh/sq. ft)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
< R-5	0.68	0.05	1.30	0.53
R-5 to R-8	0.46	0.03	0.92	0.37
R-9 to R-14	0.24	0.02	0.50	0.20
R-15 to R-22	0.10	0.01	0.22	0.09

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[269] Section 21-14 of ACCA Manual J states that, "…a foam encapsulated attic eliminates ceiling leakage to the outdoors (i.e., to a vented attic), which means that the reduction in infiltration Cfm may range from 3 to 30 percent, with an 18 percent mean, as noted above". See Air Conditioning Contractors of America. Manual J, 8th Edition Version 2.10. Nov. 2011, p. 188.

Table 151. Attic Encapsulation—Climate Zone 4: Corpus Christi, R-30 Energy Savings for Insulation Component (kWh/sq. ft)

Ceiling insulation base R-value	Cooling savings	Heating savings		
		Gas	Electric resistance	Heat pump
< R-5	0.52	0.03	0.89	0.34
R-5 to R-8	0.35	0.02	0.62	0.24
R-9 to R-14	0.18	0.01	0.33	0.13
R-15 to R-22	0.08	0.00	0.14	0.06

Table 152. Attic Encapsulation—Climate Zone 5: El Paso, R-30 Energy Savings for Insulation Component (kWh/sq. ft)

Ceiling insulation base R-value	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
< R-5	0.63	0.21	0.07	1.96	0.81
R-5 to R-8	0.43	0.15	0.05	1.40	0.57
R-9 to R-14	0.23	0.08	0.03	0.75	0.31
R-15 to R-22	0.10	0.03	0.01	0.33	0.13

Scale-Down/Up Factors for Energy Savings: Insulation to Below or Above R-30

The factors presented in this section are to be used when the average post-retrofit insulation depth is providing either more than or less than R-30 insulation. Scale-down factors are provided for the case when average post-retrofit insulation depth is not sufficient to achieve R-30; scale-up factors are provided for the case when insulating to a level greater than R-30. In either case, the following equation should be applied to scale down or scale up the energy savings.

$$Energy\ Savings\ [\Delta kWh] = \left\{R30\ Savings/ft^2 + \left[S_{D/U} \times (R_{Achieved} - 30)\right]\right\} \times A$$

Equation 66

Where:

$R30\ Savings/ft^2$ = *Sum of project-appropriate deemed Cooling and Heating Energy Savings per square feet taken from Table 148 through Table 152*

$S_{D/U}$ = *Project-appropriate scale-down or scale-up factor from either Table 153 or Table 154*

$R_{Achieved}$ = *Achieved R-value of installed insulation (e.g., for R-28,* $R_{Achieved}$ *= 28)*

A = *Treated area (sq. ft.)*

If the roof deck and attic walls are insulated to a level less than R-30, the factors in Table 153 shall be applied to scale down the achieved energy savings per square foot of treated ceiling area.

Table 153. Attic Encapsulation—Energy Scale-down Factors for Insulating to Less than R-30 (kWh/sq. ft./ΔR)

Climate zone	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	4.00E-03	1.16E-03	1.27E-03	3.26E-02	1.38E-02
Zone 2: Dallas	6.66E-03	–	7.11E-04	2.00E-02	8.20E-03
Zone 3: Houston	6.22E-03	–	4.67E-04	1.38E-02	5.47E-03
Zone 4: Corpus Christi	4.92E-03	–	2.44E-04	9.04E-03	3.47E-03
Zone 5: El Paso	4.00E-03	1.16E-03	1.27E-03	3.26E-02	1.38E-02

If the roof deck and attic walls are insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved energy savings per square foot of treated ceiling area.

Table 154. Attic Encapsulation—Energy Scale-up Factors for Insulating to Greater than R-30 (kWh/sq. ft./ΔR)

Climate zone	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.66E-03	7.63E-04	8.45E-04	2.18E-02	9.18E-03
Zone 2: Dallas	4.45E-03	–	4.82E-04	1.33E-02	5.47E-03
Zone 3: Houston	4.00E-03	–	2.97E-04	9.19E-03	3.66E-03
Zone 4: Corpus Christi	3.24E-03	–	1.62E-04	5.99E-03	2.30E-03
Zone 5: El Paso	2.66E-03	7.63E-04	8.45E-04	2.18E-02	9.18E-03

Deemed Summer Demand Savings Tables

Table 155 through Table 159 present the summer demand savings (kW/sq. ft.) associated with the Insulation Improvement component of the Attic Encapsulation Measure for the five Texas climate zones.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in the refrigerated air column in Table 155 through Table 161 by a factor of 0.6.

Table 155. Attic Encapsulation—Climate Zone 1: Amarillo, R-30 Summer Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Refrigerated	Evaporative
< R-5	8.00E-04	2.25E-04
R-5 to R-8	4.50E-04	1.47E-04
R-9 to R-14	2.33E-04	7.16E-05
R-15 to R-22	1.02E-04	2.87E-05

Table 156. Attic Encapsulation—Climate Zone 2: Dallas, R-30 Summer Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings
< R-5	9.00E-04
R-5 to R-8	5.17E-04
R-9 to R-14	2.67E-04
R-15 to R-22	1.15E-04

Table 157. Attic Encapsulation—Climate Zone 3: Houston, R-30 Summer Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings
< R-5	6.25E-04
R-5 to R-8	5.51E-04
R-9 to R-14	2.87E-04
R-15 to R-22	1.22E-04

Table 158. Attic Encapsulation—Climate Zone 4: Corpus Christi, R-30 Summer Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Demand savings
< R-5	4.75E-04
R-5 to R-8	3.40E-04
R-9 to R-14	1.79E-04
R-15 to R-22	7.95E-05

Table 159. Attic Encapsulation—Climate Zone 5: El Paso, R-30 Summer Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Refrigerated	Evaporative
< R-5	8.00E-04	2.23E-04
R-5 to R-8	4.72E-04	1.53E-04
R-9 to R-14	2.38E-04	6.25E-05
R-15 to R-22	1.03E-04	2.09E-05

Scale-Down/Up Factors: Insulation to Below or Above R-30

If the roof deck and attic walls are insulated to a level less than R-30, the following factors shall be applied to scale down the achieved summer peak demand savings per square foot of treated ceiling area.

Table 160. Attic Encapsulation—Summer Peak Demand Scale-down Factors for Insulating to Less than R-30 (kW/sq. ft./ΔR)

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	6.41E-06	1.97E-06
Zone 2: Dallas	7.30E-06	–
Zone 3: Houston	7.91E-06	–
Zone 4: Corpus Christi	5.20E-06	–
Zone 5: El Paso	6.41E-06	1.97E-06

If the roof deck and attic walls are insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved summer peak demand savings per square foot of treated ceiling area.

Table 161. Attic Encapsulation—Summer Peak Demand Scale-up Factors for Insulating to Greater than R-30 (kW/sq. ft./ΔR)

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	4.22E-06	1.89E-06
Zone 2: Dallas	4.92E-06	–
Zone 3: Houston	5.92E-06	–
Zone 4: Corpus Christi	3.47E-06	–
Zone 5: El Paso	4.22E-06	1.89E-06

Deemed Winter Demand Savings Tables

Table 162 through Table 166 present the winter demand savings associated with the Insulation Improvement component of the Attic Encapsulation Measure for the five Texas climate zones.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 162 through Table 168 by a factor of 0.24.[270]

Table 162. Attic Encapsulation—Climate Zone 1: Amarillo, R-30 Winter Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	4.25E-05	9.75E-04	8.00E-04
R-5 to R-8	2.51E-05	8.74E-04	4.53E-04
R-9 to R-14	1.37E-05	4.56E-04	2.38E-04
R-15 to R-22	4.72E-06	1.95E-04	1.01E-04

Table 163. Attic Encapsulation—Climate Zone 2: Dallas, R-30 Winter Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	3.50E-05	1.30E-03	8.25E-04
R-5 to R-8	2.79E-05	9.84E-04	6.60E-04
R-9 to R-14	1.45E-05	5.13E-04	3.51E-04
R-15 to R-22	6.42E-06	2.23E-04	1.52E-04

Table 164. Attic Encapsulation—Climate Zone 3: Houston, R-30 Winter Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	4.25E-05	1.15E-03	6.75E-04
R-5 to R-8	2.91E-05	7.71E-04	4.49E-04
R-9 to R-14	1.39E-05	4.01E-04	2.35E-04
R-15 to R-22	5.36E-06	1.74E-04	1.03E-04

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[270] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 165. Attic Encapsulation—Climate Zone 4: Corpus Christi, R-30 Winter Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	2.50E-05	8.25E-04	4.50E-04
R-5 to R-8	2.18E-05	6.31E-04	3.03E-04
R-9 to R-14	1.13E-05	3.28E-04	1.57E-04
R-15 to R-22	5.71E-06	1.44E-04	6.95E-05

Table 166. Attic Encapsulation—Zone 5: El Paso, R-30 Winter Peak Demand Savings for Insulation Component (kW/sq. ft.)

Ceiling insulation base R-value	Gas	Electric resistance	Heat pump
< R-5	2.25E-05	5.75E-04	2.25E-04
R-5 to R-8	1.14E-05	3.72E-04	1.57E-04
R-9 to R-14	5.38E-06	1.79E-04	7.54E-05
R-15 to R-22	2.26E-06	7.41E-05	3.11E-05

Scale-Down/Up Factors for Demand Reduction: Insulation to Below or Above R-30

The factors presented in this section are to be used when the average post-retrofit insulation depth is providing more or less than R-30 insulation. Scale-down factors are provided for the case when average post-retrofit insulation depth is not sufficient to achieve R-30; scale-up factors are provided for the case when insulating to a level greater than R-30. In either case, the following equation should be applied to scale down or scale up the summer peak demand savings.

$$Peak\ Demand\ Savings\ [\Delta kW] = \left\{R30\ Savings/ft^2 + \left[S_{D/U} \times (R_{Achieved} - 30)\right]\right\} \times A$$

Equation 67

Where:

R30 Savings/ft^2 = *Sum of project-appropriate deemed Cooling and Heating Energy Savings per square feet taken from Table 155 through Table 159 or Table 162 through Table 166*

$S_{D/U}$ = *Project-appropriate scale-down or scale-up factor from either Table 160 and Table 161 (summer) or Table 167 and Table 168 (winter)*

If the roof deck and attic walls are insulated to a level less than R-30, the following factors shall be applied to scale down the achieved winter peak demand savings (per square foot of treated ceiling area).

Table 167. Attic Encapsulation—Winter Peak Demand Scale-down Factors for Insulating to Less than R-30 (kW/sq. ft./ΔR)

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	4.29E-07	1.21E-05	6.30E-06
Zone 2: Dallas	3.97E-07	1.40E-05	9.55E-06
Zone 3: Houston	3.05E-07	1.10E-05	6.53E-06
Zone 4: Corpus Christi	3.19E-07	9.18E-06	4.32E-06
Zone 5: El Paso	4.29E-07	1.21E-05	6.30E-06

If the roof deck/attic walls are insulated to a level greater than R-30, the following factors shall be applied to scale up the achieved winter peak demand savings per square foot of treated ceiling area.

Table 168. Attic Encapsulation—Winter Peak Demand Scale-cp Factors for Insulating to Greater than R-30 (kW/sq. ft./ ΔR)

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.76E-07	7.85E-06	4.19E-06
Zone 2: Dallas	2.57E-07	8.33E-06	4.80E-06
Zone 3: Houston	2.19E-07	7.33E-06	4.46E-06
Zone 4: Corpus Christi	1.72E-07	5.79E-06	2.72E-06
Zone 5: El Paso	2.76E-07	7.85E-06	4.19E-06

Air Infiltration Reduction Component Savings

Energy and demand savings for the air infiltration reduction component of the attic encapsulation measure are calculated either using the results of pre- and post-retrofit blower door testing or an average percent infiltration reduction. Regardless of how air infiltration reduction component savings are calculated, they should be added to the insulation improvement component savings to arrive at the total energy and demand savings for implementing the Attic Encapsulation measure.

Homes without refrigerated cooling should not claim air infiltration reduction component savings for attic encapsulation.

With Blower Door Testing

Implementers choosing to perform pre- and post-measure blower door testing should claim the air infiltration reduction component deemed energy and demand savings for the Attic Encapsulation measure using the estimated CFM_{50} reduction from the blower door tests with the equations and coefficients in the Residential Infiltration measure (Measure 2.3.1).

Without Blower Door Testing

Implementers electing not to perform blower door testing when performing this measure shall claim air infiltration reduction component deemed energy and demand savings for the Attic Encapsulation measure using this section, which presents the annual energy (kWh) and summer and winter demand savings (kW) associated with attic encapsulation for the five Texas climate zones, taking into account a mean leakage reduction of 18 percent.[271] Savings are presented per home.

Savings Algorithms and Input Variables (Infiltration Reduction Component)

Calibrated simulation modeling was used to develop air infiltration reduction deemed savings, which are expressed in Measure 2.3.1 as linear functions of the leakage reduction achieved (in CFM_{50}).[272] For details on the derivation of the air infiltration measure savings, refer to the Residential Air Infiltration measure (Measure 2.3.1).

ACCA Manual J provides an average leakage reduction attributable to attic encapsulation projects of 18 percent.[273] Accordingly, deemed savings attributable to the air infiltration reduction component of an attic encapsulation project implemented without pre- and post-implementation blower door testing are estimated by applying an 18 percent leakage reduction to the infiltration rates embedded in the deemed savings prototype model homes used in the derivation of residential envelope measure deemed savings for the Texas TRM. This 18 percent leakage reduction provides the CFM_{50} reduction input required to estimate air infiltration measure deemed savings with the equations in Measure 2.3.1.

Table 169. Attic Encapsulation—Prototypical Home Characteristics

Shell characteristic	CFM_{50} reduction	Source
Air infiltration reduction from attic encapsulation (without blower door testing)	18 percent reduction	Mean reduction achieved via attic encapsulation according to ACCA Manual J, 8th Edition, Section 21-14[274]

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[271] Section 21-14 of ACCA Manual J states that, "…a foam encapsulated attic eliminates ceiling leakage to the outdoors (i.e., to a vented attic), which means that the reduction in infiltration CFM may range from 3 to 30 percent, with an 18 percent mean, as noted above". See Air Conditioning Contractors of America. Manual J, 8th Edition Version 2.10. Nov. 2011, p. 188.

[272] Model testing indicates a straight-line relationship between demand and energy savings achieved and CFM50 reductions is appropriate with beginning and ending leakage rates within the ranges permitted by the measure.

[273] Air Conditioning Contractors of America. Manual J, 8th Edition Version 2.10. Nov. 2011, p. 188.

[274] Section 21-14 of ACCA Manual J states that, "…a foam encapsulated attic eliminates ceiling leakage to the outdoors (i.e., to a vented attic), which means that the reduction in infiltration Cfm may range from 3 to 30 percent, with an 18 percent mean, as noted above". See Air Conditioning Contractors of America. Manual J, 8th Edition Version 2.10. Nov. 2011, p. 188.

Deemed Energy Savings Tables (Infiltration Reduction Component)

Annual energy savings are provided by the space heating equipment type combined with refrigerated cooling. Savings are specified per home based on a deemed 18 percent infiltration reduction. Homes without refrigerated cooling are not eligible to claim these savings.

Table 170. Attic Encapsulation—Energy Savings for Infiltration Reduction Component, 18 Percent Air Infiltration Reduction (kWh/home)

Climate zone	Heating type		
	Gas/ no heat	Electric resistance	Heat pump
Zone 1: Amarillo	135.0	874.5	385.8
Zone 2: Dallas	209.2	600.3	315.5
Zone 3: Houston	161.9	469.5	259.6
Zone 4: Corpus Christi	179.7	411.9	262.9
Zone 5: El Paso	64.3	524.7	226.5

Deemed Summer Demand Savings Tables (Infiltration Reduction Component)

Summer demand savings are specified per home based on a deemed 18 percent infiltration reduction. Homes without refrigerated cooling are not eligible to claim these savings.

Table 171. Attic Encapsulation—Summer Peak Demand Savings for Infiltration Reduction Component, 18 Percent Air Infiltration Reduction (kW/home)

Climate zone	Cooling type	
	Refrigerated	Evaporative
Zone 1: Amarillo	0.088	–
Zone 2: Dallas	0.117	–
Zone 3: Houston	0.117	–
Zone 4: Corpus Christi	0.098	–
Zone 5: El Paso	0.056	–

Deemed Winter Demand Savings Tables (Infiltration Reduction Component)

Winter demand savings are provided by space heating equipment types. Savings are specified per home based on a deemed 18 percent infiltration reduction.

Table 172. Attic Encapsulation—Winter Peak Demand Savings for the Infiltration Reduction Component, 18 Percent Air Infiltration Reduction (kW/home)

Climate zone	Heating type		
	Gas/ no heat	Electric resistance	Heat pump
Zone 1: Amarillo	–	0.404	0.235
Zone 2: Dallas	–	0.548	0.304
Zone 3: Houston	–	0.476	0.244
Zone 4: Corpus Christi	–	0.342	0.158
Zone 5: El Paso	–	0.161	0.066

Example Deemed Savings Calculation

Example 1. A contractor seals the attic and adds R-38 insulation to the underside of the roof to a home with 900 square feet of conditioned space below the treated attic in Climate Zone 3 with refrigerated air and a gas furnace, which has existing ceiling insulation estimated at R-7. No blower door testing is performed.

Insulation component savings:

$$Energy\ Savings/ft^2, Insulation\ to\ R-30 = 0.46 + \ 0.03 = \ 0.49\ kWh/ft^2$$

$$Energy\ Savings, Insulation\ to\ R-38 =$$

$$\{0.49 + [(4x10^{-3} + \ 2.97x10^{-4}) \times (38-30)]\} \times \ 900 = \ 471.9\ kWh$$

$$Summer\ Peak\ Demand\ Savings, Insulation\ to\ R-38 =$$

$$\{5.51 \ \times \ 10^{-4} + [5.92 \ \times \ 10^{-6}\ x\ (38-30)]\} \times \ 900 = 0.54\ kW$$

$$Winter\ Peak\ Demand\ Savings, Insulation\ to\ R-38 =$$

$$\{2.91 \ \times \ 10^{-5} + [2.19x10^{-7} \times \ (38-30)]\} \times \ 900 = 0.03\ kW$$

Infiltration reduction component savings:

$$Energy\ Savings, 18\%\ Infiltration\ Reduction = \ 161.9\ kWh$$

$$Summer\ Peak\ Demand\ Savings, 18\%\ Infiltration\ Reduction = 0.12\ kW$$

$$Winter\ Peak\ Demand\ Savings, 18\%\ Infiltration\ Reduction = 0$$

Measure savings:

$$Energy\ Savings = \ 471.9\ + 161.9 = 633.8\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 0.54 + 0.12 = 0.66\ kW$$

$$Winter\ Peak\ Demand\ Savings = 0.03 + \ 0 = 0.03\ kW$$

Example 2. A contractor seals the attic and adds R-30 insulation to the underside of the roof to a home with 1,200 square feet of conditioned space below the treated attic in Climate Zone 4 with an air-source heat pump in which existing ceiling insulation is demonstrated to be R-9. Blower door testing performed before and after measure implementation demonstrated a 750 CFM_{50} reduction in leakage rate.

Insulation component savings:

$$Energy\ Savings = (0.18 + 0.13)\ \times\ 1{,}200 = 372\ kWh$$

$$Summer\ Peak\ Demand\ Savings = (1.79\ \times\ 10^{-4})\ \times\ 1{,}200 = 0.21\ kW$$

$$Winter\ Peak\ Demand\ Savings = (1.57\ \times\ 10^{-4})\ \times\ 1{,}200 = 0.19\ kW$$

Infiltration reduction component savings:

$$Energy\ Savings, 750\ CFM_{50}\ Infiltration\ Reduction = \ 750 \times (0.39 \times 1 + 0.21) = 450 kWh$$

$$Summer\ Peak\ Demand\ Savings, 750\ CFM_{50}\ Infiltration\ Reduction = \\ 750 \times (2.24x10^{-4} \times 1) = 0.17\ kW$$

$$Winter\ Peak\ Demand\ Savings, 750\ CFM_{50}\ Infiltration\ Reduction = \\ 750 \times (3.60x10^{-4}) = 0.27\ kW$$

Measure savings:

$$Energy\ Savings = \ 372\ +\ 450 = 822\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 0.21 + 0.17 = 0.38\ kW$$

$$Winter\ Peak\ Demand\ Savings = 0.19 + \ 0.27 = 0.46\ kW$$

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007),[275] the Estimated Useful Life is 25 years for ceiling insulation. The measure life specified for ceiling insulation is also appropriate for attic encapsulation.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Base R-value of original insulation
- R-value of installed insulation
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
  - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Square footage of conditioned space directly below the treated attic
- Indicate whether blower door testing was performed and whether air infiltration reduction component savings are claimed in this measure or separately using the Air Infiltration measure
- Only for homes with a reported baseline R-value that is less than R-5:
  - Two pictures: (1) a picture showing the entire attic floor, and (2) a close-up picture of a ruler that shows the measurement of the depth of the insulation

    Note: The second photo type is required for each area of insulation where there are varying R-values less than R-5. Additionally, both photo types are required for all separate attic/ceiling areas, even when the installed R-value is the same.

References and Efficiency Standards

Petitions and Rulings

- 10/2017

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[275] GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007). http://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLightsandHVACGDS_1Jun2007.pdf.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 173. Attic Encapsulation—Revision History

TRM version	Date	Description of change
v4.0	10/10/2016	TRM v4.0 origin.
v5.0	10/2017	TRM v5.0 update. Incorporated alternative savings path that includes savings for infiltration reduction.
v6.0	11/2018	TRM v6.0 update. Removed closed cell recommendation.
v7.0	11/2019	TRM v7.0 update. Incorporated EM&V guidance memo.
v8.0	10/2020	TRM v8.0 update. Updated savings tables. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. Updated savings tables for < R-5 baseline category.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.4 Wall Insulation Measure Overview

TRM Measure ID: R-BE-WI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Wall insulation is added to the walls surrounding conditioned space in existing homes, either by removing wall enclosures and applying batt or spray insulation or by otherwise filling (e.g., blowing in loose insulation) the cavity space between studs in the walls of existing homes. Walls may be either 2x4 or 2x6 construction. Savings are estimated for filling the wall cavities of 2x4 or 2x6 walls with fiberglass batts, cellulose, or closed-cell spray foam and are presented per square foot of treated wall area (gross wall area less window and door area).

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Refer to the Baseline Condition section below for eligibility criteria regarding the pre-retrofit level of wall insulation.

Baseline Condition

The baseline is a house with little or no wall insulation in the wall cavity. For those homes for which a minimal level of insulation is encountered, the baseline is established at R-4. This baseline should be used to represent homes for which installed insulation covers a very limited amount of the wall area to be treated, is significantly degraded, and/or is less than an inch thick. Homes with more than this base level of insulation are not eligible for the measure.

Baseline homes may have either 2x4 or 2x6 construction.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[276] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[277] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

The standard throughout Texas for adding wall insulation to an existing wall cavity is R-13, as prescribed by the United States Department of Energy (DOE) and Texas Department of Housing and Community Affairs (TDHCA) programs. The standard is achieved by filling a 2x4 wall cavity with fiberglass batt or cellulose insulation, which typically provides an R-value per inch (thickness) of between 3 and 4 $ft^2 \cdot °F \cdot hr/Btu$. Other wall insulation materials may be used, such as closed-cell spray foam, which approximately provides R-6 per inch.

As such, deemed savings are provided for insulating 2x4 and 2x6 walls to the levels presented in Table 174.

Table 174. Wall Insulation—High-Efficiency Condition R-Values for 2x4 and 2x6 Walls

Insulation material	2x4 wall	2x6 wall
Fiberglass batt or cellulose	R-13	R-17
Closed-cell spray foam	R-21	R-33

Wall insulation reduces the ventilation rate in the home, and therefore, a post-installation blower door test must be conducted. Results must comply with the minimum final ventilation rate discussed in the High-Efficiency Condition section found in the Air Infiltration section of this document. This requirement applies to retrofits implemented under the HTR and RSOP programs.

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[276] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[277] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings values. Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows: the default R-11 insulation was reduced to either R-0 or R-4.

The model runs calculated energy use for the prototypical home prior to the installation of the wall insulation measure. Next, change-case models were run to calculate energy use with the wall insulation measure in place.

Table 175. Wall Insulation—Prototypical Home Characteristics

Shell characteristic	Value	Source
Base wall insulation	R-0 R-4	BEopt estimates wall assembly R-value for uninsulated walls to be 3.6 for 2x4 construction and 3.7 for 2x6 construction. Assembly R-values for R-4 walls are 6.7 and 7.1 for 2x4 and 2x6 construction, respectively. Listed base levels are for the insulation material only.
Change wall insulation 2x4 wall	R-13 R-21	For retrofit with fiberglass batt/cellulose and closed-cell spray foam, respectively.
Change wall insulation 2x6 wall	R-17 R-33	EF or retrofit with fiberglass batt/cellulose and closed-cell spray foam, respectively.

Deemed Energy Savings Tables

Savings are presented separately for insulating 2x4 wall construction and homes with 2x6 walls. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 176 through Table 179 by a factor of 0.6. Similarly for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 176 through Table 179 by a factor of 0.24.[278]

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[278] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

2x4 Walls

Table 176 presents the deemed energy savings values for insulating 2x4 walls to R-13 for all five Texas climate zones.

Table 176. Wall Insulation—Energy Savings (kWh/sq. ft.), Insulation of 2x4 Walls to R- 13

		Cooling savings		Heating savings		
Climate zone	**Baseline R-value**	**Refrigerated**	**Evaporative**	**Gas**	**Electric resistance**	**Heat pump**
Zone 1: Amarillo	Uninsulated	0.50	0.17	0.18	3.96	1.67
Zone 2: Dallas		0.85	–	0.09	2.44	0.99
Zone 3: Houston		0.90	–	0.07	1.67	0.66
Zone 4: Corpus Christi		0.53	–	0.04	1.19	0.45
Zone 5: El Paso		0.76	0.29	0.09	2.40	0.98
Zone 1: Amarillo	R-4	0.18	0.06	0.07	1.52	0.64
Zone 2: Dallas		0.32	–	0.04	0.93	0.38
Zone 3: Houston		0.33	–	0.03	0.64	0.25
Zone 4: Corpus Christi		0.19	–	0.01	0.45	0.17
Zone 5: El Paso		0.28	0.11	0.03	0.92	0.37

Table 177 presents the deemed energy savings values for insulating 2x4 walls to R-21 for all five Texas climate zones.

Table 177. Wall Insulation—Energy Savings (kWh/sq. ft.), Insulation of 2x4 Walls to R-21

		Cooling savings		Heating savings		
Climate zone	**Baseline R-value**	**Refrigerated**	**Evaporative**	**Gas**	**Electric resistance**	**Heat pump**
Zone 1: Amarillo	Uninsulated	0.56	0.18	0.20	4.44	1.87
Zone 2: Dallas		0.95	–	0.10	2.73	1.11
Zone 3: Houston		1.01	–	0.08	1.88	0.74
Zone 4: Corpus Christi		0.59	–	0.04	1.33	0.50
Zone 5: El Paso		0.85	0.33	0.10	2.69	1.09
Zone 1: Amarillo	R-4	0.24	0.08	0.09	2.00	0.84
Zone 2: Dallas		0.42	–	0.05	1.23	0.50
Zone 3: Houston		0.43	–	0.03	0.84	0.33
Zone 4: Corpus Christi		0.26	–	0.02	0.59	0.22
Zone 5: El Paso		0.37	0.14	0.05	1.20	0.49

2x6 Walls

Table 178 presents the deemed energy savings values for insulating 2x6 walls to R-17 for all five Texas climate zones.

Table 178. Wall Insulation—Energy Savings (kWh/sq. ft.), Insulation of 2x6 Walls to R-17

Climate zone	Baseline R-value	Cooling savings		Heating Savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	0.53	0.18	0.19	4.27	1.80
Zone 2: Dallas		0.91	–	0.10	2.63	1.07
Zone 3: Houston		0.97	–	0.08	1.81	0.71
Zone 4: Corpus Christi		0.56	–	0.04	1.27	0.48
Zone 5: El Paso		0.81	0.31	0.10	2.58	1.05
Zone 1: Amarillo	R-4	0.22	0.07	0.08	1.81	0.76
Zone 2: Dallas		0.38	–	0.04	1.11	0.45
Zone 3: Houston		0.39	–	0.03	0.76	0.30
Zone 4: Corpus Christi		0.23	–	0.02	0.53	0.20
Zone 5: El Paso		0.33	0.13	0.04	1.08	0.44

Table 179 presents the deemed energy savings values for insulating 2x6 walls to R-33 for all five Texas climate zones.

Table 179. Wall Insulation—Energy Savings (kWh/sq. ft.), Insulation of 2x6 Walls to R-33

Climate zone	Baseline R-value	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	0.59	0.20	0.22	4.79	2.01
Zone 2: Dallas		1.01	–	0.11	2.94	1.20
Zone 3: Houston		1.07	–	0.09	2.02	0.80
Zone 4: Corpus Christi		0.62	–	0.04	1.42	0.54
Zone 5: El Paso		0.90	0.35	0.11	2.88	1.17
Zone 1: Amarillo	R-4	0.28	0.09	0.11	2.33	0.98
Zone 2: Dallas		0.48	–	0.05	1.42	0.58
Zone 3: Houston		0.49	–	0.04	0.98	0.38
Zone 4: Corpus Christi		0.29	–	0.02	0.67	0.25
Zone 5: El Paso		0.42	0.16	0.05	1.38	0.56

Deemed Summer Demand Savings Tables

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 180 through Table 183 by a factor of 0.6.

2x4 Walls

Table 180 presents the deemed summer demand savings values for insulating 2x4 walls to R-13 for all five Texas climate zones.

Table 180. Wall Insulation—Summer Peak Demand Savings (kW/sq. ft.), Insulation of 2x4 Walls to R-13

Climate zone	Baseline R-value	Cooling type	
		Refrigerated	Evaporative
Zone 1: Amarillo	Uninsulated	6.41E-04	2.40E-04
Zone 2: Dallas		7.32E-04	–
Zone 3: Houston		8.50E-04	–
Zone 4: Corpus Christi		4.17E-04	–
Zone 5: El Paso		6.52E-04	2.00E-04
Zone 1: Amarillo	R-4	2.35E-04	9.16E-05
Zone 2: Dallas		2.70E-04	–
Zone 3: Houston		3.02E-04	–
Zone 4: Corpus Christi		1.55E-04	–
Zone 5: El Paso		2.43E-04	7.40E-05

Table 181 presents the deemed summer demand savings values for insulating 2x4 walls to R-13 for all five Texas climate zones.

Table 181. Wall Insulation—Summer Peak Demand Savings, Insulation of 2x4 Walls to R-21 (kW/sq. ft.)

Climate zone	Baseline R-value	Cooling type	
		Refrigerated	Evaporative
Zone 1: Amarillo	Uninsulated	7.34E-04	2.66E-04
Zone 2: Dallas		8.16E-04	–
Zone 3: Houston		9.55E-04	–
Zone 4: Corpus Christi		4.69E-04	–
Zone 5: El Paso		7.32E-04	2.23E-04

Climate zone	Baseline R-value	Cooling type	
		Refrigerated	Evaporative
Zone 1: Amarillo	R-4	3.29E-04	1.18E-04
Zone 2: Dallas		3.55E-04	–
Zone 3: Houston		4.08E-04	–
Zone 4: Corpus Christi		2.07E-04	–
Zone 5: El Paso		3.24E-04	9.68E-05

2x6 Walls

Table 182 presents the deemed summer demand savings values for insulating 2x6 walls to R-17 for all five Texas climate zones.

Table 182. Wall Insulation—Summer Peak Demand Savings (kW/sq. ft.), Insulation of 2x6 Walls to R-17

Climate zone	Baseline R-value	Cooling type	
		Refrigerated	Evaporative
Zone 1: Amarillo	Uninsulated	8.00E-04	2.59E-04
Zone 2: Dallas		7.87E-04	–
Zone 3: Houston		9.20E-04	–
Zone 4: Corpus Christi		4.56E-04	–
Zone 5: El Paso		8.06E-04	2.14E-04
Zone 1: Amarillo	R-4	2.88E-04	1.06E-04
Zone 2: Dallas		3.19E-04	–
Zone 3: Houston		3.67E-04	–
Zone 4: Corpus Christi		1.88E-04	–
Zone 5: El Paso		2.91E-04	8.44E-05

Table 183 presents the deemed summer demand savings values for insulating 2x6 walls to R-33 for all five Texas climate zones.

Table 183. Wall Insulation—Summer Peak Demand Savings (kW/sq. ft.), Insulation of 2x6 Walls to R-33

		Cooling type	
Climate zone	Baseline R-value	Refrigerated	Evaporative
Zone 1: Amarillo	Uninsulated	7.76E-04	2.83E-04
Zone 2: Dallas		8.77E-04	–
Zone 3: Houston		1.02E-03	–
Zone 4: Corpus Christi		5.08E-04	–
Zone 5: El Paso		7.80E-04	2.38E-04
Zone 1: Amarillo	R-4	3.64E-04	1.30E-04
Zone 2: Dallas		4.09E-04	–
Zone 3: Houston		4.64E-04	–
Zone 4: Corpus Christi		2.40E-04	–
Zone 5: El Paso		3.65E-04	1.08E-04

Deemed Winter Demand Savings

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 184 through Table 187 by a factor of 0.24.[279]

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[279] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

2x4 Walls

Table 184 presents the deemed winter demand savings values for insulating 2x4 walls to R-13 for all five Texas climate zones.

Table 184. Wall Insulation—Winter Peak Demand Savings (kW/sq. ft.), Insulation of 2x4 Walls to R-13

Climate zone	Baseline R-value	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	6.93E-05	1.71E-03	8.78E-04
Zone 2: Dallas		6.66E-05	1.96E-03	1.30E-03
Zone 3: Houston		7.49E-05	1.48E-03	8.39E-04
Zone 4: Corpus Christi		4.28E-05	1.22E-03	5.78E-04
Zone 5: El Paso		2.06E-05	6.78E-04	2.84E-04
Zone 1: Amarillo	R-4	2.58E-05	6.20E-04	3.19E-04
Zone 2: Dallas		2.46E-05	7.32E-04	4.94E-04
Zone 3: Houston		2.61E-05	5.50E-04	3.20E-04
Zone 4: Corpus Christi		1.61E-05	4.51E-04	2.13E-04
Zone 5: El Paso		6.23E-06	2.23E-04	9.39E-05

Table 185 presents the deemed winter demand savings values for insulating 2x4 walls to R-21 for all five Texas climate zones.

Table 185. Wall Insulation—Winter Peak Demand Savings (kW/sq. ft.), Insulation of 2x4 Walls to R-17

Climate zone	Baseline R-value	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	7.69E-05	1.89E-03	9.75E-04
Zone 2: Dallas		7.41E-05	2.18E-03	1.46E-03
Zone 3: Houston		8.19E-05	1.65E-03	9.40E-04
Zone 4: Corpus Christi		4.78E-05	1.36E-03	6.41E-04
Zone 5: El Paso		2.24E-05	7.37E-04	3.10E-04
Zone 1: Amarillo	R-4	3.34E-05	8.06E-04	4.16E-04
Zone 2: Dallas		3.20E-05	9.57E-04	6.50E-04
Zone 3: Houston		3.31E-05	7.19E-04	4.21E-04
Zone 4: Corpus Christi		2.11E-05	5.88E-04	2.77E-04
Zone 5: El Paso		8.01E-06	2.83E-04	1.20E-04

2x6 Walls

Table 186 presents the deemed winter demand savings values for insulating 2x6 walls to R-17 for all five Texas climate zones.

Table 186. Wall Insulation—Winter Peak Demand Savings (kW/sq. ft.), Insulation of 2x6 Walls to R-17

Climate zone	Baseline R-value	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	6.99E-05	1.76E-03	9.09E-04
Zone 2: Dallas		7.01E-05	2.07E-03	1.40E-03
Zone 3: Houston		7.86E-05	1.57E-03	9.10E-04
Zone 4: Corpus Christi		4.58E-05	1.29E-03	6.08E-04
Zone 5: El Paso		1.84E-05	6.24E-04	2.64E-04
Zone 1: Amarillo	R-4	2.68E-05	6.93E-04	3.58E-04
Zone 2: Dallas		2.84E-05	8.49E-04	5.84E-04
Zone 3: Houston		2.96E-05	6.40E-04	3.82E-04
Zone 4: Corpus Christi		1.90E-05	5.19E-04	2.41E-04
Zone 5: El Paso		5.59E-06	2.06E-04	8.81E-05

Table 187 presents the deemed winter demand savings values for insulating 2x6 walls to R-33 for all five Texas climate zones.

Table 187. Wall Insulation—Winter Peak Demand Savings (kW/sq. ft.), Insulation of 2x6 Walls to R-33

Climate zone	Baseline R-value	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	Uninsulated	7.66E-05	1.95E-03	1.00E-03
Zone 2: Dallas		7.77E-05	2.31E-03	1.56E-03
Zone 3: Houston		8.62E-05	1.75E-03	1.02E-03
Zone 4: Corpus Christi		5.11E-05	1.43E-03	6.73E-04
Zone 5: El Paso		1.96E-05	6.66E-04	2.82E-04
Zone 1: Amarillo	R-4	3.35E-05	8.76E-04	4.53E-04
Zone 2: Dallas		3.60E-05	1.08E-03	7.44E-04
Zone 3: Houston		3.72E-05	8.17E-04	4.92E-04
Zone 4: Corpus Christi		2.43E-05	6.59E-04	3.06E-04
Zone 5: El Paso		6.87E-06	2.48E-04	1.06E-04

Example Deemed Savings Calculation

Example 1. A home with uninsulated 2x4 walls in Climate Zone 1 with evaporative cooling and an electric resistance furnace insulates 750 square feet to R-13 with fiberglass batt insulation.

$$Energy\ Savings = (0.17 + 3.96)\ \times\ 750 = \mathit{3{,}091.5}\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 2.40\ \times\ 10^{-4}\ \times\ 750 = 0.18\ kW$$

$$Winter\ Peak\ Demand\ Savings = 1.71\ \times\ 10^{-3}\ \times\ 750 = 1.28\ kW$$

Example 2. A home in Climate Zone 4 with uninsulated 2x6 walls with a central air conditioning unit and a gas furnace insulates 500 square feet to R-17 with closed-cell spray foam.

$$Energy\ Savings = (0.56 + 0.04)\ \times\ 500 = \mathit{300.0}\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 4.56\ \times\ 10^{-4}\ \times\ 500 = 0.23\ kW$$

$$Winter\ Peak\ Demand\ Savings = 4.58\ \times\ 10^{-5}\ \times\ 500 = 0.02\ kW$$

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007), the Estimated Useful Life is 25 years for wall insulation.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Square footage of retrofitted wall area (gross wall area excluding window and

door area)

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 58. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 188. Wall Insulation—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Added detail on methodology and model characteristics.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. Multiplier provided to adjust cooling side savings for homes with evaporative cooling due to lower energy usage and demand associated with evaporative coolers relative to refrigerated air. Climate Zone 2 savings values awarded for Climate Zone 5 homes with heat pumps.
v3.1	11/05/2015	TRM v3.1 update. Provided example savings calculations.
v4.0	8/31/2016	TRM v4.0 update. Updated energy and demand savings per new prototype energy simulation models. Added separate savings for 2x4 and 2x6 wall framing and for homes with central AC versus evaporative cooling. Added a two-tier baseline definition of R-0 and R-4.
v5.0	10/2017	TRM v5.0 update. Make an explicit allowance for cellulose insulation.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.5 Floor Insulation Measure Overview

TRM Measure ID: R-BE-FI

Market Sector: Residential

Measure Category: Building envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Floor insulation is installed on the underside of floor areas sitting below conditioned space. Typically, it is installed in ventilated crawlspaces. Savings are presented per square foot of treated floor area.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either an electric resistance furnace or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Homes with gas heating are disqualified for adding floor insulation since this may result in an energy penalty due to floors not getting cooled from the ground during summer.

Baseline Condition

The baseline is a house with pier and beam construction and no floor insulation against the floor of the conditioned area.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[280] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[281] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

A floor insulation level of R-19 is recommended for site-built homes throughout Texas as prescribed by DOE and Texas Department of Housing and Community Affairs (TDHCA) programs. Batt insulation is recommended in most cases and must have the vapor barrier installed facing up and against the floor or conditioned area. Insulation should be attached or secured so that it can reasonably be expected to remain in place for at least 10 years.

Typical floor construction depth of manufactured homes usually does not allow R-19 batt to be installed within the floor joists, so R-15 loose-fill insulation is recommended by TDHCA.

A minimum of 24-inch clearance from the bottom of the insulation to the ground is required by the Occupational Safety and Health Association (OSHA).

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings values.

Savings values for the deemed savings estimates for this measure were developed using demand and energy savings calculated using BEopt 2.6, running Energy Plus 8.1 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows: slab foundation was replaced with a crawlspace. A 5/8" thick wood floor is also specified.

The model runs calculated energy use for the prototypical home prior to the installation of the floor insulation measure. Next, change-case models were run to calculate energy use with the floor insulation measure in place.

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[280] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[281] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

Table 189. Floor Insulation—Prototypical Home Characteristics

Shell characteristic	Value	Source
Foundation	Crawlspace	Skirting around the perimeter is assumed uninsulated and vented. The ground under the home is assumed to be bare, without any type of moisture barrier.
Base Floor Insulation	R-3.1	BEopt default for floor assembly, assuming 5/8” thick hardwood floor without carpet or another type of covering.
Change Floor Insulation	R-19 (except for manufactured housing, R-15)	Efficiency measure - retrofit insulation level as required by DOE and Texas Department of Housing and Community Affairs programs in Texas. Due to the typical floor joists depths found in manufactured housing, TDHCA recommends R-15 loose-fill insulation for manufactured housing and other non-site-built homes.

Deemed Energy Savings Tables

Table 190 through Table 194 present energy savings on a kWh per square foot of insulation installed basis for all five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 190Table 190 through Table 194 by a factor of 0.6. Similarly for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 190 through Table 194 by a factor of 0.24.[282]

Table 190. Floor Insulation—Climate Zone 1: Amarillo, Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated	Evaporative	Electric resistance	Heat pump
Site-built home	-0.13	-0.07	1.72	0.68
Manufactured home	-0.11	-0.06	1.52	0.60

Table 191. Floor Insulation—Climate Zone 2: Dallas, Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated	Evaporative	Electric resistance	Heat pump
Site-built home	-0.12	-	0.96	0.38
Manufactured home	-0.10	-	0.85	0.33

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[282] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 192. Floor Insulation—Climate Zone 3: Houston, Energy Savings (kWh/sq. ft.)

	Cooling savings		Heating savings	
Home type	Refrigerated	Evaporative	Electric resistance	Heat pump
Site-built home	-0.12	-	0.63	0.24
Manufactured home	-0.10	-	0.56	0.21

Table 193. Floor Insulation—Climate Zone 4: Corpus Christi, Energy Savings (kWh/sq. ft.)

	Cooling savings		Heating savings	
Home type	Refrigerated	Evaporative	Electric resistance	Heat pump
Site-built home	-0.07	-	0.40	0.15
Manufactured home	-0.06	-	0.35	0.13

Table 194. Floor Insulation—Climate Zone 5: El Paso, Energy Savings (kWh/sq. ft.)

	Cooling savings		Heating savings	
Home type	Refrigerated	Evaporative	Electric resistance	Heat pump
Site-built home	-0.16	-0.07	1.10	0.43
Manufactured home	-0.13	-0.06	0.97	0.38

Deemed Summer Demand Savings Tables

Table 195 through Table 199 present the deemed summer demand savings (kW) for all five Texas climate zones.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 195 through Table 199 by a factor of 0.6.

Table 195. Floor Insulation—Climate Zone 1: Amarillo, Summer Peak Demand Savings (kW/sq. ft.)

Home type	Refrigerated	Evaporative
Site-built home	6.17E-06	-1.52E-05
Manufactured home	5.48E-06	-1.30E-05

Table 196. Floor Insulation—Climate Zone 2: Dallas, Summer Peak Demand Savings (kW/sq. ft.)

Home type	Refrigerated	Evaporative
Site-built home	3.10E-05	–
Manufactured home	2.75E-05	–

Table 197. Floor Insulation—Climate Zone 3: Houston, Summer Peak Demand Savings (kW/sq. ft.)

Home type	Refrigerated	Evaporative
Site-built home	3.36E-05	–
Manufactured home	2.77E-05	–

Table 198. Floor Insulation—Climate Zone 4: Corpus Christi, Summer Peak Demand Savings (kW/sq. ft.)

Home type	Refrigerated	Evaporative
Site-built home	3.58E-05	–
Manufactured home	3.07E-05	–

Table 199. Floor Insulation—Climate Zone 5: El Paso, Summer Peak Demand Savings (kW/sq. ft.)

Home type	Refrigerated	Evaporative
Site-built home	6.29E-06	-1.34E-06
Manufactured home	8.30E-07	1.85E-07

Deemed Winter Demand Savings Tables

Table 200 through Table 204 present the deemed winter demand savings for all five Texas climate zones.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 200 through Table 204 by a factor of 0.24.[283]

Table 200. Floor Insulation—Climate Zone 1: Amarillo, Winter Peak Demand Savings (kW/sq. ft.)

Home type	Electric resistance	Heat pump
Site-built home	5.23E-04	2.55E-04
Manufactured home	4.62E-04	2.25E-04

Table 201. Floor Insulation—Climate Zone 2: Dallas, Winter Peak Demand Savings (kW/sq. ft.)

Home type	Electric resistance	Heat pump
Site-built home	5.19E-04	2.88E-04
Manufactured home	4.56E-04	2.50E-04

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[283] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 202. Floor Insulation—Climate Zone 3: Houston, Winter Peak Demand Savings (kW/sq. ft.)

Home type	Electric resistance	Heat pump
Site-built home	4.22E-04	2.03E-04
Manufactured home	3.64E-04	1.74E-04

Table 203. Floor Insulation—Climate Zone 4: Corpus Christi, Winter Peak Demand Savings (kW/sq. ft.)

Home type	Electric resistance	Heat pump
Site-built home	3.51E-04	1.53E-04
Manufactured home	3.02E-04	1.31E-04

Table 204. Floor Insulation—Climate Zone 5: El Paso, Winter Peak Demand Savings (kW/sq. ft.)

Home type	Electric resistance	Heat pump
Site-built home	3.54E-04	1.44E-04
Manufactured home	3.19E-04	1.30E-04

Example Deemed Savings Calculation

Example 1. A manufactured home in Climate Zone 5 with evaporative cooling and an electric resistance furnace insulates 500 square feet.

$$Energy\ Savings = (-0.06 + 0.97) \times 500 = 455.0\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 1.85 \times 10^{-7} \times 500 = 0.00\ kW$$

$$Winter\ Peak\ Demand\ Savings = 3.19 \times 10^{-4} \times 500 = 0.16\ kW$$

Example 2. A site-built home in Climate Zone 2 with an air-source heat pump insulates 825 square feet.

$$Energy\ Savings = (-0.12 + 0.38) \times 825 = 214.5\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 3.10 \times 10^{-5} \times 825 = 0.03\ kW$$

$$Winter\ Peak\ Demand\ Savings = 2.88 \times 10^{-4} \times 825 = 0.24\ kW$$

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007), the Estimated Useful Life is 25 years for floor insulation.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are: The climate zone

- Climate zone
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
  - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Home type (site built or manufactured)
- Square footage of installed insulation

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 205. Floor Insulation—Revision History

TRM version	Date	Description of Change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Added detail on methodology and model characteristics.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. Multiplier provided to adjust cooling side savings for homes with evaporative cooling due to lower energy usage and demand associated with evaporative coolers relative to refrigerated air. Climate Zone 2 savings values awarded for Climate Zone 5 homes with heat pumps.
v3.1	11/05/2015	TRM v3.1 update. Provided example savings calculations.
v4.0	10/10/2016	TRM v4.0 update. Updated energy and demand savings per new prototype energy simulation models. Added separate savings for homes with evaporative cooling. Disqualified homes with gas heating for adding floor insulation.
v5.0	10/2017	TRM v5.0 update. Added an explicit reference to mini-split technology.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.6 Radiant Barriers Measure Overview

TRM Measure ID: R-BE-RB

Market Sector: Residential, low-Income, and hard-to-reach

Measure Category: Building envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Radiant barriers are a highly reflective material designed to block radiant heat transfer between a roof and attic space insulation. They typically consist of a metallic foil material (usually aluminum) and are generally installed on the roof decking or beneath roof sheathing. Radiant barriers are most effective at reducing cooling consumption by reflecting heat away from a home.

Eligibility Criteria

This measure is only applicable to retrofit applications. All radiant barriers should be installed according to the Reflective Insulation Manufacturers Association International (RIMA-I) Handbook, Section 7.4.[284] However, horizontal installation is not eligible due to the potential of moisture/dust accumulation and wear-and-tear damage to the radiant barrier that may negatively impact product performance.

A radiant barrier cannot be in contact with any other materials on its underside. Therefore, once a radiant barrier is installed on the roof decking, no additional roof deck insulation can be installed. However, additional insulation may still be added where it is not in contact (e.g., attic floor).

A study performed by RIMA-I found that none of the coating-type products currently on the market had an emittance of 0.10 or lower as required by the standards set by the American Society for Testing and Materials (ASTM) for a product to be considered a radiant barrier.[285] Therefore, interior radiation control coatings are ineligible to use this measure.

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[284] RIMA-I Handbook. https://rimainternational.org/wp-content/uploads/2011/01/HandbookAll-2014-Final-1.pdf.

[285] "Radiant Barrier and STS Interior Coatings," RIMA International. https://rimainternational.org/technical/ircc/.

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes. Homes must be centrally heated with either a furnace (gas or electric resistance) or heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that are specified for homes with central refrigerated air. Customers participating in HTR or LI programs are also eligible to claim reduced heating savings for homes heated with electric resistance space heaters by applying an adjustment to deemed savings that are specified for that heat type.

Baseline Condition

The baseline condition is defined as a residence with no existing radiant barrier installed on roof decking.

High-Efficiency Condition

The high efficiency condition is defined as a radiant barrier installed on roof decking. The radiant barrier must be compliant with the standards set by RIMA-I, including proper attic ventilation. A list of verified products is available on the RIMA-I website.[286]

Table 206. Radiant Barriers—RIMA-I Product Testing Requirements[287]

Physical property	Test method or standard	Requirement
Surface emittance	ASTM C 1371	0.1 or less
Water vapor transmission	ASTM E 96 Procedure A desiccant method	0.02 for vapor retarder; 0.5 or greater for perforated products
Surface burning		
Flame spread	ASTM E 84	25 or less
Smoke density	ASTM E 84	450 or less
Corrosivity	ASTM D 3310	Corrosion on less than two percent of the affected surface
Tear resistance	ASTM D 2261	N/A
Adhesive performance		
Bleeding	Section 10.1 of ASTM C 1313	Bleeding of delamination of less than two percent of the surface area
Pliability	Section 10.2 of ASTM C 1313	No cracking or delamination
Mold and mildew	ASTM C 1338	No growth when visually examined under 5x magnification
Tensile strength	ASTM D 2261	Report tearing strength in machine direction and cross direction

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[286] RIMA International verified products. https://rimainternational.org/verify/.

[287] RIMA International Product Testing Requirements. https://rimainternational.org/technical/testing/.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

This measure references deemed savings from the Arkansas Technical Reference Manual (TRM) v9.0 where calibrated simulation modeling was used to develop these deemed savings.[288] Specifically, these deemed savings estimates were developed using BEopt, running EnergyPlus as the underlying simulation engine. Since radiant barrier savings are sensitive to weather, savings were modeled using typical meteorological year (TMY) 3 weather data.

Arkansas savings were mapped to Texas climate zones by comparing cooling and heating degree days developed using TMY data. Since TMY3 data is no longer accessible through the National Solar Radiation Database (NSRDB) Viewer, degree days were compared using TMY 2020 weather data.[289]

Degree day ratios were derived by dividing Texas cooling and heating degree days by the closest degree day match among Arkansas climate zones. These ratios were multiplied against corresponding Arkansas TRM deemed savings yielding savings values adjusted for Texas climate. The resulting ratios are specified in Table 207.

Table 207. Radiant Barriers—Cooling and Heating Adjustment Factors (AF)[290]

Climate zone	Cooling AF	Heating AF
Zone 1: Amarillo	0.95	1.02
Zone 2: Dallas	1.06	0.88
Zone 3: Houston	1.12	0.56
Zone 4: Corpus Christi	1.44	0.27
Zone 5: El Paso	0.99	0.99

Deemed Energy Demand Savings Tables

Table 208 through Table 212 present the energy savings (kWh) in the five Texas climate zones per square foot of ceiling area over conditioned space directly below an unconditioned attic where the radiant barrier is installed. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

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[288] Arkansas Public Service Commission. AR TRM v9.0. http://www.apscservices.info/EEInfo/TRMV9.0.pdf.

[289] NSRDB Viewer: https://nsrdb.nrel.gov/.

[290] These adjustment factors were multiplied against respective cooling and heating savings from the Arkansas TRM v9.0 Radiant Barriers measure. The cooling factor for Amarillo was applied against Arkansas Climate Zone 8 (Fort Smith), and the heating factor for Amarillo was applied against Arkansas Climate Zone 9 (Fayetteville). Factors for all remaining TX climate zones were applied against savings for Arkansas Climate Zone 6 (El Dorado).

For customers who participate in HTR or LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 208 through Table 212 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 208 through Table 212 by a factor of 0.24.[291]

Table 208. Radiant Barriers—Climate Zone 1: Amarillo, Energy Savings (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Cooling savings	Heating savings		
	Refrigerated air	Gas	Electric resistance	Heat pump
≤ R-19	0.2234	0.0072	0.2099	0.1106
> R-19	0.1350	0.0031	0.0962	0.0573

Table 209. Radiant Barriers—Climate Zone 2: Dallas, Energy Savings (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Cooling savings	Heating savings		
	Refrigerated air	Gas	Electric resistance	Heat pump
≤ R-19	0.2887	0.0044	0.1449	0.0334
> R-19	0.1777	0.0026	0.0676	0.0132

Table 210. Radiant Barriers—Climate Zone 3: Houston, Energy Savings (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Cooling savings	Heating savings		
	Refrigerated air	Gas	Electric resistance	Heat pump
≤ R-19	0.3046	0.0028	0.0916	0.0211
> R-19	0.1874	0.0017	0.0427	0.0083

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[291] This factor was derived based on expected capacity reduction assuming 1,200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42, 000 BTU for central electric furnaces and two 1,500 W portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 / 42,000 = 0.24.

Table 211. Radiant Barriers—Climate Zone 4: Corpus Christi, Energy Savings (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Cooling savings	Heating savings		
	Refrigerated air	Gas	Electric resistance	Heat pump
≤ R-19	0.3937	0.0013	0.0443	0.0102
> R-19	0.2423	0.0008	0.0207	0.0040

Table 212. Radiant Barriers—Climate Zone 5: El Paso, Energy Savings (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Cooling savings	Heating savings		
	Refrigerated	Gas	Electric resistance	Heat pump
≤ R-19	0.2691	0.0050	0.1636	0.0377
> R-19	0.1656	0.0030	0.0764	0.0149

Deemed Summer Demand Savings Tables

Table 213 presents the summer demand savings (kW) in the five Texas climate zones per square foot of ceiling area over conditioned space directly below an unconditioned attic where the radiant barrier in installed.

For customers who participate in HTR or LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying the appropriate cooling value in Table 213 by a factor of 0.6.

Table 213. Radiant Barriers—Summer Peak Demand Savings for Residences with Refrigerated Air (kWh/sq. ft.)

Radiant barrier with existing ceiling insulation base R-value	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
≤ R-19	0.00014	0.00015	0.00016	0.00020	0.00014
> R-19	0.00008	0.00010	0.00010	0.00013	0.00009

Deemed Winter Demand Savings Tables

Winter demand savings are not specified for this measure at this time. They will be added when savings are updated to reflect Texas consumption data.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

Radiant barriers and other reflective insulation systems have similar lifetime expectations to other attic insulation measures.[292] The estimated useful life (EUL) of radiant barriers is 25 years for radiant barriers based on the GDS Associates Measure Life Report value for ceiling insulation.

This value matches lifetime assumptions for radiant barriers from both Oak Ridge National Laboratory (ORNL)[293] and National Renewable Energy Laboratory (NREL).[294]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Cooling type (central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Baseline R-value of existing ceiling insulation (≤ R-19, > R-19)
- Square footage of treated attic area above conditioned space
- Manufacturer and product name/model number

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

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[292] US Department of Energy (DOE) Insulation Fact Sheet. https://web.ornl.gov/sci/buildings/docs/factSheets/Insulation-FactSheet-2008.pdf.

[293] "Radiant Barrier: Effect of Radiant Barriers on Heating and Cooling Bils", ORNL. https://web.ornl.gov/sci/buildings/tools/radiant/rb2/.

[294] National Residential Efficiency Measures Database, NREL. https://remdb.nrel.gov/measures.php?gId=13&ctId=51.

Document Revision History

Table 214. Radiant Barriers—Revision History

TRM version	Date	Description of change
v10.0	10/2022	TRM v10.0 origin.

2.3.7 Cool Roofs Measure Overview

TRM Measure ID: R-BE-CR

Market Sector: Residential

Measure Category: Building Envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Reflective roofing materials reduce the overall heat load on a home by reducing the total heat energy absorbed into the building system from incident solar radiation. This reduction in total load provides space cooling energy savings during the cooling season, but reduces free heat during the heating season, so the measure saves energy in the summer but uses more energy in winter. As such, cool roofs are most beneficial in warmer climates and may not be recommended for homes where the primary heat source is electric resistance. The measure is for retrofit of existing homes.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Baseline Condition

The baseline condition is an existing home with a standard medium- or dark-colored roof.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[295] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[296] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

The ENERGY STAR roofing products certification program was discontinued effective June 1, 2022.[297] Moving forward, installed roofing products will still be required to demonstrate compliance with the previous ENERGY STAR specification below.[298]

In lieu of the former ENERGY STAR list of qualified products, roofing products must now have a performance rating that is validated by the Cool Roof Rating Council (CRRC)[299,300] and be listed on the CRRC Rated Roof Products Directory.[301] This is consistent with the former ENERGY STAR test criteria, which allows for products already participating in the CRRC Product Rating Program[302] to submit solar reflectance and thermal emittance product information derived from CRRC certification.

The ENERGY STAR program classifies roofs with a slope greater than 2/12 as having a steep slope and roofs with a slope less than or equal to 2/12 as low slope roofs. ENERGY STAR performance specifications for cool roof products for use on roofs with steep slopes and low slopes are provided in Table 215.

Table 215. Cool Roofs—ENERGY STAR Specification[303]

Roof slope	Characteristic	Performance specification
Low slope ≤ 2/12	Initial solar reflectance	≥ 0.65
	3-year solar reflectance	≥ 0.50
High slope > 2/12	Initial solar reflectance	≥ 0.25
	3-year solar reflectance	≥ 0.15

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[295] Electric Resistance Heating. https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[296] Portable Heaters. https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[297] ENERGY STAR® Roof Products Sunset Decision Memo. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Roof%20Products%20Sunset%20Decision%20Memo.pdf.

[298] ENERGY STAR® Program Requirements for Roof Products v2.1. https://www.energystar.gov/ia/partners/product_specs/program_reqs/roofs_prog_req.pdf.

[299] CRRC guidance for roof rating alternative to discontinued ENERGY STAR® program. https://coolroofs.org/documents/CRRC-ENERGY-STAR-Sunset-Info-Sheet-2022-03-07.pdf.

[300] CRRC Roof Rating Program. https://coolroofs.org/programs/roof-rating-program.

[301] CRRC Rated Roof Products Directory. https://coolroofs.org/directory/roof.

[302] CRRC Rated Roof Products Directory: https://coolroofs.org/directory/roof.

[303] ENERGY STAR® Roof Products Specification. https://www.energystar.gov/products/building_products/roof_products/key_product_criteria.

If a cool roof is installed concurrently with changes to attic insulation levels, savings should be claimed for the reflective roof according to the post-retrofit (ceiling or roof deck) insulation levels. Savings for changes in insulation levels should be claimed separately according to the ceiling insulation or attic encapsulation measures, assuming the retrofit performed meets the requirements of those measures.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Calibrated simulation modeling was used to develop these deemed savings values. Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows. Roof slopes were modified to reflect representative levels for the low slope and steep slope roofs. A 1/12 slope was selected for modeling low slope roofs (defined as having slope <= 2/12), and a 4/12 slope was selected for modeling steep slope roofs (slope > 2/12). Based on the performance criteria and review of the rated 3-year reflectance of rated products listed in the CRRC database, four reflectance levels were selected for modeling: 0.2, 0.4, 0.6, and 0.8, representing 20 to 80 percent reflectance.

Because of the interplay between the performance of insulation and attic/roof deck temperatures, which are directly affected by the installation of a cool roof, savings were estimated for a range of different attic insulation scenarios: a range of ceiling insulation levels from no insulation (R-0) to R-30, and two roof deck insulation levels, R-19 and R-38, were modeled. Savings for a roof deck insulation level of R-30 are provided by interpolating between the R-19 and R-38 scenarios.

These modifications are shown in Table 216.

The model runs calculated energy use for the prototypical home prior to encapsulating the attic. Change-case models were run to calculate energy use with the floor insulation measure in place with either R-30 or R-38 insulation.

Table 216. Cool Roofs—Prototypical Home Characteristics

Shell characteristic	Value	Source
Base case roof material	Medium asphalt shingle, reflectance = 0.15	Prototype home default
Change case roof material	Medium asphalt shingle, reflectance = 0.2 reflectance = 0.4 reflectance = 0.6 Reflectance = 0.8	Lower reflectance levels only relevant for steep slope roofs. Modeled reflectance levels reflect midpoints of ranges: 0.15 ≤ R < 0.3 Reflectance 0.3 ≤ R < 0.5 Reflectance 0.5 ≤ R < 0.7 Reflectance > 0.7
Roof slope: low-slope roof	1/12	Not modified between base and change cases
Roof slope: steep slope roof	4/12	Not modified between base and change cases

Shell characteristic	Value	Source
Ceiling (attic floor) insulation levels	< R-5 R-5 to R-8 R-9 to R-14 R-15 to R-22 R-30	Not modified between base and change cases
Roof Deck (underside) Insulation Levels	R-19 R-38	Not modified between base and change cases

Deemed Energy Savings Tables

Savings are presented first for homes with ceiling insulation and subsequently for those with roof deck insulation. For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 217 through Table 221 by a factor of 0.6.

Homes with Ceiling Insulation

Table 217 through Table 221 present the energy savings (kWh) for installation of a reflective roof on homes with varying levels of ceiling (attic floor) insulation for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types. Savings are per square foot of treated roof area.

Table 217. Cool Roofs—Climate Zone 1: Amarillo, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Steep slope						
< R-5	0.15 – 0.29	0.03	0.01	0.00	-0.05	-0.02
< R-5	0.3 – 0.49	0.15	0.06	-0.02	-0.26	-0.09
< R-5	0.5 – 0.69	0.27	0.10	-0.03	-0.47	-0.18
< R-5	≥ 0.7	0.40	0.15	-0.06	-0.71	-0.26
R-5 to R-8	0.15 – 0.29	0.02	0.01	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.12	0.04	-0.02	-0.20	-0.07
R-5 to R-8	0.5 – 0.69	0.21	0.08	-0.03	-0.36	-0.14
R-5 to R-8	≥ 0.7	0.31	0.12	-0.05	-0.54	-0.20
R-9 to R-14	0.15 – 0.29	0.02	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.08	0.03	-0.01	-0.13	-0.05
R-9 to R-14	0.5 – 0.69	0.15	0.06	-0.03	-0.25	-0.09
R-9 to R-14	≥ 0.7	0.22	0.08	-0.04	-0.37	-0.14
R-15 to R-22	0.15 - 0.29	0.01	0.00	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.06	0.02	-0.01	-0.09	-0.04
R-15 to R-22	0.5 – 0.69	0.10	0.04	-0.02	-0.17	-0.06
R-15 to R-22	≥ 0.7	0.15	0.06	-0.03	-0.25	-0.10
R-30	0.15 – 0.29	0.01	0.00	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.04	0.01	-0.01	-0.06	-0.02
R-30	0.5 – 0.69	0.07	0.02	-0.02	-0.11	-0.04
R-30	≥ 0.7	0.10	0.04	-0.03	-0.16	-0.06
Low slope						
< R-5	0.5 – 0.69	0.30	0.11	-0.04	-0.52	-0.20
< R-5	≥ 0.7	0.43	0.16	-0.06	-0.77	-0.29
R-5 to R-8	0.5 – 0.69	0.23	0.09	-0.03	-0.40	-0.15
R-5 to R-8	≥ 0.7	0.34	0.13	-0.05	-0.59	-0.22
R-9 to R-14	0.5 – 0.69	0.16	0.06	-0.03	-0.27	-0.10
R-9 to R-14	≥ 0.7	0.23	0.09	-0.04	-0.41	-0.15
R-15 to R-22	0.5 – 0.69	0.11	0.04	-0.02	-0.19	-0.07

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
R-15 to R-22	≥ 0.7	0.17	0.07	-0.03	-0.28	-0.11
R-30	0.5 – 0.69	0.08	0.03	-0.02	-0.13	-0.05
R-30	≥ 0.7	0.12	0.05	-0.03	-0.19	-0.07

Table 218. Cool Roofs—Climate Zone 2: Dallas, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
< R-5	0.15 – 0.29	0.05	0.00	-0.04	-0.01
< R-5	0.3 – 0.49	0.23	-0.01	-0.17	-0.07
< R-5	0.5 – 0.69	0.43	-0.01	-0.32	-0.12
< R-5	≥ 0.7	0.64	-0.02	-0.48	-0.18
R-5 to R-8	0.15 – 0.29	0.04	0.00	-0.03	-0.01
R-5 to R-8	0.3 – 0.49	0.18	-0.01	-0.13	-0.05
R-5 to R-8	0.5 – 0.69	0.34	-0.01	-0.24	-0.09
R-5 to R-8	≥ 0.7	0.50	-0.02	-0.36	-0.14
R-9 to R-14	0.15 – 0.29	0.03	0.00	-0.02	-0.01
R-9 to R-14	0.3 – 0.49	0.13	-0.01	-0.09	-0.03
R-9 to R-14	0.5 – 0.69	0.24	-0.01	-0.16	-0.06
R-9 to R-14	≥ 0.7	0.35	-0.02	-0.25	-0.09
R-15 to R-22	0.15 – 0.29	0.02	0.00	-0.01	0.00
R-15 to R-22	0.3 – 0.49	0.09	0.00	-0.06	-0.02
R-15 to R-22	0.5 – 0.69	0.17	-0.01	-0.11	-0.04
R-15 to R-22	≥ 0.7	0.25	-0.01	-0.17	-0.06
R-30	0.15 – 0.29	0.01	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.06	0.00	-0.04	-0.02
R-30	0.5 – 0.69	0.12	-0.01	-0.07	-0.03
R-30	≥ 0.7	0.18	-0.01	-0.11	-0.04
Low slope					
< R-5	0.5 – 0.69	0.47	-0.01	-0.35	-0.13
< R-5	≥ 0.7	0.70	-0.02	-0.53	-0.20
R-5 to R-8	0.5 – 0.69	0.37	-0.01	-0.27	-0.10

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
R-5 to R-8	≥ 0.7	0.55	-0.02	-0.40	-0.15
R-9 to R-14	0.5 – 0.69	0.26	-0.01	-0.19	-0.07
R-9 to R-14	≥ 0.7	0.39	-0.02	-0.28	-0.10
R-15 to R-22	0.5 – 0.69	0.19	-0.01	-0.13	-0.05
R-15 to R-22	≥ 0.7	0.28	-0.01	-0.19	-0.07
R-30	0.5 – 0.69	0.14	-0.01	-0.08	-0.03
R-30	≥ 0.7	0.20	-0.01	-0.13	-0.05

Table 219. Cool Roofs—Climate Zone 3: Houston, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
< R-5	0.15 – 0.29	0.05	0.00	-0.02	-0.01
< R-5	0.3 – 0.49	0.26	0.00	-0.13	-0.05
< R-5	0.5 – 0.69	0.48	-0.01	-0.24	-0.09
< R-5	≥ 0.7	0.71	-0.01	-0.37	-0.13
R-5 to R-8	0.15 – 0.29	0.04	0.00	-0.02	-0.01
R-5 to R-8	0.3 – 0.49	0.20	0.00	-0.10	-0.04
R-5 to R-8	0.5 – 0.69	0.37	-0.01	-0.18	-0.07
R-5 to R-8	≥ 0.7	0.55	-0.01	-0.28	-0.10
R-9 to R-14	0.15 – 0.29	0.03	0.00	-0.01	-0.01
R-9 to R-14	0.3 – 0.49	0.14	0.00	-0.07	-0.03
R-9 to R-14	0.5 – 0.69	0.26	-0.01	-0.13	-0.05
R-9 to R-14	≥ 0.7	0.39	-0.01	-0.19	-0.07
R-15 to R-22	0.15 – 0.29	0.02	0.00	-0.01	0.00
R-15 to R-22	0.3 – 0.49	0.10	0.00	-0.05	-0.02
R-15 to R-22	0.5 – 0.69	0.18	-0.01	-0.09	-0.03
R-15 to R-22	≥ 0.7	0.27	-0.01	-0.13	-0.05
R-30	0.15 – 0.29	0.01	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.06	0.00	-0.03	-0.01

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
R-30	0.5 – 0.69	0.12	-0.01	-0.06	-0.02
R-30	≥ 0.7	0.18	-0.01	-0.08	-0.03
Low slope					
< R-5	0.5 – 0.69	0.54	-0.01	-0.27	-0.10
< R-5	≥ 0.7	0.79	-0.01	-0.41	-0.15
R-5 to R-8	0.5 – 0.69	0.42	-0.01	-0.21	-0.08
R-5 to R-8	≥ 0.7	0.62	-0.01	-0.31	-0.12
R-9 to R-14	0.5 – 0.69	0.30	-0.01	-0.14	-0.05
R-9 to R-14	≥ 0.7	0.44	-0.01	-0.21	-0.08
R-15 to R-22	0.5 – 0.69	0.21	-0.01	-0.10	-0.04
R-15 to R-22	≥ 0.7	0.31	-0.01	-0.15	-0.06
R-30	0.5 – 0.69	0.14	-0.01	-0.07	-0.03
R-30	≥ 0.7	0.22	-0.01	-0.10	-0.04

**Table 220. Cool Roofs—Climate Zone 4: Corpus Christi,
Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)**

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating Savings		
			Gas	Electric resistance	Heat pump
Steep slope					
< R-5	0.15 – 0.29	0.04	0.00	-0.01	0.00
< R-5	0.3 – 0.49	0.19	0.00	-0.08	-0.03
< R-5	0.5 – 0.69	0.34	0.00	-0.15	-0.06
< R-5	≥ 0.7	0.50	-0.01	-0.23	-0.08
R-5 to R-8	0.15 – 0.29	0.03	0.00	-0.01	0.00
R-5 to R-8	0.3 – 0.49	0.14	0.00	-0.06	-0.02
R-5 to R-8	0.5 – 0.69	0.26	0.00	-0.11	-0.04
R-5 to R-8	≥ 0.7	0.38	-0.01	-0.17	-0.06
R-9 to R-14	0.15 – 0.29	0.02	0.00	-0.01	0.00
R-9 to R-14	0.3 – 0.49	0.10	0.00	-0.04	-0.02
R-9 to R-14	0.5 – 0.69	0.17	0.00	-0.08	-0.03
R-9 to R-14	≥ 0.7	0.26	0.00	-0.11	-0.04
R-15 to R-22	0.15 - 0.29	0.01	0.00	-0.01	0.00

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating Savings		
			Gas	Electric resistance	Heat pump
R-15 to R-22	0.3 – 0.49	0.06	0.00	-0.03	-0.01
R-15 to R-22	0.5 – 0.69	0.12	0.00	-0.05	-0.02
R-15 to R-22	≥ 0.7	0.17	0.00	-0.08	-0.03
R-30	0.15 – 0.29	0.01	0.00	0.00	0.00
R-30	0.3 – 0.49	0.04	0.00	-0.02	-0.01
R-30	0.5 – 0.69	0.07	0.00	-0.03	-0.01
R-30	≥ 0.7	0.11	0.00	-0.05	-0.02
Low slope					
< R-5	0.5 – 0.69	0.37	0.00	-0.17	-0.07
< R-5	≥ 0.7	0.54	-0.01	-0.25	-0.09
R-5 to R-8	0.5 – 0.69	0.28	0.00	-0.13	-0.05
R-5 to R-8	≥ 0.7	0.41	-0.01	-0.19	-0.07
R-9 to R-14	0.5 – 0.69	0.19	0.00	-0.09	-0.03
R-9 to R-14	≥ 0.7	0.28	0.00	-0.13	-0.05
R-15 to R-22	0.5 – 0.69	0.13	0.00	-0.06	-0.02
R-15 to R-22	≥ 0.7	0.19	0.00	-0.08	-0.03
R-30	0.5 – 0.69	0.09	0.00	-0.04	-0.01
R-30	≥ 0.7	0.13	0.00	-0.06	-0.02

Table 221. Cool Roofs—Climate Zone 5: El Paso,
Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Steep slope						
< R-5	0.15 – 0.29	0.05	0.02	0.00	-0.05	-0.02
< R-5	0.3 – 0.49	0.27	0.10	-0.01	-0.26	-0.09
< R-5	0.5 – 0.69	0.50	0.19	-0.02	-0.49	-0.19
< R-5	≥ 0.7	0.74	0.29	-0.04	-0.77	-0.29
R-5 to R-8	0.15 – 0.29	0.04	0.02	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.21	0.08	-0.01	-0.20	-0.07
R-5 to R-8	0.5 – 0.69	0.39	0.15	-0.02	-0.38	-0.14
R-5 to R-8	≥ 0.7	0.58	0.23	-0.03	-0.59	-0.22

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
R-9 to R-14	0.15 – 0.29	0.03	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.15	0.06	-0.01	-0.14	-0.05
R-9 to R-14	0.5 – 0.69	0.27	0.11	-0.01	-0.27	-0.10
R-9 to R-14	≥ 0.7	0.41	0.16	-0.02	-0.41	-0.15
R-15 to R-22	0.15 – 0.29	0.02	0.01	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.10	0.04	-0.01	-0.10	-0.04
R-15 to R-22	0.5 – 0.69	0.19	0.08	-0.01	-0.18	-0.07
R-15 to R-22	≥ 0.7	0.29	0.12	-0.02	-0.28	-0.10
R-30	0.15 – 0.29	0.01	0.01	0.00	-0.01	-0.01
R-30	0.3 – 0.49	0.07	0.03	0.00	-0.06	-0.02
R-30	0.5 – 0.69	0.13	0.05	-0.01	-0.12	-0.04
R-30	≥ 0.7	0.20	0.08	-0.01	-0.18	-0.07
Low slope						
< R-5	0.5 – 0.69	0.57	0.22	-0.02	-0.56	-0.21
< R-5	≥ 0.7	0.84	0.32	-0.04	-0.88	-0.33
R-5 to R-8	0.5 – 0.69	0.45	0.18	-0.02	-0.44	-0.16
R-5 to R-8	≥ 0.7	0.66	0.26	-0.03	-0.68	-0.25
R-9 to R-14	0.5 – 0.69	0.32	0.13	-0.02	-0.31	-0.12
R-9 to R-14	≥ 0.7	0.47	0.19	-0.03	-0.47	-0.18
R-15 to R-22	0.5 – 0.69	0.23	0.09	-0.01	-0.21	-0.08
R-15 to R-22	≥ 0.7	0.34	0.14	-0.02	-0.32	-0.12
R-30	0.5 – 0.69	0.17	0.07	-0.01	-0.14	-0.06
R-30	≥ 0.7	0.25	0.10	-0.02	-0.22	-0.08

Homes with Roof Deck Insulation

Table 222 through Table 226 present the energy savings (kWh) for the installation of a reflective roof on homes with varying levels of roof deck insulation for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types. Savings are per square foot of treated roof area.

Table 222. Cool Roofs—Climate Zone 1: Amarillo, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Steep slope						
R-19	0.15 – 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.06	0.02	-0.01	-0.13	-0.05
R-19	0.5 – 0.69	0.13	0.04	-0.01	-0.28	-0.11
R-19	≥ 0.7	0.20	0.07	-0.02	-0.42	-0.16
R-30	0.15 – 0.29	0.01	0.00	0.00	-0.01	-0.01
R-30	0.3 – 0.49	0.05	0.02	-0.01	-0.12	-0.04
R-30	0.5 – 0.69	0.11	0.03	-0.01	-0.23	-0.09
R-30	≥ 0.7	0.16	0.05	-0.02	-0.35	-0.14
R-38	0.15 – 0.29	0.01	0.00	0.00	-0.02	-0.01
R-38	0.3 – 0.49	0.05	0.02	-0.01	-0.11	-0.04
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.20	-0.08
R-38	≥ 0.7	0.13	0.04	-0.02	-0.30	-0.12
Low slope						
R-19	0.5 – 0.69	0.13	0.04	-0.01	-0.27	-0.11
R-19	≥ 0.7	0.20	0.07	-0.02	-0.42	-0.16
R-30	0.5 – 0.69	0.11	0.03	-0.01	-0.23	-0.09
R-30	≥ 0.7	0.16	0.05	-0.02	-0.34	-0.13
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.20	-0.08
R-38	≥ 0.7	0.13	0.04	-0.02	-0.29	-0.11

Table 223. Cool Roofs—Climate Zone 2: Dallas, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
R-19	0.15 – 0.29	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.10	0.00	-0.09	-0.03
R-19	0.5 – 0.69	0.21	-0.01	-0.18	-0.07
R-19	≥ 0.7	0.32	-0.01	-0.28	-0.11
R-30	0.15 – 0.29	0.01	0.00	-0.01	-0.01

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
R-30	0.3 – 0.49	0.09	0.00	-0.08	-0.03
R-30	0.5 – 0.69	0.17	-0.01	-0.15	-0.06
R-30	≥ 0.7	0.26	-0.01	-0.23	-0.09
R-38	0.15 – 0.29	0.02	0.00	-0.01	-0.01
R-38	0.3 – 0.49	0.08	0.00	-0.07	-0.03
R-38	0.5 – 0.69	0.14	-0.01	-0.13	-0.05
R-38	≥ 0.7	0.21	-0.01	-0.19	-0.07
Low slope					
R-19	0.5 – 0.69	0.21	-0.01	-0.18	-0.07
R-19	≥ 0.7	0.32	-0.01	-0.28	-0.11
R-30	0.5 – 0.69	0.17	-0.01	-0.15	-0.06
R-30	≥ 0.7	0.26	-0.01	-0.23	-0.09
R-38	0.5 – 0.69	0.14	-0.01	-0.13	-0.05
R-38	≥ 0.7	0.21	-0.01	-0.19	-0.07

Table 224. Cool Roofs—Climate Zone 3: Houston, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
R-19	0.15 – 0.29	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.11	0.00	-0.07	-0.03
R-19	0.5 – 0.69	0.22	-0.01	-0.14	-0.05
R-19	≥ 0.7	0.34	-0.01	-0.22	-0.08
R-30	0.15 – 0.29	0.01	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.09	0.00	-0.06	-0.02
R-30	0.5 – 0.69	0.19	0.00	-0.12	-0.04
R-30	≥ 0.7	0.28	-0.01	-0.18	-0.07
R-38	0.15 – 0.29	0.02	0.00	-0.01	0.00
R-38	0.3 – 0.49	0.08	0.00	-0.06	-0.02
R-38	0.5 – 0.69	0.16	0.00	-0.10	-0.04
R-38	≥ 0.7	0.23	-0.01	-0.15	-0.06

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Low slope					
R-19	0.5 – 0.69	0.22	-0.01	-0.14	-0.06
R-19	≥ 0.7	0.35	-0.01	-0.22	-0.08
R-30	0.5 – 0.69	0.19	0.00	-0.12	-0.05
R-30	≥ 0.7	0.28	-0.01	-0.18	-0.07
R-38	0.5 – 0.69	0.16	0.00	-0.10	-0.04
R-38	≥ 0.7	0.23	-0.01	-0.15	-0.06

**Table 225. Cool Roofs—Climate Zone 4: Corpus Christi,
Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)**

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
R-19	0.15 – 0.29	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.09	0.00	-0.04	-0.02
R-19	0.5 – 0.69	0.17	0.00	-0.09	-0.03
R-19	≥ 0.7	0.26	0.00	-0.13	-0.05
R-30	0.15 – 0.29	0.01	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.08	0.00	-0.03	-0.01
R-30	0.5 – 0.69	0.14	0.00	-0.07	-0.02
R-30	≥ 0.7	0.21	0.00	-0.11	-0.04
R-38	0.15 – 0.29	0.01	0.00	-0.01	0.00
R-38	0.3 – 0.49	0.07	0.00	-0.03	-0.01
R-38	0.5 – 0.69	0.12	0.00	-0.06	-0.02
R-38	≥ 0.7	0.18	0.00	-0.09	-0.03
Low slope					
R-19	0.5 – 0.69	0.23	-0.01	-0.29	-0.11
R-19	≥ 0.7	0.36	-0.02	-0.46	-0.18
R-30	0.5 – 0.69	0.17	0.00	-0.16	-0.06
R-30	≥ 0.7	0.26	-0.01	-0.25	-0.09
R-38	0.5 – 0.69	0.12	0.00	-0.06	-0.02
R-38	≥ 0.7	0.18	0.00	-0.09	-0.03

Table 226. Cool Roofs—Climate Zone 5: El Paso, Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Steep slope						
R-19	0.15 – 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.11	0.04	-0.01	-0.14	-0.05
R-19	0.5 – 0.69	0.22	0.08	-0.01	-0.28	-0.11
R-19	≥ 0.7	0.35	0.12	-0.02	-0.45	-0.17
R-30	0.15 – 0.29	0.01	0.01	0.00	-0.01	-0.01
R-30	0.3 – 0.49	0.10	0.03	0.00	-0.12	-0.04
R-30	0.5 – 0.69	0.19	0.06	-0.01	-0.23	-0.09
R-30	≥ 0.7	0.28	0.10	-0.01	-0.37	-0.14
R-38	0.15 – 0.29	0.02	0.01	0.00	-0.02	-0.01
R-38	0.3 – 0.49	0.09	0.03	0.00	-0.11	-0.04
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.20	-0.08
R-38	≥ 0.7	0.23	0.08	-0.01	-0.31	-0.12
Low slope						
R-19	0.5 – 0.69	0.23	0.08	-0.01	-0.29	-0.11
R-19	≥ 0.7	0.36	0.12	-0.02	-0.46	-0.18
R-30	0.5 – 0.69	0.19	0.06	-0.01	-0.24	-0.09
R-30	≥ 0.7	0.29	0.10	-0.01	-0.38	-0.15
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.24	0.08	-0.01	-0.32	-0.12

Deemed Summer Demand Savings Tables

Savings are presented first for homes with ceiling insulation, and subsequently for those with roof deck insulation. For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 227 through Table 231 by a factor of 0.6.

Homes with Ceiling Insulation

Table 227 through Table 231 present the summer demand savings (kW) associated with the installation of a reflective roof in homes with varying levels of ceiling insulation (attic floor) for the five Texas climate zones. Savings are per square foot of treated roof area.

Table 227. Cool Roofs—Climate Zone 1: Amarillo, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
< R-5	0.15 – 0.29	–	–	2.34 x 10-5	1.06 x 10-5
< R-5	0.3 – 0.49	–	–	1.21 x 10-4	6.05 x 10-5
< R-5	0.5 – 0.69	2.50 x 10-4	1.18 x 10-4	2.35 x 10-4	1.06 x 10-4
< R-5	≥ 0.7	3.97 x 10-4	1.94 x 10-4	3.94 x 10-4	1.85 x 10-4
R-5 to R-8	0.15 – 0.29	–	–	1.48 x 10-5	6.69 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	8.09 x 10-5	4.47 x 10-5
R-5 to R-8	0.5 – 0.69	1.78 x 10-4	9.21 x 10-5	1.63 x 10-4	7.51 x 10-5
R-5 to R-8	≥ 0.7	2.85 x 10-4	1.55 x 10-4	2.86 x 10-4	1.40 x 10-4
R-9 to R-14	0.15 – 0.29	–	–	6.05 x 10-6	7.93 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	5.64 x 10-5	2.18 x 10-5
R-9 to R-14	0.5 – 0.69	1.17 x 10-4	5.99 x 10-5	1.08 x 10-4	4.52 x 10-5
R-9 to R-14	≥ 0.7	1.92 x 10-4	9.10 x 10-5	1.90 x 10-4	9.38 x 10-5
R-15 to R-22	0.15 – 0.29	–	–	2.30 x 10-6	-8.73 x 10-7
R-15 to R-22	0.3 – 0.49	–	–	3.55 x 10-5	1.53 x 10-5
R-15 to R-22	0.5 – 0.69	7.90 x 10-5	3.73 x 10-5	7.34 x 10-5	2.74 x 10-5
R-15 to R-22	≥ 0.7	1.31 x 10-4	6.28 x 10-5	1.37 x 10-4	7.50 x 10-5
R-30	0.15 – 0.29	–	–	-8.06 x 10-7	3.42 x 10-6
R-30	0.3 – 0.49	–	–	2.36 x 10-5	1.83 x 10-5
R-30	0.5 – 0.69	5.39 x 10-5	1.76 x 10-5	4.99 x 10-5	2.70 x 10-5
R-30	≥ 0.7	9.25 x 10-5	4.31 x 10-5	9.56 x 10-5	5.99 x 10-5

Table 228. Cool Roofs—Climate Zone 2: Dallas, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
< R-5	0.15 – 0.29	–	3.46 x 10-5
< R-5	0.3 – 0.49	–	1.79 x 10-4
< R-5	0.5 – 0.69	3.63 x 10-4	3.41 x 10-4
< R-5	≥ 0.7	5.36 x 10-4	5.15 x 10-4
R-5 to R-8	0.15 – 0.29	–	2.63 x 10-5
R-5 to R-8	0.3 – 0.49	–	1.36 x 10-4
R-5 to R-8	0.5 – 0.69	2.83 x 10-4	2.64 x 10-4
R-5 to R-8	≥ 0.7	4.10 x 10-4	4.06 x 10-4

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
R-9 to R-14	0.15 – 0.29	–	1.78 x 10-5
R-9 to R-14	0.3 – 0.49	–	1.02 x 10-4
R-9 to R-14	0.5 – 0.69	1.99 x 10-4	1.73 x 10-4
R-9 to R-14	≥ 0.7	2.85 x 10-4	2.85 x 10-4
R-15 to R-22	0.15 – 0.29	–	9.26 x 10-6
R-15 to R-22	0.3 – 0.49	–	7.69 x 10-5
R-15 to R-22	0.5 – 0.69	1.47 x 10-4	1.23 x 10-4
R-15 to R-22	≥ 0.7	2.04 x 10-4	2.15 x 10-4
R-30	0.15 – 0.29	–	1.34 x 10-5
R-30	0.3 – 0.49	–	5.58 x 10-5
R-30	0.5 – 0.69	1.01 x 10-4	8.64 x 10-5
R-30	≥ 0.7	1.52 x 10-4	1.58 x 10-4

Table 229. Cool Roofs—Climate Zone 3: Houston, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
< R-5	0.15 – 0.29	–	3.27 x 10-5
< R-5	0.3 – 0.49	–	1.74 x 10-4
< R-5	0.5 – 0.69	3.62 x 10-4	3.56 x 10-4
< R-5	≥ 0.7	5.86 x 10-4	5.48 x 10-4
R-5 to R-8	0.15 – 0.29	–	2.38 x 10-5
R-5 to R-8	0.3 – 0.49	–	1.33 x 10-4
R-5 to R-8	0.5 – 0.69	2.76 x 10-4	2.72 x 10-4
R-5 to R-8	≥ 0.7	4.64 x 10-4	4.28 x 10-4
R-9 to R-14	0.15 – 0.29	–	1.55 x 10-5
R-9 to R-14	0.3 – 0.49	–	1.07 x 10-4
R-9 to R-14	0.5 – 0.69	2.12 x 10-4	2.03 x 10-4
R-9 to R-14	≥ 0.7	3.30 x 10-4	3.11 x 10-4
R-15 to R-22	0.15 – 0.29	–	1.75 x 10-5
R-15 to R-22	0.3 – 0.49	–	7.56 x 10-5
R-15 to R-22	0.5 – 0.69	1.53 x 10-4	1.44 x 10-4
R-15 to R-22	≥ 0.7	2.37 x 10-4	2.26 x 10-4
R-30	0.15 – 0.29	–	9.44 x 10-6

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
R-30	0.3 – 0.49	–	5.11 x 10-5
R-30	0.5 – 0.69	1.09 x 10-4	9.65 x 10-5
R-30	> 0.7	1.75 x 10-4	1.64 x 10-4

Table 230. Cool Roofs—Climate Zone 4: Corpus Christi, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-Year reflectance	Low slope	Steep slope
< R-5	0.15 – 0.29	–	1.82 x 10-5
< R-5	0.3 – 0.49	–	9.19 x 10-5
< R-5	0.5 – 0.69	1.67 x 10-4	1.66 x 10-4
< R-5	> 0.7	2.75 x 10-4	2.69 x 10-4
R-5 to R-8	0.15 – 0.29	–	1.46 x 10-5
R-5 to R-8	0.3 – 0.49	–	6.97 x 10-5
R-5 to R-8	0.5 – 0.69	1.22 x 10-4	1.23 x 10-4
R-5 to R-8	> 0.7	2.02 x 10-4	2.01 x 10-4
R-9 to R-14	0.15 – 0.29	–	6.80 x 10-6
R-9 to R-14	0.3 – 0.49	–	4.15 x 10-5
R-9 to R-14	0.5 – 0.69	7.62 x 10-5	7.37 x 10-5
R-9 to R-14	> 0.7	1.26 x 10-4	1.28 x 10-4
R-15 to R-22	0.15 – 0.29	–	4.71 x 10-6
R-15 to R-22	0.3 – 0.49	–	2.55 x 10-5
R-15 to R-22	0.5 – 0.69	4.24 x 10-5	4.39 x 10-5
R-15 to R-22	> 0.7	7.33 x 10-5	7.94 x 10-5
R-30	0.15 – 0.29	–	2.50 x 10-6
R-30	0.3 – 0.49	–	1.01 x 10-5
R-30	0.5 – 0.69	2.41 x 10-5	2.04 x 10-5
R-30	> 0.7	4.01 x 10-5	4.77 x 10-5

Table 231. Cool Roofs—Climate Zone 5: El Paso, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
< R-5	0.15 – 0.29	–	–	3.58 x 10-5	1.28 x 10-5
< R-5	0.3 – 0.49	–	–	1.72 x 10-4	7.49 x 10-5

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
< R-5	0.5 – 0.69	3.95 x 10-4	1.54 x 10-4	3.44 x 10-4	1.65 x 10-4
< R-5	≥ 0.7	6.15 x 10-4	2.42 x 10-4	5.19 x 10-4	2.20 x 10-4
R-5 to R-8	0.15 – 0.29	–	–	2.72 x 10-5	8.96 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	1.27 x 10-4	6.00 x 10-5
R-5 to R-8	0.5 – 0.69	3.06 x 10-4	1.34 x 10-4	2.59 x 10-4	1.38 x 10-4
R-5 to R-8	≥ 0.7	4.77 x 10-4	2.05 x 10-4	3.97 x 10-4	1.78 x 10-4
R-9 to R-14	0.15 – 0.29	–	–	1.25 x 10-5	9.26 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	8.24 x 10-5	5.30 x 10-5
R-9 to R-14	0.5 – 0.69	2.07 x 10-4	1.00 x 10-4	1.73 x 10-4	8.86 x 10-5
R-9 to R-14	≥ 0.7	3.27 x 10-4	1.44 x 10-4	2.60 x 10-4	1.22 x 10-4
R-15 to R-22	0.15 – 0.29	–	–	6.16 x 10-6	3.73 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	6.18 x 10-5	4.40 x 10-5
R-15 to R-22	0.5 – 0.69	1.50 x 10-4	7.63 x 10-5	1.24 x 10-4	6.49 x 10-5
R-15 to R-22	≥ 0.7	2.42 x 10-4	1.11 x 10-4	1.88 x 10-4	8.86 x 10-5
R-30	0.15 – 0.29	–	–	6.64 x 10-6	5.65 x 10-7
R-30	0.3 – 0.49	–	–	4.77 x 10-5	2.87 x 10-5
R-30	0.5 – 0.69	1.01 x 10-4	5.91 x 10-5	8.81 x 10-5	5.07 x 10-5
R-30	≥ 0.7	1.80 x 10-4	8.50 x 10-5	1.32 x 10-4	6.75 x 10-5

Homes with Roof Deck Insulation

Table 232 through Table 236 present the summer demand savings (kW) associated with the installation of a reflective roof in homes with varying levels of roof deck for the five Texas climate zones. Savings are per square foot of treated roof area.

Table 232. Cool Roofs—Climate Zone 1: Amarillo, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
R-19	0.15 – 0.29	–	–	–	–
R-19	0.3 – 0.49	–	–	2.67 x 10-5	7.62 x 10-6
R-19	0.5 – 0.69	5.56 x 10-5	1.84 x 10-5	5.35 x 10-5	1.55 x 10-5
R-19	≥ 0.7	9.88 x 10-5	7.61 x 10-6	8.81 x 10-5	1.52 x 10-5
R-30	0.15 – 0.29	–	–	3.37 x 10-6	3.42 x 10-6
R-30	0.3 – 0.49	–	–	1.97 x 10-5	7.38 x 10-6

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
R-30	0.5 – 0.69	3.21 x 10-5	9.13 x 10-6	3.06 x 10-5	1.25 x 10-5
R-30	≥ 0.7	6.91 x 10-5	8.48 x 10-6	5.94 x 10-5	1.60 x 10-5
R-38	0.15 – 0.29	–	–	5.82 x 10-6	5.90 x 10-6
R-38	0.3 – 0.49	–	–	1.46 x 10-5	7.20 x 10-6
R-38	0.5 – 0.69	1.50 x 10-5	2.38 x 10-6	1.40 x 10-5	1.04 x 10-5
R-38	≥ 0.7	4.75 x 10-5	9.12 x 10-6	3.85 x 10-5	1.66 x 10-5

Table 233. Cool Roofs—Climate Zone 2: Dallas, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
		Refrigerated	Refrigerated
R-19	0.15 – 0.29	–	5.45 x 10-5
R-19	0.3 – 0.49	–	9.02 x 10-5
R-19	0.5 – 0.69	7.41 x 10-5	1.21 x 10-4
R-19	≥ 0.7	1.16 x 10-4	5.18 x 10-6
R-30	0.15 – 0.29	–	2.22 x 10-5
R-30	0.3 – 0.49	–	5.01 x 10-5
R-30	0.5 – 0.69	4.37 x 10-5	7.67 x 10-5
R-30	≥ 0.7	7.41 x 10-5	3.37 x 10-5
R-38	0.15 – 0.29	–	-1.31 x 10-6
R-38	0.3 – 0.49	–	2.10 x 10-5
R-38	0.5 – 0.69	2.16 x 10-5	4.44 x 10-5
R-38	≥ 0.7	4.36 x 10-5	5.45 x 10-5

Table 234. Cool Roofs—Climate Zone 3: Houston, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
		Refrigerated	Refrigerated
R-19	0.15 – 0.29	–	–
R-19	0.3 – 0.49	–	–
R-19	0.5 – 0.69	9.43 x 10-5	9.42 x 10-5
R-19	≥ 0.7	1.32 x 10-4	1.21 x 10-4
R-30	0.15 – 0.29	–	-1.46 x 10-6
R-30	0.3 – 0.49	–	2.60 x 10-5

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
		Refrigerated	Refrigerated
R-30	0.5 – 0.69	7.13 x 10-5	6.50 x 10-5
R-30	≥ 0.7	8.56 x 10-5	8.46 x 10-5
R-38	0.15 – 0.29	–	-2.53 x 10-6
R-38	0.3 – 0.49	–	1.37 x 10-5
R-38	0.5 – 0.69	5.46 x 10-5	4.37 x 10-5
R-38	≥ 0.7	5.19 x 10-5	5.82 x 10-5

Table 235. Cool Roofs—Climate Zone 4: Corpus Christi, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope	Steep slope
		Refrigerated	Refrigerated
R-19	0.15 – 0.29	–	–
R-19	0.3 – 0.49	–	3.38 x 10-5
R-19	0.5 – 0.69	4.44 x 10-5	5.01 x 10-5
R-19	≥ 0.7	7.43 x 10-5	7.37 x 10-5
R-30	0.15 – 0.29	–	3.36 x 10-6
R-30	0.3 – 0.49	–	2.68 x 10-5
R-30	0.5 – 0.69	2.09 x 10-5	3.56 x 10-5
R-30	≥ 0.7	5.33 x 10-5	5.29 x 10-5
R-38	0.15 – 0.29	–	5.81 x 10-6
R-38	0.3 – 0.49	–	2.17 x 10-5
R-38	0.5 – 0.69	3.83 x 10-6	2.51 x 10-5
R-38	≥ 0.7	3.80 x 10-5	3.78 x 10-5

Table 236. Cool Roofs—Climate Zone 5: El Paso, Summer Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
R-19	0.15 – 0.29	–	–	–	–
R-19	0.3 – 0.49	–	–	3.64 x 10-5	2.24 x 10-5
R-19	0.5 – 0.69	8.11 x 10-5	2.76 x 10-5	8.95 x 10-5	4.42 x 10-5
R-19	≥ 0.7	1.33 x 10-4	2.30 x 10-5	1.35 x 10-4	4.44 x 10-5
R-30	0.15 – 0.29	–	–	6.66 x 10-6	1.11 x 10-6
R-30	0.3 – 0.49	–	–	3.01 x 10-5	5.29 x 10-6

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated	Evaporative	Refrigerated	Evaporative
R-30	0.5 – 0.69	5.61 x 10-5	1.09 x 10-5	6.63 x 10-5	1.83 x 10-5
R-30	≥ 0.7	1.13 x 10-4	1.29 x 10-5	1.05 x 10-4	2.23 x 10-5
R-38	0.15 – 0.29	–	–	1.15 x 10-5	1.91 x 10-6
R-38	0.3 – 0.49	–	–	2.55 x 10-5	-7.15 x 10-6
R-38	0.5 – 0.69	3.79 x 10-5	-1.22 x 10-6	4.95 x 10-5	-5.19 x 10-7
R-38	≥ 0.7	9.92 x 10-5	5.60 x 10-6	8.40 x 10-5	6.29 x 10-6

Deemed Winter Demand Savings Tables

Savings are presented first for homes with ceiling insulation, and subsequently for those with roof deck insulation. For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 237 through Table 241 by a factor of 0.24.[304]

Homes with Ceiling Insulation

Table 237 through Table 241 present the winter demand savings (kW) associated with the installation of a reflective roof in homes with varying levels of ceiling insulation (attic floor) for the five Texas climate zones. Savings are per square foot of treated roof area.

Table 237. Cool Roofs—Climate Zone 1: Amarillo,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
< R-5	0.15 – 0.29	–	–	–	-5.60 x 10-7	-1.18 x 10-5	-5.68 x 10-6
< R-5	0.3 – 0.49	–	–	–	-3.08 x 10-6	-5.83 x 10-5	-2.67 x 10-5
< R-5	0.5 – 0.69	-3.03 x 10-6	-1.14 x 10-4	-5.47 x 10-5	-6.38 x 10-6	-1.06 x 10-4	-4.91 x 10-5
< R-5	≥ 0.7	-1.46 x 10-5	-1.66 x 10-4	-8.19 x 10-5	-2.21 x 10-5	-1.54 x 10-4	-7.28 x 10-5
R-5 to R-8	0.15 – 0.29	–	–	–	-1.01 x 10-6	-9.53 x 10-6	-4.74 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	–	-4.25 x 10-6	-4.66 x 10-5	-2.12 x 10-5
R-5 to R-8	0.5 – 0.69	1.52 x 10-6	-9.25 x 10-5	-4.52 x 10-5	-5.04 x 10-6	-8.62 x 10-5	-4.15 x 10-5
R-5 to R-8	≥ 0.7	-9.01 x 10-6	-1.34 x 10-4	-6.68 x 10-5	-2.13 x 10-5	-1.24 x 10-4	-5.82 x 10-5

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[304] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-9 to R-14	0.15 – 0.29	–	–	–	-8.59 x 10-7	-7.63 x 10-6	-3.69 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	–	-3.68 x 10-6	-3.63 x 10-5	-1.55 x 10-5
R-9 to R-14	0.5 – 0.69	-1.04 x 10-7	-7.28 x 10-5	-3.43 x 10-5	-1.49 x 10-5	-6.73 x 10-5	-3.07 x 10-5
R-9 to R-14	≥ 0.7	-6.86 x 10-6	-1.05 x 10-4	-4.98 x 10-5	-2.11 x 10-5	-9.83 x 10-5	-4.57 x 10-5
R-15 to R-22	0.15 – 0.29	–	–	–	-8.96 x 10-7	-5.40 x 10-6	-2.51 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	–	-3.85 x 10-6	-2.60 x 10-5	-1.08 x 10-5
R-15 to R-22	0.5 – 0.69	-1.72 x 10-6	-5.26 x 10-5	-2.47 x 10-5	-1.19 x 10-5	-4.80 x 10-5	-2.15 x 10-5
R-15 to R-22	≥ 0.7	-9.72 x 10-7	-7.65 x 10-5	-3.64 x 10-5	-1.44 x 10-5	-7.05 x 10-5	-3.23 x 10-5
R-30	0.15 – 0.29	-	-	-	-8.09 x 10-7	-3.58 x 10-6	-1.64 x 10-6
R-30	0.3 – 0.49	-	-	-	-1.08 x 10-5	-1.73 x 10-5	-7.31 x 10-6
R-30	0.5 – 0.69	-5.10 x 10-6	-3.52 x 10-5	-1.58 x 10-5	-1.54 x 10-5	-3.12 x 10-5	-1.36 x 10-5
R-30	≥ 0.7	-3.71 x 10-6	-5.35 x 10-5	-2.58 x 10-5	-2.10 x 10-5	-4.64 x 10-5	-2.11 x 10-5

**Table 238. Cool Roofs—Climate Zone 2: Dallas,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)**

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
< R-5	0.15 – 0.29	–	–	–	2.40 x 10-6	-1.29 x 10-5	-6.63 x 10-6
< R-5	0.3 – 0.49	–	–	–	-2.62 x 10-8	-6.19 x 10-5	-3.24 x 10-5
< R-5	0.5 – 0.69	-2.83 x 10-6	-1.48 x 10-4	-7.24 x 10-5	-1.44 x 10-6	-1.19 x 10-4	-6.06 x 10-5
< R-5	≥ 0.7	-6.02 x 10-6	-2.17 x 10-4	-1.07 x 10-4	-4.75 x 10-6	-1.81 x 10-4	-9.06 x 10-5
R-5 to R-8	0.15 – 0.29	–	–	–	4.57 x 10-6	-1.03 x 10-5	-5.30 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	–	1.59 x 10-6	-4.70 x 10-5	-2.68 x 10-5
R-5 to R-8	0.5 – 0.69	-3.36 x 10-6	-1.19 x 10-4	-5.69 x 10-5	1.19 x 10-6	-9.33 x 10-5	-4.88 x 10-5
R-5 to R-8	≥ 0.7	-3.79 x 10-6	-1.74 x 10-4	-8.66 x 10-5	-4.46 x 10-6	-1.43 x 10-4	-7.18 x 10-5
R-9 to R-14	0.15 – 0.29	–	–	–	-7.26 x 10-7	-8.09 x 10-6	-3.86 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	–	-2.92 x 10-6	-4.23 x 10-5	-2.03 x 10-5
R-9 to R-14	0.5 – 0.69	-1.29 x 10-5	-9.30 x 10-5	-4.31 x 10-5	-3.26 x 10-6	-7.90 x 10-5	-3.76 x 10-5
R-9 to R-14	≥ 0.7	-1.27 x 10-5	-1.41 x 10-4	-6.53 x 10-5	-7.53 x 10-6	-1.19 x 10-4	-5.52 x 10-5
R-15 to R-22	0.15 – 0.29	–	–	–	3.23 x 10-7	-5.84 x 10-6	-2.76 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	–	-1.95 x 10-6	-3.04 x 10-5	-1.43 x 10-5
R-15 to R-22	0.5 – 0.69	-1.48 x 10-5	-6.81 x 10-5	-3.23 x 10-5	-2.74 x 10-6	-5.69 x 10-5	-2.66 x 10-5

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-15 to R-22	≥ 0.7	-1.61 x 10-5	-1.02 x 10-4	-4.67 x 10-5	-3.88 x 10-7	-8.65 x 10-5	-4.05 x 10-5
R-30	0.15 – 0.29	–	–	–	-3.74 x 10-7	2.81 x 10-6	8.71 x 10-6
R-30	0.3 – 0.49	–	–	–	-1.78 x 10-6	-1.39 x 10-5	9.39 x 10-7
R-30	0.5 – 0.69	-3.37 x 10-6	-4.77 x 10-5	-2.23 x 10-5	-2.20 x 10-6	-3.16 x 10-5	-7.00 x 10-6
R-30	≥ 0.7	-1.67 x 10-5	-7.04 x 10-5	-3.03 x 10-5	-4.41 x 10-6	-5.14 x 10-5	-1.57 x 10-5

**Table 239. Cool Roofs—Climate Zone 3: Houston,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)**

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
< R-5	0.15 - 0.29	–	–	–	-7.91 x 10-7	-1.54 x 10-5	-7.77 x 10-6
< R-5	0.3 – 0.49	–	–	–	-3.12 x 10-6	-7.71 x 10-5	-3.90 x 10-5
< R-5	0.5 – 0.69	-3.28 x 10-6	-1.56 x 10-4	-7.95 x 10-5	-6.08 x 10-6	-1.40 x 10-4	-7.09 x 10-5
< R-5	≥ 0.7	-4.78 x 10-6	-2.23 x 10-4	-1.11 x 10-4	-7.97 x 10-6	-2.04 x 10-4	-1.05 x 10-4
R-5 to R-8	0.15 - 0.29	–	–	–	-7.39 x 10-7	-1.25 x 10-5	-6.46 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	–	-2.67 x 10-6	-6.28 x 10-5	-3.05 x 10-5
R-5 to R-8	0.5 – 0.69	-4.26 x 10-6	-1.28 x 10-4	-6.54 x 10-5	-5.79 x 10-6	-1.14 x 10-4	-5.59 x 10-5
R-5 to R-8	≥ 0.7	-4.68 x 10-6	-1.84 x 10-4	-9.11 x 10-5	-9.38 x 10-6	-1.68 x 10-4	-8.50 x 10-5
R-9 to R-14	0.15 - 0.29	–	–	–	-6.93 x 10-7	-9.35 x 10-6	-4.68 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	–	-3.38 x 10-6	-4.69 x 10-5	-2.31 x 10-5
R-9 to R-14	0.5 – 0.69	-5.14 x 10-6	-9.71 x 10-5	-4.78 x 10-5	-6.46 x 10-6	-8.68 x 10-5	-4.28 x 10-5
R-9 to R-14	≥ 0.7	-4.83 x 10-6	-1.41 x 10-4	-6.90 x 10-5	-1.00 x 10-5	-1.27 x 10-4	-6.19 x 10-5
R-15 to R-22	0.15 - 0.29	–	–	–	-7.06 x 10-7	-6.48 x 10-6	-3.22 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	–	-3.70 x 10-6	-3.32 x 10-5	-1.62 x 10-5
R-15 to R-22	0.5 – 0.69	-5.52 x 10-6	-6.85 x 10-5	-3.34 x 10-5	-6.80 x 10-6	-6.15 x 10-5	-3.00 x 10-5
R-15 to R-22	≥ 0.7	-8.06 x 10-6	-1.00 x 10-4	-4.89 x 10-5	-9.55 x 10-6	-9.10 x 10-5	-4.44 x 10-5
R-30	0.15 - 0.29	–	–	–	-6.32 x 10-7	-4.54 x 10-6	-2.25 x 10-6
R-30	0.3 – 0.49	–	–	–	-3.32 x 10-6	-2.23 x 10-5	-1.07 x 10-5
R-30	0.5 – 0.69	-5.55 x 10-6	-4.83 x 10-5	-2.35 x 10-5	-6.05 x 10-6	-4.13 x 10-5	-2.00 x 10-5
R-30	≥ 0.7	-6.77 x 10-6	-7.30 x 10-5	-3.95 x 10-5	-8.39 x 10-6	-6.06 x 10-5	-2.93 x 10-5

Table 240. Cool Roofs—Climate Zone 4: Corpus Christi, Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
< R-5	0.15 - 0.29	–	–	–	-4.72 x 10-7	-1.47 x 10-5	-6.94 x 10-6
< R-5	0.3 – 0.49	–	–	–	-2.45 x 10-6	-7.36 x 10-5	-3.49 x 10-5
< R-5	0.5 – 0.69	-5.41 x 10-6	-1.51 x 10-4	-7.33 x 10-5	-4.77 x 10-6	-1.34 x 10-4	-6.20 x 10-5
< R-5	≥ 0.7	-7.53 x 10-6	-2.19 x 10-4	-1.02 x 10-4	-7.11 x 10-6	-1.99 x 10-4	-9.32 x 10-5
R-5 to R-8	0.15 - 0.29	–	–	–	-4.02 x 10-7	-1.19 x 10-5	-5.71 x 10-6
R-5 to R-8	0.3 – 0.49	–	–	–	-2.13 x 10-6	-5.99 x 10-5	-2.89 x 10-5
R-5 to R-8	0.5 – 0.69	-3.72 x 10-6	-1.20 x 10-4	-5.60 x 10-5	-3.17 x 10-6	-1.08 x 10-4	-5.08 x 10-5
R-5 to R-8	≥ 0.7	-7.11 x 10-6	-1.79 x 10-4	-8.65 x 10-5	-4.84 x 10-6	-1.61 x 10-4	-7.59 x 10-5
R-9 to R-14	0.15 - 0.29	–	–	–	-6.35 x 10-7	-8.94 x 10-6	-4.36 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	–	-1.95 x 10-6	-4.53 x 10-5	-2.21 x 10-5
R-9 to R-14	0.5 – 0.69	-3.55 x 10-6	-9.21 x 10-5	-4.40 x 10-5	-2.94 x 10-6	-8.27 x 10-5	-3.89 x 10-5
R-9 to R-14	≥ 0.7	-4.77 x 10-6	-1.35 x 10-4	-6.41 x 10-5	-3.95 x 10-6	-1.23 x 10-4	-5.95 x 10-5
R-15 to R-22	0.15 - 0.29	–	–	–	-1.73 x 10-6	-6.16 x 10-6	-2.94 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	–	-2.67 x 10-6	-3.25 x 10-5	-1.62 x 10-5
R-15 to R-22	0.5 – 0.69	-3.83 x 10-6	-6.74 x 10-5	-3.45 x 10-5	-3.08 x 10-6	-5.91 x 10-5	-2.83 x 10-5
R-15 to R-22	≥ 0.7	-4.47 x 10-6	-9.81 x 10-5	-4.84 x 10-5	-4.19 x 10-6	-8.82 x 10-5	-4.34 x 10-5
R-30	0.15 - 0.29	–	–	–	-1.34 x 10-7	-4.03 x 10-6	-1.87 x 10-6
R-30	0.3 – 0.49	–	–	–	-9.58 x 10-7	-2.14 x 10-5	-1.03 x 10-5
R-30	0.5 – 0.69	-3.13 x 10-6	-4.69 x 10-5	-2.41 x 10-5	-2.42 x 10-6	-4.01 x 10-5	-2.00 x 10-5
R-30	≥ 0.7	-3.46 x 10-6	-6.78 x 10-5	-3.32 x 10-5	-2.98 x 10-6	-5.89 x 10-5	-2.88 x 10-5

Table 241. Cool Roofs—Climate Zone 5: El Paso, Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
< R-5	0.15 - 0.29	–	–	–	-6.68 x 10-7	-2.51 x 10-5	-1.01 x 10-5
< R-5	0.3 – 0.49	–	–	–	-7.29 x 10-6	-1.33 x 10-4	-5.50 x 10-5
< R-5	0.5 – 0.69	-1.53 x 10-5	-2.93 x 10-4	-1.17 x 10-4	-1.34 x 10-5	-2.50 x 10-4	-1.02 x 10-4
< R-5	≥ 0.7	-1.73 x 10-5	-4.44 x 10-4	-1.79 x 10-4	-1.93 x 10-5	-3.82 x 10-4	-1.57 x 10-4
R-5 to R-8	0.15 - 0.29	–	–	–	-2.41 x 10-7	-1.98 x 10-5	-7.98 x 10-6

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-5 to R-8	0.3 – 0.49	–	–	–	-4.83 x 10-6	-1.03 x 10-4	-4.14 x 10-5
R-5 to R-8	0.5 – 0.69	-1.33 x 10-5	-2.36 x 10-4	-9.44 x 10-5	-1.22 x 10-5	-1.99 x 10-4	-7.97 x 10-5
R-5 to R-8	≥ 0.7	-1.47 x 10-5	-3.64 x 10-4	-1.48 x 10-4	-1.73 x 10-5	-3.11 x 10-4	-1.28 x 10-4
R-9 to R-14	0.15 - 0.29	–	–	–	-5.77 x 10-7	-1.35 x 10-5	-5.48 x 10-6
R-9 to R-14	0.3 – 0.49	–	–	–	-4.07 x 10-6	-7.56 x 10-5	-3.15 x 10-5
R-9 to R-14	0.5 – 0.69	-9.52 x 10-6	-1.70 x 10-4	-6.83 x 10-5	-9.66 x 10-6	-1.44 x 10-4	-5.76 x 10-5
R-9 to R-14	≥ 0.7	-1.06 x 10-5	-2.73 x 10-4	-1.12 x 10-4	-1.38 x 10-5	-2.33 x 10-4	-9.66 x 10-5
R-15 to R-22	0.15 - 0.29	–	–	–	-4.29 x 10-7	-9.41 x 10-6	-4.20 x 10-6
R-15 to R-22	0.3 – 0.49	–	–	–	-3.14 x 10-6	-4.91 x 10-5	-2.00 x 10-5
R-15 to R-22	0.5 – 0.69	-7.55 x 10-6	-1.14 x 10-4	-4.66 x 10-5	-7.70 x 10-6	-9.71 x 10-5	-4.02 x 10-5
R-15 to R-22	≥ 0.7	-8.94 x 10-6	-1.85 x 10-4	-7.43 x 10-5	-1.05 x 10-5	-1.55 x 10-4	-6.29 x 10-5
R-30	0.15 - 0.29	–	–	–	-2.85 x 10-7	-6.26 x 10-6	-2.54 x 10-6
R-30	0.3 – 0.49	–	–	–	-2.32 x 10-6	-3.11 x 10-5	-1.25 x 10-5
R-30	0.5 – 0.69	-5.52 x 10-6	-7.44 x 10-5	-2.95 x 10-5	-6.01 x 10-6	-5.97 x 10-5	-2.46 x 10-5
R-30	≥ 0.7	-7.73 x 10-6	-1.20 x 10-4	-4.89 x 10-5	-7.78 x 10-6	-9.69 x 10-5	-3.98 x 10-5

Homes with Roof Deck Insulation

Table 242 through Table 246 present the winter demand savings (kW) associated with the installation of a reflective roof in homes with varying levels of roof deck for the five Texas climate zones. Savings are per square foot of treated roof area.

Table 242. Cool Roofs—Climate Zone 1: Amarillo,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	0.15 - 0.29	–	–	–	–	–	–
R-19	0.3 – 0.49	–	–	–	6.62 x 10-7	-3.75 x 10-5	-1.86 x 10-5
R-19	0.5 – 0.69	1.68 x 10-6	-6.28 x 10-5	-2.35 x 10-5	5.59 x 10-6	-7.49 x 10-5	-3.71 x 10-5
R-19	≥ 0.7	-1.78 x 10-6	-9.77 x 10-5	-4.08 x 10-5	7.13 x 10-6	-1.12 x 10-4	-5.19 x 10-5
R-30	0.15 - 0.29	–	–	–	-1.08 x 10-7	-3.00 x 10-6	-1.52 x 10-6
R-30	0.3 – 0.49	–	–	–	2.49 x 10-6	-3.23 x 10-5	-1.75 x 10-5
R-30	0.5 – 0.69	-5.08 x 10-7	-5.14 x 10-5	-2.26 x 10-5	3.99 x 10-6	-6.01 x 10-5	-3.15 x 10-5

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-30	≥ 0.7	-1.76 x 10-6	-7.76 x 10-5	-3.59 x 10-5	4.24 x 10-6	-8.76 x 10-5	-4.38 x 10-5
R-38	0.15 - 0.29	–	–	–	-1.87 x 10-7	-5.19 x 10-6	-2.62 x 10-6
R-38	0.3 – 0.49	–	–	–	3.82 x 10-6	-2.85 x 10-5	-1.67 x 10-5
R-38	0.5 – 0.69	-2.10 x 10-6	-4.31 x 10-5	-2.20 x 10-5	2.82 x 10-6	-4.93 x 10-5	-2.74 x 10-5
R-38	≥ 0.7	-1.74 x 10-6	-6.29 x 10-5	-3.23 x 10-5	2.13 x 10-6	-6.99 x 10-5	-3.79 x 10-5

Table 243. Cool Roofs—Climate Zone 2: Dallas, Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	0.15 - 0.29	–	–	–	–	–	–
R-19	0.3 – 0.49	–	–	–	-1.68 x 10-6	-4.21 x 10-5	-2.13 x 10-5
R-19	0.5 – 0.69	3.73 x 10-6	-8.26 x 10-5	-3.29 x 10-5	3.93 x 10-6	-8.72 x 10-5	-4.49 x 10-5
R-19	≥ 0.7	2.09 x 10-6	-1.33 x 10-4	-5.96 x 10-5	2.27 x 10-6	-1.30 x 10-4	-5.31 x 10-5
R-30	0.15 - 0.29	–	–	–	-7.35 x 10-8	-3.36 x 10-6	-1.70 x 10-6
R-30	0.3 – 0.49	–	–	–	-1.19 x 10-6	-3.52 x 10-5	-1.73 x 10-5
R-30	0.5 – 0.69	6.09 x 10-7	-6.66 x 10-5	-3.33 x 10-5	8.00 x 10-8	-6.99 x 10-5	-3.56 x 10-5
R-30	≥ 0.7	-1.22 x 10-6	-1.03 x 10-4	-5.11 x 10-5	-1.19 x 10-6	-1.03 x 10-4	-4.63 x 10-5
R-38	0.15 - 0.29	–	–	–	-1.27 x 10-7	-5.81 x 10-6	-2.93 x 10-6
R-38	0.3 – 0.49	–	–	–	-8.41 x 10-7	-3.02 x 10-5	-1.44 x 10-5
R-38	0.5 – 0.69	-1.66 x 10-6	-5.49 x 10-5	-3.36 x 10-5	-2.72 x 10-6	-5.73 x 10-5	-2.88 x 10-5
R-38	≥ 0.7	-3.63 x 10-6	-8.17 x 10-5	-4.49 x 10-5	-3.70 x 10-6	-8.42 x 10-5	-4.14 x 10-5

Table 244. Cool Roofs—Climate Zone 3: Houston, Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	0.15 - 0.29	–	–	–	–	–	–
R-19	0.3 – 0.49	–	–	–	5.21 x 10-8	-4.60 x 10-5	-2.10 x 10-5
R-19	0.5 – 0.69	-4.82 x 10-7	-9.84 x 10-5	-5.19 x 10-5	-1.73 x 10-7	-9.69 x 10-5	-4.88 x 10-5
R-19	≥ 0.7	1.47 x 10-6	-1.47 x 10-4	-7.52 x 10-5	2.13 x 10-6	-1.52 x 10-4	-8.03 x 10-5
R-30	0.15 - 0.29	–	–	–	2.41 x 10-8	-3.94 x 10-6	-2.10 x 10-6

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-30	0.3 – 0.49	–	–	–	1.86 x 10-7	-4.00 x 10-5	-1.93 x 10-5
R-30	0.5 – 0.69	-1.49 x 10-6	-8.32 x 10-5	-4.30 x 10-5	-4.20 x 10-7	-7.79 x 10-5	-4.01 x 10-5
R-30	≥ 0.7	-1.30 x 10-6	-1.17 x 10-4	-6.28 x 10-5	-7.36 x 10-7	-1.19 x 10-4	-6.33 x 10-5
R-38	0.15 - 0.29	–	–	–	4.96 x 10-8	-6.80 x 10-6	-3.63 x 10-6
R-38	0.3 – 0.49	–	–	–	4.75 x 10-7	-3.56 x 10-5	-1.81 x 10-5
R-38	0.5 – 0.69	-2.23 x 10-6	-7.22 x 10-5	-3.66 x 10-5	-5.99 x 10-7	-6.41 x 10-5	-3.37 x 10-5
R-38	≥ 0.7	-3.32 x 10-6	-9.52 x 10-5	-5.37 x 10-5	-2.82 x 10-6	-9.58 x 10-5	-5.09 x 10-5

**Table 245. Cool Roofs—Climate Zone 4: Corpus Christi,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)**

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	0.15 - 0.29	–	–	–	–	–	–
R-19	0.3 – 0.49	–	–	–	-1.53 x 10-6	-4.45 x 10-5	-2.26 x 10-5
R-19	0.5 – 0.69	-2.27 x 10-6	-9.14 x 10-5	-3.90 x 10-5	-2.29 x 10-6	-9.18 x 10-5	-4.65 x 10-5
R-19	≥ 0.7	-2.65 x 10-6	-1.39 x 10-4	-6.06 x 10-5	-4.16 x 10-6	-1.37 x 10-4	-6.18 x 10-5
R-30	0.15 - 0.29	–	–	–	-1.08 x 10-7	-3.76 x 10-6	-1.77 x 10-6
R-30	0.3 – 0.49	–	–	–	-1.19 x 10-6	-3.68 x 10-5	-1.74 x 10-5
R-30	0.5 – 0.69	-2.72 x 10-6	-7.35 x 10-5	-3.29 x 10-5	-2.34 x 10-6	-7.31 x 10-5	-3.62 x 10-5
R-30	≥ 0.7	-3.34 x 10-6	-1.09 x 10-4	-4.88 x 10-5	-3.60 x 10-6	-1.09 x 10-4	-5.07 x 10-5
R-38	0.15 - 0.29	–	–	–	-1.87 x 10-7	-6.50 x 10-6	-3.06 x 10-6
R-38	0.3 – 0.49	–	–	–	-9.37 x 10-7	-3.12 x 10-5	-1.36 x 10-5
R-38	0.5 – 0.69	-3.05 x 10-6	-6.05 x 10-5	-2.85 x 10-5	-2.37 x 10-6	-5.95 x 10-5	-2.87 x 10-5
R-38	≥ 0.7	-3.85 x 10-6	-8.74 x 10-5	-4.03 x 10-5	-3.19 x 10-6	-8.78 x 10-5	-4.27 x 10-5

**Table 246. Cool Roofs—Climate Zone 5: El Paso,
Winter Peak Demand Savings for Residential Reflective Roof Installation (kW/sq. ft.)**

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	0.15 - 0.29	–	–	–	–	–	–
R-19	0.3 – 0.49	–	–	–	2.07 x 10-6	-5.87 x 10-5	-2.38 x 10-5
R-19	0.5 – 0.69	7.97 x 10-7	-1.30 x 10-4	-5.39 x 10-5	1.10 x 10-6	-1.31 x 10-4	-5.30 x 10-5

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas	Electric resistance	Heat pump	Gas	Electric resistance	Heat pump
R-19	≥ 0.7	-1.19 x 10-6	-2.13 x 10-4	-8.83 x 10-5	-8.95 x 10-7	-2.10 x 10-4	-8.53 x 10-5
R-30	0.15 - 0.29	–	–	–	-1.04 x 10-7	-4.45 x 10-6	-1.81 x 10-6
R-30	0.3 – 0.49	–	–	–	4.81 x 10-7	-4.81 x 10-5	-1.95 x 10-5
R-30	0.5 – 0.69	3.74 x 10-8	-1.01 x 10-4	-4.16 x 10-5	-7.12 x 10-7	-1.01 x 10-4	-4.15 x 10-5
R-30	≥ 0.7	-1.64 x 10-6	-1.61 x 10-4	-6.73 x 10-5	-2.51 x 10-6	-1.60 x 10-4	-6.58 x 10-5
R-38	0.15 - 0.29	–	–	–	-1.79 x 10-7	-7.68 x 10-6	-3.13 x 10-6
R-38	0.3 – 0.49	–	–	–	-6.75 x 10-7	-4.04 x 10-5	-1.63 x 10-5
R-38	0.5 – 0.69	-5.15 x 10-7	-7.93 x 10-5	-3.26 x 10-5	-2.03 x 10-6	-7.94 x 10-5	-3.31 x 10-5
R-38	≥ 0.7	-1.97 x 10-6	-1.24 x 10-4	-5.20 x 10-5	-3.68 x 10-6	-1.24 x 10-4	-5.16 x 10-5

Example Deemed Savings Calculation

Example 1. A contractor installs 1500 square feet of white asphalt shingle roofing with a 3-year rated reflectance of 0.55 on a home in Climate Zone 3 with a roof slope of 4/12, refrigerated air, and a gas furnace, which has existing ceiling insulation estimated at R-12.

$$Energy\ Savings = (0.26 - \ 0.01) \times 1500 = 375\ kWh$$

$$Summer\ Peak\ Demand\ Savings = 2.03x10^{-4} \times 1500 = 0.30\ kW$$

$$Winter\ Peak\ Demand\ Savings = -6.46x10^{-6} \times 1500 = -0.01\ kW$$

Example 2. A contractor applies a reflective coating to a 1200 square foot home with a heat pump and a low-slope roof in Climate Zone 2, with R-19 roof deck insulation. The coating has a 3-year rated reflectance of 0.75.

$$Energy\ Savings = (0.32 - \ 0.11) \times 1200 = 252\ kWh$$

$$Summer\ Peak\ Demand\ Savings = N/A$$

$$Winter\ Peak\ Demand\ Savings = -5.96x10^{-5} \times 1200 = -0.07\ kW$$

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 15 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID BS-LtRoof.[305]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Insulation R-value (as is, post measure installation of ceiling/roof insulation)
- Only for homes with a reported baseline R-value that is less than R-5:
  - Two pictures: (1) a picture showing the entire attic floor, and (2) a close-up picture of a ruler that shows the measurement of the depth of the insulation.

    Note: The second photo type is required for each area of insulation where there are varying R-values less than R-5. Additionally, both photo types are required for all separate attic/ceiling areas, even when the installed R-value is the same.
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
  - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Square footage of reflective roofing material installed
- Slope of the roof (low or high slope)
- Three-year solar reflectance as rated by Cool Roof Rating Certification of the reflective material installed
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 47755-1. Petition of AEP Texas Inc., CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric

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[305] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Delivery Company LLC, Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company. Petition To Approve Revisions To Residential And Nonresidential Deemed Savings Incorporated In Texas Technical Reference Manual Version 5.0 Program Year 2018 And Deemed Savings Derived For A New Measure. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 247. Cool Roofs—Revision History

TRM version	Date	Description of change
v6.0	11/2018	TRM v6.0 origin.
v7.0	11/2019	TRM v7.0 update. Added savings for R-30 insulation.
v8.0	10/2020	TRM v8.0 update. Updated savings tables. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. Updated savings tables for < R-5 baseline category. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Addressed sunsetting of ENERGY STAR Roof program.

2.3.8 Solar Screens Measure Overview

TRM Measure ID: R-BE-SS

Market Sector: Residential

Measure Category: Building Envelope

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Savings are presented for the installation of solar screens on west- and/or south-facing windows or glass doors. Deemed savings are calculated per square foot of treated window or door opening.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. The heating savings penalty applies to homes that are centrally heated with either a furnace (gas or electric resistance) or a heat pump. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Solar screens must be installed on windows or glass doors that face west or south and receive significant direct sun exposure. Solar screens must block at least 65 percent of the solar heat gain to qualify for deemed savings.

Baseline Condition

The baseline is a single pane, clear glass, unshaded, west-, or south-facing window with a solar heat gain coefficient of 0.68. The baseline window area is assumed to be 7.5 percent of the total wall area.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[306] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[307] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

Solar screen material installed on south- or west-facing windows must reduce solar heat gain by at least 65 percent. Solar screens are not recommended for homes with electric resistance heat.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Deemed savings values have been estimated using calibrated simulation models. Specifically, these deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. A single modification was made to the prototype models for the various climate zone-HVAC type combinations to create the base case models for estimating savings for the solar screens measure. Windows facing all directions are assumed to be single-pane windows with U-values of 1.16 BTU/h-sq. ft.-R and solar heat gain coefficients (SHGC) of 0.76.

For the change case models, an 80 percent reduction was applied to the solar heat gain coefficient for the south- and west-facing windows.

Summer and winter peak demand savings are estimated by taking the difference in demand for the 20 hours identified from the TMY3 datasets in which the summer and winter peaks are most likely to occur, as described in TRM Volume 1 Section 4 - Peak Demand Definitions.

The model assumes the average solar screen installed blocks 80 percent of the solar heat gain attributed to the south and west-facing windows based on performance data from solar screens analyzed at sun angles of 30, 45, and 75 degrees to the window.[308]

While it is recommended that solar screens be removed during winter to allow the advantage of free heat from the sun, they are often not removed seasonally. This may be due to solar screens serving as an insect screen in addition to blocking the sun or simply that they're installed in difficult-to-reach areas such as second-floor windows. The savings estimates presented herein assume that the installed solar screens remain in place year-round.

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[306] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[307] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[308] Performance data from Matrix, Inc., Mesa, Arizona testing facility for Phifer Wire Products' SunTex screen, blocks 80 percent of solar heat gain.

Thermal Performance Improvement

Manual J and other studies researched indicate a thermal improvement to a window with a solar screen due to reduced air infiltration. The National Certified Testing Laboratories provided a report stating a 15 percent reduction in the thermal transmittance of a single pane, ¼" clear glass window with a solar screen added to the exterior.

Another study that was conducted for NFRC indicated between a 22 percent and 4 percent improvement to the U-value of a window with a solar screen. A single pane, clear window has a 22 percent improvement with the addition of a solar screen, whereas a double pane, spectrally selective low-E window may only have a 4 percent improvement. The deemed savings models assume an average 10 percent improvement in thermal performance with the addition of a solar screen.

Window Frame

The window frame accounts for 10-30 percent[309] of the window area, and since it is opaque and blocks sunlight from entering the home, it is factored into the model. An average of 15 percent frame area was incorporated into the performance of the window.

Example Calculation

Example 1. A home in Climate Zone 4 with a central air conditioning unit and an electric resistance furnace installs 75 square feet of solar screens.

$$Energy\ Savings = \left(6.09 + (-3.21)\right) \times 75 = 216\,kWh$$

$$Summer\ Peak\ Demand\ Savings = 3.17 \times 10^{-3} \times 75 = 0.24\,kW$$

$$Winter\ Peak\ Demand\ Savings = -2.32 \times 10^{-3} \times 75 = -0.17\,kW$$

Deemed Energy Savings Tables

Table 248 presents the deemed energy savings value per square foot of solar screen installed. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling value in Table 248 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 248 by a factor of 0.24.[310]

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[309] Residential Windows – A Guide to New Technologies and Energy Performance, 2000.

[310] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 248. Solar Screens—Energy Savings (kWh) per Square Foot of Solar Screen

Climate zone	Cooling savings (kWh/sq. ft.)		Heating savings (kWh/sq. ft.)		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	3.67	1.34	-0.62	-12.81	-4.54
Zone 2: Dallas	5.38	-	-0.29	-7.14	-2.56
Zone 3: Houston	5.33	-	-0.16	-4.69	-1.69
Zone 4: Corpus Christi	6.09	-	-0.09	-3.21	-1.16
Zone 5: El Paso	5.62	1.99	-0.44	-10.48	-3.81

Deemed Summer Demand Savings Tables

Table 249 presents the deemed summer peak demand savings value per square foot of solar screen installed.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling value in Table 249 by a factor of 0.6.

Table 249. Solar Screens—Summer Peak Demand Savings (kW) per Square Foot of Solar Screen

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	2.89E-03	1.35E-03
Zone 2: Dallas	3.42E-03	-
Zone 3: Houston	3.29E-03	-
Zone 4: Corpus Christi	3.17E-03	-
Zone 5: El Paso	3.12E-03	1.07E-03

Deemed Winter Demand Savings Tables

Table 250 presents the deemed winter peak demand savings value per square foot of solar screen installed.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate heating values in Table 250 by a factor of 0.24.[311]

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[311] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 250. Solar Screens—Winter Peak Demand Savings (kW) per Square Foot of Solar Screen

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	-1.16E-04	-1.73E-03	-9.45E-04
Zone 2: Dallas	-5.20E-05	-1.32E-03	-7.96E-04
Zone 3: Houston	-1.07E-04	-2.65E-03	-1.71E-03
Zone 4: Corpus Christi	-7.68E-05	-2.32E-03	-1.08E-03
Zone 5: El Paso	-1.45E-04	-3.34E-03	-1.30E-03

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID BS-WinFilm.[312]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Square footage of windows or door openings treated
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or other pre-approved method of installation verification

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[312] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 251. Solar Screens—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Added detail on methodology and model characteristics. Savings awarded for south-facing windows, in addition to east- and west-facing windows.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. Multiplier provided to adjust cooling side savings for homes with evaporative cooling due to lower energy usage and demand associated with evaporative coolers relative to refrigerated air. Climate Zone 2 savings values awarded for Climate Zone 5 homes with heat pumps.
v3.1	11/05/2015	TRM v3.1 update. Provided example savings calculations.
v4.0	10/10/2016	TRM v4.0 update. Updated energy and demand savings per new prototype energy simulation models. Added separate savings for homes with evaporative cooling.
v5.0	10/2017	TRM v5.0 update. Added explicit reference to mini-split technology. Added provision for low-income and hard-to-reach customers cooled by room air conditioners to claim savings.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Updated documentation requirements.
v8.0	10/2020	TRM v8.0 update. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. No revision.

2.3.9 ENERGY STAR® Windows Measure Overview

TRM Measure ID: R-BE-EW

Market Sector: Residential

Applicable Building Types: Single-family, multifamily, manufactured

Measure Category: Building envelope

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling

Measure Description

Replacing existing single- or double-pane windows with ENERGY STAR-compliant windows can help reduce heat transfer through window glazing, minimize air infiltration around window frames, reduce sun ultraviolet damage to household furniture, and lower household energy bills by an average of 12 percent nationwide.[313]

Window savings are calculated on a per-square-foot-of-window basis, inclusive of frame and sash.

Eligibility Criteria

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes, or to customers in TRM Climate Zones 1 and 5 who have evaporative cooling systems. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Baseline

There are two base cases: single-pane and double-pane windows. In both cases, a metal frame is specified. Estimated U-Values and SHGCs for baseline windows are presented in Table 252. A weighted single- and double-pane baseline is also provided, assuming a standard distribution

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[313] ENERGY STAR Windows, Doors, & Skylights. https://www.energystar.gov/products/res_windows_doors_skylights.

of 46 percent single-pane and 54 percent double-pane based on 2020 RECS survey data.[314] This baseline may be used exclusively if applied consistently for all projects.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[315] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[316] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

Table 252. Windows—Baseline Window Specification

Number of panes	U-factor Btu/(h·sq. ft.·°F)	Solar heat gain coefficient (SHGC)
1	1.16	0.76
2	0.76	0.67

High-Efficiency Condition

Performance criteria are based on ratings certified by the National Fenestration Rating Council (NFRC) and vary by location.

The table below displays the ENERGY STAR Final Version 6.0 Requirements for eligible windows, doors, and skylights effective January 1, 2015.[317] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 253. Windows—High-Efficiency Requirements effective January 2015

US region, ENERGY STAR	U-factor Btu/(h·sq. ft.·°F)	Solar heat gain coefficient (SHGC)
North-Central	≤ 0.30	≤ 0.40
South-Central	≤ 0.30	≤ 0.25
Southern	≤ 0.40	≤ 0.25

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[314] 2020 Residential Energy Consumption Survey (RECS). Structural and geographic characteristics in the South and West regions (HC2.8). Analysis based on West South-Central census region. https://www.eia.gov/consumption/residential/data/2020/.

[315] Electric Resistance Heating. https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[316] Portable Heaters. https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[317] ENERGY STAR® Residential Windows, Doors, and Skylights Final Version 6.0 Program Requirements. https://www.energystar.gov/sites/default/files/Windows_Doors_and_Skylights_Program_Requirements%20v6.pdf.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Deemed savings values have been estimated using calibrated simulation models. Base case homes were fitted with single-pane and double-pane windows. Efficiency case homes were equipped with windows meeting the appropriate ENERGY STAR window specification for the location in which the window was to be installed. The climate zones in the ENERGY STAR windows specification were mapped to the Texas TRM climate zones as shown in Table 254.

Table 254. Windows—TRM and ENERGY STAR Climate Zones

Climate zone	US region, ENERGY STAR
Zone 1: Amarillo	North-Central
Zone 2: Dallas	South-Central
Zone 3: Houston	Southern
Zone 4: Corpus Christi	Southern
Zone 5: El Paso	South-Central

Deemed Energy Savings Tables

Table 255 through Table 257 present the energy savings (kWh) for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in hard-to-reach (HTR) or low-income (LI) programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 255 and Table 257 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate deemed heating values by a factor of 0.24.[318]

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[318] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 255. Windows—Energy Savings (kWh/sq. ft.), Single-Pane Baseline

Climate zone	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.83	0.98	0.29	6.70	3.16
Zone 2: Dallas	5.42	–	0.10	3.09	1.45
Zone 3: Houston	5.32	–	0.02	0.77	0.41
Zone 4: Corpus Christi	5.97	–	0.02	0.82	0.34
Zone 5: El Paso	5.67	1.90	0.00	0.99	0.69

Table 256. Windows—Energy Savings (kWh/sq. ft.), Double-Pane Baseline

Climate zone	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.03	0.72	0.18	4.15	2.00
Zone 2: Dallas	4.11	–	0.04	1.47	0.76
Zone 3: Houston	3.96	–	-0.01	-0.21	0.01
Zone 4: Corpus Christi	4.45	–	0.00	-0.01	0.02
Zone 5: El Paso	4.24	1.46	-0.03	-0.18	0.16

Table 257. Windows—Energy Savings (kWh/sq. ft.), Weighted-Pane Baseline

Climate zone	Cooling savings		Heating savings		
	Refrigerated	Evaporative	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.40	0.84	0.23	5.33	2.54
Zone 2: Dallas	4.71	–	0.07	2.22	1.08
Zone 3: Houston	4.59	–	–	0.24	0.19
Zone 4: Corpus Christi	5.15	–	0.01	0.37	0.17
Zone 5: El Paso	4.90	1.66	-0.02	0.36	0.40

Deemed Summer Demand Savings Tables

Table 258 through Table 260 presents the summer demand savings (kW) for the five Texas climate zones.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate deemed cooling values by a factor of 0.6.

Table 258. Windows—Summer Peak Demand Savings (kW/sq. ft.), Single-Pane Baseline

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	3.09E-03	1.16E-03
Zone 2: Dallas	3.89E-03	–
Zone 3: Houston	3.51E-03	–
Zone 4: Corpus Christi	2.99E-03	–
Zone 5: El Paso	3.86E-03	1.05E-03

Table 259. Windows—Summer Peak Demand Savings (kW/sq. ft.), Double-Pane Baseline

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	2.08E-03	8.36E-04
Zone 2: Dallas	2.80E-03	–
Zone 3: Houston	2.40E-03	–
Zone 4: Corpus Christi	2.15E-03	–
Zone 5: El Paso	2.76E-03	8.09E-04

Table 260. Windows—Summer Peak Demand Savings (kW/sq. ft.), Weighted-Pane Baseline

Climate zone	Refrigerated	Evaporative
Zone 1: Amarillo	2.55E-03	9.86E-04
Zone 2: Dallas	3.30E-03	–
Zone 3: Houston	2.91E-03	–
Zone 4: Corpus Christi	2.54E-03	–
Zone 5: El Paso	3.27E-03	9.20E-04

Deemed Winter Demand Savings Table 261 through Table 263 presents the winter demand savings (kW) for the five Texas climate zones.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate deemed heating values by a factor of 0.24.[319]

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[319] This factor was derived based on expected capacity reduction assuming 1200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 261. Windows—Winter Peak Demand Savings (kW/sq. ft.), Single-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	2.01E-04	4.98E-03	2.43E-03
Zone 2: Dallas	1.77E-04	4.73E-03	2.74E-03
Zone 3: Houston	6.89E-05	1.78E-03	3.11E-04
Zone 4: Corpus Christi	4.78E-05	1.65E-03	6.68E-04
Zone 5: El Paso	2.83E-05	1.10E-03	5.00E-04

Table 262. Windows—Winter Peak Demand Savings (kW/sq. ft.), Double-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	1.32E-04	3.30E-03	1.64E-03
Zone 2: Dallas	1.12E-04	3.16E-03	1.89E-03
Zone 3: Houston	2.33E-05	6.68E-04	3.58E-06
Zone 4: Corpus Christi	1.53E-05	5.62E-04	2.34E-04
Zone 5: El Paso	1.31E-05	5.84E-04	2.76E-04

Table 263. Windows—Winter Peak Demand Savings (kW/sq. ft.), Weighted-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	1.64E-04	4.08E-03	2.00E-03
Zone 2: Dallas	4.42E-04	3.88E-03	2.28E-03
Zone 3: Houston	4.44E-05	1.18E-03	1.46E-04
Zone 4: Corpus Christi	3.03E-05	1.06E-03	4.34E-04
Zone 5: El Paso	2.01E-05	8.22E-04	3.79E-04

Example Deemed Savings Calculation

Example 1. A home in Climate Zone 1 with evaporative cooling and an electric resistance furnace replaces 125 square feet of single-pane windows with ENERGY STAR windows.

$$Energy\ Savings = (0.98\ +\ 6.70)\ \times\ 125 = \mathit{960\ kWh}$$

$$Summer\ Peak\ Demand\ Savings = 1.16x10^{-3}\ \times\ 125 = 0.15\ kW$$

$$Winter\ Peak\ Demand\ Savings = 4.98x10^{-3}\ \times\ 125 = 0.62\ kW$$

Example 2. A home in Climate Zone 5 with a central air conditioning unit and a gas furnace replaces 250 square feet of windows with unknown number of panes with ENERGY STAR windows.

$$Energy\ Demand\ Savings = \left(4.90 +\ (-0.02)\right)\ \times\ 250 = \mathit{1{,}220\ kWh}$$

$$Summer\ Peak\ Demand\ Savings = 3.27\ \times\ 10^{-3}\ \times\ 250 = 0.82\ kW$$

$$Winter\ Peak\ Demand\ Savings = 2.01\ \times\ 10^{-5}\ \times\ 250 = 0.01\ kW$$

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007), the Estimated Useful Life is 25 years for ENERGY STAR windows[320].

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone
- Cooling type (evaporative cooling, central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Baseline window number of panes (single, double, weighted)
    - The weighted baseline may be used if applied universally for all projects in a given program during the entire program year.
- Area of ENERGY STAR windows installed
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 48. Petition by Frontier Energy for Approval of Second

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[320] "Measure Life Report: Residential and Commercial Industrial Lighting and HVAC Measures," The New England State Program Working Group (SPWG). June 2007. https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf.

Set of Deemed Savings Estimates. Public Utility Commission of Texas.

- Docket No. 27903. Order Adopting New §25.184 as Approved at the August 21, 2003, Open Meeting and Submitted to the Secretary of State. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 264. Windows—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. Multiplier provided to adjust cooling side savings for homes with evaporative cooling due to lower energy usage and demand associated with evaporative coolers relative to refrigerated air. Climate Zone 2 savings values awarded for Climate Zone 5 homes.
v3.1	11/05/2015	TRM v3.1 update. Provided example savings calculations. Consolidated table formats.
v4.0	10/10/2016	TRM v4.0 update. Updated energy and demand savings per new prototype energy simulation models. Added separate savings for homes with evaporative cooling.
v5.0	10/2017	TRM v5.0 update. Added explicit reference to mini-split technology
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Updated documentation requirements.
v8.0	10/2020	TRM v8.0 update. Added space heat adjustment factor and electric resistance documentation requirement.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. Added option for a weighted single-pane and double-pane baseline.

2.3.10 ENERGY STAR® Low-E Storm Windows Measure Overview

TRM Measure ID: R-BE-SW

Market Sector: Residential

Applicable Building Types: Single-family, multifamily, manufactured

Measure Category: Building envelope

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Building simulation modeling and third-party field testing

Measure Description

ENERGY STAR low-e storm windows are a glazing attachment added to single- or double-pane windows. Storm windows are an affordable option for homes where full window replacement may be difficult. Low-emissivity (low-e) metal oxide coating decreases the summer heat gain and winter heat loss of an existing window by reducing thermal transmission. Thermal transmission is reduced as follows:

- The low-e coating acts as a selective heat mirror that reflects infrared light back outside during the summer and back onto the home during the winter.
- The marine-quality glazing and caulked or compression-sealed interface reduces air leakage and infiltration.
- The dead air space, or air barrier, created between the existing window and new storm window frame further reduces thermal transmission during both summer and winter.

The low-e coating is extremely durable and has negligible impact on visible light transmission.

Eligibility Criteria

A low-e storm window may be installed on the interior or exterior of the existing window assembly. Installation is a simple process that is often completed by residential homeowners without the assistance of professional contractors. Due to the simple installation process, low-e storm windows are sometimes installed seasonally. However, savings estimates assume windows are installed for the entire year. Therefore, windows should be permanently mounted and operable.

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning in their homes. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings. Customers who participate in hard-to-reach (HTR) or low-income (LI) programs are eligible to claim reduced heating savings for homes heated with gas or electric resistance space heaters by applying an adjustment to deemed savings that is specified for that heat type. Customers participating in HTR or LI programs are also eligible to claim reduced cooling savings for homes cooled by one or more room air conditioners by applying an adjustment to deemed savings that is specified for homes with central refrigerated air.

Baseline

The baseline condition is an existing single- or double-pane window assembly according to manufacturer specifications. A weighted single- and double-pane baseline is also provided, assuming a standard distribution of 46 percent single-pane and 54 percent double-pane based on 2020 RECS survey data.[321] This baseline may be used exclusively if applied consistently for all projects.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[322] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[323] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters may be eligible for reduced savings as described in the Deemed Energy and Summer/Winter Demand Savings Tables sections.

High-Efficiency Condition

Performance criteria are based on ratings certified by the National Fenestration Rating Council (NFRC) and vary by location.

The table below displays the ENERGY STAR Final Version 1.0 Requirements for eligible exterior and interior storm windows effective September 5, 2018.[324] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[321] 2020 Residential Energy Consumption Survey (RECS). Structural and geographic characteristics in the South and West regions (HC2.8). Analysis based on West South-Central census region. https://www.eia.gov/consumption/residential/data/2020/.

[322] Electric Resistance Heating. https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[323] Portable Heaters. https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[324] ENERGY STAR® Program Requirements Product Specification for Exterior and Interior Storm Windows, v1.0. https://www.energystar.gov/sites/default/files/Storm%20Window%20Product%20Specification_Final_0.pdf.

Table 265. Low-E Storm Windows—ENERGY STAR Requirements

US region, ENERGY STAR®	Emissivity	Solar transmission
North-Central	≤ 0.22	Any
South-Central	≤ 0.22	≤ 0.55
Southern	≤ 0.22	≤ 0.55

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Deemed savings values have been estimated using Lawrence Berkeley National Laboratory's RESFEN building simulation models for residential fenestration.[325] The properties of low-e storm windows used in the RESFEN building models are presented in Table 266. This measure assumes equal weighting between the three low-e storm window glass options.

Table 266. Low-E Storm Windows—Window Assembly Properties[326]

Window type	Glass options	U-factor	SHGC	Air leakage
Storm window over existing single-pane	Low-e	0.35	0.47	1.25
	Low-e with solar control	0.35	0.32	1.25
Storm window over existing double-pane	Low-e	0.26	0.43	1.25
	Low-e with solar control	0.27	0.29	1.25

Assumed building characteristics are based on a 1,700 square-foot single-story and 2,800 square-foot two-story residence. The modeled residence has a 15 percent window-to-floor-area ratio. Assumed building characteristics are presented in Table 267.

Table 267. Low-E Storm Windows—Modeled Building Characteristics

Characteristic	Model assumption
Area	Single-story: 1,700 sq. ft. Two-story: 2,800 sq. ft.
Existing window performance[327,328]	Single pane: 0.88 U-factor, 0.61 SHGC, 2 cfm/sq. ft. air infiltration Double pane: 0.51 U-factor, 0.57 SHGC, 2 cfm/sq. ft. air infiltration
Existing window area	15 percent of floor area
Existing window frame	Wood double-hung

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[325] RESFEN window tool. LBNL. https://windows.lbl.gov/software/resfen.

[326] Averaged values from the selected products in Attachments Energy Rating Council (AERC). https://aercenergyrating.org/product-search/residential-product-search/.

[327] Culp, TD and KA Cort. "Database of Low-e Storm Window Energy Performance across US Climate Zones." US DOE, September 2014. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22864rev2.pdf.

[328] Air infiltration assumption from: "AERC 1.2: Physical Test Methods for Measuring Energy Performance Properties of Fenestration Attachments." AERC, 2018. www.aercnet.org.

Characteristic	Model assumption
Foundation	Slab on-grade
Insulation	Newer construction: IECC 2006 based on climate zone Older construction: See RESFEN 6 documentation
HVAC efficiency	Newer construction: 13 SEER, 7.7 HSPF, 0.8 AFUE for IECC Climate Zones 1-3 and 0.9 AFUE for IECC Climate Zones 4-8 Older construction: 10 SEER, 6.8 HSPF, 0.78 AFUE

Deemed Energy Savings Tables

Table 268 through Table 270 present the energy savings (kWh) for the five Texas climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

For customers who participate in HTR or LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate cooling values in Table 268 and Table 270 by a factor of 0.6. Similarly, for HTR/LI customers, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate deemed heating values by a factor of 0.24.[329]

Savings are an average of newer and older construction baselines for retrofit applications.

Table 268. Low-E Storm Windows—Energy Savings (kWh/sq. ft.), Single-Pane Baseline

	Cooling savings	Heating savings		
Climate zone	Refrigerated	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	1.49	–	15.66	5.34
Zone 2: Dallas	2.52	–	6.65	2.09
Zone 3: Houston	2.49	–	4.55	1.48
Zone 4: Corpus Christi	3.22	–	2.82	0.80
Zone 5: El Paso	2.35	–	6.00	2.06

Table 269. Low-E Storm Windows—Energy Savings (kWh/sq. ft.), Double-Pane Baseline

	Cooling savings	Heating savings		
Climate zone	Refrigerated	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	1.56	–	6.23	2.35
Zone 2: Dallas	2.50	–	2.46	0.88
Zone 3: Houston	2.62	–	1.84	0.67

---

[329] This factor was derived based on expected capacity reduction assuming 1,200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Climate zone	Cooling savings	Heating savings		
	Refrigerated	Gas	Electric resistance	Heat pump
Zone 4: Corpus Christi	3.21	–	1.05	0.32
Zone 5: El Paso	2.37	–	1.90	0.79

Table 270. Low-E Storm Windows—Energy Savings (kWh/sq. ft.), Weighted-Pane Baseline

Climate zone	Cooling savings	Heating savings		
	Refrigerated	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	1.53	–	10.58	3.73
Zone 2: Dallas	2.51	–	4.39	1.44
Zone 3: Houston	2.56	–	3.09	1.04
Zone 4: Corpus Christi	3.21	–	1.87	0.54
Zone 5: El Paso	2.36	–	3.79	1.38

Deemed Summer Demand Savings Tables

Table 271 through Table 273 present the summer demand savings (kW) for the five Texas climate zones.

For customers who participate in HTR/LI programs, cooling savings may be claimed for homes cooled by one or more room air conditioners by multiplying appropriate deemed cooling values by a factor of 0.6.

Table 271. Low-E Storm Windows—Summer Peak Demand Savings (kW/sq. ft.), Single-Pane Baseline

Climate zone	Refrigerated air
Zone 1: Amarillo	0.0016
Zone 2: Dallas	0.0018
Zone 3: Houston	0.0016
Zone 4: Corpus Christi	0.0016
Zone 5: El Paso	0.0016

Table 272. Low-E Storm Windows—Summer Peak Demand Savings (kW/sq. ft.), Double-Pane Baseline

Climate zone	Refrigerated air
Zone 1: Amarillo	0.0016
Zone 2: Dallas	0.0017
Zone 3: Houston	0.0016
Zone 4: Corpus Christi	0.0016
Zone 5: El Paso	0.0015

Table 273. Low-E Storm Window—Summer Peak Demand Savings (kW/sq. ft.), Weighted-Pane Baseline

Climate zone	Refrigerated air
Zone 1: Amarillo	0.0016
Zone 2: Dallas	0.0017
Zone 3: Houston	0.0016
Zone 4: Corpus Christi	0.0016
Zone 5: El Paso	0.0015

Deemed Winter Demand Savings Tables

Table 274 through Table 276 present the winter demand savings (kW) for the five Texas climate zones.

For customers who participate in HTR/LI programs, heating savings may be claimed for homes with electric resistance space heaters serving as the primary heating source by multiplying appropriate deemed heating values by a factor of 0.24.[330]

Table 274. Low-E Storm Windows—Winter Peak Demand Savings (kW/sq. ft.), Single-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	–	0.0116	0.0041
Zone 2: Dallas	–	0.0102	0.0039
Zone 3: Houston	–	0.0105	0.0011
Zone 4: Corpus Christi	–	0.0057	0.0016
Zone 5: El Paso	–	0.0067	0.0015

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[330] This factor was derived based on expected capacity reduction assuming 1,200 sq. ft. (historical analysis of HTR participants) x 0.35 BTU/sq. ft. = 42,000 BTU for central electric furnaces and two 1,500-watt portable heaters per home rated at 5,100 BTU/heater. Taking the ratio of portable to furnace capacity yields 10,200 ÷ 42,000 = 0.24.

Table 275. Low-E Storm Windows—Peak Demand Savings (kW/sq. ft.), Double-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	–	0.0050	0.0019
Zone 2: Dallas	–	0.0053	0.0022
Zone 3: Houston	–	0.0039	0.0002
Zone 4: Corpus Christi	–	0.0019	0.0037
Zone 5: El Paso	–	0.0035	0.0014

Table 276. Low-E Storm Windows—Winter Peak Demand Savings (kW/sq. ft.), Weighted-Pane Baseline

Climate zone	Gas	Electric resistance	Heat pump
Zone 1: Amarillo	–	0.0080	0.0029
Zone 2: Dallas	–	0.0076	0.0030
Zone 3: Houston	–	0.0069	0.0006
Zone 4: Corpus Christi	–	0.0037	0.0027
Zone 5: El Paso	–	0.0050	0.0014

Claimed Peak Demand Savings

No load shape could be extracted from the building simulation for this measure. Due to the equivalent load shape with the existing ENERGY STAR Windows measure, demand savings were estimated by applying the ratio of energy to demand savings from the windows measure to the modeled storm windows energy savings.

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for low-e storm windows is 20 years according to the US Department of Energy.[331]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone

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[331] Culp, TD and KA Cort. “Database of Low-e Storm Window Energy Performance across US Climate Zones.” US DOE, September 2014. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22864rev2.pdf.

- Cooling type (central refrigerated cooling, room air conditioner, none)
- Heating type (central gas, portable gas, central electric resistance, portable electric resistance, heat pump, none)
    - Additional documentation is required to validate electric resistance heat (e.g., nameplate photo, utility inspection, or other evaluator-approved approach); sampling is allowed for multifamily complexes
- Baseline window number of panes (single, double, weighted)
    - The weighted baseline may be used if applied universally for all projects in a given program during the entire program year.
- Area of ENERGY STAR storm windows installed
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 277. Low-E Storm Windows—Revision History

TRM version	Date	Description of change
v9.0	10/2021	TRM v9.0 origin.
v10.0	10/2022	TRM v10.0 update. Added option for a weighted single-pane and double-pane baseline.

2.4 RESIDENTIAL: WATER HEATING

2.4.1 Water Heater Installations—Electric Tankless and Fuel Substitution Measure Overview

TRM Measure ID: R-WH-WH

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves installing a new electric tankless or gas-fueled water heater (storage or tankless) in place of an electric storage water heater.[332]

Eligibility Criteria

This measure involves installing a gas storage, gas tankless (instantaneous), or electric tankless water heater in place of an electric storage water heater, and which meets all the additional requirements described below. HPWHs are not eligible for installation through this measure (see separate *heat pump water heater* measure). Currently, there are no conventional, electrically fueled storage units that sufficiently exceed the new federal standard to merit inclusion as an efficient condition in these deemed savings; therefore, deemed savings are only calculated for new gas storage, gas tankless, and electric tankless systems. Electric tankless water heaters may only replace systems with tanks less than 55 gallons. For the installation of an electric water heater with a tank size greater than 55 gallons, please refer to the *heat pump water heater* measure.

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[332] Previous versions of this measure included an incentive for installing high-efficiency conventional (electric resistance) storage water heaters. Increments to the federal standard for electric storage water heaters went into effect on April 16, 2015, eliminating the feasibility of continuing to provide deemed savings for these units.

These deemed savings are for water heater replacements installed as a replace-on-burnout, new construction, or early retirement measure. However, savings are calculated under the assumption of replace-on-burnout or new construction. Savings may be awarded for installations in newly constructed homes where customer and utility representatives provide written indication that an electric storage water heater would otherwise have been installed, along with relevant design documentation showing an electric storage water heater.

Baseline Condition

This baseline applies to replace-on-burnout, early retirement, and new construction.

For most installations, the baseline condition is an electric storage water heater with baseline efficiency determined by tank size according to the amended federal energy efficiency standards for residential water heaters with tank sizes from 20 to 120 gallons, which took effect April 16, 2015, as published in 10 CFR Part 430.32 of the Federal Register (see Table 278).[333]

Table 278. DHW Replacements—Federal Standard for Residential Electric Storage Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR)[334,335]	Uniform energy factor (UEF)[336]
≥ 20 gal and ≤ 55 gal	Very small usage	$0 \leq FHR < 18$	$0.8808 - (0.0008 \times V_r)$
	Low usage	$18 \leq FHR < 51$	$0.9254 - (0.0003 \times V_r)$
	Medium usage	$51 \leq FHR < 75$	$0.9307 - (0.0002 \times V_r)$
	High usage	$75 \leq FHR$	$0.9349 - (0.0001 \times V_r)$
> 55 gal and ≤ 120 gal	Very small usage	$0 \leq FHR < 18$	$1.9236 - (0.0011 \times V_r)$
	Low usage	$18 \leq FHR < 51$	$2.0440 - (0.0011 \times V_r)$
	Medium usage	$51 \leq FHR < 75$	$2.1171 - (0.0011 \times V_r)$
	High usage	$75 \leq FHR$	$2.2418 - (0.0011 \times V_r)$

The new DOE efficiency standard effectively requires HPWHs (assuming electric water heating) for electric storage water heaters with tank size greater than 55 gallons. As such, electric water heaters with tanks greater than 55 gallons are not eligible for this measure. Instead, see the *heat pump water heater* measure. Furthermore, gas water heaters greater than 55 gallons must use HPWH baseline consumption to calculate savings.

For smaller systems, the baseline technology remains an electric storage water heater with electric resistance as the primary heat source.

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[333] 10 CFR Part 430.32 Energy and water conservation standards and their effective dates. Available online: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32.

[334] "The Revised Method of Test for Residential Water Heating and Its Impact on Incentive Programs" presentation, Glanville, Paul. ACEEE Hot Water Forum. February 24, 2015. https://aceee.org/sites/default/files/pdf/conferences/hwf/2015/6B-Glanville.pdf.

[335] Assume FHR equal to that of installed water heater.

[336] Vr is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

High-Efficiency Condition

For water heater replacement and fuel substitution, the new unit must meet the following federal minimum energy factor shown in Table 279. Water heaters must be installed in accordance with local code requirements.

Table 279. DHW Replacements—Efficiency Standards[337]

DHW type	Rated storage volume	Draw pattern	FHR	UEF[338]
Electric tankless[339]	< 2 gal	Very small usage	$0 \leq FHR < 18$	0.91
		Low usage	$18 \leq FHR < 51$	0.91
		Medium usage	$51 \leq FHR < 75$	0.91
		High usage	$75 \leq FHR$	0.92
Gas tankless	< 2 gal and > 50,000 Btuh	Very small usage	$0 \leq FHR < 18$	0.80
		Low usage	$18 \leq FHR < 51$	0.81
		Medium usage	$51 \leq FHR < 75$	0.81
		High usage	$75 \leq FHR$	0.81
Gas storage	≥ 20 gal and ≤ 55 gal	Very small usage	$0 \leq FHR < 18$	$0.3456 – (0.0020 \times V_r)$
		Low usage	$18 \leq FHR < 51$	$0.5982 – (0.0019 \times V_r)$
		Medium usage	$51 \leq FHR < 75$	$0.6483 – (0.0017 \times V_r)$
		High usage	$75 \leq FHR$	$0.6920 – (0.0013 \times V_r)$
	> 55 gal and ≤ 100 gal	Very small usage	$0 \leq FHR < 18$	$0.6470 – (0.0006 \times V_r)$
		Low usage	$18 \leq FHR < 51$	$0.7689 – (0.0005 \times V_r)$
		Medium usage	$51 \leq FHR < 75$	$0.7897 – (0.0004 \times V_r)$
		High usage	$75 \leq FHR$	$0.8072 – (0.0003 \times V_r)$

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

All deemed savings values are calculated using the following standard algorithms for water heating. These algorithms assume a replace-on-burnout or new construction scenario but may be used to award savings for early retirement projects.

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[337] 10 CFR Part 430.32 Energy and water conservation standards. Available online: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32.

[338] Vr is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

[339] There is no ENERGY STAR tankless water heater category because all products perform at or near the federal standard. These units are still eligible to claim savings against the *electric storage water heater* baseline if FHR and UEF can be verified using manufacturer specification sheets or other documentation.

Electric Tankless Water Heater

Energy Savings Algorithm

$$Energy\ Savings\ [\Delta kWh] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,avg}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{3{,}412}$$

Equation 68

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb·°F] = 1*

GPY = *Estimated annual hot water use in gallons/year, specified by number of bedrooms in the home (see Table 280)*

Table 280. DHW Replacements—Water Heater Consumption (Gal/Year)[340]

Climate zone	Number of bedrooms			
	1	2	3	4
Zone 1: Amarillo	15,476	20,171	24,866	29,561
Zone 2: Dallas	14,778	19,244	23,710	28,177
Zone 3: Houston	14,492	18,864	23,236	27,608
Zone 4: Corpus Christi	14,213	18,494	22,775	27,056
Zone 5: El Paso	14,905	19,412	23,920	28,427

$T_{setpoint}$ = *Water heater setpoint temperature [°F][341] = 120*

$T_{supply,avg}$ = *Average annual supply water temperature [°F] (see Table 281)*

UEF_{pre} = *Baseline uniform energy factor (see Table 279)[342]*

UEF_{post} = *Uniform energy factor of new water heater (see Table 279)*

3,412 = *Constant to convert from Btu to kWh*

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[340] Building America Research Benchmark Definition. December 2009, p 13. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.

[341] 120°F represents the assumed water heater setpoint. The New York Department of Public Service recommends using the water heater setpoint as a default value, see “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs.” Page 99. October 2010. The data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015) also supports a default value of 120°F.

[342] Note that for efficient water heater installations in newly-constructed homes, the baseline energy factor is the efficiency of the electric storage water heater that would otherwise have been installed, according to appropriate design documentation.

Table 281. DHW Replacements—Water Mains Temperature (°F)[343]

Climate zone	$T_{supply,avg}$	$T_{supply,seasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

Demand Savings Algorithm

$$Peak\ Demand\ Savings\ [\Delta kW]$$

$$= \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,w}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{365 \times 3{,}412} \times CF_{S/W}$$

Equation 69

Where:

$CF_{S/W}$ = *Summer/winter peak coincidence factor (see Table 282)*

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 281)*

Table 282. DHW Replacements—Coincidence Factors[344]

Climate zone	Summer	Winter
Zone 1: Amarillo	0.042	0.067
Zone 2: Dallas	0.039	0.068
Zone 3: Houston	0.041	0.070
Zone 4: Corpus Christi	0.041	0.065
Zone 5: El Paso	0.036	0.067

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[343] Based on typical meteorological year (TMY) 3 dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-viewer. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

[344] Probability weighted peak load factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from Building America Performance Analysis Procedures for Existing Homes, page 18, Figure 4: Combined Domestic Hot Water Use Profile. https://www.nrel.gov/docs/fy06osti/38238.pdf.

Gas Storage or Tankless Water Heater (Fuel Substitution)

Energy and demand savings awarded for replacing an electric water heater with a gas storage or gas tankless water heater are equal to the consumption of the unit replaced.

For gas storage water heaters with a tank size greater than 55 gallons, or gas tankless water heaters replacing a unit greater than 55 gallons, the appropriate baseline is a HPWH. The baseline consumption values are calculated using the federal standard baseline condition specified in the Heat Pump Water Heater measure.

<u>Energy Savings Algorithm for Units Less than 55 Gallons</u>

$$Energy\ Savings\ [\Delta kWh] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}}\right)}{3{,}412}$$

Equation 70

<u>Demand Savings Algorithm for Units Less than 55 Gallons</u>

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = CF_S \times \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,summer}) \times \left(\frac{1}{UEF_{pre}}\right)}{365 \times 3{,}412}$$

Equation 71

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW] = CF_W \times \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,winter}) \times \left(\frac{1}{UEF_{pre}}\right)}{365 \times 3{,}412}$$

Equation 72

Example Deemed Savings Calculation

Example 1. An old 40-gallon electric water heater in a two-bedroom home in Dallas is replaced with a new, tankless electric water heater with a first-hour rating of 60 gal/hr and a uniform energy factor of 0.99.

$$\Delta kWh = \frac{\left[8.33 \times 1 \times 19{,}244 \times (120 - 71.8) \times \left(\frac{1}{0.9227} - \frac{1}{0.99}\right)\right]}{3{,}412} = 167\ kWh$$

$$\Delta kW_S = 0.042 \times \frac{\left[8.33 \times 1 \times 19{,}244 \times (120 - 84) \times \left(\frac{1}{0.9227} - \frac{1}{0.99}\right)\right]}{365 \times 3{,}412} = 0.01\ kW$$

$$\Delta kW_W = 0.068 \times \frac{\left[8.33 \times 1 \times 19{,}244 \times (120 - 60.6) \times \left(\frac{1}{0.9227} - \frac{1}{0.99}\right)\right]}{365 \times 3{,}412} = 0.04\ kW$$

Example 2. An old 30-gallon electric water heater in a one-bedroom house in El Paso is replaced with a new gas storage water heater with a first-hour rating of 51 gal/hr and a uniform energy factor of 0.81.

$$\Delta kWh = \frac{\left[8.33 \times 1 \times 14{,}905 \times (120 - 70.4) \times \left(\frac{1}{0.9247}\right)\right]}{3{,}412} = \mathit{1{,}952\ kWh}$$

$$\Delta kW_S = 0.036 \times \frac{\left[8.33\ \times\ 1\ \times\ 14{,}905\ \times\ (120 - 81.5)\ \times\ \left(\frac{1}{0.9247}\right)\right]}{365 \times 3{,}412} = 0.15\ kW$$

$$\Delta kW_W = 0.067 \times \frac{\left[8.33\ \times\ 1\ \times\ 14{,}905\ \times\ (120 - 60.4)\ \times\ \left(\frac{1}{0.9247}\right)\right]}{365 \times 3{,}412} = 0.43\ kW$$

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 20 years for a tankless water heater (gas or electric), as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-Instant-Res.[345]

The EUL is 11 years for a high-efficiency gas water heater, as specified for EUL ID WtrHt-Res-Gas.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone

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[345] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

- Volume of the newly installed water heater (gallons, zero if tankless)
- Volume of the baseline water heater (gallons)
- First hour rating of newly installed water heater (gal/hr)
- Uniform energy factor of the newly installed water heater
- Number of bedrooms
- Manufacturer and model number of newly installed unit
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 283. DHW Replacements—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	04/18/2014	TRM v2.0 update. Updated measure to require electric tankless rather than electric storage water heater installation for non-fuel-switching option. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	01/30/2015	TRM v2.1 update. Updated to reflect that new construction permitted to claim savings subject to documentation requirements and that gas-fueled tankless water heaters are eligible for installation.
v3.0	04/10/2015	TRM v3.0 update. Amended fuel substitution savings to reflect the full consumption of the electric unit being replaced. Revised demand savings for installing an electric tankless unit to reflect daily usage patterns.
v3.1	11/05/2015	TRM v3.1 update. Clarified the baseline for water heaters greater than 55 gallons.
v4.0	10/10/2016	TRM v4.0 update. Updated HPWH baseline usage for gas storage water heaters larger than 55 gallons.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.

TRM version	Date	Description of change
v7.0	11/2019	TRM v7.0 update. Implemented new baseline and high-efficiency standards.
v8.0	10/2020	TRM v8.0 update. Clarified HPWH baseline for tanks sizes over 55 gal. Updated algorithms to refer to UEF.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Version 4.0 Requirements. Updated documentation requirements.

2.4.2 Heat Pump Water Heaters Measure Overview

TRM Measure ID: R-WH-HW

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves the installation of an ENERGY STAR®-compliant heat pump water heater (HPWH). Note that this measure does not account for the interactive air conditioning energy savings and heating penalty associated with the HPWH when installed inside conditioned space considering interaction with space heating equipment only affects deemed savings for units below 55 gallons.[346]

Eligibility Criteria

This measure applies to residential, electric, and storage-type heat pump water heaters. Heat pump add-ons to existing storage water heaters are ineligible. The measure does not apply to the replacement of gas water heaters.

Baseline Condition

The baseline condition is an electric storage water heater (EWH) with baseline efficiency (UEF) determined by tank size and draw pattern—a proxy for first-hour rating—according to the amended federal energy efficiency standards for residential water heaters with tank sizes 20 to 120 gallons, as published in 10 CFR Part 430.32 of the Federal Register.[347]

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[346] This is because the measure assumes replace on burnout and because the latest manufacturer standards effectively require heat pump water heaters (assuming electric water heating) for residential units with storage tank size greater than 55 gallons. For these units any interaction with the space conditioning systems is essentially the same for base and change case systems, so they cancel each other out.

[347] 10 CFR Part 430.32 Energy and water conservation standards and their effective dates. www.ecfr.gov/cgi-bin/text-idx?SID=80dfa785ea350ebeee184bb0ae03e7f0&mc=true&node=se10.3.430_132&rgn=div8..

This baseline applies to replace-on-burnout and new construction applications. No additional savings are awarded for early retirement at this time. Early retirement projects should calculate savings using an assumed replace-on-burnout baseline.

Table 284. HPWHs—Federal Standard for Residential Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR) [348][349]	Uniform energy factor[350]
≥ 20 gal and ≤ 55 gal	Very Small Usage	$0 \leq FHR < 18$	$0.8808 - (0.0008 \times V_r)$
	Low Usage	$18 \leq FHR < 51$	$0.9254 - (0.0003 \times V_r)$
	Medium Usage	$51 \leq FHR < 75$	$0.9307 - (0.0002 \times V_r)$
	High Usage	$75 \leq FHR$	$0.9349 - (0.0001 \times V_r)$
> 55 gal and ≤ 120 gal	Very Small Usage	$0 \leq FHR < 18$	$1.9236 - (0.0011 \times V_r)$
	Low Usage	$18 \leq FHR < 51$	$2.0440 - (0.0011 \times V_r)$
	Medium Usage	$51 \leq FHR < 75$	$2.1171 - (0.0011 \times V_r)$
	High Usage	$75 \leq FHR$	$2.2418 - (0.0011 \times V_r)$

There are no certified ENERGY STAR water heaters in the *very small usage* category, and 98 percent of certified units are in the *medium* and *high usage* categories.

The Department of Energy (DOE) efficiency standard effectively requires heat pump water heaters (assuming electric water heating) for storage water heaters with tank sizes greater than 55 gallons. As such, the baseline technology for water heaters with tanks greater than 55 gallons is a heat pump water heater.

High-Efficiency Condition

The efficient condition is an HPWH certified by ENERGY STAR that adheres to the criteria outlined in Table 285.[351]

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[348] "The Revised Method of Test for Residential Water Heating and Its Impact on Incentive Programs" presentation, Glanville, Paul. ACEEE Hot Water Forum. February 24, 2015. https://aceee.org/sites/default/files/pdf/conferences/hwf/2015/6B-Glanville.pdf.

[349] Assume FHR equal to that of installed water heater.

[350] Vr is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

[351] ENERGY STAR® Requirements (as of March 2022). HPWH must have a maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Water%20Heaters%20Final%20Specification%20and%20Partner%20Commitments-March2022_5.pdf

Table 285. HPWHs—Federal Standard for Residential Water Heaters

Criteria		ENERGY STAR Requirements
Uniform energy factor	Integrated HPWH	UEF ≥ 3.30
	Integrated HPWH, 120 volt/15 amp circuit	UEF ≥ 2.20
	Split-system HPWHT	UEF ≥ 2.20
First-hour rating		FHR ≥ 45 gallons per hour
Warranty		Warranty ≥ 6 years on sealed system
Safety		UL 174 and UL 1995 or UL 60335-2-40
Lower compressor cut-off temperature (reporting requirement only)		Report ambient temperature below which the compressor cuts off and electric-resistance-only operation begins

A complete list of certified ENERGY STAR heat pump water heaters can be accessed via the ENERGY STAR program website.[352]

Heat pump water heaters depend on adequate ventilation to properly function, including adequate space for both inlet and outlet airflow, and should be installed in spaces in where temperature does not drop below a certain level. The Department of Energy recommends installation in locations that remain above 40°F year-round and provide a minimum of 1,000 cubic feet of air space around the water heater.[353]

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

HPWH savings are calculated on a per-unit basis. Deemed savings are calculated utilizing the standard algorithms outlined below for water heating. Consumption in gallons per year us estimated using data from Building America Performance Analysis Procedures for Existing Homes.[354] Temperature data are based on TMY3 dataset.[355]

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[352] ENERGY STAR®-certified water heaters qualified product listing. https://www.energystar.gov/productfinder/product/certified-water-heaters/?formId=96913462-da32-4dc2-ad53-f31203352209&scrollTo=546&search_text=&type_filter=Hybrid%2FElectric+Heat+Pump&fuel_filter=Electric&brand_name_isopen=0&input_rate_thousand_btu_per_hour_isopen=0&markets_filter=United+States&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=brand_name&sort_direction=asc&page_number=0&lastpage=0.

[353] Heat Pump Water Heaters. Department of Energy, May 2012. http://energy.gov/energysaver/articles/heat-pump-water-heaters

[354] Building America Performance Analysis Procedures for Existing Homes, page 18, figure 4: combined domestic hot water use profile. https://www.nrel.gov/docs/fy06osti/38238.pdf..

[355] TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

For upstream/midstream program delivery, a default of three bedrooms may be used to calculate the annual hot water use in gallons per year (GPY). The default number of bedrooms was estimated by taking the weighted average calculated from 2020 RECS Survey Data.

Energy Savings Algorithm

$$Energy\ Savings\ [\Delta kWh] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{3{,}412}$$

Equation 73

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb·°F] = 1*

GPY = *Estimated annual hot water use in gallons/year, specified by number of bedrooms in the home (see Table 286). For midstream/upstream applications, the number of bedrooms is assumed to be 3.*[356]

Table 286. HPWHs—Water Heater Consumption (Gal/Year) [357]

Climate zone	Number of bedrooms			
	1	2	3	4
Zone 1: Amarillo	15,476	20,171	24,866	29,561
Zone 2: Dallas	14,778	19,244	23,710	28,177
Zone 3: Houston	14,492	18,864	23,236	27,608
Zone 4: Corpus Christi	14,213	18,494	22,775	27,056
Zone 5: El Paso	14,905	19,412	23,920	28,427

$T_{setpoint}$ = *Water heater setpoint temperature [°F]*[358] *= 120*

$T_{supply,annual}$ = *Average annual supply water temperature [°F] (see Table 287)*

EF_{pre} = *Baseline uniform energy factor (calculate per Table 284)*[359]

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[356] Weighted Average of number of bedrooms in West South Central Region. 2020 RECS Survey Data – Table HC2.8 Structural and geographic characteristics of homes in the South and West regions, 2020. https://www.eia.gov/consumption/residential/data/2020/.

[357] Building America Research Benchmark Definition. December 2009, p 13. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.

[358] 120°F represents the assumed water heater setpoint. The New York Department of Public Service recommends using the water heater setpoint as a default value, see “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs.” Page 99. October 2010. The data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015) also supports a default value of 120°F.

EF_{post} = *Uniform energy factor of new water heater*

3,412 = *Constant to convert from Btu to kWh*

Table 287. HPWHs—Water Mains Temperature (°F)[360]

Climate zone	$T_{supply,annual}$	$T_{supply,seasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

Demand Savings Algorithm

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,seasonal}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{365 \times 3{,}412} \times CF_{S/W}$$

Equation 74

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 287)*

$CF_{S/W}$ = *Summer/winter peak coincidence factor (see Table 288)*

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[359] Note that for efficient water heater installations in new construction homes, the baseline uniform energy factor is the efficiency of the electric storage water heater that would otherwise have been installed, according to appropriate design documentation.

[360] Based on TMY3 dataset. TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Table 288. HPWHs—Coincidence Factors[361]

Climate zone	Summer	Winter
Zone 1: Amarillo	0.042	0.067
Zone 2: Dallas	0.039	0.068
Zone 3: Houston	0.041	0.070
Zone 4: Corpus Christi	0.041	0.065
Zone 5: El Paso	0.036	0.067

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for this measure is 13 years.[362]

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[361] Probability weighted peak load factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from Building America Performance Analysis Procedures for Existing Homes, page 18, Figure 4: Combined Domestic Hot Water Use Profile. https://www.nrel.gov/docs/fy06osti/38238.pdf.

[362] 2010 ACEEE Summer Study on Energy Efficiency in Buildings, LBNL, “Heat Pump Water Heaters and American Homes: A Good Fit?” p 9-74. https://www.aceee.org/files/proceedings/2010/data/papers/2205.pdf.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of bedrooms (not required for upstream/midstream program delivery)
- Approximate volume of the newly installed HPWH tank in gallons
- Newly installed water heater UEF
- First-hour rating (FHR) of the newly installed water heater
- Manufacturer and model number of newly installed unit
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 289. HPWHs—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	04/18/2014	TRM v2.0 update. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	01/30/2015	TRM v2.1 update. No revision.
v3.0	04/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v4.0	10/10/2016	TRM v4.0 update. Consolidated table formats.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. Implementation of new baseline and update to the efficiency of qualifying HPWHs.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Added new construction eligibility

TRM version	Date	Description of change
v9.0	10/2021	TRM v9.0 update. Clarified baseline condition. Confirmed ENERGY STAR®-qualified product listing still does not contain a significant number of products with low or very small usage patterns.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Version 4.0 Requirements. Updated savings methodology to algorithm approach. Updated documentation requirements.

2.4.3 Solar Water Heaters Measure Overview

TRM Measure ID: R-WH-SW

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves installing a new solar water heater in place of an electric storage water heater. Solar water heating deemed savings values are calculated based on the Solar Rating and Certification Corporation's (SRCC) test for solar water heaters (test OG-300).

Eligibility Criteria

These deemed savings are for solar water heaters installed as a replace-on-burnout measure or as an early retirement measure in existing homes and in new construction homes. However, savings are calculated under the assumption of replace-on-burnout.

Baseline Condition

The baseline condition is an electric storage water heater with baseline efficiency (UEF, uniform energy factor) determined by tank size and draw pattern—a proxy for first hour rating—according to the amended federal energy efficiency standards for residential water heaters with tank sizes from 20 to 120 gallons, and draw pattern (a proxy for first hour rating) as published in 10 CFR Part 430.32 of the Federal Register (see Table 279).[363] This baseline applies to replace-on-burnout, early retirement, and new construction applications.

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[363] 10 CFR Part 430.32 Energy and water conservation standards and their effective dates. Available online: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32.

Table 290. Solar DHW—Federal Standard for Residential Electric Storage Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR)[364,365]	Uniform energy factor (UEF)[366]
≥ 20 gal and ≤ 55 gal	Very small usage	0 ≤ FHR < 18	$0.8808 - (0.0008 \times V_r)$
	Low usage	18 ≤ FHR < 51	$0.9254 - (0.0003 \times V_r)$
	Medium usage	51 ≤ FHR < 75	$0.9307 - (0.0002 \times V_r)$
	High usage	75 ≤ FHR	$0.9349 - (0.0001 \times V_r)$
> 55 gal and ≤ 120 gal	Very small usage	0 ≤ FHR < 18	$1.9236 - (0.0011 \times V_r)$
	Low usage	18 ≤ FHR < 51	$2.0440 - (0.0011 \times V_r)$
	Medium usage	51 ≤ FHR < 75	$2.1171 - (0.0011 \times V_r)$
	High usage	75 ≤ FHR	$2.2418 - (0.0011 \times V_r)$

High-Efficiency Condition

The efficient condition is a solar water heater certified by ENERGY STAR with a solar uniform energy factor (SUEF) greater than or equal to 3.0, and warranties of ≥ 10 years on collectors, ≥ 6 years on sealed systems, ≥ 2 years on controls, and ≥ 1 year on piping and parts.[367] A complete list of certified ENERGY STAR solar water heaters can be accessed via the ENERGY STAR program website.[368]

Additionally, only solar water heaters certified according to the current SRCC OG-300 standard (based on tank size and final SUEF), which encompass the criteria stated above, qualify for these deemed savings estimates. [369]

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[364] "The Revised Method of Test for Residential Water Heating and Its Impact on Incentive Programs" presentation, Glanville, Paul. ACEEE Hot Water Forum. February 24, 2015. https://aceee.org/sites/default/files/pdf/conferences/hwf/2015/6B-Glanville.pdf.

[365] Assume FHR equal to that of installed water heater.

[366] Vr is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.17.

[367] ENERGY STAR® Requirements (effective January 5th, 2022, released March 29, 2022). https://www.energystar.gov/products/water_heaters/residential_water_heaters_key_product_criteria.

[368] ENERGY STAR®-certified water heaters qualified product listing. https://www.energystar.gov/productfinder/product/certified-water-heaters/?formId=bb099b76-3da7-49bf-a746-fbde4d076d0d&scrollTo=422&search_text=&type_filter=Solar+with+Electric+Backup&fuel_filter=&brand_name_isopen=0&input_rate_thousand_btu_per_hour_isopen=0&markets_filter=United+States&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=brand_name&sort_direction=asc&currentZipCode=78701&page_number=0&lastpage=0

[369] https://solar-rating.org/programs/estar/

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Solar water heating savings values are on a per-unit basis. Variables utilized to compute deemed savings include tank volume and installed unit SUEF as rated in the SRCC “Summary of SRCC Certified Solar Collector and Water Heating System Ratings.” The SUEF is determined under SRCC's Operating Guideline 300, "Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems" and was developed as a means to compare solar water heating systems with conventional water heating systems rated with an UEF and listed in the Gas Appliance Manufacturers Association Directory of Certified Water Heating Products.

Both UEF and SUEF are based on the same environmental and hot water use conditions used in the DOE Test Procedures for Water Heaters. The only significant difference is that the DOE test does not specify solar radiation. So SRCC uses a 1500 Btu/sq. ft./day solar radiation profile—a value typical of Sunbelt states (note - the annual average solar radiation for Dallas is 1533 Btu/sq. ft./day. Information on the SRCC can be found at http://www.solar-rating.org/.

All deemed savings values are calculated using the following standard algorithms for water heating. These algorithms assume a replace-on-burnout or new construction scenario but may be used to award savings for early retirement projects.

Energy Savings Algorithm

$$Energy\ Savings\ [\Delta kWh] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{SUEF_{post}}\right)}{3{,}412}$$

Equation 75

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb·°F] = 1*

GPY = *Estimated annual hot water use in gallons/year, specified by number of bedrooms in the home (see Table 291)*

$T_{setpoint}$ = *Water heater setpoint temperature [°F]*[370] *= 120*

$T_{supply,annual}$ = *Average annual supply water temperature [°F] (see Table 292)*

UEF_{pre} = *Baseline uniform energy factor (calculate per Table 290)*[371]

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[370] 120°F represents the assumed water heater setpoint. The New York Department of Public Service recommends using the water heater setpoint as a default value, see “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs.” Page 99. October 2010. The data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015) also supports a default value of 120°F.

$SUEF_{post}$ = *Solar uniform energy factor of new water heater*

3,412 = *Constant to convert from Btu to kWh*

Table 291. Solar DHW—Water Heater Consumption (Gal/Year) [372]

Climate zone	Number of bedrooms			
	1	2	3	4
Zone 1: Amarillo	15,476	20,171	24,866	29,561
Zone 2: Dallas	14,778	19,244	23,710	28,177
Zone 3: Houston	14,492	18,864	23,236	27,608
Zone 4: Corpus Christi	14,213	18,494	22,775	27,056
Zone 5: El Paso	14,905	19,412	23,920	28,427

Table 292. Solar DHW—Water Mains Temperature (°F)[373]

Climate zone	$T_{supply,annual}$	$T_{supply,seasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

Demand Savings Algorithm

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,seasonal}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{SUEF_{post}}\right)}{365 \times 3{,}412} \times CF_{S/W}$$

Equation 76

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 292)*

$CF_{S/W}$ = *Summer/winter peak coincidence factor (see Table 293)*

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[371] Note that for efficient water heater installations in new construction homes, the baseline uniform energy factor is the efficiency of the electric storage water heater that would otherwise have been installed, according to appropriate design documentation.

[372] Building America Research Benchmark Definition. December 2009, p 13. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.

[373] Based on TMY3 dataset. TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Table 293. Solar DHW—Coincidence Factors[374]

Climate zone	Summer	Winter
Zone 1: Amarillo	0.042	0.067
Zone 2: Dallas	0.039	0.068
Zone 3: Houston	0.041	0.070
Zone 4: Corpus Christi	0.041	0.065
Zone 5: El Paso	0.036	0.067

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 15 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-SWH.[375]

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[374] Probability weighted peak load factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from Building America Performance Analysis Procedures for Existing Homes, page 18, Figure 4: Combined Domestic Hot Water Use Profile. https://www.nrel.gov/docs/fy06osti/38238.pdf.

[375] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of bedrooms
- The approximate volume of the newly installed water heater in gallons
- First hour rating of baseline water heater
- Manufacturer and model number of newly installed unit
- SRCC OG-300 SUEF of the newly installed unit
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 22241, Item 62. Petition by Frontier Energy for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.
- Docket No. 27903. Order Adopting New §25.184 as Approved at the August 21, 2003, Open Meeting and Submitted to the Secretary of State. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 294. Solar DHW—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v4.0	10/10/2016	TRM v4.0 update. No revision
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated algorithms and coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Version 4.0 Requirements. Updated documentation requirements.

2.4.4 Water Heater Tank Insulation Measure Overview

TRM Measure ID: R-WH-TI

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure requires the installation of tank insulation on uninsulated water heater tanks that are served by an electric water heater.

Eligibility Criteria

Water heaters meeting the National Appliance Energy Conservation Act standards with respect to insulation and standby loss requirements are not eligible for this measure. To ensure compliance, the contractor shall inspect the build date listed on the existing water heater label and verify that the listed build date is before 1991.

Water heater pipe insulation is a residential retrofit measure. New construction and water heater replacements are not eligible for this measure because they must meet current code requirements. To be awarded these deemed savings, the fuel type of the water heater must be electricity.

Baseline Condition

The baseline is assumed to be a typical electric water heater with no insulation.

High-Efficiency Condition

There is no minimum insulation requirement. The manufacturer’s instructions on the water heater jacket and the water heater itself should be followed. Thermostat and heating element access panels must be left uncovered.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Hot water tank insulation energy savings are calculated using the following formula:

$$Energy\ Savings\ [\Delta kWh] = \left(U_{pre} - U_{post}\right) \times A \times \left(T_{tank} - T_{ambient,avg}\right) \times \left(\frac{1}{RE}\right) \times \frac{Hours}{3{,}412}$$

Equation 77

Where:

U_{pre} = *1/ (5) Btu/hr sq. ft. °F*[376]

U_{post} = *1/ (5+$\mathrm{R_{Insulation}}$) Btu/hr sq. ft. °F*

$R_{Insulation}$ = *R-value of installed insulation*

A = *Tank surface area insulated in square feet (πDL) with L (length) and D (tank diameter) in feet; if the tank area is not known, use Table 295*

Table 295. DHW Tank Insulation—Estimated Tank Area[377]

Volume (gal)	A (sq. ft.)
30	17.45
40	21.81
50	22.63
60	26.94
80	30.36
120	38.73

T_{tank} = *Average tank water temperature [°F]; default = 120°F* [378]

$T_{ambient,avg}$ = *Average annual ambient temperature [°F] (see Table 296)*

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[376] Baseline storage tank assembly is assumed to have thermal performance of R5.

[377] Tank area was obtained from a survey of electric water heater manufacturer data from A.O. Smith and Whirlpool conducted in 2013. Dimensions for each tank size were collected and averaged to determine typical square footage of each size water heater.

[378] 120°F represents the assumed water heater setpoint. New York Department of Public Service recommends using water heater setpoint as a default value, see “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs” October 2010, page 99.
Data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015), supports a default value of 120°F.

RE = *Recovery efficiency (or in the case of heat pump water heaters, COP); if unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters*[379]

Hours = *8,760 hours per year*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW]\ = \left(U_{pre} - U_{post}\right) \times A \times \left(T_{Tank} - T_{ambient,seasonal}\right) \times \frac{1}{RE} \times \frac{CF_{S/W}}{3{,}412}$$

Equation 78

Where:

$T_{ambient,seasonal}$ = *Seasonal ambient temperature [°F] (see Table 296)*

$CF_{S/W}$ = *Seasonal peak coincidence factor*[380] *= 1*

Table 296. DHW Tank Insulation—Ambient Temperature (°F)

	Water heater location: unconditioned space[381]			Water heater location: conditioned space[382]		
		Peak seasonal			Peak seasonal	
Climate zone	**Annual**	**Summer**	**Winter**	**Annual**	**Summer**	**Winter**
Zone 1: Amarillo	65.5	106.0	32.0	71.8	73.9	69.6
Zone 2: Dallas	73.1	108.1	42.0			
Zone 3: Houston	76.3	108.2	46.0			
Zone 4: Corpus Christi	78.4	103.0	55.0			
Zone 5: El Paso	71.8	108.0	41.1			

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[379] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://www.ahrinet.org.

[380] Coincidence factor of 1 assumes that a constant tank temperature is maintained across all hours of the year.

[381] Average ambient temperatures for unconditioned space were taken from TMY3 data, with a 7°F increase in winter and an 11°F increase in summer based on ASHRAE 152 Heating System and Cooling System Location Temperatures (Garage).

[382] Average ambient temperatures for conditioned space were taken from the US Energy Information Administration Residential Energy Consumption Survey (RECS), tables hc7.9 and hc6.8. Summer and winter indoor temperature averages are weighted by the number of homes. Annual temperature is the average of summer and winter weighted by number of days.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 7 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-TankIns-Elec.[383]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Water heater location (conditioned, unconditioned)
- Recovery Efficiency (RE) or COP, if available
- The R-value of the installed insulation
- Tank surface area insulated in square feet (πDL) with L (length) and D (tank diameter) in feet; if unable to determine tank area, tank volume must be recorded
- Water heater manufacture date

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service

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[383] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 297. DHW Tank Insulation—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. Supplemented reference for water heater setpoint temperature.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	11/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated ambient temperatures.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated documentation requirements.

2.4.5 Water Heater Pipe Insulation Measure Overview

TRM Measure ID: R-WH-PI

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure requires the installation of pipe insulation on uninsulated water heater pipes that are served by an electric water heater.

Eligibility Criteria

Water heaters plumbed with heat traps are not eligible to receive incentives for this measure. It is recommended that the installer (or contractor) checks to see if the water heater heat trap works properly before declaring the water heater ineligible.

Water heater pipe insulation is a residential retrofit measure. New construction and retrofits involving the installation of new water heaters are not eligible for this measure, because they must meet current code requirements. To use these deemed savings, the fuel type of the water heater must be electricity.

Baseline Condition

The baseline is assumed to be a typical electric water heater with no heat traps and no insulation on water heater pipes.

High-Efficiency Condition

The efficiency standard requires an insulation thickness R-3. The International Residential Code (IRC) 2018 section N1103.4: Mechanical system piping insulation requires R-3 insulation.

All visible hot water piping must be insulated. Savings are based on a maximum allowable insulation length of 6 feet of piping.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Hot water pipe insulation energy savings are calculated using the following formula:

$$Energy\ Savings\ [\Delta kWh] = (U_{pre} - U_{post}) \times A \times (T_{pipe} - T_{ambient,avg}) \times \left(\frac{1}{RE}\right) \times \frac{Hours_{Total}}{3{,}412}$$

Equation 79

Where:

U_{pre} = $\frac{1}{2.03} = 0.49\, {}^{Btu}/_{hr \cdot sq.ft. \cdot {}^{\circ}\mathrm{F}}$ [384]

U_{post} = $\frac{1}{2.03+R_{Insulation}}\, {}^{Btu}/_{hr \cdot sq.ft. \cdot {}^{\circ}\mathrm{F}}$

$R_{Insulation}$ = *R-value of installed insulation*

A = *Pipe surface area insulated in square feet* (πDL) *with L (length) and D (pipe diameter) in feet. The maximum length allowable for insulation is 6 feet; if the pipe area is unknown, use the following table:*

Table 298. DHW Pipe Insulation—Estimated Pipe Surface Area

Pipe diameter (inches)	Pipe surface area (square feet)[385]
0.5	0.16 x required input "Pipe Length insulated (feet)"
0.75	0.23 x required input "Pipe Length insulated (feet)"
1.0	0.29 x required input "Pipe Length insulated (feet)"

T_{pipe} = *Average pipe water temperature [°F]; default*[386] *= 120*

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[384] 2.03 is the R-value representing the film coefficients between water and the inside of the pipe, and between the surface and air. Mark's Standard Handbook for Mechanical Engineers, 8th edition.

[385] Factors used in the calculation for pipe area were determined by using the outside diameter of the pipe in inches, converting it to feet, and multiplying by π as shown below.

Nominal diameter (inches)	Outside diameter (inches)	Factor to calculate pipe area
0.5	0.625	0.16
0.75	0.875	0.23
1.0	1.125	0.29

$T_{ambient,avg}$ = *Average annual ambient temperature [°F] (see Table 299)*

RE = *Recovery efficiency (or in the case of heat pump water heaters, COP). If unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters.*[387]

Hours = *8,760 hours per year*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \left(U_{pre} - U_{post}\right) \times A \times (T_{Pipe} - T_{ambient,seasonal}) \times \left(\frac{1}{RE}\right) \times \frac{CF_{S/W}}{3{,}412}$$

Equation 80

Where:

$T_{ambient,seasonal}$ = *Seasonal ambient temperature [°F] (see Table 299)*

$CF_{S/W}$ = *Seasonal peak coincidence factor*[388] *= 1*

Table 299. DHW Pipe Insulation—Ambient Temperature (°F)

	Water heater location: unconditioned space[389]			Water heater location: Conditioned Space[390]		
		Peak seasonal			Peak seasonal	
Climate zone	Annual	Summer	Winter	Annual	Summer	Winter
Zone 1: Amarillo	65.5	106	32	71.8	73.9	69.6
Zone 2: Dallas	73.1	108.1	42			
Zone 3: Houston	76.3	108.2	46			
Zone 4: Corpus Christi	78.4	103	55			
Zone 5: El Paso	71.8	108	41.1			

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[386] 120°F represents the assumed water heater setpoint. New York Department of Public Service recommends using water heater setpoint as a default value, see "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs" October 2010, page 102.
Data collection discussed in Appendix D of the EM&V team's Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015), also supports a default value of 120°F.

[387] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://www.ahrinet.org.

[388] Coincidence factor of 1 assumes that a constant tank and near tank piping temperature is maintained across all hours of the year.

[389] Average ambient temperatures for unconditioned space were taken from TMY3 data, with a 7°F increase in winter and an 11°F increase in summer based on ASHRAE 152 Heating System and Cooling System Location Temperatures (Garage).

[390] Average ambient temperatures for conditioned space were taken from the US Energy Information Administration Residential Energy Consumption Survey (RECS), tables hc7.9 and hc6.8. Summer and winter indoor temperature averages are weighted by the number of homes. Annual temperature is the average of summer and winter weighted by number of days.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 13 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-WH-PipeIns-Elec.[391]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Water heater location (conditioned, unconditioned)
- The R-value of the installed insulation
- Recovery efficiency (RE) or COP, if available
- Pipe length insulated (feet)
- The pipe surface area insulated in square feet (at least the pipe diameter in inches)

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[391] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 300. DHW Pipe Insulation—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. Supplemented reference for water heater setpoint temperature.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	11/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated ambient temperatures.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated documentation requirements.

2.4.6 Faucet Aerators Measure Overview

TRM Measure ID: R-WH-FA

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves installing aerators on kitchen and bathroom water faucets as a retrofit measure.

Eligibility Criteria

The savings values are per faucet aerator installed. It is not a requirement that all faucets in a home be treated for the deemed savings to be applicable.

These deemed savings are for residential, retrofit or new construction, and installations of kitchen and bathroom faucet aerators. To be awarded these deemed savings, the fuel type of the water heater must be electricity.

Baseline Condition

The 2.2 gallon per minute (GPM) baseline faucet flow rate is based on the Department of Energy (DOE) maximum flow rate standard.[392] The deemed savings assume that the existing faucet aerators have a minimum flow rate of 2.2 GPM. The US EPA WaterSense specification for faucet aerators is 1.5 GPM.[393]

High-Efficiency Condition

Aerators that have been defaced to make the flow rating illegible are not eligible for replacement. For direct install programs, all aerators removed shall be collected by the contractor and held for possible inspection by the utility until all inspections for invoiced installations have been completed.

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[392] DOE maximum flow rate for faucet aerators. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=40.

[393] https://www.epa.gov/watersense/bathroom-faucets.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

The deemed savings, for any faucet aerator change case using aerators with flow rates of 1.5 GPM or lower, are calculated as follows:

$$Energy\ Savings\ per\ aerator\ [\Delta kWh] = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times 365 \times \left(T_{faucet,avg} - T_{supply,avg}\right)}{FPH \times RE \times 3{,}412}$$

Equation 81

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb°F] = 1*

GPM_{Base} = *Average baseline flow rate of aerator = 2.2 gallons per minute*

GPM_{Low} = *Post-installation flow rate of aerator, typically 1.5, 1.0, or 0.5 gallons per minute; if unknown, assume 1.5 gallons per minute*

N = *Average number of persons per household = 2.83 persons*[394]

t = *Average time in minutes of hot water usage per person per day; default = 2.34 min/person/day*[395]

$T_{faucet,avg}$ = *Average faucet temperature [°F]* [396] *= 88*

$T_{supply,avg}$ = *Average annual supply water temperature [°F] (see Table 301)*

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[394] Occupants per home for Texas from US Census Bureau, “Persons Per Household, 2016-2020”. https://www.census.gov/quickfacts/fact/table/TX,US/PST045221.

[395] Cadmus and Opinion Dynamics Evaluation Team, “Memorandum: Showerhead and Faucet Aerator Meter Study.” Prepared for Michigan Evaluation Working Group. Derived by taking weighted average of average minutes per person per day specified for kitchens (4.5) and bathrooms (1.6) assuming 1 kitchen aerator and 2.93 bathrooms.

[396] Cadmus and Opinion Dynamics Evaluation Team, “Memorandum: Showerhead and Faucet Aerator Meter Study.” Prepared for Michigan Evaluation Working Group. Derived by taking weighted average of average temperature for kitchens (93°F) and bathrooms (86°F) assuming 1 kitchen aerator and 2.93 bathrooms.

Data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015), also supports a default value of 120°F.

FPH = *Average number of faucets per household = 3.87 faucets*[397]

RE = *Recovery Efficiency (or in the case of heat pump water heaters, COP). If unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters.*[398]

3,412 = *Constant to convert from Btu to kWh*

Demand Savings Algorithms

Demand savings are calculated by substituting the average supply temperature for the average seasonal temperature, multiplying by a coincidence factor equivalent to the daily fraction hot water use during the weighted peak hour for each climate zone (see Volume 1, Section 4), and dividing by 365 days/year, with 365 canceling from the savings algorithm numerator and denominator.

$$Peak\ Demand\ Savings\ per\ aerator\ [\Delta kW] = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times \left(T_{faucet,avg} - T_{supply,seasonal}\right)}{FPH \times RE \times 3{,}412} \times CF_{S/W}$$

Equation 82

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (Table 301)*

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 302)*

Table 301. Faucet Aerators—Water Mains Temperature (°F)[399]

Climate zone	$T_{supply,avg}$	$T_{supply,seasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

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[397] Faucets per home assumed to be equal to one per kitchen and each half-bath plus 1.5 per each full bathroom per home. Bathroom counts extracted from the 2015 Residential Energy Consumption Survey (RECS), Table HC2.8 Structural and Geographic Characteristics of Homes in West South-Central Region.

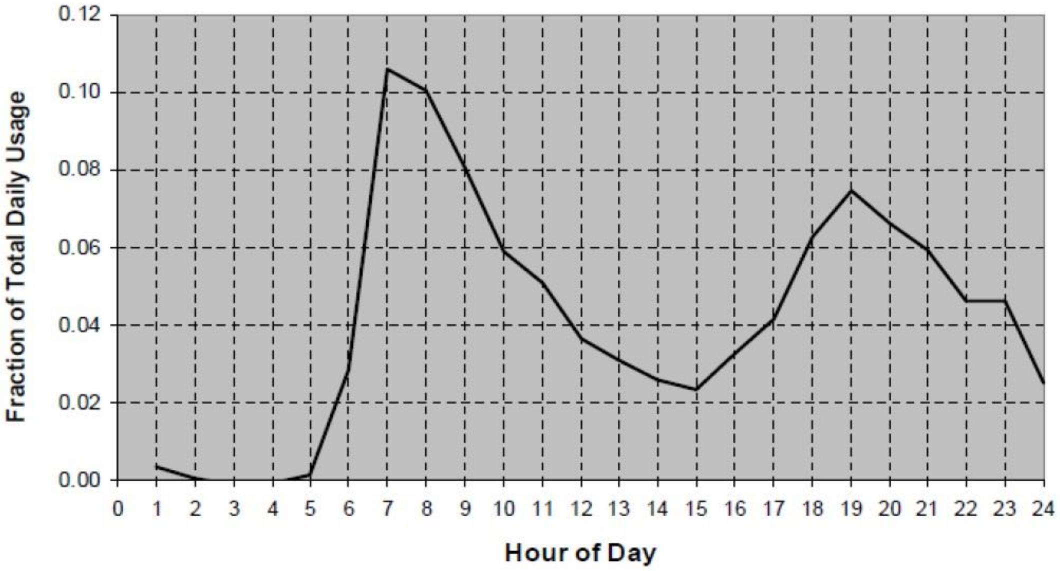
[398] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, https://www.ahridirectory.org/.

[399] Based on typical meteorological year (TMY) dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-viewer. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Table 302. Faucet Aerators—Coincidence Factors

Climate zone	Summer	Winter
Zone 1: Amarillo	0.039	0.073
Zone 2: Dallas	0.035	0.075
Zone 3: Houston	0.038	0.080
Zone 4: Corpus Christi	0.038	0.068
Zone 5: El Paso	0.028	0.069

Figure 10. Faucet Aerators—Shower, Bath, and Sink Hot Water Use Profile[400]



Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[400] Building America performance analysis procedures for existing homes.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-WH-Aertr.[401]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Recovery Efficiency (RE) or COP, if available
- Flow rate in gallons per minute (GPM) of faucet installed
- Water heater type (e.g., heat pump, electric resistance)

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

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[401] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Document Revision History

Table 303. Faucet Aerators—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	10/30/2015	TRM v3.1 update. Supplemented reference for water heater setpoint temperature.
v4.0	10/10/2016	TRM v4.0 update. Updated methodology to calculate energy and demand savings.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	11/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated number of occupants per home.

2.4.7 Low-Flow Showerheads Measure Overview

TRM Measure ID: R-WH-SH

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure consists of removing existing showerheads and installing low-flow showerheads in residences.

Eligibility Criteria

The incentive is for replacement of an existing showerhead with a new showerhead rated at or below 2.0gallons per minute (GPM). The only showerheads eligible for installation are those that are not easily modified to increase the flow rate.

These deemed savings are for showerheads installed as a retrofit or new construction measure. To be awarded these deemed savings, the fuel type of the water heater must be electricity.

Baseline Condition

Federal standards set a maximum flow rate of 2.5 GPM,[402] while the US Environmental Protection Agency (EPA) WaterSense Program has implemented efficiency standards for showerheads requiring a maximum flow rate of 2.0 GPM.[403]

High-Efficiency Condition

In addition to meeting the baseline requirements above, existing showerheads that have been defaced to make the flow rating illegible are not eligible for replacement. All showerheads removed shall be collected by the contractor and held for possible inspection by the utility until all inspections for invoiced installations have been completed.

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[402] http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/37.
[403] http://www.epa.gov/watersense/products/showerheads.html.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure are calculated as follows:

$$Energy\ Savings\ per\ showerhead\ [\Delta kWh] = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times 365 \times (T_{shower,avg} - T_{supply,avg})}{SPH \times RE \times Conversion\ Factor}$$

Equation 83

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb°F] = 1*

GPM_{Base} = *Average baseline flow rate of aerator = 2.5 gallons per minute*

GPM_{Low} = *Post-installation flow rate of aerator; if unknown, assume 2.0 gallons per minute*

N = *Average number of persons per household = 2.83 persons*[404]

t = *Average time in minutes of hot water usage per person per day; default = 7.8 min/person/day*[405]

$T_{shower,avg}$ = *Average shower temperature [°F]*[406] *= 101*

$T_{supply,avg}$ = *Average annual supply water temperature [°F] (see Table 304)*

SPH = *Average number of showerheads per household = 1.74 showerheads*[407]

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[404] Occupants per home for Texas from US Census Bureau, "Persons per household, 2016-2020". https://www.census.gov/quickfacts/fact/table/TX,US/PST045221.

[405] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study." Prepared for Michigan Evaluation Working Group.

[406] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study." Prepared for Michigan Evaluation Working Group

[407] Showerheads per home assumed to be equal to the number of full bathrooms per home as specified in the 2009 Residential Energy Consumption Survey (RECS), Table HC2.10.

RE = *Recovery Efficiency (or in the case of heat pump water heaters, COP); if unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters*[408]

3,412 = *Constant to convert from Btu to kWh*

Demand Savings Algorithms

Demand savings are calculated by substituting the average supply temperature for the average seasonal temperature, multiplying by a coincidence factor equivalent to the daily fraction hot water use during the weighted peak hour for each climate zone (see Volume 1, Section 4), and dividing by 365 days/year, with 365 canceling from the savings algorithm numerator and denominator.

$$Demand\ Savings\ per\ showerhead\ [\Delta kWh] = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times (T_{shower,avg} - T_{supply,seasonal})}{SPH \times RE \times 3{,}412} \times CF_{S/W}$$

Equation 84

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 304)*

$CF_{S/W}$ = *Seasonal peak coincidence factor (see Table 305)*

Table 304. Low-Flow Showerheads—Water Mains Temperature (°F)[409]

Climate zone	$T_{SupplyAverage}$	$T_{SupplySeasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

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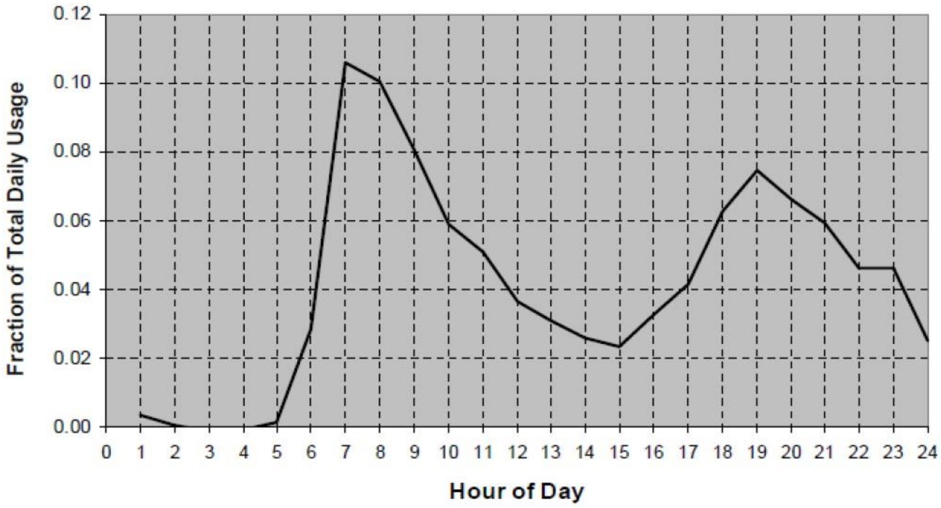
[408] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://cafs.ahrinet.org/gama_cafs/sdpsearch/search.jsp?table=CWH .

[409] Based on typical meteorological year (TMY) dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-viewer. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Table 305. Low-Flow Showerheads—Coincidence Factors

Climate zone	Summer	Winter
Zone 1: Amarillo	0.039	0.073
Zone 2: Dallas	0.035	0.075
Zone 3: Houston	0.038	0.080
Zone 4: Corpus Christi	0.038	0.068
Zone 5: El Paso	0.028	0.069

Figure 11. Low-Flow Showerheads—Shower, Bath, and Sink Hot Water Use Profile[410]



Source: Building America Performance Analysis Procedures for Existing Homes.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[410] Building America performance analysis procedures for existing homes.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-WH-Shrhd.[411]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Recovery efficiency (RE) or COP, if available
- Flow rate in gallons per minute (GPM) of showerhead installed
- Water heater type (e.g., heat pump, electric resistance)

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

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[411] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Document Revision History

Table 306. Low-Flow Showerheads—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. No revision.
v3.1	11/05/2015	TRM v3.1 update. Provided clarification that savings are to be awarded per showerhead. Supplemented reference for water heater setpoint temperature.
v4.0	10/10/2016	TRM v4.0 update. Updated methodology to calculate energy and demand savings.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	11/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Added new savings category and updated coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Updated number of occupants per home.

2.4.8 Showerhead Temperature Sensitive Restrictor Valves Measure Overview

TRM Measure ID: R-WH-SV

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily; manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure consists of installing a temperature sensitive restrictor valve (TSRV)[412] between the existing shower arm and showerhead. The valve restricts hot water flow through the showerhead once the water reaches a set temperature (generally 95˚F) to prevent water from going down the drain prior to the user entering the shower, thereby eliminating behavioral waste.

Eligibility Criteria

These deemed savings are for temperature sensitive restrictor valves installed in new construction or as a retrofit measure in residential applications. Buildings must have electrically-fueled hot water to be eligible for this measure.

Baseline Condition

The baseline condition is the residential shower arm and standard (2.5 GPM) showerhead without a temperature sensitive restrictor valve installed.

High-Efficiency Condition

The high-efficiency condition is a temperature sensitive restrictor valve installed on a residential shower arm and showerhead with either a standard (2.5 GPM) or low-flow (2.0, 1.75, or 1.5 GPM) showerhead. If this measure is installed in conjunction with a low-flow showerhead, refer to the Low-flow Showerheads measure and claim additional savings as outlined in that measure.

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[412] A temperature sensitive restrictor valve is any device that uses water temperature to regulate water flow in showers.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Estimated Hot Water Usage Reduction

To determine gallons of behavioral waste (defined as hot water that goes down the drain before the user enters the shower) per year, the following formula was used:

$$Annual\ Showerhead\ Behavioral\ Waste = SHFR \times BW \times n_S \times 365 \times \frac{n_O}{n_{SH}}$$

Equation 85

Where:

$SHFR$ = *Showerhead flow rate, gallons per minute [gpm] (see Table 307)*

BW = *Behavioral waste, minutes per shower (see Table 307)*

n_S = *Number of showers per person per day (see Table 307)*

365 = *Constant to convert days to years (see Table 307)*

n_O = *Number of occupants per home (see Table 307)*

n_{SH} = *Number of showerheads per home (see Table 307)*

Applying the formula to the values from Table 307 returns the following values for baseline behavioral waste in gallons per showerhead per year:

$$Showerhead\ (2.5\ GPM): 2.5 \times\ 0.783 \times 0.6 \times 365 \times \frac{2.86}{1.72} = 713\ gal$$

$$Showerhead\ (2.0\ GPM): 2.0 \times 0.783 \times 0.6 \times 365 \times \frac{2.86}{1.72} = 570\ gal$$

$$Showerhead\ (1.75\ GPM): 1.75 \times 0.783 \times 0.6 \times 365 \times \frac{2.86}{1.72} = 499\ gal$$

$$Showerhead\ (1.5\ GPM): 1.5 \times 0.783 \times 0.6 \times 365 \times \frac{2.86}{1.72} = 428\ gal$$

Gallons of hot water saved per year can be found by multiplying the baseline behavioral waste gallons per year by the percent of hot water from Table 307.

$$Gallons\ of\ hot\ water\ saved\ per\ year = Annual\ Behavioral\ Waste \times HW\%$$

Equation 86

Where:

HW% = *Hot water percentage (see Table 307)*

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (2.5\ GPM): 713 \times\ 0.825 = 588\ gal$$

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (2.0\ GPM): 570 \times\ 0.825 = 470\ gal$$

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.75\ GPM): 499 \times\ 0.825 = 412\ gal$$

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.5\ GPM): 428 \times\ 0.825 = 353\ gal$$

Table 307. Showerhead TSRVs—Hot Water Usage Reduction

Description	2.5 GPM	2.0 GPM	1.75 GPM	1.5 GPM
Average behavioral waste (minutes per shower)[413]	0.783			
Showers/person/day[414]	0.6			
Occupants per home[415]	2.83			
Showerheads/home[416]	1.72			
Behavioral waste/showerhead/year (gal)	713	570	499	428
Percent hot water[417]	80-85%, or 82.5% average			
Hot water saved/year (gal)	588	470	412	353

Energy Savings Algorithms

Energy savings for this measure are calculated as follows:

$$Energy\ Savings\ per\ TSRV\ [\Delta kWh] = \frac{\rho \times C_P \times V \times (T_{setpoint} - T_{supply,avg})}{RE \times 3{,}412}$$

Equation 87

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb°F] = 1*

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[413] "Disaggregating Residential Shower Warm-Up Waste", Sherman, Troy. August 2014. Derived by dividing average behavioral waste time (47 seconds) by 60 seconds.

[414] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study". Prepared for Michigan Evaluation Working Group. June 2013.

[415] Occupants per home for Texas from US Census Bureau, "Persons per household, 2016-2020". https://www.census.gov/quickfacts/fact/table/TX,US/PST045221.

[416] Showerheads per home assumed to be equal to the number of full bathrooms per home. Bathroom counts extracted from the 2015 Residential Energy Consumption Survey (RECS) Table HC2.8 Structural and geographic characteristics of homes in the West South-Central region. https://www.eia.gov/consumption/residential/data/2015/#structural.

[417] "Calculating Savings For: Auto-Diverting Tub Spout System with ShowerStart TSV", Sherman, Troy. Evolve Technologies. December 15, 2015.

V = *Gallons of hot water saved per year per showerhead (see Table 307)*

$T_{setpoint}$ = *Water heater setpoint temperature [°F]*[418] *= 120*

$T_{supply,avg}$ = *Average annual supply water temperature [°F] (see Table 308)*

RE = *Recovery Efficiency (or in the case of heat pump water heaters, COP); if unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters*

3,412 = *Constant to convert from Btu to kWh*

Demand Savings Algorithms

Demand savings are calculated by substituting the average supply temperature for the average seasonal temperature, multiplying by a coincidence factor equivalent to the daily fraction hot water use during the weighted peak hour for each climate zone (see Volume 1, Section 4), and dividing by 365 days/year.

$$Peak\ Demand\ Savings\ per\ TSRV\ [\Delta kW] = \frac{\rho \times C_P \times V \times (T_{setpoint} - T_{supply,seasonal})}{RE \times 3{,}412 \times 365} \times CF_{S/W}$$

Equation 88

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 308)*

$CF_{S/W}$ = *Seasonal peak coincidence factor (see Table 309)*

Table 308. Showerhead TSRVs—Water Mains Temperature (°F)[419]

Climate zone	$T_{SupplyAverage}$	$T_{SupplySeasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5

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[418] 120°F represents the assumed water heater setpoint. New York Department of Public Service recommends using water heater setpoint as a default value, see “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs” October 2010, page 99.
Data collection discussed in Appendix D of the EM&V team’s Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015), also supports a default value of 120°F.

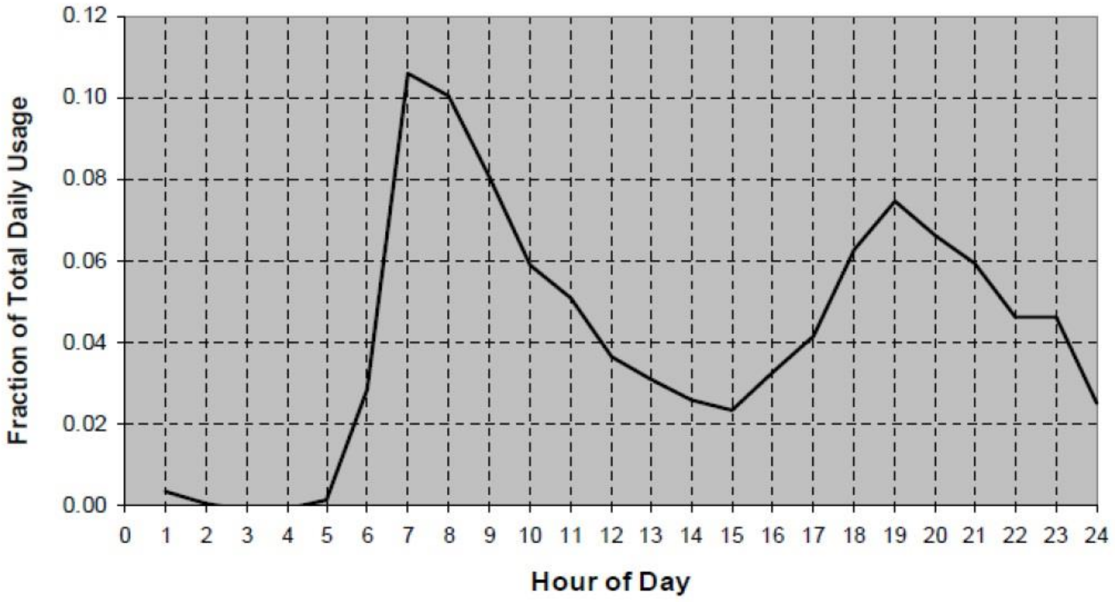
[419] Based on typical meteorological year (TMY) dataset for TMY3 available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-viewer. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Climate zone	$T_{SupplyAverage}$	$T_{SupplySeasonal}$	
		Summer	Winter
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

Table 309. Showerhead TSRVs—Coincidence Factors

Climate zone	Summer	Winter
Zone 1: Amarillo	0.039	0.073
Zone 2: Dallas	0.035	0.075
Zone 3: Houston	0.038	0.080
Zone 4: Corpus Christi	0.038	0.068
Zone 5: El Paso	0.028	0.069

Figure 12. Showerhead TSRVs—Shower, Bath, and Sink Hot Water Use Profile[420]



Source: Building America Performance Analysis Procedures for Existing Homes.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

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[420] Building America performance analysis procedures for existing homes.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-WH-Shrhd.[421]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- DHW recovery efficiency (RE) or COP, if available
- Flow rate in gallons per minute (GPM) of showerhead installed
- Water heater type (heat pump, electric resistance)

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

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[421] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Document Revision History

Table 310. Showerhead TSRVs—Revision History

TRM version	Date	Description of change
v5.0	10/2017	TRM v5.0 origin.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference and restricted measure to electric DHW.
v10.0	10/2022	TRM v10.0 update. Updated number of occupants per home.

2.4.9 Tub Spout and Showerhead Temperature Sensitive Restrictor Valves Measure Overview

TRM Measure ID: R-WH-TV

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure consists of replacing existing tub spouts and showerheads with an automatically diverting tub spout and showerhead system with a temperature sensitive restrictor valve (TSRV) [422] between the existing shower arm and showerhead. The tub spout will contain temperature sensitive restrictor technology that will cause the tub spout to automatically engage the anti-leak diverter once the water reaches a set temperature (generally 95˚F). The water will divert to a showerhead with a normally closed valve that will prevent the hot water from going down the drain prior to the user entering the shower, thereby eliminating behavioral waste and tub spout leakage waste.

Eligibility Criteria

These deemed savings are for tub spout and showerhead systems with temperature sensitive restrictor technology installed in new construction or as a retrofit measure in existing homes. Buildings must have electrically fueled hot water to be eligible for this measure.

Baseline Condition

The baseline condition is the residential tub spout with a standard diverter and a standard (2.5 gpm) showerhead.

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[422] A temperature sensitive restrictor valve is any device that uses water temperature to regulate water flow in showers.

High-Efficiency Condition

The high-efficiency condition is an anti-leak, automatically diverting tub spout system with temperature sensitive restrictor technology installed on a residential shower arm and showerhead with a standard (2.5 GPM) or low-flow (2.0, 1.75, or 1.5 GPM) showerhead. If this measure is installed in conjunction with a low-flow showerhead, refer to the Low-flow Showerheads measure and claim additional savings as outlined in that measure.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Estimated Hot Water Usage Reduction

This system provides savings in two parts: elimination of behavioral waste (hot water that goes down the drain prior to the user entering the shower) and elimination of tub spout diverter leakage.

Part 1: To determine baseline gallons of behavioral waste per year, the following formula was used:

$$Annual\ Showerhead\ Behavioral\ Waste = \%WUE_{SH} \times SHFR \times BW \times n_S \times 365 \times \frac{n_O}{n_{SH}}$$

Equation 89

$$Annual\ Tub\ Spout\ Behavioral\ Waste = \%WUE_{TS} \times TSFR \times BW \times n_S \times 365 \times \frac{n_O}{n_{SH}}$$

Equation 90

Where:

$\%WUE_{SH}$ = *Showerhead percentage of warm-up events (see Table 311)*

$\%WUE_{TS}$ = *Tub spout percentage of warm-up events (see Table 311)*

SHFR = *Showerhead flow rate, gallons per minute [gpm] (see Table 311)*

TSFR = *Tub spout flow rate, gallons per minute [gpm] (see Table 311)*

BW = *Behavioral waste, minutes per shower (see Table 311)*

n_S = *Number of showers per person per day (see Table 311)*

365 = *Constant to convert days to years (see Table 311)*

n_O = *Number of occupants per home (see Table 311)*

n_{SH} = *Number of showerheads per home (see Table 311)*

Applying the formula to the values from Table 311 returns the following values:

$$Showerhead\ (1.5\ GPM): 0.6 \times \left(1.5 \times 0.783 \times 0.60 \times 365 \times \frac{2.86}{1.72}\right) = 257$$

$$Showerhead\ (1.75\ GPM): 0.6 \times \left(1.75 \times 0.783 \times 0.60 \times 365 \times \frac{2.86}{1.72}\right) = 299$$

$$Showerhead\ (2.0\ GPM): 0.6 \times \left(2.0 \times 0.783 \times 0.60 \times 365 \times \frac{2.86}{1.72}\right) = 342$$

$$Showerhead\ (2.5\ GPM): 0.6 \times \left(2.5 \times 0.783 \times 0.60 \times 365 \times \frac{2.86}{1.72}\right) = 428$$

$$Tub\ Spout\ (5.0\ GPM): 0.4 \times \left(5.0 \times 0.783 \times 0.60 \times 365 \times \frac{2.86}{1.72}\right) = 570$$

Part 2: To determine baseline gallons of diverter leakage per year, the following formula was used:

$$Annual\ Diverter\ Waste = DLR \times t_S \times n_S \times 365\ \frac{days}{year} \times \frac{n_O}{n_{SH}}$$

Equation 91

Where:

DLR = *Diverter leakage rate [gpm] (see Table 311)*

t_S = *Shower time (min/shower) (see Table 311)*

Applying the formula to the values from Table 311 returns the following values:

$$Diverter\ (0.8\ GPM): 0.8 \times 7.8 \times 0.60 \times 365 \times \frac{2.86}{1.72} = 2{,}272$$

Part 3: To determine gallons of water saved per year can be found by multiplying the total waste by the percent of hot water from Table 311.

$$Gallons\ of\ hot\ water\ saved = (SHBW + TSBW) \times HW\%_{SH,TS} + DW \times HW\%_D$$

Equation 92

Where:

SHBW = *Showerhead behavioral waste [gal]*

TSBW = *Tub spout behavioral waste [gal]*

DW = *Diverter waste [gal]*

$HW\%_{SH,TS}$ = *Showerheads and tub spout hot water percentage (see Table 311)*

$HW\%_D$ = *Diverter hot water percentage (see Table 311)*

Applying the formula to the values from Table 311 returns the following values:

$$Total\ Annual\ Waste\ (1.5\ gpm): (257 + 570) \times 0.825 + 2{,}272 \times 0.737 = 2{,}357$$

$$Total\ Annual\ Waste\ (1.75\ gpm): (299 + 570) \times 0.825 + 2{,}272 \times 0.737 = 2{,}392$$

$$Total\ Annual\ Waste\ (2.0\ gpm): (342 + 570) \times 0.825 + 2{,}272 \times 0.737 = 2{,}427$$

$$Total\ Annual\ Waste\ (2.5\ gpm): (428 + 570) \times 0.825 + 2{,}272 \times 0.737 = 2{,}498$$

Table 311. Tub Spout/Showerhead TSRVs—Hot Water Usage Reduction

Description	Part 1—Behavioral Waste		Part 2—Diverter Leakage	Part 3—Total
	SH Warm-up	TS Warm-up		
Baseline showerhead flow rate (GPM)	1.5, 1.75, 2.0, or 2.5	–		
Tub spout flow rate (GPM)[423]	–	5.0	–	
Percent of warm-up events[424]	60%	40%	–	
Average behavioral waste (minutes per shower)[425]	0.783		–	
Average diverter leakage rate (GPM)[426]	–		0.80	–
Average shower time (minutes per shower)[427]	–		7.8	–
Showers/person/day[428]	0.60			
Occupants/home[429]	2.83			
Showerheads/home[430]	1.72			
Gallons behavioral waste. per tub spout/showerhead per year (1.5 GPM)	257	570	2,272	3,099
Gallons behavioral waste per tub spout/showerhead per year (1.75 GPM)	299			3,142

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[423] Assumption from (Sherman 2015) Calculating Savings For: Auto-Diverting Tub Spout System with ShowerStart TSV.

[424] Percent of warm-up events from (Sherman 2014) Disaggregating Residential Shower Warm-Up Waste (Appendix B, Question 8).

[425] Average behavioral waste from Lutz (2004) Feasibility Study and Roadmap to Improve Residential Hot Water Distribution Systems and Sherman (2014) Disaggregating Residential Shower Warm-Up Waste. Derived by dividing 47 seconds by 60 seconds.

[426] Average diverter leak rate from (Taitem 2011) Taitem Tech Tip – Leaking Shower Diverters.

[427] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study". Prepared for Michigan Evaluation Working Group.

[428] Derivation of value for showers per person per day defined in the Low Flow Showerhead measure.

[429] Occupants per home for Texas from US Census Bureau, Texas, "Persons per household, 2016-2020." https://www.census.gov/quickfacts/fact/table/TX,US/PST045221.

[430] Showerheads per home assumed to be equal to the number of full bathrooms per home, taken from 2015 RECS, Table HC2.8. https://www.eia.gov/consumption/residential/data/2015/#structural.

Description	Part 1—Behavioral Waste		Part 2—Diverter Leakage	Part 3—Total
	SH Warm-up	TS Warm-up		
Gallons behavioral waste per tub spout/showerhead per year (2.0 GPM)	342			3,185
Gallons behavioral waste per tub spout/showerhead per year (2.5 GPM)	428			3,270
Percentage hot water[431]	80-85%, or 82.5% average		73.7%	–
Gallons hot water saved per year (1.5 GPM)			–	2,357
Gallons hot water saved per year (1.75 GPM)			–	2,392
Gallons hot water saved per year (2.0 GPM)			–	2,427
Gallons hot water saved per year (2.5 GPM)			–	2,498

Energy Savings Algorithms

Energy savings for this measure are calculated as follows:

$$Energy\ Savings\ per\ TSRV\ [\Delta kWh] = \frac{\rho \times C_P \times V \times (T_{setpoint} - T_{supply,avg})}{RE \times 3{,}412}$$

Equation 93

Where:

ρ = *Water density [lbs/gal] = 8.33*

C_p = *Specific heat of water [Btu/lb°F] = 1*

V = *Gallons of hot water saved per year per showerhead (see Table 311)*

$T_{setpoint}$ = *Water heater setpoint temperature* [432] *[°F] = 120*

$T_{supply,avg}$ = *Average annual supply water temperature [°F] (see Table 312)*

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[431] Average percentage hot water for warm up events from (Lutz 2004) Feasibility Study and Roadmap to Improve Residential Hot Water Distribution Systems and (Sherman 2015) Calculating Savings For: Auto-Diverting Tub Spout System with ShowerStart TSV.

[432] 120°F represents the assumed water heater setpoint. New York Department of Public Service recommends using water heater setpoint as a default value, see "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs" October 2010, page 99.
Data collection discussed in Appendix D of the EM&V team's Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015), also supports a default value of 120°F.

RE = *Recovery Efficiency (or in the case of heat pump water heaters, COP); if unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters*

3,412 = *Constant to convert from Btu to kWh*

Demand Savings Algorithms

Demand savings are calculated by substituting the average supply temperature for the average seasonal temperature, multiplying by a coincidence factor equivalent to the daily fraction hot water use during the weighted peak hour for each climate zone (see Volume 1, Section 4), and dividing by 365 days/year.

$$Peak\ Demand\ Savings\ per\ TSRV\ [\Delta kW] = \frac{\rho \times C_P \times V \times (T_{setpoint} - T_{supply,seasonal})}{RE \times 3{,}412 \times 365} \times CF_{S/W}$$

Equation 94

Where:

$T_{supply,seasonal}$ = *Seasonal supply water temperature [°F] (see Table 312)*

$CF_{S/W}$ = *Peak coincidence factor (see Table 313)*

Table 312. Tub Spout/Showerhead TSRVs—Water Mains Temperature (°F)[433]

Climate zone	$T_{SupplyAverage}$	$T_{SupplySeasonal}$	
		Summer	Winter
Zone 1: Amarillo	62.9	73.8	53.7
Zone 2: Dallas	71.8	84.0	60.6
Zone 3: Houston	74.7	84.5	65.5
Zone 4: Corpus Christi	77.2	86.1	68.5
Zone 5: El Paso	70.4	81.5	60.4

Table 313. Tub Spout/Showerhead TSRVs—Coincidence Factors

Climate zone	Summer	Winter
Zone 1: Amarillo	0.039	0.073
Zone 2: Dallas	0.035	0.075
Zone 3: Houston	0.038	0.080
Zone 4: Corpus Christi	0.038	0.068
Zone 5: El Paso	0.028	0.069

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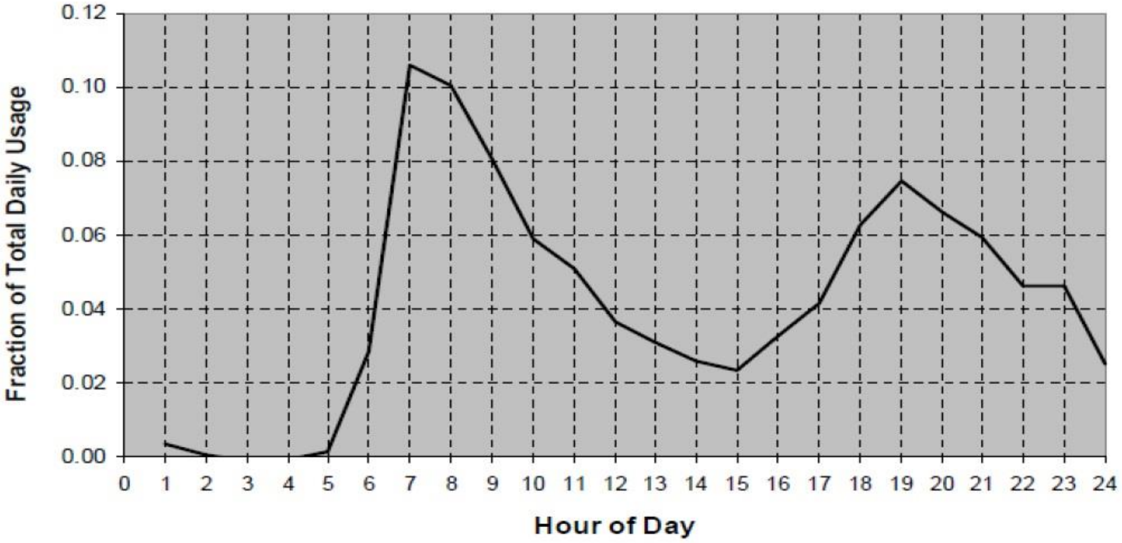
[433] Based on typical meteorological year (TMY) dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-viewer. Data for Texas climate zones can also be accessed directly here: https://texasefficiency.com/index.php/regulatory-filings/deemed-savings.

Figure 13. Tub Spout/Showerhead TSRVs—Shower, Bath, and Sink Hot Water Use Profile[434]



Source: Building America Performance Analysis Procedures for Existing Homes.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

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[434] Building America performance analysis procedures for existing homes.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID WtrHt-WH-Shrhd.[435]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Flow rate in gallons per minute (GPM) of showerhead installed
- Water heater type (heat pump, electric resistance)
- DHW recovery efficiency (RE) or COP, if available

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 314. Tub Spout/Showerhead TSRVs—Revision History

TRM version	Date	Description of change
v5.0	10/2017	TRM v5.0 origin.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated coincidence factors.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference and restricted measure to electric DHW.
v10.0	10/2022	TRM v10.0 update. Updated number of occupants per home.

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[435] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

2.4.10 Water Heater Temperature Setback Measure Overview

TRM Measure ID: R-WH-TS

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure outlines the demand and energy savings yielded from reprogramming residential water heater thermostats with default settings of greater than 120°F to 120°F.

Eligibility Criteria

Electric storage water heaters with default temperature setpoints in excess of 120°F are eligible to claim savings from this measure.

Baseline Condition

The baseline condition is an electric storage water heater with a thermostat setting that is higher than 120°F.

High-Efficiency Condition

The efficient condition is an electric storage water heater with a thermostat setting reduced to 120°F.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Water heater temperature setback savings are calculated on a per-unit basis. Deemed savings variables include the tank surface area, the heat transfer coefficient for the tank, and hot water setpoint prior to adjustment.

Energy Savings Algorithm

$$Energy\ Savings\ [\Delta kWh] = \frac{A \times U \times (T_{pre} - T_{post}) \times 8{,}760}{RE \times 3{,}412}$$

Equation 95

Where:

A = *Tank surface area insulated in square feet (πDL) with L (length) and D (tank diameter) in feet; if the tank area is not known, use Table 315*

Table 315. DHW Temperature Setback—Estimated Tank Area[436]

Volume (gal)	A (sq. ft.)
30	17.45
40	21.81
50	22.63
60	26.94
80	30.36
120	38.73

U = *Overall heat transfer coefficient for the tank*[437] *(Btu/Hr·°F·ft^2)*

T_{pre} = *Hot water setpoint prior to adjustment [°F]*

T_{post} = *Water heater setpoint [°F]*[438] *= 120*

8,760 = *Total hours per year*

RE = *Recovery efficiency of electric hot water heater = 0.98*[439]

3,412 = *Constant to convert from Btu to kWh*

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[436] Texas TRM Vol 2, 2.4.4 Water Heater Tank Insulation, Table 315.

[437] If unknown, assume R-5 (U = 1/5).

[438] 120°F represents the assumed water heater setpoint. The New York Department of Public Service recommends using the water heater setpoint as a default value, see "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs." Page 99. October 2010. The data collection discussed in Appendix D of the EM&V team's Annual Statewide Portfolio Report for Program Year 2014-Volume 1, Project Number 40891 (August 2015) also supports a default value of 120°F.

[439] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://www.ahrinet.org.

Demand Savings Algorithm

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \frac{kWh_{savings}}{8{,}760} \times CF_S$$

Equation 96

Where:

CF_S = *Summer peak coincidence factor = 1.0*

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 2 years[440].

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone

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[440] 2022 Illinois Statewide Technical Reference Manual Version 10.0, Volume 3 – 5.4.6 Water Heater Temperature Setback. September 24, 2021.

- R-value or overall heat transfer coefficient of tank (1 / R-value)
- Tank surface area insulated in square feet (πDL) with L (length) and D (tank diameter) in feet; if unable to determine tank area, tank volume must be recorded
- Hot water setpoint prior to adjustment
- Photo of reprogrammed temperature setpoint or another pre-approved method of verification
- Water heater manufacture date

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 316. DHW Temperature Setback—Revision History

TRM version	Date	Description of change
v10.0	10/2022	TRM v10.0 origin.

2.5 RESIDENTIAL: APPLIANCES

2.5.1 ENERGY STAR® Ceiling Fans Measure Overview

TRM Measure ID: R-AP-CF

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR ceiling fan and light kit. Savings are awarded at a flat per-unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

Savings values in this measure are based on indoor usage patterns and are not applicable to outdoor applications.

Baseline Condition

The baseline is a conventional non-ENERGY STAR labeled ceiling fan and light kit.

High-Efficiency Condition

The table below displays the ENERGY STAR Version 4.0 Requirements for eligible ceiling fans effective June 15, 2018.[441] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[441] ENERGY STAR® Ceiling Fan and Light Kits, Final Version 4.0 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Ceiling%20Fans%20and%20Ceiling%20Fan%20Light%20Kits%20Version%204.0_Program%20Requirements_0_0.pdf.

Table 317. Ceiling Fans—Fan Definitions

Fan type	Description
Ceiling fan	A non-portable device designed for home use that is suspended from the ceiling for circulating air via the rotation of fan blades; for which the lowest point on fan blades is greater than 10 inches from the ceiling.
Hugger ceiling fan	A ceiling fan for which the lowest point on the fan blades is less than or equal to 10 inches from the ceiling. Hugger ceiling fans can be safely installed on low ceilings, and some are sold with ceiling fan light kits.

Table 318. Ceiling Fans—Efficiency Requirements

Type	Diameter (inches)	Minimum efficiency (cfm/W)	Minimum high speed airflow (cfm)
Ceiling fan	D ≤ 36	≥ 0.72 x D + 41.93	≥ 1,767
	36 < D < 78	≥ 2.63 x D – 26.83	≥ 250 x π x $(D/24)^2$
	D ≥ 78		≥ 8,296
Hugger ceiling fan	D ≤ 36	≥ 0.31 x D + 36.84	≥ 1,414
	36 < D < 78	≥ 1.75 x D – 15	≥ 200 x π x $(D/24)^2$
	D ≥ 78		≥ 6,637

Table 319. Ceiling Fans—Light Kit Efficacy Requirements

Type	Minimum efficacy (lumens/W)	Minimum light output (lumens)
Shipped with ENERGY STAR certified light bulbs	65.0	–
Separable light source	65.0	800
Integrated light source	70.0	

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings were calculated using the ENERGY STAR Ceiling Fan Savings Calculator found on the ENERGY STAR website.[442] Default values were taken directly from the ENERGY STAR Ceiling Fan Savings Calculator, unless otherwise specified.

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[442] ENERGY STAR® Ceiling Fan Savings Calculator (updated September 2013). https://www.energystar.gov/sites/default/files/asset/document/light_fixture_ceiling_fan_calculator.xlsx.

$$Energy\ Savings\ [\Delta kWh] = (kWh_{baseline} - kWh_{ES})_{fan} + (kWh_{baseline} - kWh_{ES})_{lgt} \times IEF_E$$

Equation 97

$$kWh_{baseline,Fan} = \frac{W_{Fan,baseline} \times AOH_{Fan}}{1{,}000}$$

Equation 98

$$kWh_{ES,Fan} = \frac{W_{Fan,ES} \times AOH_{Fan}}{1{,}000}$$

Equation 99

$$W_{Fan} = (W_{LS} \times OP_{LS}) + (W_{MS} \times OP_{MS}) + (W_{HS} \times OP_{HS})$$

Equation 100

$$kWh_{baseline,Lgt} = \frac{W_{Lgt,baseline} \times AOH_{Lgt}}{1{,}000}$$

Equation 101

$$kWh_{ES,Lgt} = \frac{W_{Lgt,ES} \times AOH_{Lgt}}{1{,}000}$$

Equation 102

Where:

$kWh_{baseline}$ = *Non-ENERGY STAR baseline energy usage*

kWh_{ES} = *ENERGY STAR average energy usage*

IEF_E = *Energy interactive effects factor from Table 320 assuming heating/cooling unknown*[443]

$W_{Lgt,baseline}$ = *Conventional lighting total wattage = 58 W (160 W default value from ENERGY STAR calculator reduced to comply with EISA 2007 45 lumens/watt backstop)*[444]

$W_{Lgt,ES}$ = *Actual wattage of installed ENERGY STAR lighting; assume one high-efficiency 32 W lamp*

$W_{Fan,baseline}$ = *Conventional fan motor wattage*

$W_{Fan,ES}$ = *ENERGY STAR fan motor wattage*

$W_{LS/MS/HS}$ = *Fan motor wattage at low, medium, and high speed; see Table 321*

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[443] The assumed energy interactive effects factors are taken from the residential lighting measure.

[444] Assumes a mix of general service incandescent lamps. EISA 2007 45 lumens/watt backstop is approximately 36 percent of standard incandescent wattages for the 40, 60, 75, and 100 equivalent wattage categories. 160 W x 0.36 = 58 W.

$OP_{LS/MS/HS}$ = *Fan operating percentage at low, medium, and high speed; see Table 322*

AOH_{Lgt} = *Annual lighting operating hours = 803 hours/year (assuming 2.2 hours/day and 365 days/year operation)*[445]

AOH_{Fan} = *Annual fan operating hours = 1,095 hours/year (assuming 3.0 hours/day and 365 days/year operation)*[446]

1,000 = *Constant to convert from W to kW*

Table 320. Ceiling Fans—Interactive Effects Factor for Cooling Energy Savings and Heating Energy Penalties[447]

IEF_E					
Heating/cooling type	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Heating/cooling unknown[448]	0.88	0.98	1.04	1.07	0.95

Table 321. Ceiling Fans— Motor Wattages

Fan type	Fan speed	Fan motor wattage (W)
Conventional	Low	15
	Medium	34
	High	67
ENERGY STAR	Low	6
	Medium	23
	High	56

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[445] The assumed annual operating hours are taken from the residential lighting measure.

[446] The assumed annual operating hours are taken from the previously cited ENERGY STAR® Light Fixture and Ceiling Fan Calculator.

[447] Extracted from BEopt energy models used to estimate savings for envelope measures. Referencing the EISA baseline table, the typical lumen output was determined by taking the midpoint for the 60-watt equivalent lamp (900 lm), which was assumed to be the most typical installation. The resulting lumens were divided by the default wattage for incandescents (43 W), CFLs (13 W), and LEDs (10 W) resulting in an assumed efficacy for incandescents (21 lm/W), CFLs (70 lm/W), and LEDs (90 lm/W). IEF values were calculated using the following formula: $1 + HVAC_{savings}/Lighting_{savings}$.

[448] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

Table 322. Ceiling Fans—Operating Percentages

Fan speed	Operating percentage (OP)
Low	40%
Medium	40%
High	20%

Demand Savings Algorithms

Peak demand savings were calculated using separate coincidence factors for the lighting and the fan motor portion of the ceiling fan savings. For lighting the coincidence factor varies based on climate zone. For the fan motor a coincidence factor of 0.446 was applied (derived from the EnergyGauge software ceiling fan profiles).

$$Peak\ Demand\ Savings\ [\Delta kW] = kW_{Fan} + kW_{Lgt}$$

Equation 103

$$kW_{Fan} = \frac{W_{Fan,baseline} - W_{Fan,ES}}{1{,}000} \times CF_{Fan}$$

Equation 104

$$kW_{Lgt} = \frac{W_{Lgt,baseline} - W_{Lgt,ES}}{1{,}000} \times CF_{Lgt,S/W} \times IEF_{D,S/W}$$

Equation 105

Where:

kW_{Fan} = *Fan demand savings*

CF_{Fan} = *Fan motor peak coincidence factor = 0.446*

kW_{Lgt} = *Lighting demand savings*

$CF_{Lgt,S/W}$ = *Lighting seasonal peak coincidence factor (Table 323)*

$IEF_{D,S/W}$ = *Demand interactive effects factor from Table 324 assuming heating/cooling unknown*[449]

Table 323. Ceiling Fans—Lighting Coincidence Factors[450]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.060	0.053	0.063	0.059	0.032
Winter	0.275	0.232	0.199	0.263	0.358

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[449] The assumed demand interactive effects factors are taken from the residential lighting measure.
[450] See Volume 1, Section 4.

Table 324. Ceiling Fans—Interactive Effects Factor for Cooling Demand Savings and Heating Demand Penalties[451]

$IEF_{D,S}$					
Heating/cooling type	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Heating/cooling unknown[452]	1.39	1.28	1.58	1.20	1.38
$IEF_{D,W}$					
Heating/cooling type	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Heating/cooling unknown[453]	0.76	0.72	0.73	0.75	0.80

Deemed Energy Savings Tables

Table 325. Ceiling Fans—Energy Savings (kWh)

Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
29.5	31.6	32.9	33.5	31.0

Deemed Summer Demand Savings Tables

Table 326. Ceiling Fans—Summer Peak Demand Savings (kW)

Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
0.007	0.006	0.007	0.006	0.006

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[451] Extracted from BEopt energy models used to estimate savings for envelope measures. Referencing the EISA baseline table, the typical lumen output was determined by taking the midpoint for the 60-watt equivalent lamp (900 lm), which was assumed to be the most typical installation. The resulting lumens were divided by the default wattage for incandescents (43 W), CFLs (13 W), and LEDs (10 W) resulting in an assumed efficacy for incandescents (21 lm/W), CFLs (70 lm/W), and LEDs (90 lm/W). IEF values were calculated using the following formula: $1 + HVAC_{savings}/Lighting_{savings}$.

[452] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

[453] Calculated using IEFs from Cadmus report, weighted using TMY CDD and HDD for Texas, and adjusted to exclude 16 percent outdoor lighting except for upstream defaults. Cadmus report: Cadmus. Entergy Energy-Efficiency Portfolio Evaluation Report 2013 Program Year. Prepared for Entergy Arkansas, Inc. March 14, 2014. Docket No. 07-082-TF.

Deemed Winter Demand Savings Tables

Table 327. Ceiling Fans—Winter Peak Demand Savings (kW)

Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
0.010	0.009	0.008	0.010	0.012

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 10 years according to the ENERGY STAR Ceiling Fan Savings Calculator.

This EUL is consistent with Docket No. 38025 approved in 2010.[454]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Quantity of installed ENERGY STAR ceiling fan and light kits
- Manufacturer and model number
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

- Docket No. 38025. Petition of Electric Utility Marketing Managers of Texas to Amend Deemed Savings for ENERGY STAR Appliance Measures. Public Utility Commission of Texas.

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[454] Docket No. 38025. Petition of Electric Utility Marketing Managers of Texas to Amend Deemed Savings for ENERGY STAR® Appliance Measures. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 328. Ceiling Fans—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Minor edits to language and updates to the ENERGY STAR specification table.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2014	TRM v3.0 update. Explanation of methodology and alignment with ENERGY STAR calculator. Introduction of interactive effects factors and in-service rates. New peak savings calculated according to revised peak definition.
v3.1	11/05/2015	TRM v3.1 update. Revision of interactive effects factors to reflect indoor-specific values for additional heating and cooling equipment types.
v3.1	3/28/2016	TRM v3.1 March revision. Updated summer and winter coincidence factors.
v4.0	10/10/2016	TRM v4.0 update. Updated interactive effect values using building energy simulation.
v5.0	10/2017	TRM v5.0 update. Updated footnote reference to ENERGY STAR calculator.
v6.0	11/2018	TRM v6.0 update. Updated interactive effect values.
v7.0	11/2019	TRM v7.0 update. Established deemed savings approach.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. Reduced baseline lighting wattage and resulting deemed energy savings for compliance with reinstated EISA 2007 45 lumens/watt baseline.

2.5.2 ENERGY STAR® Clothes Washers Measure Overview

TRM Measure ID: R-AP-CW

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR clothes washer. Savings are awarded at a flat per unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

These deemed savings are calculated using the federal standards effective January 1, 2018.

Eligibility Criteria

Not applicable.

Baseline Condition

Effective January 1, 2018, the baseline is the Department of Energy (DOE) minimum efficiency standard[455] for top-loading clothes washers. While the DOE provides criteria for both top- and front-loading washers, only the standards for top-loading washers are listed below, as a top-loading unit is assumed to be the baseline equipment. This approach is based on customers having the option to install a top-loading clothes washer. Therefore, savings are calculated using the lower top-loading baseline condition.

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[455] DOE minimum efficiency standard for residential clothes washers. https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39.

Table 329. Clothes Washers—Federal Standard

Product type	Current criteria as of January 1, 2018
Top-loading, standard (1.6 ft^3 or greater capacity)	IMEF ≥ 1.57 IWF≤ 6.5
Top-loading, compact (less than 1.6 ft^3 capacity)	IMEF ≥ 1.15 IWF≤ 12.0

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 8.1 Requirements for eligible clothes washers effective February 5, 2018.[456] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 330. Clothes Washers—ENERGY STAR Requirements

Product type	Current criteria as of February 5, 2018
ENERGY STAR residential front-loading (> 2.5 ft^3)	IMEF ≥ 2.76 IWF ≤ 3.2
ENERGY STAR residential top-loading (> 2.5 ft^3)	IMEF ≥ 2.06 IWF ≤ 4.3
ENERGY STAR residential small or compact (< 2.5 ft^3)	IMEF ≥ 2.07 IWF ≤ 4.2

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure were derived using the ENERGY STAR Appliance Savings Calculator found on the ENERGY STAR website.[457] This document will be updated regularly to apply the values provided in the latest available ENERGY STAR Appliance Savings Calculator. The most recent TRM version should be referenced to determine the savings for this measure.

$$Energy\ Savings\ [\Delta kWh] = kWh_{baseline} - kWh_{ES}$$

Equation 106

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[456] ENERGY STAR® Clothes Washer Final Version 8.1 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%208.0%20Clothes%20Washer%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf.

[457] ENERGY STAR® Appliance Savings Calculator (updated October 2016). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

Baseline Unit

$$kWh_{baseline} = kWh_{conv,machine} + kWh_{conv,WH} + kWh_{conv,dryer} + kWh_{conv,LPM}$$

Equation 107

$$kWh_{conv,machine} = MCF \times RUEC_{conv} \times \frac{LPY}{RLPY}$$

Equation 108

$$kWh_{conv,WH} = WHCF \times RUEC_{conv} \times \frac{LPY}{RLPY}$$

Equation 109

$$kWh_{conv,LPM} = kW_{conv,LPM} \times (8{,}760 - LPY)$$

Equation 110

$$kWh_{conv,dryer} = \left[\left(\frac{Cap_{conv}}{IMEF_{FS}} \times LPY\right) - \left(RUEC_{conv} \times \frac{LPY}{RLPY}\right) - kWh_{conv,LPM}\right] \times \frac{DU}{DUF}$$

Equation 111

Where:

$kWh_{baseline}$ = *Federal standard baseline energy usage*

$kWh_{conv,machine}$ = *Conventional machine energy*

$kWh_{conv,WH}$ = *Conventional water heater energy*

$kWh_{conv,dryer}$ = *Conventional dryer energy*

$kWh_{conv,LPM}$ = *Conventional combined low-power mode energy*

$RUEC_{conv}$ = *Conventional rated unit electricity consumption = 381 kWh/year (top-loading, standard)* [458]*, 163 kWh/year top-loading, compact)*

LPY = *Loads per year = 295*

$RLPY$ = *Reference loads per year = 392*

$kW_{conv,LPM}$ = *Combined low-power mode wattage of conventional unit = 0.00115 kW (top-loading, standard), 0.00144 kW (top-loading, compact)*

Cap_{conv} = *Average machine capacity = 4.5 ft*^{3} *(top-loading, standard), 2.1 ft*^{3} *(top-loading, compact)*

$IMEF_{FS}$ = *Federal standard integrated modified energy factor (Table 329)*

MCF = *Machine consumption factor = 20 percent*

---

[458] This value is taken from the ENERGY STAR® appliance calculator and corresponds with the federal standard after March 7, 2015.

WHCF = Water heater consumption factor = 80 percent

DU = Dryer usage in households with both a washer and a dryer = 95 percent

DUF = Dryer use factor (percentage of washer loads dried in machine)= 91 percent

<u>ENERGY STAR Unit</u>

$$kWh_{ES} = kWh_{ES,machine} + kWh_{ES,WH} + kWh_{ES,dryer} + kWh_{ES,LPM}$$

Equation 112

$$kWh_{ES,machine} = MCF \times RUEC_{ES} \times \frac{LPY}{RLPY}$$

Equation 113

$$kWh_{ES,WH} = WHCF \times RUEC_{ES} \times \frac{LPY}{RLPY}$$

Equation 114

$$kWh_{ES,LPM} = kW_{ES,LPM} \times (8{,}760 - LPY)$$

Equation 115

$$kWh_{ES,dryer} = \left[\left(\frac{Cap_{ES}}{IMEF_{ES}} \times LPY\right) - \left(RUEC_{ES} \times \frac{LPY}{RLPY}\right) - kWh_{ES,LPM}\right] \times \frac{DU}{DUF}$$

Equation 116

Where:

kWh_{ES} = *ENERGY STAR average energy usage*

$kWh_{ES,machine}$ = *ENERGY STAR machine energy*

$kWh_{ES,WH}$ = *ENERGY STAR water heater energy*

$kWh_{ES,dryer}$ = *ENERGY STAR dryer energy*

$kWh_{ES,LPM}$ = *ENERGY STAR combined low-power mode energy*

$RUEC_{ES}$ = *ENERGY STAR rated unit electricity consumption (see Table 331)*

$kW_{ES,LPM}$ = *Combined low-power mode wattage of ENERGY STAR unit (see Table 331)*

$IMEF_{ES}$ = *ENERGY STAR integrated modified energy factor (see Table 330)*

Cap_{ES} = *Average machine capacity (see Table 331)*

Table 331. Clothes Washers—ENERGY STAR Characteristics[459]

Product type	ENERGY STAR rated unit electricity consumption (kWh)	Average capacity (ft^3)	Combined low-power mode wattage (kW)
Residential front-loading (> 2.5 ft^3)	127	4.0	0.00160
Residential top-loading (> 2.5 ft^3)	230	4.5	0.00115
Residential small or compact (< 2.5 ft^3)	108	2.1	0.00144

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{AOH} \times CF_{S/W}$$

Equation 117

$$AOH = LPY \times d$$

Equation 118

Where:

AOH = *Annual operating hours*

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 332)*

LPY = *Loads per year = 295*

d = *Average wash cycle duration = 1 hour* [460,461]

Table 332. Clothes Washers—Coincidence Factors[462]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.040	0.040	0.040	0.041	0.041
Winter	0.043	0.043	0.043	0.044	0.039

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[459] This value is taken from the ENERGY STAR® appliance calculator and corresponds with the ENERGY STAR® specification after March 7, 2015.

[460] Weighted average of Consumer Reports Cycle Times for Top and Front-Loading Clothes Washers.

[461] Consumer Reports. "Top-loading washers remain more popular with Americans". April 13, 2010. Weighted average of 75 percent Top-Loading Clothes Washers and 25 percent Front-Loading Clothes Washers.

[462] See Volume 1, Section 4.

Deemed Energy Savings Tables

Table 333. Clothes Washers—Energy Savings (kWh)

Type	Water heater fuel type	Dryer fuel type	kWh/unit
Front-loading > 2.5 ft^3	Electric	Electric	428
		Gas	187
	Gas	Electric	275
		Gas	34
Top-loading > 2.5 ft^3	Electric	Electric	205
		Gas	114
	Gas	Electric	114
		Gas	23
All ≤ 2.5 ft^3	Electric	Electric	248
		Gas	41
	Gas	Electric	215
		Gas	8

Deemed Summer Demand Savings Tables

Table 334. Clothes Washers—Summer Peak Demand Savings (kW)

Washer type	Fuel Type		Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
	Water heater	Dryer					
Front-loading > 2.5 ft^3	Electric	Electric	0.058	0.058	0.058	0.060	0.060
		Gas	0.025	0.025	0.025	0.026	0.026
	Gas	Electric	0.037	0.037	0.037	0.038	0.038
		Gas	0.005	0.005	0.005	0.005	0.005
Top-loading > 2.5 ft^3	Electric	Electric	0.028	0.028	0.028	0.028	0.028
		Gas	0.015	0.015	0.015	0.016	0.016
	Gas	Electric	0.015	0.015	0.015	0.016	0.016
		Gas	0.003	0.003	0.003	0.003	0.003
All ≤ 2.5 ft^3	Electric	Electric	0.034	0.034	0.034	0.034	0.034
		Gas	0.006	0.006	0.006	0.006	0.006
	Gas	Electric	0.029	0.029	0.029	0.030	0.030
		Gas	0.001	0.001	0.001	0.001	0.001

Deemed Winter Demand Savings Tables

Table 335. Clothes Washers—Winter Peak Demand Savings (kW)

Washer type	Fuel type		Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
	Water heater	Dryer					
Front-loading > 2.5 ft^3	Electric	Electric	0.062	0.062	0.062	0.064	0.057
		Gas	0.027	0.027	0.027	0.028	0.025
	Gas	Electric	0.040	0.040	0.040	0.041	0.036
		Gas	0.005	0.005	0.005	0.005	0.005
Top-loading > 2.5 ft^3	Electric	Electric	0.030	0.030	0.030	0.031	0.027
		Gas	0.017	0.017	0.017	0.017	0.015
	Gas	Electric	0.017	0.017	0.017	0.017	0.015
		Gas	0.003	0.003	0.003	0.003	0.003
All ≤ 2.5 ft^3	Electric	Electric	0.036	0.036	0.036	0.037	0.033
		Gas	0.006	0.006	0.006	0.006	0.005
	Gas	Electric	0.031	0.031	0.031	0.032	0.028
		Gas	0.001	0.001	0.001	0.001	0.001

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of an ENERGY STAR clothes washer is established at 11 years based on the Technical Support Document for the current DOE Final Rule standards for residential clothes washers.[463]

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[463] The median lifetime was calculated using the survival function outlined in the DOE Technical Support Document. Final Rule: Standards, Federal Register, 77 FR 32308 (May 31, 2012) and associated Technical Support Document. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=68&action=viewlive. Download TSD at: https://www.regulations.gov/document/EERE-2008-BT-STD-0019-0047.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Manufacturer and model number
- Type of unit (top-loading, front-loading, or compact)
- DHW fuel type (gas or electric)
- Dryer fuel type (gas or electric)
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 336. Clothes Washers—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	1/30/2015	TRM v2.1 update. New ENERGY STAR standards incorporated.
v3.0	4/10/2015	TRM v3.0 update. Updated EUL to align with median lifetime. New peak savings calculated according to revised peak definition.
v3.1	11/05/2015	TRM v3.1 update. New ENERGY STAR algorithms and default assumptions incorporated.
v3.1	3/28/2016	TRM v3.1 March revision. Updated winter coincidence factors and winter and summer demand savings tables.
v4.0	10/10/2016	TRM v4.0 update. No revision.

TRM version	Date	Description of change
v5.0	10/2017	TRM v5.0 update. Updated baseline IMEF to reflect changes in Federal Standard. Updated Front Load Washer IMEF to reflect changes in ENERGY STAR Specification. Added baseline for compact units to reflect Federal Standard for compact washers.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	11/2019	TRM v7.0 update. Updated links and dates.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. General reference checks and text edits. Updated deemed savings tables to match savings algorithms and ENERGY STAR calculator.
v10.0	10/2022	TRM v10.0 update. No revision.

2.5.3 ENERGY STAR® Clothes Dryers Measure Overview

TRM Measure ID: R-AP-CD

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR electric clothes dryer. Savings are awarded at a flat per-unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

Gas dryers are ineligible to claim savings under this measure. Savings may be claimed for the replacement of gas dryers if the decision to switch fuels predates the decision to install efficient equipment.

Baseline Condition

Effective January 1, 2015, the baseline is the Department of Energy (DOE) minimum federal efficiency standard[464], adjusted to reflect recent combined energy factor (CEF) definition updates for vented and ventless clothes dryers. These adjusted baselines consider calculated differences between CEF values under original clothes dryer testing procedures of 10 CFR 430, Subpart B, Appendix D1, and those amended procedures outlined in Appendix D2; a change indicated in detail in the September 5, 2013, ENERGY STAR stakeholder webinar. These values are consistent with the current ENERGY STAR Appliance Savings Calculator.

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[464] DOE minimum efficiency standard for residential clothes dryers. https://www.regulations.gov/document?D=EERE-2007-BT-STD-0010-0050.

Table 337. Clothes Dryers—Federal Standard

Product type	Average capacity (ft^3)	Amended minimum CEF: calculations	Minimum CEF levels (lbs/kWh)
Vented electric, standard	≥ 4.4	3.73 – (3.73 x 0.166)	3.11
Vented electric, compact (120 V)	< 4.4	3.61 – (3.61 x 0.166)	3.01
Vented electric, compact (240 V)	< 4.4	3.27 – (3.27 x 0.166)	2.73
Ventless electric, compact (240 V)	< 4.4	2.55 – (2.55 x 0.166)	2.13

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 1.1 Requirements for eligible clothes dryers effective January 1, 2015.[465] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 338. Clothes Dryers—ENERGY STAR Requirements

Product type	Average Capacity (ft^3)	Minimum CEF levels (lbs/kWh)
ENERGY STAR ventless or vented electric, standard	≥ 4.4	3.93
ENERGY STAR ventless or vented electric, compact (120 V)	< 4.4	3.80
ENERGY STAR vented electric, compact (240 V)	< 4.4	3.45
ENERGY STAR ventless electric, compact (240 V)	< 4.4	2.68

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure were derived using the ENERGY STAR Appliance Savings Calculator found on the ENERGY STAR website.[466] This document will be updated regularly to apply the values provided in the latest available ENERGY STAR appliance calculator. The most recent TRM version should be referenced to determine the savings for this measure.

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[465] ENERGY STAR® Clothes Dryers Final Version 1.1 Program Requirements. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Final%20Version%201.1%20Clothes%20Dryers%20Specification%20-%20Program%20Commitment%20Criteria%20and%20Eligibility%20Criteria.pdf.

[466] ENERGY STAR® Appliance Savings Calculator (updated October 2016). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

Table 339. Clothes Dryers—Default Average Load

Product type	Average load (lbs)
Vented electric, standard	8.45
Vented electric, compact (120 V)	3.00
Vented electric, compact (240 V)	3.00
Ventless electric, compact (240 V)	3.00

$$Energy\ Savings\ [\Delta kWh] = \ kWh_{baseline} - kWh_{ES}$$

Equation 119

Baseline Unit

$$kWh_{baseline} = \frac{AvgLoad \times LPY}{CEF_{baseline}}$$

Equation 120

Where:

$kWh_{baseline}$ = *Federal standard baseline energy usage*

$AvgLoad$ = *Average load in lbs (Table 339)*

LPY = *Loads per year = 283*

$CEF_{baseline}$ = *Baseline combined energy factor (see Table 337)*

ENERGY STAR Unit

$$kWh_{ES} = \frac{AvgLoad \times LPY}{CEF_{ES}}$$

Equation 121

Where:

kWh_{ES} = *ENERGY STAR average energy usage*

CEF_{ES} = *ENERGY STAR minimum combined energy factor (see Table 338)*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{AOH} \times CF_{S/W}$$

Equation 122

Where:

AOH = *Annual operating hours = (8,760 – 8,463) = 297 hours*[467]

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 340)*

Table 340. Clothes Dryers—Coincidence Factors[468]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.041	0.041	0.041	0.041	0.042
Winter	0.045	0.045	0.041	0.048	0.047

Deemed Energy Savings Tables

Table 341. Clothes Dryers—Energy Savings (kWh)

Product type	Average capacity (ft^3)	Energy savings (kWh)
Ventless or vented electric, standard	≥ 4.4	160
Ventless or vented electric, compact (120 V)	< 4.4	59
Vented electric, compact (240 V)	< 4.4	65
Ventless electric, compact (240 V)	< 4.4	82

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[467] Concerning annual operating hours: Minute-by-minute field data shows “96.6% ± 0.5% idle time, or about 8463 hours.” Hannas, Benjamin and Gilman, Lucinda. Dryer Field Study, 39. https://neea.org/img/uploads/neea-clothes-dryer-field-study.pdf.

[468] See Volume 1, Section 4.

Deemed Summer Demand Savings Tables

Table 342. Clothes Dryers—Summer Peak Demand Savings (kW)

Product type	Average capacity (ft³)	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Ventless or vented electric, standard	≥ 4.4	0.022	0.022	0.022	0.022	0.023
Ventless or vented electric, compact (120 V)	< 4.4	0.008	0.008	0.008	0.008	0.008
Vented electric, compact (240 V)	< 4.4	0.009	0.009	0.009	0.009	0.009
Ventless electric, compact (240 V)	< 4.4	0.011	0.011	0.011	0.011	0.012

Deemed Winter Demand Savings Tables

Table 343. Clothes Dryers—Winter Peak Demand Savings (kW)

Product type	Average capacity (ft³)	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Ventless or vented electric, standard	≥ 4.4	0.024	0.024	0.022	0.026	0.025
Ventless or vented electric, compact (120 V)	< 4.4	0.009	0.009	0.008	0.009	0.009
Vented electric, compact (240 V)	< 4.4	0.010	0.010	0.009	0.011	0.010
Ventless electric, compact (240 V)	< 4.4	0.012	0.013	0.011	0.013	0.013

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of an ENERGY STAR clothes dryer is established at 16 years based on the current DOE Final Rule standards for clothes dryers.[469]

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[469] Technical Support Document (April 2011). See “Appendix 8C.Lifetime Distributions”: https://www.regulations.gov/document?D=EERE-2007-BT-STD-0010-0053

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Manufacturer and model number
- Type of unit (vented or ventless)
- Capacity (≥ 4.4 ft^3/standard or < 4.4 ft^3/compact)
- Proof of purchase – including date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 344. Clothes Dryers—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. No revision.

2.5.4 ENERGY STAR® Dishwashers Measure Overview

TRM Measure ID: R-AP-DW

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR dishwasher. Savings are awarded at a flat per-unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

This measure applies to both standard and compact dishwasher types.

Baseline Condition

Effective May 30, 2013, the baseline is the Department of Energy (DOE) minimum efficiency standard[470] for dishwashers.

Table 345. Dishwashers—Federal Standard

Product type	Annual energy use (kWh/year)	Water consumption (gallons/cycle)
Standard (≥ 8 place settings)	≤ 307	≤ 5.0
Compact (< 8 place settings)	≤ 222	≤ 3.5

High-Efficiency Condition

The following table displays the ENERGY STAR Final Version 6.0 Requirements for eligible dishwashers effective January 29, 2016.[471] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[470] DOE minimum efficiency standard for residential dishwashers. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=38&action=viewlive.

Table 346. Dishwashers—ENERGY STAR Requirements

Product type	Annual energy use (kWh/year)	Water consumption (gallons/cycle)
Standard (≥ 8 place settings + 6 serving pieces)	≤ 270	≤ 3.5
Compact (< 8 place settings + 6 serving pieces)	≤ 203	≤ 3.1

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure were derived using the ENERGY STAR Appliance Savings Calculator found on the ENERGY STAR website and the revised ENERGY STAR specification in Table 346.[472] Default values were taken directly from the ENERGY STAR Appliance Savings Calculator. This document will be updated regularly to apply the values provided in the latest available ENERGY STAR specification and appliance calculator. The most recent TRM version should be referenced to determine measure savings for this measure.

$$Energy\ Savings\ [\Delta kWh] = kWh_{baseline} - kWh_{ES}$$

Equation 123

$$kWh_{baseline} = kWh_{conv,machine} + kWh_{conv,WH}$$

Equation 124

$$kWh_{conv,machine} = RUEC_{conv} \times MCF$$

Equation 125

$$kWh_{conv,WH} = RUEC_{conv} \times WHCF$$

Equation 126

$$kWh_{ES} = kWh_{ES,machine} + kWh_{ES,WH}$$

Equation 127

$$kWh_{ES,machine} = RUEC_{ES} \times MCF$$

Equation 128

$$kWh_{ES,WH} = RUEC_{ES} \times WHCF$$

Equation 129

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[471] ENERGY STAR® Dishwashers Final Version 6.0 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements.pdf.

[472] ENERGY STAR® Appliance Savings Calculator (updated October 2016). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

Where:

$kWh_{baseline}$ = *Federal standard baseline energy usage*

kWh_{ES} = *ENERGY STAR average energy usage*

$kWh_{conv,machine}$ = *Conventional machine energy*

$kWh_{conv,WH}$ = *Conventional water heater energy*

$kWh_{ES,machine}$ = *ENERGY STAR machine energy*

$kWh_{ES,WH}$ = *ENERGY STAR water heater energy*

$RUEC_{conv}$ = *Conventional rated use electricity consumption = 307 kWh/year for standard and 222 kWh/year for compact (Table 345)*

$RUEC_{ES}$ = *ENERGY STAR rated use electricity consumption = 270 kWh/year for standard and 203 kWh/year for compact (Table 346)*

MCF = *Machine consumption factor = 44 percent*

$WHCF$ = *Water heater consumption factor = 56 percent*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{AOH} \times CF_{S/W}$$

Equation 130

$$AOH = CPY \times d$$

Equation 131

Where:

AOH = *Annual operating hours*

$CF_{S/W}$ = *Seasonal peak coincidence factor = (Table 347)*

CPY = *Cycles per year = 215*

d = *Average wash cycle duration = 2.1 hours*[473]

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[473] Average of consumer reports cycle times for dishwashers.

Table 347. Dishwashers—Coincidence Factors[474]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.042	0.041	0.042	0.041	0.042
Winter	0.106	0.104	0.090	0.112	0.129

Deemed Energy Savings Tables

Table 348. Dishwashers—Energy Savings (kWh)

Product type	Electric DHW	Gas DHW
Standard	37	16
Compact	19	8

Deemed Summer Demand Savings Tables

Table 349. Dishwashers—Summer Peak Demand Savings (kW)

Dishwasher type	DHW fuel	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Standard	Electric	0.003	0.003	0.003	0.003	0.003
	Gas	0.002	0.001	0.002	0.001	0.002
Compact	Electric	0.002	0.002	0.002	0.002	0.002
	Gas	0.001	0.001	0.001	0.001	0.001

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[474] See Volume 1, Section 4.

Deemed Winter Demand Savings Tables

Table 350. Dishwashers—Winter Peak Demand Savings (kW)

Dishwasher type	DHW fuel	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Standard	Electric	0.009	0.009	0.007	0.009	0.011
	Gas	0.004	0.004	0.003	0.004	0.005
Compact	Electric	0.004	0.004	0.004	0.005	0.005
	Gas	0.002	0.002	0.002	0.002	0.002

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 15 years based on the Technical Support Document for the current DOE Final Rule standards for residential dishwashers.[475]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Manufacturer and model number
- Type of dishwasher (standard or compact)
- Fuel type of water heater (gas or electric)
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification

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[475] The median lifetime was calculated using the survival function outlined in the DOE Technical Support Document. Final Rule: Standards, Federal Register, 77 FR 31918 (May 30, 2012) and associated Technical Support Document. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=38&action=viewlive.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 351. Dishwashers—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin.
v2.0	4/18/2014	TRM v2.0 update. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	1/30/2015	TRM v2.1 update. No revision.
v3.0	4/10/2015	TRM v3.0 update. New ENERGY STAR specification incorporated into the measure. New peak savings calculated according to revised peak definition.
v3.1	11/05/2015	TRM v3.1 update. Final ENERGY STAR specification incorporated into the measure. Consolidated table formats.
v3.1	3/28/2016	TRM 3.1 March revision. Updated summer and winter coincidence factors and demand savings tables.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. Updated footnote reference to ENERGY STAR calculator.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Updated links and dates.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. No revision.
v10.0	10/2022	TRM v10.0 update. No revision.

2.5.5 ENERGY STAR® Refrigerators Measure Overview

TRM Measure ID: R-AP-RF

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure applies to all ENERGY STAR refrigerators that meet the criteria for the ENERGY STAR label specified below.

Eligibility Criteria

To qualify for early retirement, the ENERGY STAR unit must replace an existing, full-size unit with a maximum age of 20 years. To determine the remaining useful life of an existing unit, see Table 355. All retired refrigerators must be dismantled in an environmentally safe manner in accordance with applicable federal, state, and local regulations. The installer will provide documentation of proper disposal of refrigerators. To receive early retirement savings, the unit to be replaced must be functioning at the time of removal.

Newly installed refrigerators must meet current ENERGY STAR efficiency levels.

Baseline Condition

For new construction or replace-on-burnout, the baseline is the Department of Energy (DOE) minimum efficiency standard[476] for refrigerators, effective September 15, 2014.

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[476] DOE minimum efficiency standard for residential refrigerators and freezers. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43.

For early retirement, the baseline for refrigerators is the annual unit energy consumption of an assumed refrigerator's adjusted energy usage rating based on an average of values reported by the Midwest Energy Performance Analytics (MwEPA) Refrigerator and Freezer Energy Rating Database.[477] Since the federal standard effective date occurred in late 2014, existing units manufactured as of 2015 are not eligible for early retirement.

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 5.1 Requirements for eligible consumer refrigeration products effective September 15, 2014.[478] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 352. Refrigerators—ENERGY STAR Requirements

ENERGY STAR refrigerator		
Product type	**Volume**	**Criteria as of September 15, 2014**
Full-size refrigerators and refrigerator-freezers	7.75 cubic feet or greater	Approximately 10 percent more energy efficient than the minimum federal standard (see Table 353)

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[477] Refrigerator and Freezer Energy Rating Database. Midwest Energy Performance Analytics, Inc. in combination with the State of Wisconsin and US Department of Energy's Weatherization Assistance Program. https://www.energy.gov/eere/wap/articles/refrigerator-and-freezer-energy-rating-database-search-tool.

[478] ENERGY STAR® Consumer Refrigeration Products Final Version 5.1 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%205.1%20Consumer%20Refrigeration%20Products%20Final%20Specification_0.pdf.

Table 353. Refrigerators—Formulas to Calculate the Energy Usage by Product Class[479]

Product number	Product class	Baseline energy usage federal standard as of September 15, 2014 (kWh/year)[480]	Average ENERGY STAR energy usage (kWh/year)[481]	Adjusted volume[482] (cubic feet)	Baseline energy usage (kWh/year)	ENERGY STAR energy usage (kWh/year)
3	Refrigerator freezers—automatic defrost with top-mounted freezer without an automatic icemaker	8.07 × AV + 233.7	7.26 × AV + 210.3	16.9	370.1	333.0
5	Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	8.85 × AV + 317.0	7.97 × AV + 285.3	18.6	481.5	433.5
5A	Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	9.25 × AV + 475.4	8.33 × AV + 436.3	32.1	772.1	703.5
7	Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	8.54 × AV + 432.8	7.69 × AV + 397.9	30.4	692.1	631.4

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[479] Federal standard for refrigerators and freezers. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=37&action=viewlive. Select product classes excluded.

[480] http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf.

[481] Approximately ten percent more efficient than baseline, as specified in the ENERGY STAR® Appliance Savings Calculator (updated September 2015). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

[482] AV is calculated as a simple average across all refrigerators in the corresponding Product Class utilizing data provided by https://www.energystar.gov/productfinder/product/certified-residential-refrigerators/results.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

New Construction or Replace-on-Burnout

Energy Savings Algorithms

$$Energy\ Savings\ [\Delta kWh] = kWh_{baseline} - kWh_{ES}$$

Equation 132

Where:

$kWh_{baseline}$ = *Federal standard baseline energy usage (see Table 353)*

kWh_{ES} = *ENERGY STAR average energy usage (see Table 353)*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{8{,}760\ hrs} \times LSAF_{S/W}$$

Equation 133

Where:

$LSAF_{S/W}$ = *Seasonal load shape adjustment factor (see Table 354)*

Table 354. Refrigerators—Load Shape Adjustment Factors[483]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	1.112	1.099	1.108	1.100	1.081
Winter	0.929	0.966	0.924	0.941	0.966

Early Retirement

Annual energy (kWh) and peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL)

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[483] See Volume 1, Section 4.

Annual energy and peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 355); if unknown, assume the age of the replaced unit is equal to the EUL resulting in a default RUL of 5.0 years*

EUL = *Estimated useful life = 16 years*[484]

Table 355. Refrigerators—RUL of Replaced Unit [485]

Age of replaced refrigerator (years)	RUL (years)	Age of replaced refrigerator (years)	RUL (years)
1	15.2	12	7.0
2	14.2	13	6.6
3	13.2	14	6.3
4	12.2	15	6.0
5	11.2	16	5.0
6	10.3	17	4.0
7	9.6	18	3.0
8	8.9	19	2.0
9	8.3	20	1.0
10	7.8	21[486,487]	0.0
11	7.4		

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[484] Department of Energy, Federal Register, 76 Final Rule 57516, Technical Support Document: 8.2.3.1 Estimated Survival Function. September 15, 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43. Download TSD at: https://www.regulations.gov/document/EERE-2008-BT-STD-0012-0128.

[485] Current federal standard effective date is 9/15/2014. Since the federal standard effective date occurred in late 2014, existing units manufactured as of 2015 are not eligible to use the early retirement baseline and should use the ROB baseline instead.

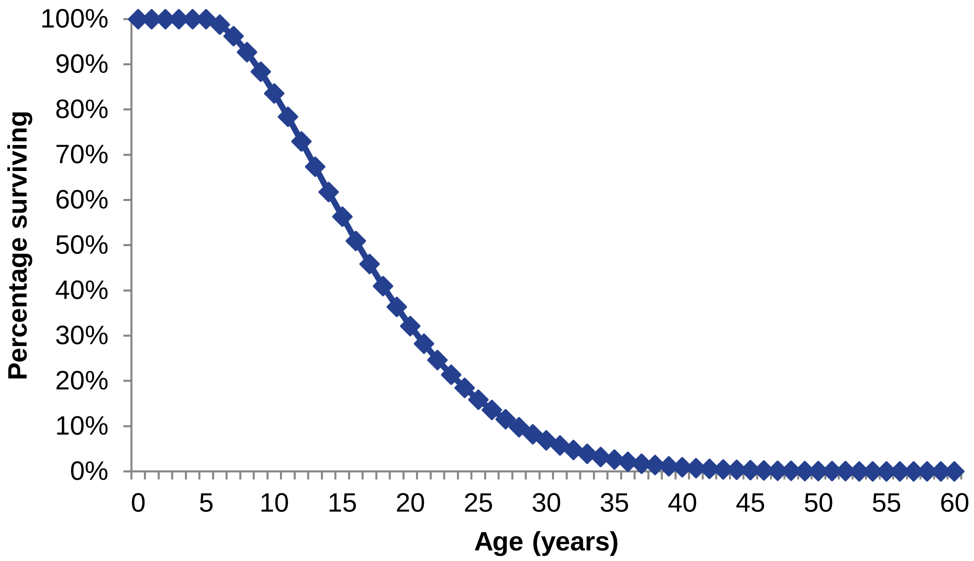
[486] RULs are capped at the 75th percentile of equipment age as determined based on DOE survival curves (see Figure 14). Systems older than this age should use the ROB baseline. See the January 2015 memo, "Considerations for early replacement of residential equipment," for further detail.

[487] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. "Considerations for early replacement of residential equipment." Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to all Texas investor-owned utilities through the EM&V team's SharePoint.

Derivation of RULs

ENERGY STAR refrigerators have an estimated useful life of 16 years. This estimate is consistent with the age at which approximately 50 percent of the refrigerators installed in a given year will no longer be in service, as described by the survival function in Figure 14.

Figure 14. Refrigerators—Survival Function[488]



The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 14. The age of the refrigerator being replaced is found on the horizontal axis, and the corresponding percentage of surviving refrigerators is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. Then, the age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

For example, assume a refrigerator being replaced is 15 years old. The corresponding percent surviving value is 56 percent. Half of 56 percent is 28 percent. The age corresponding to 28 percent on the chart is 21 years. Therefore, the RUL of the refrigerator being replaced is (21 – 15) = 6 years.

Energy Savings Algorithms

For the RUL time period:

$$kWh_{savings,ER} = kWh_{manf} - kWh_{ES}$$

Equation 134

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[488] Department of Energy, Federal Register, 76 Final Rule 57516, Technical Support Document: 8.2.3.1 Estimated Survival Function. September 15, 2011. http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/refrig_finalrule_tsd.pdf.

For the remaining time in the EUL period., calculate annual savings as you would for a replace-on-burnout project:

$$kWh_{savings,ROB} = kWh_{baseline} - kWh_{ES}$$

Equation 135

Where:

kWh_{manf} = *968 kWh/Year*[489]

Demand Savings Algorithms

To calculate demand savings for the early retirement of a refrigerator, a similar methodology is used as for replace-on-burnout installations, with separate savings calculated for the remaining useful life of the unit, and the remainder of the EUL as outlined in the section above.

For the RUL time period:

$$kW_{savings,ER} = \frac{kWh_{savings,ER}}{8{,}760\ hrs} \times LSAF_{S/W}$$

Equation 136

For the remaining time in the EUL period, calculate annual savings as you would for a replace-on-burnout project:

$$kW_{savings,ROB} = \frac{kWh_{savings,ROB}}{8{,}760\ hrs} \times LSAF_{S/W}$$

Equation 137

Annual deemed summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

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[489] This is the weighted average of Adjusted annual unit energy consumption, derived from the MwEPA Refrigerator and Freezer Energy Rating Database (or from metering). Weights are calculated from the millions-of-households measurements obtained from the Residential Energy Consumption Survey, or RECS, (https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.6.php) corresponding to the year range classifications of refrigerators greater than 15 years old (specifically, 15-to-19-years-old and 20-or-more-years-old). Data in which refrigerators' model years were older than 1975 were excluded.

Deemed Energy Savings Tables

Table 356. Refrigerators—Energy Savings (kWh)

Through-the-door ice?	Door type	Product class	ROB savings (kWh/year)	ER savings (kWh/year)
No	Top freezer	3: Refrigerator freezers—automatic defrost with a top-mounted freezer without an automatic icemaker	37	224
	Bottom freezer	5: Refrigerator-freezers—automatic defrost with a bottom-mounted freezer without an automatic icemaker	48	200
Yes	Bottom freezer	5A: Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	69	147
	Side-by-side	7: Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	61	130
Unknown or average refrigerator[490]			44	205

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[490] An “Unknown or Average” refrigerator’s savings are calculated as the difference between the weighted average of baseline energy usage ratings and the weighted average of ENERGY STAR® energy usage ratings for the four selected refrigerator categories, with weights ascertained from averages of refrigerators in 10–14-year-old, 5–9-year-old, and 2–4-year-old age groups. The data used to calculate weights is hosted by Natural Resources Canada (NRCAN) at the following link which contains a table of the distribution of refrigerator types in households by year: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CM&sector=aaa&juris=ca&rn=3&page=1. Weights were similarly calculated utilizing data from RECS (data, which is summarized, i.e., not yearly, and located here: https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.6.php). While the reported distribution of refrigerator types between the two sets of data varies, we prefer the year-level granularity of the data from NRCAN considering that the differences between both sets of weighted average baseline energy usage and weighted average ENERGY STAR® energy usage were nearly identical. Hence, we elect to utilize the more detailed weightings derived from the data hosted by NRCAN.

Deemed Summer Demand Savings Tables

Table 357. Refrigerators—Replace-on-Burnout – Summer Peak Demand Savings (kW)

Through-the-door ice?	Door type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
No	Top freezer	3: Refrigerator freezers—automatic defrost with top-mounted freezer without an automatic icemaker	0.0047	0.0047	0.0047	0.0047	0.0046
	Bottom freezer	5: Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	0.0061	0.0060	0.0061	0.0060	0.0059
Yes	Bottom freezer	5A: Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	0.0087	0.0086	0.0087	0.0086	0.0085
	Side-by-side	7: Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	0.0077	0.0076	0.0077	0.0076	0.0075
Unknown or average refrigerator			0.0056	0.0056	0.0056	0.0056	0.0055

Table 358. Refrigerators—Early Retirement—Summer Peak Demand Savings (kW)

Through-the-door ice?	Door type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
No	Top freezer	3: Refrigerator freezers—automatic defrost with top-mounted freezer without an automatic icemaker	0.028	0.028	0.028	0.028	0.028
	Bottom freezer	5: Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	0.025	0.025	0.025	0.025	0.025
Yes	Bottom freezer	5A: Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	0.016	0.016	0.016	0.016	0.016
	Side-by-side	7: Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	0.019	0.018	0.019	0.018	0.018
Unknown or average refrigerator			0.026	0.026	0.026	0.026	0.025

Deemed Winter Demand Savings Tables

Table 359. Refrigerators—Replace-on-Burnout—Winter Peak Demand Savings (kW)

Through-the-door ice?	Door type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
No	Top freezer	3: Refrigerator freezers—automatic defrost with top-mounted freezer without an automatic icemaker	0.0039	0.0041	0.0039	0.0040	0.0041
	Bottom freezer	5: Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	0.0051	0.0053	0.0051	0.0052	0.0053
Yes	Bottom freezer	5A: Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	0.0073	0.0076	0.0072	0.0074	0.0076
	Side-by-side	7: Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	0.0064	0.0067	0.0064	0.0065	0.0067
Unknown or average refrigerator			0.0047	0.0049	0.0047	0.0048	0.0049

Table 360. Refrigerators—Early Retirement—Winter Peak Demand Savings (kW)

Through-the-door ice?	Door type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
No	Top freezer	3: Refrigerator freezers—automatic defrost with top-mounted freezer without an automatic icemaker	0.024	0.025	0.024	0.024	0.025
	Bottom freezer	5: Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker	0.021	0.022	0.021	0.021	0.022
Yes	Bottom freezer	5A: Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker with TTD ice service	0.014	0.014	0.014	0.014	0.014
	Side-by-side	7: Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker with TTD ice service	0.016	0.016	0.015	0.016	0.016
Unknown or average refrigerator			0.022	0.023	0.022	0.022	0.023

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 16 years based on the current DOE Final Rule standards for residential refrigerators.[491]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Baseline type (new construction, replace-on-burnout, or early retirement)
- Manufacturer and model number
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only)
- Document proper disposal of the existing refrigerator (early retirement only)
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

Not applicable.

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[491] Final Rule: Standards, Federal Register, 76 FR 57516 (Sept. 15, 2011) and associated Technical Support Document. http://www1.eere.energy.gov/buildings/appliance_sta https://www.regulations.gov/document/EERE-2008-BT-STD-0012-0128 ndards/product.aspx/productid/43. Download TSD at: http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0012-0128.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 361. Refrigerators—Revision History

TRM version	Date	Description of change
v1.0	11/25/2013	TRM v1.0 origin
v2.0	4/18/2014	TRM v2.0 update. Low-income and hard-to-reach Market Transformation section merged with the main measure as "early retirement" option. Updated by Frontier Energy, March 2014, based on new federal standards.
v2.1	1/30/2015	TRM v2.1 update. New ENERGY STAR standards incorporated.
v3.0	4/10/2015	TRM v3.0 update. early retirement savings may be claimed through any appropriately designed program in accordance with the EM&V team's memo, "Considerations for early replacement of residential equipment." Remaining useful lifetimes updated. LSAF updated to align with new peak demand methodology.
v3.1	11/05/2015	TRM v3.1 update. Correction to legacy LSAF. Revision to align with ENERGY STAR calculator and specification.
v3.1	3/28/2016	TRM v3.1 March revision. Updated summer and winter coincidence factors.
v4.0	10/10/2016	TRM v4.0 update. Updated RUL value for units with the age of seven years and added RUL values for units with an age of one to five years. Added a default RUL value for when the age of the unit is unknown. Eliminated the eligibility requirement of the existing unit to have an age of minimum of five years.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. Updated database reference.
v7.0	10/2019	TRM v7.0 update. Established deemed savings approach.
v8.0	10/2020	TRM v8.0 update. Updated early retirement age eligibility.
v9.0	10/2021	TRM v9.0 update. Updated early retirement age eligibility.
v10.0	10/2022	TRM v10.0 update. Updated early retirement age eligibility.

2.5.6 ENERGY STAR® Freezers Measure Overview

TRM Measure ID: R-AP-FZ

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure applies to all ENERGY STAR freezers that meet the criteria for the ENERGY STAR label specified below.

Eligibility Criteria

To qualify for early retirement, the ENERGY STAR unit must replace an existing, full-size unit with a maximum age of 27 years. To determine the remaining useful life of an existing unit, see Table 365. All retired freezers must be dismantled in an environmentally safe manner in accordance with applicable federal, state, and local regulations. The installer will provide documentation of proper disposal of freezers. In order to receive early retirement savings, the unit to be replaced must be functioning at the time of removal.

Newly-installed freezers must meet current ENERGY STAR efficiency levels.

Baseline Condition

For new construction or replace-on-burnout, the baseline is the Department of Energy (DOE) minimum efficiency standard[492] for freezers, effective September 15, 2014.

For early retirement, the baseline for freezers is the annual unit energy consumption of a freezer's adjusted energy usage rating based on an average of values reported by the Midwest Energy Performance Analytics (MwEPA) Refrigerator and Freezer Energy Rating Database.[493]

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[492] DOE minimum efficiency standard for residential refrigerators and freezers. https://www.ecfr.gov/cgi-bin/text-idx?SID=48f64e166fe3561666f871e521996e13&mc=true&node=se10.3.430_132&rgn=div8.

[493] Refrigerator and Freezer Energy Rating Database. Midwest Energy Performance Analytics, Inc. in combination with the State of Wisconsin and US Department of Energy's Weatherization Assistance Program. https://www.energy.gov/eere/wap/articles/refrigerator-and-freezer-energy-rating-database-search-tool.

Since the federal standard effective date occurred in late 2014, existing units manufactured as of 2015 are not eligible for early retirement.

Alternatively, the baseline annual energy usage of the freezer being replaced may be estimated by metering for a period of at least two hours using the measurement protocol specified in the DOE report, "Incorporating Refrigerator Replacement into the Weatherization Assistance Program."[494]

To determine annual kWh of the freezer being replaced, use the following formula:

$$Annual\ kWh\ Usage = \frac{WH \times 8{,}760}{h \times 1{,}000}$$

Equation 138

Where:

WH = *Watt-hours metered during a time period*

h = *Measurement time period (hours)*

8,760 = *Total hours per year*

1,000 = *Constant to convert from W to kW*

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 5.1 Requirements for eligible consumer refrigeration products effective September 15, 2014.[495] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Table 362. Freezers—ENERGY STAR Requirements[496]

ENERGY STAR freezer		
Product type	**Volume**	**Criteria as of September 15, 2014**
Freezers	7.75 cubic feet or greater	Approximately ten percent more energy efficient than the minimum federal standard (see Table 353)
Compact freezers	Less than 7.75 cubic feet	Approximately ten percent more energy efficient than the minimum federal standard (see Table 353)

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[494] Alex Moore, DandR International, Ltd. "Incorporating Refrigerator Replacement into the Weatherization Assistance Program" Information Tool Kit." Department of Energy. November 19, 2001. https://aceee.org/files/proceedings/2002/data/papers/SS02_Panel2_Paper16.pdf.

[495] ENERGY STAR® Consumer Refrigeration Products Final Version 5.1 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%205.1%20Consumer%20Refrigeration%20Products%20Final%20Specification_0.pdf.

[496] https://www.energystar.gov/products/appliances/refrigerators/key_product_criteria.

Table 363. Freezers—Formulas to Calculate the Energy Usage by Product Class[497]

Product number	Full product name[498]	Product class	Baseline energy usage federal standard (kWh/year)[499]	Average ENERGY STAR energy usage (kWh/year)[500]	Adjusted volume[501] (cubic feet)	Baseline energy usage (kWh/year)	ENERGY STAR energy usage (kWh/year)
8	Upright freezers with manual defrost	Upright (manual defrost)	5.57 × AV + 193.7	5.01 × AV + 174.3	16.12	283.5	255.1
9	Upright freezers with automatic defrost without an automatic icemaker	Upright (auto defrost)	8.62 × AV + 228.3	7.76 × AV + 205.5	29.96	486.6	438.0
10	Chest freezers and all other freezers except compact freezers	Chest	7.29 × AV + 107.8	6.56 × AV + 97	25.25	291.8	262.6
16	Compact upright freezers with manual defrost	Compact upright (manual defrost)	8.65 × AV + 225.7	7.79 × AV + 203.1	5.34	271.9	244.7
17	Compact upright freezers with automatic defrost	Compact upright (auto defrost)	10.17 × AV + 351.9	9.15 × AV + 316.7	7.95	432.7	389.4
18	Compact chest freezers	Compact chest	9.25 × AV + 136.8	8.33 × AV + 123.1	9.06	220.6	198.6

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[497] Federal standard for refrigerators and freezers. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=37&action=viewlive. Select product classes excluded.

[498] Note that when calculating deemed savings for upright freezers, we calculated a weighted average of adjusted energy usage of manual versus automatic defrost upright freezers, with weights based on the number of millions-of-households which contain these types of freezers, obtained from the Residential Energy Consumption Survey, or RECS, (https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.6.php), thus eliminating this input from consideration.

[499] https://www.ecfr.gov/cgi-bin/text-idx?SID=48f64e166fe3561666f871e521996e13&mc=true&node=se10.3.430_132&rgn=div8.

[500] Approximately 10 percent more efficient than baseline, as specified in the ENERGY STAR® Appliance Savings Calculator (updated September 2015). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

[501] AV is calculated as a simple average per selected freezer product type in the corresponding Product Class utilizing data provided by https://www.energystar.gov/productfinder/product/certified-residential-freezers/results.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

New Construction or Replace-on-Burnout

Energy Savings Algorithms

$$Energy\ Savings\ [\Delta kWh] = kWh_{baseline} - kWh_{ES}$$

Equation 139

Where:

$kWh_{baseline}$ = *Federal standard baseline energy usage (see Table 363)*

kWh_{ES} = *ENERGY STAR average energy usage (see Table 363)*

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{8{,}760\ hrs} \times LSAF_{S/W}$$

Equation 140

Where:

$LSAF_{S/W}$ = *Seasonal load shape adjustment factor (see Table 364)*

Table 364. Freezers—Load Shape Adjustment Factors[502]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	1.112	1.099	1.108	1.100	1.081
Winter	0.929	0.966	0.924	0.941	0.966

Early Retirement

Annual energy (kWh) and peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL)

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[502] See Volume 1, Section 4.

Annual energy and peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL = *Remaining useful life (see Table 365); if unknown, assume the age of the replaced unit is equal to the EUL resulting in a default RUL of 5.0 years*

EUL = *Estimated useful life = 22 years*[503]

Table 365. Freezers—RUL of Replaced Unit [504]

Age of replaced freezer (years)	RUL (years)	Age of replaced freezer (years)	RUL (years)	Age of replaced freezer (years)	RUL (years)
1	20.7	10	12.1	19	6.6
2	19.7	11	11.3	20	6.2
3	18.7	12	10.6	21	5.9
4	17.7	13	9.9	22	5.0
5	16.7	14	9.2	23	4.0
6	15.7	15	8.6	24	3.0
7	14.8	16	8.1	25	2.0
8	13.8	17	7.5	26	1.0
9	13.0	18	7.1	27[505,506]	0.0

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[503] Department of Energy, Federal Register, 76 Final Rule 57516, Technical Support Document: 8.2.3.1 Estimated Survival Function. September 15, 2011. Download TSD at: https://www.regulations.gov/document/EERE-2008-BT-STD-0012-0128.

[504] Current federal standard effective date is 9/15/2014. Since the federal standard effective date occurred in late 2014, existing units manufactured as of 2015 are not eligible to use the early retirement baseline and should use the ROB baseline instead.

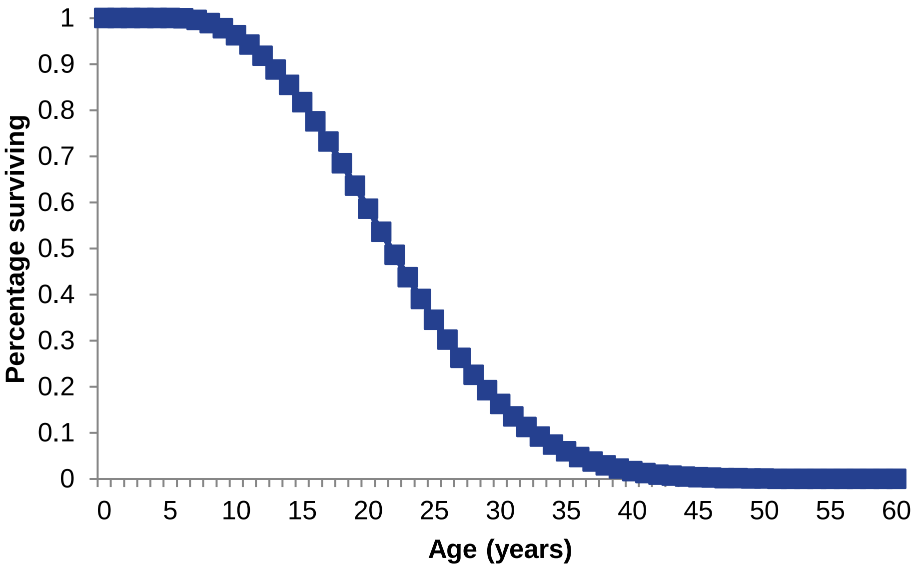
[505] RULs are capped at the 75th percentile of equipment age as determined based on DOE survival curves (see Figure 14). Systems older than this age should use the ROB baseline. See the January 2015 memo, “Considerations for early replacement of residential equipment,” for further detail.

[506] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. “Considerations for early replacement of residential equipment.” Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to all Texas investor-owned utilities through the EM&V team’s SharePoint.

Derivation of RULs

ENERGY STAR freezers have an estimated useful life of 22 years. This estimate is consistent with the age at which approximately 50 percent of the freezers installed in a given year will no longer be in service, as described by the survival function in Figure 15.

Figure 15. Freezers—Survival Function[507]



The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 15. The age of the freezer being replaced is found on the horizontal axis, and the corresponding percentage of surviving freezers is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. Then, the age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

For example, assume a freezer being replaced is 22 years old (the estimated useful life). The corresponding percent surviving value is approximately 50 percent. Half of 50 percent is 25 percent. The age corresponding to 25 percent on the chart is approximately 27 years. Therefore, the RUL of the freezer being replaced is 27 – 22 = 5 years.

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[507] Department of Energy, Federal Register, 76 Final Rule 57516, Technical Support Document: 8.2.3.1 Estimated Survival Function. September 15, 2011. http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/refrig_finalrule_tsd.pdf.

Energy Savings Algorithms

For the RUL time period:

$$kWh_{savings,ER} = kWh_{manf} - kWh_{ES}$$

Equation 141

For the remaining time in the EUL period., calculate annual savings as you would for a replace-on-burnout project:

$$kWh_{savings,ROB} = \; kWh_{baseline} - kWh_{ES}$$

Equation 142

Where:

kWh_{manf} = *841 kWh/Year*[508]

Demand Savings Algorithms

To calculate demand savings for the early retirement of a freezer, a similar methodology is used as for replace-on-burnout installations, with separate savings calculated for the remaining useful life of the unit, and the remainder of the EUL as outlined in the section above.

For the RUL time period:

$$kW_{savings,ER} = \frac{kWh_{savings,ER}}{8{,}760\; hrs} \times LSAF_{S/W}$$

Equation 143

For The remaining time in the EUL period., calculate annual savings as you would for a replace-on-burnout project:

$$kW_{savings,ROB} = \frac{kWh_{savings,ROB}}{8{,}760\; hrs} \times LSAF_{S/W}$$

Equation 144

Annual deemed summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

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[508] This is the weighted average of adjusted annual unit energy consumption, a metric obtained from the MwEPA Refrigerator and Freezer Energy Rating Database (if from metering, substitute recorded value in lieu of this weighted average). Weights are calculated from the millions-of-households measurements obtained from RECS, (https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.6.php) corresponding to the year range classifications of freezers greater than 15 years old (specifically, 15-to-19-years-old and 20-or-more-years-old). The oldest freezers for which we had data were from 1979.

Deemed Energy Savings Tables

Table 366. Freezers—Savings (kWh)

Freezer type	Size	ROB savings (kWh)	ER savings (kWh)
Chest	Standard (≥ 7.75 ft^3)	29	154
	Compact (< 7.75 ft^3)	22	163
Upright	Standard (≥ 7.75 ft^3)	48	130
	Compact (< 7.75 ft^3)	32	151

Deemed Summer Demand Savings Tables

Table 367. Freezers—Replace-on-Burnout—Summer Peak Demand Savings (kW)

Freezer type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Chest	Standard (≥ 7.75 ft^3)	0.004	0.004	0.004	0.004	0.004
	Compact (< 7.75 ft^3)	0.003	0.003	0.003	0.003	0.003
Upright	Standard (≥ 7.75 ft^3)	0.006	0.006	0.006	0.006	0.006
	Compact (< 7.75 ft^3)	0.004	0.004	0.004	0.004	0.004

Table 368. Freezers—Early Retirement—Summer Peak Demand Savings (kW)

Freezer type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Chest	Standard (≥ 7.75 ft^3)	0.020	0.019	0.019	0.019	0.019
	Compact (< 7.75 ft^3)	0.021	0.020	0.021	0.020	0.020
Upright	Standard (≥ 7.75 ft^3)	0.017	0.016	0.016	0.016	0.016
	Compact (< 7.75 ft^3)	0.019	0.019	0.019	0.019	0.019

Deemed Winter Demand Savings Tables

Table 369. Freezers—Replace-on-Burnout—Winter Peak Demand Savings (kW)

Freezer type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Chest	Standard (≥ 7.75 ft^3)	0.003	0.003	0.003	0.003	0.003
	Compact (< 7.75 ft^3)	0.002	0.002	0.002	0.002	0.002
Upright	Standard (≥ 7.75 ft^3)	0.005	0.005	0.005	0.005	0.005
	Compact (< 7.75 ft^3)	0.003	0.003	0.003	0.003	0.003

Table 370. Freezers—Early Retirement—Winter Peak Demand Savings (kW)

Freezer type	Product class	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Chest	Standard (≥ 7.75 ft^3)	0.016	0.017	0.016	0.017	0.017
	Compact (< 7.75 ft^3)	0.017	0.018	0.017	0.018	0.018
Upright	Standard (≥ 7.75 ft^3)	0.014	0.014	0.014	0.014	0.014
	Compact (< 7.75 ft^3)	0.016	0.017	0.016	0.016	0.017

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 22 years based on the current DOE Final Rule standards for residential freezers.[509]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Baseline type (new construction, replace-on-burnout, or early retirement)
- Manufacturer and model number
- Freezer type (upright or chest)
- Freezer size (standard, i.e., ≥ 7.75 ft^3, or compact, i.e., < 7.75 ft^3)
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only)
- The installer will provide documentation of proper disposal of freezers in accordance with applicable federal, state, and local regulations (early retirement only)
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification

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[509] Final Rule: Standards, Federal Register, 76 FR 57516 (Sept. 15, 2011) and associated Technical Support Document. https://www.ecfr.gov/cgi-bin/text-idx?SID=48f64e166fe3561666f871e521996e13&mc=true&node=se10.3.430_132&rgn=div8. Download TSD at: https://www.regulations.gov/document/EERE-2008-BT-STD-0012-0128.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 371. Freezers—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. Updated early retirement age eligibility.
v9.0	10/2021	TRM v9.0 update. Updated early retirement age eligibility.
v10.0	10/2022	TRM v10.0 update. Updated early retirement age eligibility.

2.5.7 Refrigerator/Freezer Recycling Measure Overview

TRM Measure ID: R-AP-RR

Market Sector: Residential

Measure Category: Appliance Recycling

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early retirement

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves early retirement and recycling of an existing, full-size (7.75 ft^3 or greater) refrigerator or combined refrigerator/freezer in a residential application. Savings represent the entire estimated energy consumption of the existing unit and are applicable over the estimated remaining life of the existing unit.

Eligibility Criteria

This measure applies to operable primary and secondary retired refrigerators/freezers. Recycling savings for this measure are limited to the removal of a working refrigerator/freezer from the electrical grid and differ from the savings specified in the ENERGY STAR Refrigerator replacement measure. The latter, which pertain to the direct replacement of a refrigerator and reflect the difference in energy consumption between new ENERGY STAR qualifying and standard efficiency models, may be claimed for the recycling of primary refrigerators/freezers that have been replaced if savings for that replacement were not already claimed in another energy efficiency program. To qualify, the customer must release the existing unit to the utility or utility representative to ensure proper disposal in accordance with applicable federal, state, and local regulations.

Baseline Condition

Without program intervention, the recycled refrigerator or refrigerator/freezer would have remained operable on the electrical grid. As a result, the baseline condition for early retirement programs is continued operation of the existing refrigerator.

High-Efficiency Condition

There is no efficiency standard for a recycling measure because the energy efficient action is the removal of an operable appliance, not—as with most demand-side management programs—the installation of a higher efficiency model.

Energy and Demand Savings Methodology

The basis for estimating energy savings is the annual energy consumption of the refrigerator or refrigerator/freezer being retired.

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings are calculated as follows:

$$Energ\ Savings\ [\Delta kWh] = kWh_{existing} \times ISAF \times PUF$$

Equation 145

Where:

$kWh_{existing}$ = *Average annual energy consumption*[510] *(see Table 372)*

$ISAF$ = *In situ adjustment factor*[511] *= 0.942*

PUF = *Part use factor*[512] *= 0.915*

Table 372. Refrigerator/Freezer Recycling—Average Annual Energy Consumption

Total capacity (ft^3)	Year manufactured	$kWh_{existing}$ by freezer configuration				
		Top	Bottom	Side	Upright	Chest
< 16.5	< 2000	861	962	1,139	937	532
	2001-2010	556	724	747	713	435
	> 2011	374	483	592	449	292

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[510] ENERGY STAR Flip Your Fridge Calculator. https://www.energystar.gov/index.cfm?fuseaction=refrig.calculator.

[511] The Cadmus Group, Inc. "Residential Retrofit High Impact Measure Evaluation Report". Prepared for California Public Utilities Commission Energy Division. February 8, 2010. Factor to account for variation between site conditions and controlled DOE testing conditions (90 °F test chamber, empty refrigerator and freezer cabinets, and no door openings). Appliances in warmer climate zones use more energy than those in cooler climate zones; utilized SCE data (highest percentage of warm climate projects) to best approximate Texas climate, p. 139-140.

[512] Ibid. Factor to account for the number of refrigerators that were running, running part time, or not running at the time of recycling, p. 142-143 (weighted by representative utility survey participation, p. 117).

Total capacity (ft^3)	Year manufactured	$kWh_{existing}$ by freezer configuration				
		Top	Bottom	Side	Upright	Chest
16.5-18.9	≤ 2000	962	1,051	1,266	1,058	621
	2001-2010	613	747	818	805	508
	≥ 2011	412	517	640	507	341
19.0-21.4	≤ 2000	1,031	1,110	1,329	1,138	680
	2001-2010	651	762	854	866	557
	≥ 2011	438	539	664	545	373
21.5-24.4	≤ 2000	1,090	1,172	1,368	1,194	721
	2001-2010	683	777	876	909	591
	≥ 2011	459	562	679	572	396
≥ 24.5	≤ 2000	1,223	1,347	1,528	1,355	840
	2001-2010	758	822	966	1,031	688
	≥ 2011	508	627	740	648	461

Demand Savings Algorithms

Summer peak demand savings are calculated as follows:

$$Peak\ Demand\ Savings\ [\Delta \mathrm{kW}] = \frac{\Delta kWh}{AOH} \times LSAF_{S/W}$$

Equation 146

Where:

AOH = *Annual operating hours = 8,760 hours*

$LSAF_{S/W}$ = *Seasonal load shape adjustment factor (see Table 373)*

Table 373. Refrigerator/Freezer Recycling—Load Shape Adjustment Factors[513]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	1.112	1.099	1.108	1.100	1.081
Winter	0.929	0.966	0.924	0.941	0.966

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[513] See Volume 1, Appendix B.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

Based on the KEMA Residential Refrigerator Recycling Ninth Year Retention Study,[514] the Estimated Useful Life of Refrigerator Recycling is 8 years, representing the assumed remaining useful life of the retired unit.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Number of refrigerators/freezers removed
- Year removed unit manufactured
- Total capacity (in cubic feet)
- Freezer configuration (top, bottom, side-by-side, upright, or chest)

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[514] KEMA, Inc. “Residential Refrigerator Recycling Ninth Year Retention Study.” Prepared for Southern California Edison Company. July 22, 2004.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 42212. Petition of El Paso Electric Company to Approve Revisions to the Deemed Savings for the Appliance Recycling Market Transformation program. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 374. Refrigerator/Freezer Recycling—Revision History

TRM version	Date	Description of change
v2.1	1/30/2015	TRM v2.1 origin.
v3.0	4/10/2015	TRM v3.0 update. LSAF updated to align with new peak demand methodology.
v3.1	11/05/2015	TRM v3.1 update. No revision.
v3.1	3/28/2016	TRM v3.1 March revision. Updated summer and winter coincidence factors.
v4.0	10/10/2016	TRM v4.0 update. No revision.
v5.0	10/2017	TRM v5.0 update. No revision.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated baseline energy consumption.
v9.0	10/2021	TRM v9.0 update. Correct deemed ranges for refrigerator volume.
v10.0	10/2022	TRM v10.0 update. No revision.

2.5.8 ENERGY STAR® Air Purifiers Measure Overview

TRM Measure ID: R-AP-AP

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR air purifier. Savings are awarded at a flat per-unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

This measure applies to floor, tabletop, and wall-mounted air purifiers/room air cleaners.

Baseline Condition

The baseline condition is defined as 1.0 cfm/W for a conventional air purifier unit's efficiency, a value from EPA research conducted in 2011, as cited in the previous October 2016 ENERGY STAR Appliance Savings Calculator.

High-Efficiency Condition

The table below displays the ENERGY STAR Final Version 2.0 Requirements for eligible room air cleaners effective October 17, 2020, and revised May 2022.[515] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[515] ENERGY STAR® Room Air Cleaners Final Version 2.0 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%202.0%20Room%20Air%20Cleaners%20Specification%20%28Rev.%20May%202022%29_0.pdf.

Table 375. Air Purifiers—ENERGY STAR Requirements

Smoke CADR	Minimum CADR/W
30–99	1.9
100–149	2.4
150+	2.9

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure were derived using the ENERGY STAR Appliance Savings Calculator and the revised ENERGY STAR specification in Table 346.[516] Default baseline standby power and clean air delivery rate (CADR) efficiency (CADR/W) values were taken from the ENERGY STAR calculator. ENERGY STAR standby power, CADR, and CADR/W are averages from the ENERGY STAR qualified product listing. Baseline CADR is assumed to be equivalent to ENERGY STAR CADR.

This measure will be updated to comply with the latest available ENERGY STAR specification and appliance calculator. It will also periodically be updated to comply with the latest updates to the ENERGY STAR qualified product listing.

$$Energy\ Savings\ [\Delta kWh] = \ (kWh_{baseline,OP} + kWh_{baseline,SB}) - (kWh_{ES,OP} + kWh_{ES,SB})$$

Equation 147

$$kWh_{baseline,OP} = \left(\frac{CADR_{baseline}}{\eta_{baseline}}\right)/1{,}000 \times hours \times days$$

Equation 148

$$kWh_{baseline,SB} = (8{,}760 - hours \times days) \times \frac{W_{baseline,SB}}{1{,}000}$$

Equation 149

$$kWh_{ES,OP} = \left(\frac{CADR_{ES}}{\eta_{ES}}\right)/1{,}000 \ \times hours \times days$$

Equation 150

$$kWh_{ES,SB} = \ (8{,}760 - hours \times days) \times \frac{W_{ES,SB}}{1{,}000}$$

Equation 151

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[516] ENERGY STAR® Appliance Savings Calculator (updated October 2016). The previously cited URL is no longer available, but a copy of the calculator can be provided upon request.

Where:

$kWh_{baseline,OP}$ = Baseline/conventional operating energy usage

$kWh_{baseline,SB}$ = Baseline/conventional standby energy usage

$kWh_{ES,OP}$ = ENERGY STAR average operating energy usage

$kWh_{ES,SB}$ = ENERGY STAR average standby energy usage

$CADR_{baseline}$ = Baseline unit clean air delivery rate (cu ft/min), assume equivalent to $CADR_{ES}$

$CADR_{ES}$ = ENERGY STAR unit clean air delivery rate (cu ft/min) (see Table 377)

$\eta_{baseline}$ = Baseline clean air delivery efficiency = 1.0 cfm/W

η_{ES} = ENERGY STAR air delivery efficiency (cfm/W) (see Table 377)

hours = Average hours of operation per day = 16

days = Average days of operation per year = 365

$W_{baseline,SB}$ = Conventional model standby power = 1.0 W

$W_{ES,SB}$ = ENERGY STAR model standby power = 0.6 W

1,000 = Constant to convert from W to kW

8,760 = Total hours per year

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh}{hours \times days} \times CF_{S/W}$$

Equation 152

Where:

$CF_{S/W}$ = Seasonal peak coincidence factor (see Table 376)

Table 376. Air Purifiers—Coincidence Factors[517]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.636	0.617	0.631	0.620	0.564
Winter	0.882	0.907	0.829	0.876	0.926

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[517] See Volume 1, Section 4.

Deemed Energy Savings Tables

Table 377. Air Purifiers—Energy Savings (kWh)

Smoke CADR range (cu ft/min)	ENERGY STAR QPL Average Smoke CADR	ENERGY STAR QPL Average Smoke CADR/W	kWh savings
30–99	75	3.0	296
100–149	129	4.3	580
150–199	171	4.6	784
200–249	225	4.4	1,021
250–299	275	5.7	1,326
300+	375	5.5	1,795

Deemed Summer Demand Savings Tables

Table 378. Air Purifiers—Summer Peak Demand Savings (kW)

Smoke CADR range (cu ft/min)	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
30–99	0.032	0.031	0.032	0.031	0.029
100–149	0.063	0.061	0.063	0.062	0.056
150–199	0.085	0.083	0.085	0.083	0.076
200–249	0.111	0.108	0.110	0.108	0.099
250–299	0.144	0.140	0.143	0.141	0.128
300+	0.195	0.190	0.194	0.191	0.174

Deemed Winter Demand Savings Tables

Table 379. Air Purifiers—Winter Peak Demand Savings (kW)

Smoke CADR range (cu ft/min)	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
30–99	0.045	0.046	0.042	0.044	0.047
100–149	0.088	0.090	0.082	0.087	0.092
150–199	0.119	0.122	0.111	0.118	0.124
200–249	0.154	0.159	0.145	0.153	0.162
250–299	0.200	0.206	0.188	0.199	0.210
300+	0.271	0.279	0.255	0.269	0.285

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 9 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID RES-AirCleaner.[518]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone
- Unit quantity
- Manufacturer and model number
- Smoke clean air delivery rate (CADR) in cu ft/min (cfm)
- Proof of purchase – including date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

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[518] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 380. Air Purifiers—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Final Version 2.0 Requirements. Updated dust CADR references to refer to smoke CADR. Updated deemed savings ranges and values.

2.5.9 ENERGY STAR® Pool Pumps Measure Overview

TRM Measure ID: R-AP-PP

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves the replacement of a single-speed pool pump with an ENERGY STAR-certified variable-speed or multi-speed pool pump.

Eligibility Criteria

This measure applies to all residential applications of in-ground pools or above-ground pools. Pools that serve multiple tenants in a common area are not eligible for this measure. Ineligible pump products include waterfall, integral cartridge filter, integral sand filter, storable electric spa, and rigid electric spa.[519]

Multi-speed pool pumps are an alternative to variable speed pumps. The multi-speed pump uses an induction motor that functions as two motors in one, with full-speed and half-speed options. Multi-speed pumps may enable significant energy savings. However, if the half-speed motor is unable to complete the required water circulation task, the larger motor will operate exclusively. Having only two speed-choices limits the ability of the pump motor to fine-tune the flow rates required for maximum energy savings.[520] Therefore, multi-speed pumps must have a high-speed override capability to revert back to low speed after a period not to exceed 24 hours.

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[519] These product types are excluded by the ENERGY STAR® specification. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%203.1%20Pool%20Pumps%20Final%20Specification_0.pdf.

[520] Hunt, A. and Easley, S., 2012, "Measure Guideline: Replacing Single-Speed Pool Pumps with Variable Speed Pumps for Energy Savings." Building America Retrofit Alliance (BARA), US DOE. May 2012. http://www.nrel.gov/docs/fy12osti/54242.pdf.

Baseline Condition

The baseline condition is a 1 to 5 horsepower (hp) standard efficiency[521] single-speed pool pump. This measure is only applicable to retrofit applications. New construction applications are not eligible as of July 19, 2021.[522]

High-Efficiency Condition

The high-efficiency condition is a 1 to 5 hp variable speed pump (VSP) or multi-speed pool pump that is compliant with the ENERGY STAR Final Version 3.1 Requirements for pool pumps effective July 19, 2021.[523] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

Energy and Demand Savings Methodology

Savings for this measure are based on methods and input assumptions from the ENERGY STAR Pool Pump Savings Calculator.

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure were derived using the ENERGY STAR Pool Pump Savings Calculator with Texas selected as the applicable location, so Texas-specific assumptions were used.[524]

$$Energy\ Savings\ [\Delta kWh] = kWh_{conv} - kWh_{ES}$$

Equation 153

Where:

kWh_{conv} = *Conventional single-speed pool pump energy (kWh)*

kWh_{ES} = *ENERGY STAR variable speed pool pump energy (kWh)*

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[521] The US DOE passed minimum efficiency standards for pool pumps effective July 19, 2021. These new baseline standards will be incorporated into TRM 10.0 to allow for sell down of existing inventory.

[522] Federal standard for dedicated-purpose pool pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=67.

[523] ENERGY STAR® Pool Pumps Final Version 3.1 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%203.1%20Pool%20Pumps%20Final%20Specification_0.pdf.

[524] The ENERGY STAR® Pool Pump Savings Calculator, updated February 2013, can be found on the ENERGY STAR® website at: https://www.energystar.gov/productfinder/product/certified-pool-pumps/results.

Algorithms to calculate the above parameters are defined as:

$$kWh_{conv} = \frac{PFR_{conv} \times 60 \times hours \times days}{EF_{conv} \times 1{,}000}$$

Equation 154

$$kWh_{ES} = \frac{V \times TO \times days}{EF_{ES} \times 1{,}000}$$

Equation 155

Where:

PFR_{conv} = *Conventional single-speed pump flow rate [gal/min] (Table 381)*

EF_{conv} = *Conventional single-speed pump energy factor [gal/W x hr] (Table 381)*

EF_{ES} = *ENERGY STAR pump energy factor [gal/W x hr] (Table 382)*

hours = *Pump daily operating hours (Table 381)*

days = *Operating days per year = 365 days (default)*

V = *Pool volume [gal] (Table 381)*

TO = *Turnovers per day, number of times the volume of the pool is run through the pump per day (Table 382)*

60 = *Constant to convert between minutes and hours*

1,000 = *Constant to convert from W to kW*

Table 381. Pool Pumps—Conventional Unit Assumptions[525]

New pump HP	Hours[526]	PFR_{conv}(gal/min)	EF_{conv} (gal/W·h)
≤ 1.25	9.1062	75.5000	2.5131
1.25 < hp ≤ 1.75		78.1429	2.2677
1.75 < hp ≤ 2.25		88.6667	2.2990
2.25 < hp ≤ 2.75		93.0910	2.1812
2.75 < hp ≤ 5		101.6667	1.9987

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[525] Conventional pump PFR and EF values are taken from pump curves found in the ENERGY STAR® Pool Pump Savings Calculator. Note: input assumptions will be updated once calculator has been updated for compliance with the current specification.

[526] The daily average operating hours for conventional single-speed pumps, based on 2014 residential pool pump program survey results from CenterPoint Energy.

Table 382. Pool Pumps—ENERGY STAR Unit Assumptions[527]

New pump HP	V (gal)	EF_{ES} (gal/W·h)	Turnovers/day[528]
≤ 1.25	22,000	8.7	1.9
1.25 < hp ≤ 1.75		8.9	1.9
1.75 < hp ≤ 2.25		9.3	2.2
2.25 < hp ≤ 2.75		7.4	2.3
2.75 < hp ≤ 5		7.1	2.5

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{kWh_{conv} - kWh_{ES}}{hours} \times \frac{CF_{S/W}}{days}$$

Equation 156

Where:

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 383)*

Table 383. Pool Pumps—Demand Factors[529]

Climate zone	Summer CF	Winter CF
Zone 1: Amarillo	0.258	-0.002
Zone 2: Dallas	0.329	0.025
Zone 3: Houston	0.276	0.108
Zone 4: Corpus Christi	0.266	0.036
Zone 5: El Paso	0.497	-0.143

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[527] ENERGY STAR® values are taken from default inputs and pump curves found in the ENERGY STAR® Pool Pump Savings Calculator. Note: input assumptions will be updated once calculator has been updated for compliance with the current specification.

[528] Calculated as TO = hours x 60 x PFR_{conv} ÷ V.

[529] Demand factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from the US Department of Energy's Building America B10 Benchmark load profiles for pool pumps. The profile used to determine demand factors is calculated as the difference of single speed and variable speed profiles. Summer profiles include April through September and winter profiles include October through March.

Deemed Energy Savings Tables

Table 384. Pool Pumps—Energy Savings (kWh)[530]

New pump hp	kWh savings
≤ 1.25	4,238
1.25 < hp ≤ 1.75	5,158
1.75 < hp ≤ 2.25	5,792
2.25 < hp ≤ 2.75	6,015
2.75 < hp ≤ 5	7,317

Deemed Summer Demand Savings Tables[531]

Table 385. Pool Pumps—Summer Peak Demand Savings (kW)

New pump HP	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
≤ 1.25	0.329	0.419	0.352	0.339	0.634
1.25 < hp ≤ 1.75	0.401	0.510	0.429	0.413	0.771
1.75 < hp ≤ 2.25	0.450	0.573	0.481	0.463	0.866
2.25 < hp ≤ 2.75	0.468	0.595	0.500	0.481	0.900
2.75 < hp ≤ 5	0.569	0.724	0.608	0.586	1.094

Deemed Winter Demand Savings Tables

Table 386. Pool Pumps—Peak Demand Savings (kW)

New pump HP	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
≤ 1.25	-0.002	0.032	0.138	0.046	-0.182
1.25 < hp ≤ 1.75	-0.003	0.039	0.168	0.056	-0.222
1.75 < hp ≤ 2.25	-0.003	0.043	0.189	0.062	-0.249
2.25 < hp ≤ 2.75	-0.003	0.045	0.196	0.065	-0.259
2.75 < hp ≤ 5	-0.004	0.055	0.239	0.079	-0.315

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[530] The results in this table may vary slightly from results produced by the ENERGY STAR® calculator because of rounding of default savings coefficients throughout the measure and pool volume.

[531] Ibid.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

ENERGY STAR Pool Pump Savings Calculator, updated May 2020, can be found on the ENERGY STAR website at https://www.energystar.gov/productfinder/product/certified-pool-pumps/results.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years, as specified in the California Database of Energy Efficiency Resources (DEER) READI tool for EUL ID OutD-PoolPump.[532]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly include the below.

For all projects collect:

- Unit quantity
- Manufacturer and model number of new pool pump
- Rated horsepower of new pool pump
- Climate zone
- Proof of purchase – with date of purchase and quantity
    - Alternative: photo of unit installed or other pre-approved method of installation verification

For a significant sample of projects where attainable (e.g., those projects that are selected for inspection, not midstream or retail programs):

- Items listed for all projects above
- Decision/action type: early retirement, replace-on-burnout, or new construction
- Rated horsepower of existing pool pump
- Existing and new pool pump operating hours

References and Efficiency Standards

Petitions and Rulings

Not applicable.

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[532] DEER READI (Remote Ex-Ante Database Interface). http://www.deeresources.com/index.php/readi.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 387. Pool Pumps—Revision History

TRM version	Date	Description of change
v5.0	10/2017	TRM v5.0 origin.
v6.0	11/2018	TRM v6.0 update. No revision.
v7.0	10/2019	TRM v7.0 update. Updated eligibility to include above ground pool pumps now eligible for ENERGY STAR certification. Acknowledged the forthcoming ENERGY STAR v2.0.
v8.0	10/2020	TRM v8.0 update. Incorporated ENERGY STAR v2.0 updated deemed savings.
v9.0	10/2021	TRM v9.0 update. Updated EUL reference and tracking requirements.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Final Version 3.1 Requirements. Updated savings coefficient definitions.

2.5.10 Advanced Power Strips Measure Overview

TRM Measure ID: R-AP-PS

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed savings values

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure involves the installation of a multi-plug advanced power strip (APS) with the ability to automatically disconnect specific loads depending on the power draw of a specified, or "master," load.

For a Tier 1 APS, a load sensor in the strip disconnects power from the control outlets when the master power draw is below a certain threshold. This feature allows for a reduction of power draw from peripheral consumer electronics, which usually maintain some load even when in the off or standby position. Therefore, when the master device (e.g., television) is turned off, the power supply is cut to other related equipment (e.g., set-top boxes, speakers, video game consoles).

A Tier 2 APS uses an external sensor paired with a configurable countdown timer to manage both active and standby power loads for controlled devices in a complete system. A Tier 2 APS may operate either with or without a master control socket. Those without a master control socket sense power of all devices connected to the controlled sockets, while those with a master control socket sense power for the device connected to the master control socket. The external sensor of a Tier 2 APS may use an infrared-only sensor, or it may use a "multi-sensor," which detects both infrared (IR) remote control signals and motion to determine device inactivity and deliver additional savings as compared to a Tier 1 APS. Both versions of external sensors use IR filtering to prevent inappropriate switching events that may have otherwise resulted from natural interference, such as sunlight or CFL light bulbs.

Eligibility Criteria

This measure applies to all residential applications. For Tier 2 applications, the APS must control at least two audiovisual devices.

Baseline Condition

The baseline condition is assumed to be uncontrolled peripheral loads, each plugged into a traditional surge protector or wall outlet.

High-Efficiency Condition

The high-efficiency condition is peripheral loads controlled by a Tier 1 or Tier 2 APS.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Savings were developed based on reported plug load electricity consumption and hourly use data. A set of home entertainment and home office peripheral equipment and related performance data are presented in the following table. “Daily Standby Hours” and “Daily Off Hours” represent the average number of hours the device is left in standby or off mode. For each device, a weighted watt per hour value is calculated based on projected watts consumed in either mode.

There are three savings paths available for Tier 1. Savings can be estimated by:

1. Complete system type (home entertainment or home office)
2. Per APS for an average complete system if the type is unknown
3. Per individual peripheral device

Tier 2 savings are determined using the average component uses for a complete system and an energy reduction percentage.

Table 388. APS—Peripheral Watt Consumption Breakdown[533]

System type	Peripheral device	Daily standby hours	Daily off hours	Standby power (W)	Off power (W)	Weighted W/hr	Annual APS hours
Home entertainment	Audio equipment: AV receiver	0.0	18.0	19.2	3.1	3.1	6,570
	Audio equipment: Speakers	0.0	18.0	3.0	0.0	0.0	6,570
	Audio equipment: Subwoofer	0.0	18.0	7.8	0.6	0.6	6,570
	Media player: Blu-ray	2.5	20.8	7.0	0.1	0.8	8,505
	Media player: DVD	2.5	20.8	5.0	2.0	2.3	8,505
	Media player: DVD-R	2.5	20.8	7.0	3.0	3.4	8,505
	Media player: DVD/VCR	2.5	20.4	8.0	4.0	4.4	8,359
	Media player: VCR	2.2	21.4	6.0	3.0	3.3	8,614
	Set-top box: Cable	0.0	16.5	25.0	16.0	16.0	6,023
	Set-top box: Cable with DVR	0.0	16.5	45.0	43.0	43.0	6,023
	Set-top box: Satellite	0.0	15.1	10.0	15.0	15.0	5,512
	Set-top box: Satellite with DVR	0.0	15.1	27.0	28.0	28.0	5,512
	Set-top box: Stand-alone DVR	0.0	18.3	27.0	27.0	27.0	6,680
	Television: CRT	0.0	18.7	5.3	1.6	1.6	6,826
	Television: LCD	0.0	18.7	2.2	0.5	0.5	6,826
	Television: Plasma	0.0	18.7	0.9	0.6	0.6	6,826
	Television: Projection	0.0	18.7	4.4	7.0	7.0	6,826
	Video game console: Nintendo Wii	1.5	21.4	10.5	1.9	2.5	8,359
	Video game console: Wii U	1.5	21.4	34.0	0.4	2.6	8,359
	Video game console: PlayStation 2	1.5	21.4	17.0	0.2	1.3	8,359

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[533] Derived from New York State Energy Research and Development Authority (NYSERDA), “Advanced Power Strip Research Report.” August 2011.

System type	Peripheral device	Daily standby hours	Daily off hours	Standby power (W)	Off power (W)	Weighted W/hr	Annual APS hours
Home entertainment	Video game console: PlayStation 3	1.5	21.4	152.9	1.1	11.0	8,359
	Video game console: PlayStation 4	1.5	21.4	137.0	6.4	14.9	8,359
	Video game console: XBOX	1.5	21.4	68.0	2.0	6.3	8,359
	Video game console: XBOX 360	1.5	21.4	117.5	3.1	10.6	8,359
	Video game console: XBOX One	1.5	21.4	112.0	11.9	18.4	8,359
Home office	Computer: Desktop	4.1	16.7	11.6	3.3	4.9	7,592
	Computer: Laptop	4.1	16.7	7.6	4.4	5.0	7,592
	Computer monitor: CRT	2.4	16.5	7.6	1.5	2.3	6,899
	Computer monitor: LCD	2.4	16.5	1.9	1.1	1.2	6,899
	Computer speakers	0.0	18.7	3.7	2.3	2.3	6,826
	Copier	0.0	23.5	2.8	1.5	1.5	8,578
	Fax machine: Inkjet	0.5	23.3	6.0	5.3	5.3	8,687
	Fax machine: Laser	0.5	23.3	5.3	2.2	2.3	8,687
	Printer: Inkjet	4.4	19.5	2.5	1.3	1.5	8,724
	Printer: Laser	4.4	19.5	9.0	3.3	4.3	8,724
	Scanner	0.0	23.5	3.6	2.1	2.1	8,578

Energy Savings Algorithms

Tier 1 APS

Energy savings for a Tier 1 APS in use for home entertainment or home office are calculated using the following algorithm, where kWh saved is calculated and summed for all peripheral devices.

$$Energy\ Savings\ [\Delta kWh] = \sum \frac{W_i \times H_i}{1{,}000}$$

Equation 157

Where:

W = *Weighted watts per hour consumed in standby/off mode for each peripheral device (see* Table 388*)*

H = *Annual hours per year controlled by APS (see Table 388)*

1,000 = *Constant to convert from W to kW*

Tier 2 APS

Energy savings for a Tier 2 APS are calculated using the average household home entertainment and home office usages, multiplied by an assumed energy reduction percentage.

$$\Delta kWh_{Home\ Entertainment} = kWh_{TV} \times ERP \times ISR$$

Equation 158

$$\Delta kWh_{Home\ Office} = kWh_{Comp} \times ERP \times ISR$$

Equation 159

$$\Delta kWh_{Unspecified} = \frac{kWh_{TV} + kWh_{Comp}}{2} \times ERP \times ISR$$

Equation 160

Where:

kWh_{TV} = *Average annual energy consumption of Tier 2 qualifying TV systems; default = 602.8 kWh*[534]

kWh_{Comp} = *Average annual energy consumption of Tier 2 qualifying computer systems; default = 197.9 kWh*[535]

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[534] New York State Energy Research and Development Authority (NYSERDA), “Advanced Power Strip Research Report”. August 2011. Page 30.

[535] New York State Energy Research and Development Authority (NYSERDA), “Advanced Power Strip Research Report”. August 2011. Page 30.

ERP = *Energy reduction percentage (default = 47.5%[536])*

ISR = *In-service rate or the percentage of units rebated that are installed; default = 1.0*

Demand Savings Algorithms

Tier 1 and Tier 2 APS

Demand savings for a Tier 1 APS in use for a home entertainment system or home office are calculated using the following algorithm, where kWh saved is calculated and summed for all peripheral devices. Demand savings for a Tier 2 APS are calculated using the average household home office and home entertainment center usages, multiplied by an assumed energy reduction percentage.

$$Peak\ Demand\ Savings\ [\Delta kW] = \sum \frac{\Delta kWh}{hours} \times CF_{S/W}$$

Equation 161

Where:

hours = *Annual hours per year controlled by APS (see Table 388 for Tier 1 APS; assume 4,380 for Tier 2 APS[537])*

$CF_{S/W}$ = *Seasonal peak coincidence factor (see Table 389)[538]*

Table 389. APS—Coincidence Factors[539]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.33	0.43	0.36	0.30	0.66
Winter	0.89	0.88	0.86	0.85	0.87

Deemed Energy Savings Tables

Refer to Table 390 and Table 391.

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[536] Average of ERP from Northeast Energy Efficiency Partnerships (NEEP), “Case Study: Tier 2 Advanced Power Strips and Efficiency Programs”. April 2015.

[537] Estimated based on assumption that approximately half of savings are during active hours (assumed to be 5.3 hours/day, or 1,936 hours/year) and half during standby hours (8,760-1,936 = 6,824 hours/year). The resulting weighted average is 4,380 hours/year.

[538] Derived using Electric Power Research Institute (EPRI) End Use Load Shapes for Residential TV and PC. http://loadshape.epri.com/enduse.

[539] See Volume 1, Section 4.

Deemed Summer Demand Savings Tables

Refer to Table 390 and Table 391.

Deemed Winter Demand Savings Tables

Refer to Table 390 and Table 391.

Table 390. APS—Tier 1 Deemed Savings

System type	Peripheral device	kWh savings	Summer kW savings					Winter kW savings				
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Home entertainment	Audio equipment: AV receiver	20.4	0.0010	0.0013	0.0011	0.0009	0.0020	0.0028	0.0027	0.0027	0.0026	0.0027
	Audio equipment: speakers	0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Audio equipment: subwoofer	3.9	0.0002	0.0003	0.0002	0.0002	0.0004	0.0005	0.0005	0.0005	0.0005	0.0005
	Media player: Blu-ray	7.1	0.0003	0.0004	0.0003	0.0002	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007
	Media player: DVD	19.7	0.0008	0.0010	0.0008	0.0007	0.0015	0.0021	0.0020	0.0020	0.0020	0.0020
	Media player: DVD-R	29.2	0.0011	0.0015	0.0012	0.0010	0.0023	0.0031	0.0030	0.0029	0.0029	0.0030
	Media player: DVD/VCR	37.1	0.0015	0.0019	0.0016	0.0013	0.0029	0.0040	0.0039	0.0038	0.0038	0.0038
	Media player: VCR	28.3	0.0011	0.0014	0.0012	0.0010	0.0022	0.0029	0.0029	0.0028	0.0028	0.0028
	Set-top box: Cable	96.4	0.0052	0.0069	0.0057	0.0047	0.0105	0.0142	0.0141	0.0137	0.0136	0.0139
	Set-top box: Cable with DVR	259.0	0.0141	0.0186	0.0153	0.0128	0.0283	0.0383	0.0378	0.0369	0.0365	0.0372
	Set-top box: Satellite	82.7	0.0049	0.0065	0.0053	0.0044	0.0099	0.0134	0.0132	0.0129	0.0127	0.0130
	Set-top box: Satellite with DVR	154.3	0.0092	0.0121	0.0100	0.0083	0.0184	0.0249	0.0246	0.0240	0.0238	0.0242
	Set-top box: Stand alone DVR	180.3	0.0088	0.0117	0.0096	0.0080	0.0178	0.0240	0.0238	0.0232	0.0229	0.0234
	Television: CRT	10.9	0.0005	0.0007	0.0006	0.0005	0.0011	0.0014	0.0014	0.0014	0.0014	0.0014
	Television: LCD	3.4	0.0002	0.0002	0.0002	0.0001	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004
	Television: Plasma	4.1	0.0002	0.0003	0.0002	0.0002	0.0004	0.0005	0.0005	0.0005	0.0005	0.0005
	Television: Projection	47.8	0.0023	0.0030	0.0025	0.0021	0.0046	0.0062	0.0062	0.0060	0.0059	0.0061

System type	Peripheral device	kWh savings	Summer kW savings					Winter kW savings				
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Home entertainment	Video game console: Nintendo Wii	20.6	0.0008	0.0011	0.0009	0.0007	0.0016	0.0022	0.0022	0.0021	0.0021	0.0021
	Video game console: Wii U	21.7	0.0009	0.0011	0.0009	0.0008	0.0017	0.0023	0.0023	0.0022	0.0022	0.0023
	Video game console: PlayStation 2	10.9	0.0004	0.0006	0.0005	0.0004	0.0009	0.0012	0.0011	0.0011	0.0011	0.0011
	Video game console: PlayStation 3	92.3	0.0036	0.0048	0.0039	0.0033	0.0073	0.0098	0.0097	0.0095	0.0094	0.0096
	Video game console: PlayStation 4	124.8	0.0049	0.0065	0.0053	0.0044	0.0098	0.0133	0.0131	0.0128	0.0127	0.0129
	Video game console: XBOX	52.9	0.0021	0.0027	0.0023	0.0019	0.0042	0.0056	0.0056	0.0054	0.0054	0.0055
	Video game console: XBOX 360	88.5	0.0035	0.0046	0.0038	0.0031	0.0070	0.0094	0.0093	0.0091	0.0090	0.0092
	Video game console: XBOX One	154.1	0.0060	0.0080	0.0066	0.0055	0.0121	0.0164	0.0162	0.0158	0.0157	0.0160
	Home entertainment system[540]	269.9	0.0132	0.0174	0.0143	0.0119	0.0265	0.0358	0.0354	0.0345	0.0342	0.0348

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[540] Assuming Audio Equipment: AV Receiver, Media Player: Average, Set-Top Box: Average, and Video Game Console: Average.

System type	Peripheral device	kWh savings	Summer kW savings					Winter kW savings				
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Home office	Computer: Desktop	37.5	0.0016	0.0021	0.0018	0.0015	0.0032	0.0044	0.0043	0.0042	0.0042	0.0043
	Computer: Laptop	38.2	0.0016	0.0022	0.0018	0.0015	0.0033	0.0045	0.0044	0.0043	0.0043	0.0044
	Computer monitor: CRT	15.7	0.0007	0.0010	0.0008	0.0007	0.0015	0.0020	0.0020	0.0020	0.0019	0.0020
	Computer monitor: LCD	8.3	0.0004	0.0005	0.0004	0.0004	0.0008	0.0011	0.0011	0.0010	0.0010	0.0010
	Computer speakers	15.7	0.0008	0.0010	0.0008	0.0007	0.0015	0.0020	0.0020	0.0020	0.0020	0.0020
	Copier	12.9	0.0005	0.0006	0.0005	0.0004	0.0010	0.0013	0.0013	0.0013	0.0013	0.0013
	Fax machine: Inkjet	46.2	0.0017	0.0023	0.0019	0.0016	0.0035	0.0047	0.0047	0.0046	0.0045	0.0046
	Fax machine: Laser	19.7	0.0007	0.0010	0.0008	0.0007	0.0015	0.0020	0.0020	0.0019	0.0019	0.0020
	Printer: Inkjet	13.3	0.0005	0.0007	0.0005	0.0005	0.0010	0.0014	0.0013	0.0013	0.0013	0.0013
	Printer: Laser	37.9	0.0014	0.0019	0.0015	0.0013	0.0029	0.0039	0.0038	0.0037	0.0037	0.0038
	Scanner	18.0	0.0007	0.0009	0.0007	0.0006	0.0014	0.0019	0.0018	0.0018	0.0018	0.0018
	Home office system[541]	87.1	0.0037	0.0049	0.0041	0.0034	0.0075	0.0101	0.0100	0.0098	0.0097	0.0098
Upstream/ midstream	Unspecified system[542]	178.5	0.0084	0.0112	0.0092	0.0077	0.0170	0.0230	0.0227	0.0221	0.0219	0.0223

Table 391. APS—Tier 2 Deemed Savings

System type	kWh savings	Summer kW savings					Winter kW savings				
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Home entertainment	286.3	0.021	0.028	0.023	0.019	0.043	0.058	0.058	0.056	0.056	0.057
Home office	94.0	0.007	0.009	0.008	0.006	0.014	0.019	0.019	0.018	0.018	0.019
Upstream/midstream	190.2	0.014	0.019	0.015	0.013	0.029	0.039	0.038	0.037	0.037	0.038

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[541] Assuming Computer: desktop, computer monitor: LCD, computer speakers, and printer: average.
[542] Average of *home entertainment* and *home office system* averages.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 10 years for a Tier 1 APS, according to the 2011 NYSERDA Advanced Power Strip Research Report.[543] While Tier 2 APS is not covered by the NYSERDA report, assume the same 10-year EUL for Tier 2 APS.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Unit quantity
- Manufacturer and model number
- APS type (Tier 1 or Tier 2)
- System or peripheral type
- Climate zone
- Proof of purchase – including date of purchase and quantity
    - Alternative: photo of unit installed or another pre-approved method of installation verification.

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

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[543] New York State Energy Research and Development Authority (NYSERDA), “Advanced Power Strip Research Report”. August 2011. Page 30.

Document Revision History

Table 392. APS—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. No revision.
v9.0	10/2021	TRM v9.0 update. Updated savings with current coincidence factors.
v10.0	10/2022	TRM v10.0 update. Corrected typos in deemed savings tables from TRM v9.0 update.

2.5.11 ENERGY STAR® Electric Vehicle Supply Equipment

TRM Measure ID: R-AP-EV

Market Sector: Residential

Measure Category: Appliance

Applicable Business Types: Single-family, manufactured

Fuels Affected: Electricity

Decision/Action Type: Retrofit, new construction

Program Delivery Type: Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

This measure applies to the installation of ENERGY STAR qualified Level 2 electric vehicle supply equipment (EVSE) at a residential site. EVSE is the infrastructure that enables plug-in electric vehicles (PEV) to charge onboard batteries. Level 2 EVSE require 240-volt electrical service. This measure provides deemed savings for the energy efficiency improvement of an ENERGY STAR EVSE over a standard or non-ENERGY STAR EVSE.

Eligibility Criteria

Eligible equipment includes an ENERGY STAR qualified Level 2 EVSE installed at a residence. The EVSE may be installed for use on either an all-battery electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV). Multifamily buildings should use the commercial EVSE measure.

Baseline Condition

The baseline condition is a non-ENERGY STAR qualified Level 2 EVSE.

High-Efficiency Condition

The high-efficiency EVSE is a Level 2 EVSE compliant with ENERGY STAR Final Version 1.1 Requirements for eligible electric vehicle supply equipment effective March 31, 2021.[544] Energy efficiency service providers are expected to comply with the latest ENERGY STAR requirements.

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[544] ENERGY STAR® Electric Vehicle Supply Equipment Final Version 1.1 Program Requirements. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20V1.1%20DC%20EVSE%20Final%20Specification_0.pdf.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Savings for EVSE come from efficiency gains of the ENERGY STAR equipment during operating modes when the vehicle is plugged in but not charging and when not plugged in. Deemed savings are calculated according to the following algorithms.

Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh \times HCF \times DCF}{hours_{p,c}}$$

Equation 162

Where:

ΔkWh = *Energy savings (Table 394)*

HCF = *Hourly coincidence factor (Table 393)*

DCF = *Daily coincidence factor*[545] *= 0.88*

$hours_{p,c}$ = *Hours per day vehicle is plugged in and charging = 2.4 hr* [546]

Table 393. EVSE—Coincidence Factors[547]

Climate zone	Summer	Winter
Zone 1: Amarillo	0.044	0.058
Zone 2: Dallas	0.040	0.053
Zone 3: Houston	0.043	0.041
Zone 4: Corpus Christi	0.042	0.059
Zone 5: El Paso	0.033	0.085

Deemed Energy Savings Tables

Table 394 presents the deemed energy savings per EVSE. Networked chargers refer to EVSE that are connected remotely to a larger network and are part of an infrastructure system of connected chargers.

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[545] Idaho National Lab (INL) EV Project, June 2015, “Characterize the Demand and Energy Characteristics of Residential Electric Vehicle Supply Equipment,” page 6. Eighty-eight percent of PEV owners charge every day.

[546] INL, page 5. A vehicle plugged in for 11.7 hours and charging for 2.4 hours leaves 9.3 hours when it is plugged in and not charging.

[547] Probability weighted peak load factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from 3 studies: CCET Wind Integration in ERCOT, Avista Utilities Semi-Annual Report on Electric Vehicle Supply, and Xcel CO EVCS Pilot.

Table 394. EVSE—Energy Savings (kWh)[548]

EVSE type	Steady state charging (kWh)	Standby mode (kWh)	Total savings (kWh)
Non-networked charger	18	22	40
Networked charger		53	71

Deemed Summer and Winter Demand Savings Tables

Table 395 presents the deemed summer and winter peak kW savings per EVSE.

Table 395. EVSE—Summer/Winter Peak Demand Savings (kW)[549]

Climate Zone	Summer	Winter
Zone 1: Amarillo	0.0009	0.0012
Zone 2: Dallas	0.0008	0.0011
Zone 3: Houston	0.0009	0.0008
Zone 4: Corpus Christi	0.0009	0.0012
Zone 5: El Paso	0.0007	0.0017

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for an EVSE is assumed to be 10 years.[550]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly:

- Climate zone

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[548] ENERGY STAR® Market and Industry Scoping Report Electric Vehicle Supply Equipment (EVSE), September 2013. https://www.energystar.gov/sites/default/files/asset/document/Electric_Vehicle_Scoping_Report.pdf.

[549] Demand savings are only presented for steady state charging because those savings are higher than demand for plugged-in standby mode.

[550] US Department of Energy Vehicle Technologies Office, November 2015, “Costs Associated with Non-Residential Electric Vehicle Supply Equipment” p. 21. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf.

- EVSE type (networked, non-networked)
- ESVE quantity
- EVSE manufacturer and model number
- Vehicle year, make, and model (if available)
- Estimated number of miles driven per day (if available)

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 396. EVSE—Revision History

TRM version	Date	Description of change
v7.0	10/2019	TRM v7.0 origin.
v8.0	10/2020	TRM v8.0 update. Updated deemed savings tables
v9.0	10/2021	TRM v9.0 update. Updated documentation requirements.
v10.0	10/2022	TRM v10.0 update. Verified compliance with ENERGY STAR Final Version 1.1 Requirements. Updated savings calculation assumptions, deemed savings, and documentation requirements.

2.5.12 Induction Cooking

TRM Measure ID: R-AP-IC

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Look-up tables

Savings Methodology: Engineering algorithms and estimates

Measure Description

Residential cooking appliances include ovens, cooktops, and full ranges. A full range consists of an oven with a built-in cooktop. An induction range is an electric oven with a built-in induction cooktop.

Induction technology works on the principle of magnetic induction, where excited eddy currents in ferromagnetic cookware within the presence of an oscillating magnetic field dissipate heat through the Joule effect. This heat is directly generated by the cookware and is transmitted to the food within it, lessening thermal condition heat loss between the heating element and the cookware. Induction cooktops include a switching-power electronics circuit that delivers high-frequency current to a planar coil of wire embedded in the cooking surface. The cookware is magnetically coupled to the coil by the oscillating magnetic field. Current flows in the cooking vessel due to the low resistance of the metal. Resistance is a function of permeability and resistivity of the cookware as well as the frequency of excitation. Typical induction cooktops operate at switching frequency between 25 kHz and 50 kHz, which restricts coupling to ferromagnetic cookware such as cast iron, and some alloys of stainless steel.[551]

According to manufacturers, induction cooktops heat food faster, are easier to clean, are less likely to burn those using them, and have a higher cooking efficiency than electric resistance cooktops.

Eligibility Criteria

This measure requires the installation of an electric range with an induction cooktop or a standalone induction cooktop in a residential application. This measure assumes the use of small cookware typical of residential applications.

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[551] Sweeney, M., J. Dols, B. Fortenbery, and F. Sharp (EPRI), "Induction Cooking Technology Design and Assessment." Proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings, p. 9-370. https://www.aceee.org/files/proceedings/2014/data/papers/9-702.pdf.

Baseline Condition

The baseline condition is defined as an electric range with electric resistance cooktop or a standalone electric resistance cooktop. This measure assumes a default of four burners.

Table 397. Induction Cooking—Baseline Electric Resistance Cooktop Energy Consumption[552]

Number of burners	Electric cooktop baseline kWh
0	84
1	89
2	95
3	101
4	106
5	112
6	118
7+	124

High-Efficiency Condition

The high efficiency condition is defined as an electric range with an induction cooktop or a standalone induction cooktop.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings are calculated as the difference between the baseline and high-efficiency condition unit energy consumption (UEC). These exclude HVAC interactive effects or savings due to reduced kitchen hood consumption. Range oven cooking efficiency varies by cooktop type. Ranges with electric resistance and induction cooktops both have electric resistance oven components. Therefore, baseline and high-efficiency condition oven cooking efficiencies are equivalent and are excluded from the savings calculation.

$$Energy\ Savings\ [\Delta kWh] = UEC_{base} - UEC_{IC}$$

Equation 163

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[552] "Plug Loads and Lighting Modeling," Codes and Standards Enhancement Initiative (CASE). 2016 California Building Energy Efficiency Standards. June 2016. Table 35. https://www.caetrm.com/media/reference-documents/2016_T24CASE_Report_-_Plug_Load_and_Ltg_Modeling_-_June_2016.pdf.

$$UEC_{IC} = UEC_{base} \times \frac{CE_{base}}{CE_{IC}}$$

Equation 164

Where:

UEC_{base} = *Baseline annual unit energy consumption [kWh]; see Table 206*

UEC_{IC} = *Induction cooking annual unit energy consumption [kWh]*

CE_{base} = *Baseline cooking efficiency = 75 percent*[553]

CE_{IC} = *Induction cooking efficiency = 85 percent*[554]

Summer Demand Savings Algorithms

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{kWh_{savings}}{8{,}760} \times CF_{S/W}$$

Equation 165

8,760 = *Total hours per year*

$CF_{S/W}$ = *Seasonal peak coincidence factor (Table 398)*

Table 398. Induction Cooking—Coincidence Factors[555]

Season	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
Summer	0.003	0.003	0.003	0.003	0.002
Winter	0.009	0.008	0.007	0.008	0.010

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[553] "2021-2022 Residential Induction Cooking Tops," ENERGY STAR®. https://www.energystar.gov/about/2021_residential_induction_cooking_tops#:~:text=The%20per%20unit%20efficiency%20of,times%20more%20efficient%20than%20gas.

[554] Ibid.

[555] Calculated according to TX TRM Volume 1, Section 4 using data from the US DOE Building America B10 Benchmark load profiles for cooking equipment. Summer profiles include April through September, and winter profiles include October through March. https://www.energy.gov/eere/buildings/building-america-analysis-spreadsheets.

Deemed Energy Savings Tables

For all applications, this measure assumes a default value of four burners.[556]

Table 399. Induction Cooking—Energy Savings (kWh)

Number of burners	kWh savings
4	12

Deemed Summer Demand Savings Tables

For all applications, this measure assumes a default value of four burners.

Table 400. Induction Cooking—Summer Peak Demand Savings (kW)

Number of burners	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
4	0.000004	0.000004	0.000004	0.000004	0.000003

Deemed Winter Demand Savings Tables

For all applications, this measure assumes a default value of four burners.

Table 401. Induction Cooking—Winter Peak Demand Savings (kW)

Number of burners	Climate Zone 1: Amarillo	Climate Zone 2: Dallas	Climate Zone 3: Houston	Climate Zone 4: Corpus Christi	Climate Zone 5: El Paso
4	0.000013	0.000011	0.000010	0.000011	0.000014

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of an induction cooktop is 16 years based on the average lifetime specified for electric cooktops in the 2016 DOE life-cycle cost tool for residential cooking products.[557]

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[556] Savings for 0–7+ burners only vary from 10–15 kWh.

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Baseline unit type (electric range with electric resistance cooktop, standalone electric resistance cooktop)
- New unit type (electric range with induction cooktop, standalone induction cooktop)
- Manufacturer and model number
- Unit quantity
- Burner quantity
- Proof of purchase – with date of purchase and quantity
  - Alternative: photo of unit installed or another pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 402. Induction Cooking—Revision History

TRM version	Date	Description of change
v10.0	10/2022	TRM v10.0 origin.

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[557] US Department of Energy (DOE), Energy Efficiency and Renewable Energy Office (EERE). 2016 SNOPR Analytical Tools: Life-Cycle Cost and Payback Period Analysis Spreadsheet. “Cooking_Pds_LCC_SNOPR_DOE_2016_publication.xlsm.” Dockett EERE-2014-BT-STD-0005.

APPENDIX A: CENTRAL HEAT PUMPS WITHOUT SEER2 RATINGS DEEMED SAVINGS TABLES

Deemed Energy Savings Tables[558]

Table 403 through Table 442 present the energy savings (kWh) for all five Texas climate zones. In each table, the capacity of the efficient unit is represented in the columns and the capacity of the existing unit is represented in the rows. The savings are in the intersection of the appropriate efficient and existing capacities. Replacements where there has been to change in capacity are highlighted in light blue.

The rightsizing savings specified in the tables below are only applicable to replace-on-burnout and early retirement projects. New construction projects are not eligible to receive deemed savings for system rightsizing.[559]

Climate Zone 1: Panhandle Region, Amarillo

Cooling, New Construction

Table 403. Central Energy Savings (Cooling kWh) for 14.0 SEER Baseline—Zone 1

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–20.9	21.0-23.9	24.0+
< 15,000	43	83	154	264	307	411	490
15,000-20,999	65	124	231	396	461	617	735
21,000-26,999	86	166	307	529	615	822	980
27,000-32,999	108	207	384	661	769	1,028	1,225
33,000-38,999	129	248	461	793	922	1,234	1,470
39,000-44,999	151	290	538	925	1,076	1,439	1,715
45,000-53,999	172	331	615	1,057	1,230	1,645	1,960
54,000-64,999	215	414	769	1,322	1,537	2,056	2,450

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[558] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[559] For projects using a custom baseline, see TRM Volume 4.

Cooling, Replace-on-Burnout

Table 404. Central Energy Savings (Cooling kWh) for 13.08 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	119							
15,000-20,999	695	178						
21,000-26,999	1,271	754	237					
27,000-32,999	1,847	1,330	813	297				
33,000-38,999	2,423	1,906	1,389	873	356			
39,000-44,999	2,998	2,482	1,965	1,449	932	416		
45,000-53,999	3,574	3,058	2,541	2,025	1,508	992	475	
54,000-64,999	4,726	4,210	3,693	3,177	2,660	2,143	1,627	594
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	158							
15,000-20,999	734	238						
21,000-26,999	1,310	814	317					
27,000-32,999	1,886	1,390	893	396				
33,000-38,999	2,462	1,966	1,469	972	475			
39,000-44,999	3,038	2,541	2,045	1,548	1,051	555		
45,000-53,999	3,614	3,117	2,621	2,124	1,627	1,131	634	
54,000-64,999	4,766	4,269	3,773	3,276	2,779	2,283	1,786	792

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	229							
15,000-20,999	805	344						
21,000-26,999	1,381	920	459					
27,000-32,999	1,957	1,496	1,035	574				
33,000-38,999	2,533	2,072	1,611	1,150	688			
39,000-44,999	3,109	2,648	2,187	1,725	1,264	803		
45,000-53,999	3,685	3,224	2,763	2,301	1,840	1,379	918	
54,000-64,999	4,837	4,376	3,915	3,453	2,992	2,531	2,070	1,147

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	340							
15,000-20,999	916	510						
21,000-26,999	1,492	1,086	680					
27,000-32,999	2,068	1,662	1,256	850				
33,000-38,999	2,644	2,238	1,832	1,426	1,020			
39,000-44,999	3,220	2,814	2,408	2,002	1,596	1,190		
45,000-53,999	3,796	3,390	2,984	2,578	2,172	1,766	1,360	
54,000-64,999	4,948	4,542	4,136	3,730	3,324	2,918	2,512	1,700

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	383							
15,000-20,999	959	575						
21,000-26,999	1,535	1,151	766					
27,000-32,999	2,111	1,727	1,342	958				
33,000-38,999	2,687	2,303	1,918	1,534	1,149			
39,000-44,999	3,263	2,879	2,494	2,110	1,725	1,341		
45,000-53,999	3,839	3,454	3,070	2,686	2,301	1,917	1,533	
54,000-64,999	4,991	4,606	4,222	3,838	3,453	3,069	2,684	1,916

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	487							
15,000-20,999	1,063	730						
21,000-26,999	1,639	1,306	974					
27,000-32,999	2,215	1,882	1,550	1,217				
33,000-38,999	2,791	2,458	2,126	1,793	1,461			
39,000-44,999	3,367	3,034	2,702	2,369	2,037	1,704		
45,000-53,999	3,943	3,610	3,278	2,945	2,613	2,280	1,948	
54,000-64,999	5,094	4,762	4,430	4,097	3,765	3,432	3,100	2,435

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	566							
15,000-20,999	1,142	849						
21,000-26,999	1,718	1,425	1,132					
27,000-32,999	2,294	2,001	1,708	1,414				
33,000-38,999	2,870	2,577	2,283	1,990	1,697			
39,000-44,999	3,446	3,152	2,859	2,566	2,273	1,980		
45,000-53,999	4,021	3,728	3,435	3,142	2,849	2,556	2,263	
54,000-64,999	5,173	4,880	4,587	4,294	4,001	3,708	3,415	2,829

Cooling, Early Retirement

Table 405. Central Energy Savings (Cooling kWh) for 12.44 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	178							
15,000-20,999	784	267						
21,000-26,999	1,389	873	356					
27,000-32,999	1,995	1,478	962	445				
33,000-38,999	2,600	2,084	1,567	1,051	534			
39,000-44,999	3,206	2,689	2,173	1,656	1,140	623		
45,000-53,999	3,811	3,295	2,778	2,262	1,745	1,229	712	
54,000-64,999	5,023	4,506	3,989	3,473	2,956	2,440	1,923	890
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	218							
15,000-20,999	823	327						
21,000-26,999	1,429	932	435					
27,000-32,999	2,034	1,538	1,041	544				
33,000-38,999	2,640	2,143	1,647	1,150	653			
39,000-44,999	3,246	2,749	2,252	1,756	1,259	762		
45,000-53,999	3,851	3,354	2,858	2,361	1,864	1,368	871	
54,000-64,999	5,062	4,566	4,069	3,572	3,076	2,579	2,082	1,089

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	289							
15,000-20,999	894	433						
21,000-26,999	1,500	1,039	577					
27,000-32,999	2,105	1,644	1,183	722				
33,000-38,999	2,711	2,250	1,789	1,327	866			
39,000-44,999	3,317	2,855	2,394	1,933	1,472	1,010		
45,000-53,999	3,922	3,461	3,000	2,538	2,077	1,616	1,155	
54,000-64,999	5,133	4,672	4,211	3,750	3,288	2,827	2,366	1,443

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	399							
15,000-20,999	1,005	599						
21,000-26,999	1,610	1,204	799					
27,000-32,999	2,216	1,810	1,404	998				
33,000-38,999	2,822	2,416	2,010	1,604	1,198			
39,000-44,999	3,427	3,021	2,615	2,209	1,803	1,397		
45,000-53,999	4,033	3,627	3,221	2,815	2,409	2,003	1,597	
54,000-64,999	5,244	4,838	4,432	4,026	3,620	3,214	2,808	1,996

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	442							
15,000-20,999	1,048	664						
21,000-26,999	1,654	1,269	885					
27,000-32,999	2,259	1,875	1,490	1,106				
33,000-38,999	2,865	2,480	2,096	1,712	1,327			
39,000-44,999	3,470	3,086	2,702	2,317	1,933	1,548		
45,000-53,999	4,076	3,691	3,307	2,923	2,538	2,154	1,770	
54,000-64,999	5,287	4,903	4,518	4,134	3,750	3,365	2,981	2,212

21.0-23.9 SEER

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	546							
15,000-20,999	1,152	819						
21,000-26,999	1,757	1,425	1,092					
27,000-32,999	2,363	2,030	1,698	1,365				
33,000-38,999	2,968	2,636	2,304	1,971	1,639			
39,000-44,999	3,574	3,242	2,909	2,577	2,244	1,912		
45,000-53,999	4,180	3,847	3,515	3,182	2,850	2,517	2,185	
54,000-64,999	5,391	5,058	4,726	4,393	4,061	3,728	3,396	2,731

24.0+ SEER

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	625							
15,000-20,999	1,231	938						
21,000-26,999	1,836	1,543	1,250					
27,000-32,999	2,442	2,149	1,856	1,563				
33,000-38,999	3,047	2,754	2,461	2,168	1,875			
39,000-44,999	3,653	3,360	3,067	2,774	2,481	2,188		
45,000-53,999	4,259	3,965	3,672	3,379	3,086	2,793	2,500	
54,000-64,999	5,470	5,177	4,884	4,591	4,297	4,004	3,711	3,125

Table 406. Central Energy Savings (Cooling kWh) for 10.0 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	474							
15,000-20,999	1,227	710						
21,000-26,999	1,980	1,464	947					
27,000-32,999	2,734	2,217	1,700	1,184				
33,000-38,999	3,487	2,970	2,454	1,937	1,421			
39,000-44,999	4,240	3,724	3,207	2,690	2,174	1,657		
45,000-53,999	4,994	4,477	3,960	3,444	2,927	2,411	1,894	
54,000-64,999	6,500	5,984	5,467	4,950	4,434	3,917	3,401	2,368
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	513							
15,000-20,999	1,267	770						
21,000-26,999	2,020	1,523	1,027					
27,000-32,999	2,773	2,277	1,780	1,283				
33,000-38,999	3,527	3,030	2,533	2,036	1,540			
39,000-44,999	4,280	3,783	3,287	2,790	2,293	1,796		
45,000-53,999	5,033	4,537	4,040	3,543	3,046	2,550	2,053	
54,000-64,999	6,540	6,043	5,547	5,050	4,553	4,056	3,560	2,566

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	584							
15,000-20,999	1,338	876						
21,000-26,999	2,091	1,630	1,168					
27,000-32,999	2,844	2,383	1,922	1,461				
33,000-38,999	3,598	3,136	2,675	2,214	1,753			
39,000-44,999	4,351	3,890	3,428	2,967	2,506	2,045		
45,000-53,999	5,104	4,643	4,182	3,721	3,259	2,798	2,337	
54,000-64,999	6,611	6,150	5,688	5,227	4,766	4,305	3,844	2,921

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	695							
15,000-20,999	1,448	1,042						
21,000-26,999	2,201	1,796	1,390					
27,000-32,999	2,955	2,549	2,143	1,737				
33,000-38,999	3,708	3,302	2,896	2,490	2,084			
39,000-44,999	4,461	4,056	3,650	3,244	2,838	2,432		
45,000-53,999	5,215	4,809	4,403	3,997	3,591	3,185	2,779	
54,000-64,999	6,721	6,316	5,910	5,504	5,098	4,692	4,286	3,474

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	738							
15,000-20,999	1,491	1,107						
21,000-26,999	2,245	1,860	1,476					
27,000-32,999	2,998	2,614	2,229	1,845				
33,000-38,999	3,751	3,367	2,983	2,598	2,214			
39,000-44,999	4,505	4,120	3,736	3,351	2,967	2,583		
45,000-53,999	5,258	4,874	4,489	4,105	3,720	3,336	2,952	
54,000-64,999	6,765	6,380	5,996	5,612	5,227	4,843	4,458	3,690

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	842							
15,000-20,999	1,595	1,263						
21,000-26,999	2,348	2,016	1,683					
27,000-32,999	3,102	2,769	2,437	2,104				
33,000-38,999	3,855	3,523	3,190	2,858	2,525			
39,000-44,999	4,608	4,276	3,943	3,611	3,278	2,946		
45,000-53,999	5,362	5,029	4,697	4,364	4,032	3,699	3,367	
54,000-64,999	6,868	6,536	6,203	5,871	5,538	5,206	4,874	4,209
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	921							
15,000-20,999	1,674	1,381						
21,000-26,999	2,427	2,134	1,841					
27,000-32,999	3,181	2,888	2,594	2,301				
33,000-38,999	3,934	3,641	3,348	3,055	2,762			
39,000-44,999	4,687	4,394	4,101	3,808	3,515	3,222		
45,000-53,999	5,441	5,148	4,854	4,561	4,268	3,975	3,682	
54,000-64,999	6,947	6,654	6,361	6,068	5,775	5,482	5,189	4,603

Heating, New Construction/Replace-on-Burnout

Table 407. Central Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	139							
15,000-20,999	1,177	208						
21,000-26,999	2,216	1,247	278					
27,000-32,999	3,254	2,285	1,316	347				
33,000-38,999	4,293	3,324	2,355	1,386	417			
39,000-44,999	5,331	4,362	3,393	2,424	1,455	486		
45,000-53,999	6,370	5,401	4,432	3,463	2,493	1,524	555	
54,000-64,999	8,447	7,478	6,509	5,539	4,570	3,601	2,632	694
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	297							
15,000-20,999	1,335	445						
21,000-26,999	2,373	1,483	593					
27,000-32,999	3,412	2,522	1,632	741				
33,000-38,999	4,450	3,560	2,670	1,780	890			
39,000-44,999	5,489	4,599	3,708	2,818	1,928	1,038		
45,000-53,999	6,527	5,637	4,747	3,857	2,967	2,076	1,186	
54,000-64,999	8,604	7,714	6,824	5,934	5,043	4,153	3,263	1,483

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	378							
15,000-20,999	1,417	568						
21,000-26,999	2,455	1,606	757					
27,000-32,999	3,494	2,645	1,795	946				
33,000-38,999	4,532	3,683	2,834	1,984	1,135			
39,000-44,999	5,571	4,721	3,872	3,023	2,174	1,324		
45,000-53,999	6,609	5,760	4,911	4,061	3,212	2,363	1,514	
54,000-64,999	8,686	7,837	6,988	6,138	5,289	4,440	3,591	1,892

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	409							
15,000-20,999	1,448	614						
21,000-26,999	2,486	1,652	818					
27,000-32,999	3,525	2,691	1,857	1,023				
33,000-38,999	4,563	3,729	2,895	2,061	1,228			
39,000-44,999	5,602	4,768	3,934	3,100	2,266	1,432		
45,000-53,999	6,640	5,806	4,972	4,138	3,304	2,471	1,637	
54,000-64,999	8,717	7,883	7,049	6,215	5,381	4,548	3,714	2,046

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	439							
15,000-20,999	1,477	658						
21,000-26,999	2,516	1,697	878					
27,000-32,999	3,554	2,735	1,916	1,097				
33,000-38,999	4,593	3,774	2,955	2,136	1,316			
39,000-44,999	5,631	4,812	3,993	3,174	2,355	1,536		
45,000-53,999	6,670	5,851	5,032	4,212	3,393	2,574	1,755	
54,000-64,999	8,747	7,928	7,108	6,289	5,470	4,651	3,832	2,194

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	467							
15,000-20,999	1,506	701						
21,000-26,999	2,544	1,740	935					
27,000-32,999	3,583	2,778	1,973	1,168				
33,000-38,999	4,621	3,816	3,012	2,207	1,402			
39,000-44,999	5,660	4,855	4,050	3,245	2,441	1,636		
45,000-53,999	6,698	5,893	5,089	4,284	3,479	2,674	1,870	
54,000-64,999	8,775	7,970	7,166	6,361	5,556	4,751	3,946	2,337
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	495							
15,000-20,999	1,533	742						
21,000-26,999	2,572	1,781	990					
27,000-32,999	3,610	2,819	2,028	1,237				
33,000-38,999	4,649	3,858	3,067	2,276	1,485			
39,000-44,999	5,687	4,896	4,105	3,314	2,523	1,732		
45,000-53,999	6,726	5,935	5,144	4,353	3,562	2,771	1,980	
54,000-64,999	8,803	8,012	7,221	6,430	5,639	4,848	4,057	2,475
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	511							
15,000-20,999	1,549	766						
21,000-26,999	2,588	1,805	1,022					
27,000-32,999	3,626	2,843	2,060	1,277				
33,000-38,999	4,665	3,882	3,099	2,316	1,533			
39,000-44,999	5,703	4,920	4,137	3,354	2,571	1,788		
45,000-53,999	6,742	5,959	5,176	4,393	3,610	2,827	2,044	
54,000-64,999	8,819	8,036	7,253	6,470	5,687	4,904	4,121	2,555

Heating, Early Retirement of a Heat Pump

Table 408. Central Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	336							
15,000-20,999	1,472	503						
21,000-26,999	2,609	1,640	671					
27,000-32,999	3,746	2,777	1,808	839				
33,000-38,999	4,883	3,914	2,945	1,976	1,007			
39,000-44,999	6,020	5,050	4,081	3,112	2,143	1,174		
45,000-53,999	7,156	6,187	5,218	4,249	3,280	2,311	1,342	
54,000-64,999	9,430	8,461	7,492	6,523	5,554	4,585	3,616	1,678
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	493							
15,000-20,999	1,630	740						
21,000-26,999	2,767	1,877	986					
27,000-32,999	3,904	3,013	2,123	1,233				
33,000-38,999	5,040	4,150	3,260	2,370	1,480			
39,000-44,999	6,177	5,287	4,397	3,507	2,616	1,726		
45,000-53,999	7,314	6,424	5,534	4,643	3,753	2,863	1,973	
54,000-64,999	9,588	8,697	7,807	6,917	6,027	5,137	4,246	2,466

9.5-9.9 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	575							
15,000-20,999	1,712	863						
21,000-26,999	2,849	1,999	1,150					
27,000-32,999	3,985	3,136	2,287	1,438				
33,000-38,999	5,122	4,273	3,424	2,574	1,725			
39,000-44,999	6,259	5,410	4,561	3,711	2,862	2,013		
45,000-53,999	7,396	6,547	5,697	4,848	3,999	3,149	2,300	
54,000-64,999	9,669	8,820	7,971	7,122	6,272	5,423	4,574	2,875

10.0-10.4 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	606							
15,000-20,999	1,743	909						
21,000-26,999	2,879	2,046	1,212					
27,000-32,999	4,016	3,182	2,348	1,515				
33,000-38,999	5,153	4,319	3,485	2,651	1,818			
39,000-44,999	6,290	5,456	4,622	3,788	2,954	2,120		
45,000-53,999	7,427	6,593	5,759	4,925	4,091	3,257	2,423	
54,000-64,999	9,700	8,866	8,033	7,199	6,365	5,531	4,697	3,029

10.5-10.9 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	635							
15,000-20,999	1,772	953						
21,000-26,999	2,909	2,090	1,271					
27,000-32,999	4,046	3,227	2,408	1,589				
33,000-38,999	5,183	4,364	3,545	2,726	1,906			
39,000-44,999	6,320	5,500	4,681	3,862	3,043	2,224		
45,000-53,999	7,456	6,637	5,818	4,999	4,180	3,361	2,542	
54,000-64,999	9,730	8,911	8,092	7,273	6,454	5,635	4,816	3,177

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	664							
15,000-20,999	1,801	996						
21,000-26,999	2,938	2,133	1,328					
27,000-32,999	4,074	3,270	2,465	1,660				
33,000-38,999	5,211	4,406	3,602	2,797	1,992			
39,000-44,999	6,348	5,543	4,738	3,934	3,129	2,324		
45,000-53,999	7,485	6,680	5,875	5,071	4,266	3,461	2,656	
54,000-64,999	9,758	8,954	8,149	7,344	6,539	5,735	4,930	3,320

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	692							
15,000-20,999	1,828	1,037						
21,000-26,999	2,965	2,174	1,383					
27,000-32,999	4,102	3,311	2,520	1,729				
33,000-38,999	5,239	4,448	3,657	2,866	2,075			
39,000-44,999	6,376	5,585	4,794	4,003	3,211	2,420		
45,000-53,999	7,512	6,721	5,930	5,139	4,348	3,557	2,766	
54,000-64,999	9,786	8,995	8,204	7,413	6,622	5,831	5,040	3,458

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	708							
15,000-20,999	1,844	1,061						
21,000-26,999	2,981	2,198	1,415					
27,000-32,999	4,118	3,335	2,552	1,769				
33,000-38,999	5,255	4,472	3,689	2,906	2,123			
39,000-44,999	6,392	5,609	4,826	4,043	3,260	2,477		
45,000-53,999	7,528	6,745	5,962	5,179	4,396	3,613	2,830	
54,000-64,999	9,802	9,019	8,236	7,453	6,670	5,887	5,104	3,538

Table 409. Central Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	808							
15,000-20,999	2,181	1,212						
21,000-26,999	3,554	2,585	1,616					
27,000-32,999	4,927	3,958	2,989	2,020				
33,000-38,999	6,300	5,331	4,362	3,393	2,424			
39,000-44,999	7,673	6,704	5,735	4,766	3,797	2,828		
45,000-53,999	9,046	8,077	7,108	6,139	5,170	4,201	3,232	
54,000-64,999	11,792	10,823	9,854	8,885	7,916	6,947	5,978	4,040
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	966							
15,000-20,999	2,339	1,448						
21,000-26,999	3,712	2,821	1,931					
27,000-32,999	5,085	4,195	3,304	2,414				
33,000-38,999	6,458	5,568	4,677	3,787	2,897			
39,000-44,999	7,831	6,941	6,050	5,160	4,270	3,380		
45,000-53,999	9,204	8,314	7,423	6,533	5,643	4,753	3,863	
54,000-64,999	11,950	11,060	10,169	9,279	8,389	7,499	6,609	4,828

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,048							
15,000-20,999	2,421	1,571						
21,000-26,999	3,794	2,944	2,095					
27,000-32,999	5,167	4,317	3,468	2,619				
33,000-38,999	6,540	5,690	4,841	3,992	3,143			
39,000-44,999	7,913	7,063	6,214	5,365	4,516	3,666		
45,000-53,999	9,286	8,436	7,587	6,738	5,889	5,039	4,190	
54,000-64,999	12,032	11,182	10,333	9,484	8,635	7,785	6,936	5,238
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,078							
15,000-20,999	2,451	1,617						
21,000-26,999	3,824	2,990	2,157					
27,000-32,999	5,197	4,364	3,530	2,696				
33,000-38,999	6,570	5,737	4,903	4,069	3,235			
39,000-44,999	7,943	7,110	6,276	5,442	4,608	3,774		
45,000-53,999	9,316	8,483	7,649	6,815	5,981	5,147	4,313	
54,000-64,999	12,063	11,229	10,395	9,561	8,727	7,893	7,059	5,391
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,108							
15,000-20,999	2,481	1,662						
21,000-26,999	3,854	3,035	2,216					
27,000-32,999	5,227	4,408	3,589	2,770				
33,000-38,999	6,600	5,781	4,962	4,143	3,324			
39,000-44,999	7,973	7,154	6,335	5,516	4,697	3,878		
45,000-53,999	9,346	8,527	7,708	6,889	6,070	5,251	4,432	
54,000-64,999	12,092	11,273	10,454	9,635	8,816	7,997	7,178	5,540

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,136							
15,000-20,999	2,510	1,705						
21,000-26,999	3,883	3,078	2,273					
27,000-32,999	5,256	4,451	3,646	2,841				
33,000-38,999	6,629	5,824	5,019	4,214	3,409			
39,000-44,999	8,002	7,197	6,392	5,587	4,783	3,978		
45,000-53,999	9,375	8,570	7,765	6,960	6,156	5,351	4,546	
54,000-64,999	12,121	11,316	10,511	9,706	8,902	8,097	7,292	5,682

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,164							
15,000-20,999	2,537	1,746						
21,000-26,999	3,910	3,119	2,328					
27,000-32,999	5,283	4,492	3,701	2,910				
33,000-38,999	6,656	5,865	5,074	4,283	3,492			
39,000-44,999	8,029	7,238	6,447	5,656	4,865	4,074		
45,000-53,999	9,402	8,611	7,820	7,029	6,238	5,447	4,656	
54,000-64,999	12,148	11,357	10,566	9,775	8,984	8,193	7,402	5,820

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,180							
15,000-20,999	2,553	1,770						
21,000-26,999	3,926	3,143	2,360					
27,000-32,999	5,299	4,516	3,733	2,950				
33,000-38,999	6,672	5,889	5,106	4,323	3,540			
39,000-44,999	8,045	7,262	6,479	5,696	4,913	4,130		
45,000-53,999	9,418	8,635	7,852	7,069	6,286	5,503	4,720	
54,000-64,999	12,164	11,381	10,598	9,815	9,032	8,249	7,466	5,900

Heading, Early Retirement of an Electric Resistance Furnace

Table 410. Central Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,313							
15,000-20,999	7,438	6,469						
21,000-26,999	10,564	9,595	8,626					
27,000-32,999	13,689	12,720	11,751	10,782				
33,000-38,999	16,815	15,846	14,876	13,907	12,938			
39,000-44,999	19,940	18,971	18,002	17,033	16,064	15,095		
45,000-53,999	23,065	22,096	21,127	20,158	19,189	18,220	17,251	
54,000-64,999	29,316	28,347	27,378	26,409	25,440	24,471	23,502	21,564
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,470							
15,000-20,999	7,596	6,706						
21,000-26,999	10,721	9,831	8,941					
27,000-32,999	13,847	12,957	12,066	11,176				
33,000-38,999	16,972	16,082	15,192	14,302	13,411			
39,000-44,999	20,098	19,207	18,317	17,427	16,537	15,647		
45,000-53,999	23,223	22,333	21,443	20,552	19,662	18,772	17,882	
54,000-64,999	29,474	28,584	27,694	26,803	25,913	25,023	24,133	22,352

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,552							
15,000-20,999	7,678	6,828						
21,000-26,999	10,803	9,954	9,105					
27,000-32,999	13,929	13,079	12,230	11,381				
33,000-38,999	17,054	16,205	15,356	14,506	13,657			
39,000-44,999	20,180	19,330	18,481	17,632	16,782	15,933		
45,000-53,999	23,305	22,456	21,606	20,757	19,908	19,059	18,209	
54,000-64,999	29,556	28,707	27,857	27,008	26,159	25,310	24,460	22,762
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,583							
15,000-20,999	7,709	6,875						
21,000-26,999	10,834	10,000	9,166					
27,000-32,999	13,959	13,126	12,292	11,458				
33,000-38,999	17,085	16,251	15,417	14,583	13,749			
39,000-44,999	20,210	19,376	18,543	17,709	16,875	16,041		
45,000-53,999	23,336	22,502	21,668	20,834	20,000	19,166	18,332	
54,000-64,999	29,587	28,753	27,919	27,085	26,251	25,417	24,583	22,916
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,613							
15,000-20,999	7,738	6,919						
21,000-26,999	10,864	10,045	9,226					
27,000-32,999	13,989	13,170	12,351	11,532				
33,000-38,999	17,115	16,295	15,476	14,657	13,838			
39,000-44,999	20,240	19,421	18,602	17,783	16,964	16,145		
45,000-53,999	23,365	22,546	21,727	20,908	20,089	19,270	18,451	
54,000-64,999	29,616	28,797	27,978	27,159	26,340	25,521	24,702	23,064

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,641							
15,000-20,999	7,767	6,962						
21,000-26,999	10,892	10,087	9,283					
27,000-32,999	14,018	13,213	12,408	11,603				
33,000-38,999	17,143	16,338	15,534	14,729	13,924			
39,000-44,999	20,269	19,464	18,659	17,854	17,049	16,245		
45,000-53,999	23,394	22,589	21,784	20,980	20,175	19,370	18,565	
54,000-64,999	29,645	28,840	28,035	27,231	26,426	25,621	24,816	23,207

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,669							
15,000-20,999	7,794	7,003						
21,000-26,999	10,920	10,129	9,338					
27,000-32,999	14,045	13,254	12,463	11,672				
33,000-38,999	17,171	16,380	15,589	14,798	14,007			
39,000-44,999	20,296	19,505	18,714	17,923	17,132	16,341		
45,000-53,999	23,422	22,631	21,839	21,048	20,257	19,466	18,675	
54,000-64,999	29,672	28,881	28,090	27,299	26,508	25,717	24,926	23,344

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,685							
15,000-20,999	7,810	7,027						
21,000-26,999	10,936	10,153	9,370					
27,000-32,999	14,061	13,278	12,495	11,712				
33,000-38,999	17,187	16,404	15,621	14,838	14,055			
39,000-44,999	20,312	19,529	18,746	17,963	17,180	16,397		
45,000-53,999	23,438	22,655	21,872	21,089	20,306	19,523	18,740	
54,000-64,999	29,688	28,905	28,122	27,339	26,556	25,773	24,990	23,424

Climate Zone 2: North Region, Dallas/Fort Worth

Cooling, New Construction

Table 411. Central Energy Savings (Cooling kWh) for 14.0 SEER Baseline—Zone 2

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–20.9	21.0-23.9	24.0+
< 15,000	70	134	249	433	502	672	800
15,000-20,999	105	201	374	649	753	1,008	1,200
21,000-26,999	140	268	498	865	1,004	1,343	1,601
27,000-32,999	174	335	623	1,082	1,256	1,679	2,001
33,000-38,999	209	403	748	1,298	1,507	2,015	2,401
39,000-44,999	244	470	872	1,514	1,758	2,351	2,801
45,000-53,999	279	537	997	1,731	2,009	2,687	3,201
54,000-64,999	349	671	1,246	2,163	2,511	3,359	4,001

Cooling, Replace-on-Burnout

Table 412. Central Energy Savings (Cooling kWh) for 13.08 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	192							
15,000-20,999	1,126	289						
21,000-26,999	2,060	1,222	385					
27,000-32,999	2,993	2,156	1,318	481				
33,000-38,999	3,927	3,089	2,252	1,415	577			
39,000-44,999	4,860	4,023	3,186	2,348	1,511	674		
45,000-53,999	5,794	4,956	4,119	3,282	2,445	1,607	770	
54,000-64,999	7,661	6,824	5,986	5,149	4,312	3,474	2,637	962

15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	257							
15,000-20,999	1,190	385						
21,000-26,999	2,124	1,319	514					
27,000-32,999	3,058	2,252	1,447	642				
33,000-38,999	3,991	3,186	2,381	1,576	771			
39,000-44,999	4,925	4,120	3,314	2,509	1,704	899		
45,000-53,999	5,858	5,053	4,248	3,443	2,638	1,833	1,028	
54,000-64,999	7,725	6,920	6,115	5,310	4,505	3,700	2,895	1,284

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	372							
15,000-20,999	1,305	558						
21,000-26,999	2,239	1,491	744					
27,000-32,999	3,173	2,425	1,677	930				
33,000-38,999	4,106	3,359	2,611	1,863	1,116			
39,000-44,999	5,040	4,292	3,544	2,797	2,049	1,302		
45,000-53,999	5,973	5,226	4,478	3,730	2,983	2,235	1,488	
54,000-64,999	7,840	7,093	6,345	5,598	4,850	4,102	3,355	1,859

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	555							
15,000-20,999	1,489	833						
21,000-26,999	2,422	1,767	1,111					
27,000-32,999	3,356	2,700	2,044	1,388				
33,000-38,999	4,290	3,634	2,978	2,322	1,666			
39,000-44,999	5,223	4,567	3,911	3,256	2,600	1,944		
45,000-53,999	6,157	5,501	4,845	4,189	3,533	2,877	2,221	
54,000-64,999	8,024	7,368	6,712	6,056	5,400	4,744	4,089	2,777

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	625							
15,000-20,999	1,558	937						
21,000-26,999	2,492	1,871	1,250					
27,000-32,999	3,426	2,805	2,183	1,562				
33,000-38,999	4,359	3,738	3,117	2,496	1,875			
39,000-44,999	5,293	4,672	4,051	3,429	2,808	2,187		
45,000-53,999	6,226	5,605	4,984	4,363	3,742	3,121	2,500	
54,000-64,999	8,093	7,472	6,851	6,230	5,609	4,988	4,367	3,125

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	794							
15,000-20,999	1,728	1,192						
21,000-26,999	2,662	2,125	1,589					
27,000-32,999	3,595	3,059	2,522	1,986				
33,000-38,999	4,529	3,992	3,456	2,920	2,383			
39,000-44,999	5,462	4,926	4,389	3,853	3,317	2,780		
45,000-53,999	6,396	5,859	5,323	4,787	4,250	3,714	3,178	
54,000-64,999	8,263	7,727	7,190	6,654	6,117	5,581	5,045	3,972

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	923							
15,000-20,999	1,857	1,384						
21,000-26,999	2,790	2,318	1,846					
27,000-32,999	3,724	3,252	2,779	2,307				
33,000-38,999	4,657	4,185	3,713	3,241	2,769			
39,000-44,999	5,591	5,119	4,647	4,174	3,702	3,230		
45,000-53,999	6,524	6,052	5,580	5,108	4,636	4,164	3,692	
54,000-64,999	8,391	7,919	7,447	6,975	6,503	6,031	5,559	4,615

Cooling, Early Retirement

Table 413. Central Energy Savings (Cooling kWh) for 12.44 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	289							
15,000-20,999	1,270	433						
21,000-26,999	2,252	1,414	577					
27,000-32,999	3,233	2,396	1,559	721				
33,000-38,999	4,215	3,378	2,540	1,703	866			
39,000-44,999	5,196	4,359	3,522	2,684	1,847	1,010		
45,000-53,999	6,178	5,341	4,503	3,666	2,829	1,991	1,154	
54,000-64,999	8,141	7,304	6,467	5,629	4,792	3,955	3,117	1,443
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	353							
15,000-20,999	1,335	529						
21,000-26,999	2,316	1,511	706					
27,000-32,999	3,298	2,493	1,687	882				
33,000-38,999	4,279	3,474	2,669	1,864	1,059			
39,000-44,999	5,261	4,456	3,651	2,846	2,040	1,235		
45,000-53,999	6,242	5,437	4,632	3,827	3,022	2,217	1,412	
54,000-64,999	8,206	7,400	6,595	5,790	4,985	4,180	3,375	1,765

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	468							
15,000-20,999	1,450	702						
21,000-26,999	2,431	1,684	936					
27,000-32,999	3,413	2,665	1,917	1,170				
33,000-38,999	4,394	3,647	2,899	2,151	1,404			
39,000-44,999	5,376	4,628	3,881	3,133	2,385	1,638		
45,000-53,999	6,357	5,610	4,862	4,115	3,367	2,619	1,872	
54,000-64,999	8,321	7,573	6,825	6,078	5,330	4,583	3,835	2,340

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	651							
15,000-20,999	1,633	977						
21,000-26,999	2,615	1,959	1,303					
27,000-32,999	3,596	2,940	2,284	1,629				
33,000-38,999	4,578	3,922	3,266	2,610	1,954			
39,000-44,999	5,559	4,903	4,248	3,592	2,936	2,280		
45,000-53,999	6,541	5,885	5,229	4,573	3,917	3,262	2,606	
54,000-64,999	8,504	7,848	7,192	6,536	5,881	5,225	4,569	3,257

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	721							
15,000-20,999	1,703	1,081						
21,000-26,999	2,684	2,063	1,442					
27,000-32,999	3,666	3,045	2,424	1,802				
33,000-38,999	4,647	4,026	3,405	2,784	2,163			
39,000-44,999	5,629	5,008	4,387	3,766	3,145	2,523		
45,000-53,999	6,610	5,989	5,368	4,747	4,126	3,505	2,884	
54,000-64,999	8,574	7,953	7,331	6,710	6,089	5,468	4,847	3,605

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	890							
15,000-20,999	1,872	1,336						
21,000-26,999	2,854	2,317	1,781					
27,000-32,999	3,835	3,299	2,763	2,226				
33,000-38,999	4,817	4,280	3,744	3,208	2,671			
39,000-44,999	5,798	5,262	4,726	4,189	3,653	3,117		
45,000-53,999	6,780	6,244	5,707	5,171	4,635	4,098	3,562	
54,000-64,999	8,743	8,207	7,670	7,134	6,598	6,061	5,525	4,452
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,019							
15,000-20,999	2,001	1,529						
21,000-26,999	2,982	2,510	2,038					
27,000-32,999	3,964	3,492	3,020	2,548				
33,000-38,999	4,945	4,473	4,001	3,529	3,057			
39,000-44,999	5,927	5,455	4,983	4,511	4,039	3,567		
45,000-53,999	6,909	6,436	5,964	5,492	5,020	4,548	4,076	
54,000-64,999	8,872	8,400	7,928	7,455	6,983	6,511	6,039	5,095

Table 414. Central Energy Savings (Cooling kWh) for 10.0 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	768							
15,000-20,999	1,989	1,151						
21,000-26,999	3,210	2,372	1,535					
27,000-32,999	4,431	3,593	2,756	1,919				
33,000-38,999	5,652	4,815	3,977	3,140	2,303			
39,000-44,999	6,873	6,036	5,198	4,361	3,524	2,686		
45,000-53,999	8,094	7,257	6,419	5,582	4,745	3,907	3,070	
54,000-64,999	10,536	9,699	8,862	8,024	7,187	6,350	5,512	3,838
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	832							
15,000-20,999	2,053	1,248						
21,000-26,999	3,274	2,469	1,664					
27,000-32,999	4,495	3,690	2,885	2,080				
33,000-38,999	5,716	4,911	4,106	3,301	2,496			
39,000-44,999	6,937	6,132	5,327	4,522	3,717	2,912		
45,000-53,999	8,158	7,353	6,548	5,743	4,938	4,133	3,328	
54,000-64,999	10,601	9,796	8,990	8,185	7,380	6,575	5,770	4,160

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	947							
15,000-20,999	2,168	1,420						
21,000-26,999	3,389	2,642	1,894					
27,000-32,999	4,610	3,863	3,115	2,367				
33,000-38,999	5,831	5,084	4,336	3,589	2,841			
39,000-44,999	7,052	6,305	5,557	4,810	4,062	3,314		
45,000-53,999	8,274	7,526	6,778	6,031	5,283	4,535	3,788	
54,000-64,999	10,716	9,968	9,220	8,473	7,725	6,978	6,230	4,735

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,130							
15,000-20,999	2,352	1,696						
21,000-26,999	3,573	2,917	2,261					
27,000-32,999	4,794	4,138	3,482	2,826				
33,000-38,999	6,015	5,359	4,703	4,047	3,391			
39,000-44,999	7,236	6,580	5,924	5,268	4,612	3,957		
45,000-53,999	8,457	7,801	7,145	6,489	5,833	5,178	4,522	
54,000-64,999	10,899	10,243	9,587	8,932	8,276	7,620	6,964	5,652

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,200							
15,000-20,999	2,421	1,800						
21,000-26,999	3,642	3,021	2,400					
27,000-32,999	4,863	4,242	3,621	3,000				
33,000-38,999	6,084	5,463	4,842	4,221	3,600			
39,000-44,999	7,305	6,684	6,063	5,442	4,821	4,200		
45,000-53,999	8,527	7,905	7,284	6,663	6,042	5,421	4,800	
54,000-64,999	10,969	10,348	9,727	9,105	8,484	7,863	7,242	6,000

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,369							
15,000-20,999	2,591	2,054						
21,000-26,999	3,812	3,275	2,739					
27,000-32,999	5,033	4,496	3,960	3,424				
33,000-38,999	6,254	5,717	5,181	4,645	4,108			
39,000-44,999	7,475	6,939	6,402	5,866	5,330	4,793		
45,000-53,999	8,696	8,160	7,623	7,087	6,551	6,014	5,478	
54,000-64,999	11,138	10,602	10,065	9,529	8,993	8,456	7,920	6,847

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,498							
15,000-20,999	2,719	2,247						
21,000-26,999	3,940	3,468	2,996					
27,000-32,999	5,161	4,689	4,217	3,745				
33,000-38,999	6,382	5,910	5,438	4,966	4,494			
39,000-44,999	7,603	7,131	6,659	6,187	5,715	5,243		
45,000-53,999	8,825	8,352	7,880	7,408	6,936	6,464	5,992	
54,000-64,999	11,267	10,795	10,323	9,851	9,378	8,906	8,434	7,490

Heading, New Construction/Replace-on-Burnout

Table 415. Central Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	78							
15,000-20,999	649	118						
21,000-26,999	1,220	688	157					
27,000-32,999	1,790	1,259	728	196				
33,000-38,999	2,361	1,830	1,298	767	235			
39,000-44,999	2,932	2,400	1,869	1,337	806	275		
45,000-53,999	3,502	2,971	2,440	1,908	1,377	845	314	
54,000-64,999	4,644	4,112	3,581	3,049	2,518	1,987	1,455	392
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	168							
15,000-20,999	738	251						
21,000-26,999	1,309	822	335					
27,000-32,999	1,880	1,393	906	419				
33,000-38,999	2,450	1,963	1,476	990	503			
39,000-44,999	3,021	2,534	2,047	1,560	1,073	586		
45,000-53,999	3,592	3,105	2,618	2,131	1,644	1,157	670	
54,000-64,999	4,733	4,246	3,759	3,272	2,785	2,298	1,812	838

9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	214							
15,000-20,999	784	321						
21,000-26,999	1,355	891	428					
27,000-32,999	1,926	1,462	998	535				
33,000-38,999	2,496	2,033	1,569	1,105	641			
39,000-44,999	3,067	2,603	2,140	1,676	1,212	748		
45,000-53,999	3,638	3,174	2,710	2,247	1,783	1,319	855	
54,000-64,999	4,779	4,315	3,852	3,388	2,924	2,460	1,997	1,069

10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	231							
15,000-20,999	802	347						
21,000-26,999	1,373	917	462					
27,000-32,999	1,943	1,488	1,033	578				
33,000-38,999	2,514	2,059	1,604	1,149	694			
39,000-44,999	3,085	2,629	2,174	1,719	1,264	809		
45,000-53,999	3,655	3,200	2,745	2,290	1,835	1,380	925	
54,000-64,999	4,797	4,341	3,886	3,431	2,976	2,521	2,066	1,156

10.5-10.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	248							
15,000-20,999	819	372						
21,000-26,999	1,389	943	496					
27,000-32,999	1,960	1,513	1,067	620				
33,000-38,999	2,531	2,084	1,637	1,191	744			
39,000-44,999	3,101	2,655	2,208	1,761	1,315	868		
45,000-53,999	3,672	3,225	2,779	2,332	1,885	1,438	992	
54,000-64,999	4,813	4,367	3,920	3,473	3,027	2,580	2,133	1,240

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	264							
15,000-20,999	835	396						
21,000-26,999	1,405	967	528					
27,000-32,999	1,976	1,537	1,099	660				
33,000-38,999	2,547	2,108	1,670	1,231	792			
39,000-44,999	3,117	2,679	2,240	1,802	1,363	924		
45,000-53,999	3,688	3,249	2,811	2,372	1,934	1,495	1,056	
54,000-64,999	4,829	4,391	3,952	3,514	3,075	2,636	2,198	1,320
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	280							
15,000-20,999	850	419						
21,000-26,999	1,421	990	559					
27,000-32,999	1,992	1,561	1,130	699				
33,000-38,999	2,562	2,131	1,701	1,270	839			
39,000-44,999	3,133	2,702	2,271	1,840	1,410	979		
45,000-53,999	3,704	3,273	2,842	2,411	1,980	1,549	1,119	
54,000-64,999	4,845	4,414	3,983	3,552	3,122	2,691	2,260	1,398
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	289							
15,000-20,999	859	433						
21,000-26,999	1,430	1,004	577					
27,000-32,999	2,001	1,574	1,148	722				
33,000-38,999	2,571	2,145	1,719	1,292	866			
39,000-44,999	3,142	2,716	2,289	1,863	1,437	1,010		
45,000-53,999	3,713	3,286	2,860	2,434	2,007	1,581	1,155	
54,000-64,999	4,854	4,428	4,001	3,575	3,149	2,722	2,296	1,444

Heating, Early Retirement of a Heat Pump

Table 416. Central Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	190							
15,000-20,999	816	284						
21,000-26,999	1,442	911	379					
27,000-32,999	2,068	1,537	1,005	474				
33,000-38,999	2,694	2,163	1,632	1,100	569			
39,000-44,999	3,321	2,789	2,258	1,726	1,195	664		
45,000-53,999	3,947	3,416	2,884	2,353	1,821	1,290	758	
54,000-64,999	5,199	4,668	4,137	3,605	3,074	2,542	2,011	948
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	279							
15,000-20,999	905	418						
21,000-26,999	1,531	1,044	557					
27,000-32,999	2,157	1,670	1,184	697				
33,000-38,999	2,784	2,297	1,810	1,323	836			
39,000-44,999	3,410	2,923	2,436	1,949	1,462	975		
45,000-53,999	4,036	3,549	3,062	2,575	2,088	1,602	1,115	
54,000-64,999	5,288	4,802	4,315	3,828	3,341	2,854	2,367	1,393

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	325							
15,000-20,999	951	487						
21,000-26,999	1,577	1,114	650					
27,000-32,999	2,204	1,740	1,276	812				
33,000-38,999	2,830	2,366	1,902	1,439	975			
39,000-44,999	3,456	2,992	2,529	2,065	1,601	1,137		
45,000-53,999	4,082	3,619	3,155	2,691	2,227	1,763	1,300	
54,000-64,999	5,335	4,871	4,407	3,943	3,480	3,016	2,552	1,625
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	342							
15,000-20,999	969	513						
21,000-26,999	1,595	1,140	685					
27,000-32,999	2,221	1,766	1,311	856				
33,000-38,999	2,847	2,392	1,937	1,482	1,027			
39,000-44,999	3,473	3,018	2,563	2,108	1,653	1,198		
45,000-53,999	4,100	3,645	3,190	2,734	2,279	1,824	1,369	
54,000-64,999	5,352	4,897	4,442	3,987	3,532	3,077	2,622	1,712
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	359							
15,000-20,999	985	539						
21,000-26,999	1,612	1,165	718					
27,000-32,999	2,238	1,791	1,344	898				
33,000-38,999	2,864	2,417	1,971	1,524	1,077			
39,000-44,999	3,490	3,044	2,597	2,150	1,703	1,257		
45,000-53,999	4,116	3,670	3,223	2,776	2,330	1,883	1,436	
54,000-64,999	5,369	4,922	4,476	4,029	3,582	3,135	2,689	1,795

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	375							
15,000-20,999	1,001	563						
21,000-26,999	1,628	1,189	750					
27,000-32,999	2,254	1,815	1,377	938				
33,000-38,999	2,880	2,441	2,003	1,564	1,126			
39,000-44,999	3,506	3,068	2,629	2,190	1,752	1,313		
45,000-53,999	4,133	3,694	3,255	2,817	2,378	1,939	1,501	
54,000-64,999	5,385	4,946	4,508	4,069	3,631	3,192	2,753	1,876

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	391							
15,000-20,999	1,017	586						
21,000-26,999	1,643	1,212	782					
27,000-32,999	2,269	1,839	1,408	977				
33,000-38,999	2,896	2,465	2,034	1,603	1,172			
39,000-44,999	3,522	3,091	2,660	2,229	1,798	1,368		
45,000-53,999	4,148	3,717	3,286	2,856	2,425	1,994	1,563	
54,000-64,999	5,401	4,970	4,539	4,108	3,677	3,246	2,815	1,954

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	400							
15,000-20,999	1,026	600						
21,000-26,999	1,652	1,226	800					
27,000-32,999	2,279	1,852	1,426	1,000				
33,000-38,999	2,905	2,478	2,052	1,626	1,199			
39,000-44,999	3,531	3,105	2,678	2,252	1,826	1,399		
45,000-53,999	4,157	3,731	3,305	2,878	2,452	2,026	1,599	
54,000-64,999	5,410	4,983	4,557	4,131	3,704	3,278	2,852	1,999

Table 417. Central Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	457							
15,000-20,999	1,216	685						
21,000-26,999	1,976	1,444	913					
27,000-32,999	2,736	2,204	1,673	1,141				
33,000-38,999	3,495	2,964	2,432	1,901	1,370			
39,000-44,999	4,255	3,724	3,192	2,661	2,129	1,598		
45,000-53,999	5,015	4,483	3,952	3,420	2,889	2,358	1,826	
54,000-64,999	6,534	6,003	5,471	4,940	4,408	3,877	3,346	2,283
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	546							
15,000-20,999	1,305	818						
21,000-26,999	2,065	1,578	1,091					
27,000-32,999	2,825	2,338	1,851	1,364				
33,000-38,999	3,584	3,098	2,611	2,124	1,637			
39,000-44,999	4,344	3,857	3,370	2,883	2,397	1,910		
45,000-53,999	5,104	4,617	4,130	3,643	3,156	2,669	2,182	
54,000-64,999	6,623	6,136	5,649	5,163	4,676	4,189	3,702	2,728

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	592							
15,000-20,999	1,352	888						
21,000-26,999	2,111	1,648	1,184					
27,000-32,999	2,871	2,407	1,943	1,480				
33,000-38,999	3,631	3,167	2,703	2,239	1,776			
39,000-44,999	4,390	3,927	3,463	2,999	2,535	2,072		
45,000-53,999	5,150	4,686	4,223	3,759	3,295	2,831	2,368	
54,000-64,999	6,670	6,206	5,742	5,278	4,814	4,351	3,887	2,959

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	609							
15,000-20,999	1,369	914						
21,000-26,999	2,129	1,674	1,219					
27,000-32,999	2,888	2,433	1,978	1,523				
33,000-38,999	3,648	3,193	2,738	2,283	1,828			
39,000-44,999	4,408	3,953	3,498	3,043	2,588	2,132		
45,000-53,999	5,168	4,712	4,257	3,802	3,347	2,892	2,437	
54,000-64,999	6,687	6,232	5,777	5,322	4,867	4,412	3,956	3,046

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	626							
15,000-20,999	1,386	939						
21,000-26,999	2,145	1,699	1,252					
27,000-32,999	2,905	2,458	2,012	1,565				
33,000-38,999	3,665	3,218	2,771	2,325	1,878			
39,000-44,999	4,425	3,978	3,531	3,084	2,638	2,191		
45,000-53,999	5,184	4,738	4,291	3,844	3,397	2,951	2,504	
54,000-64,999	6,704	6,257	5,810	5,364	4,917	4,470	4,023	3,130

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	642							
15,000-20,999	1,402	963						
21,000-26,999	2,162	1,723	1,284					
27,000-32,999	2,921	2,483	2,044	1,605				
33,000-38,999	3,681	3,242	2,804	2,365	1,926			
39,000-44,999	4,441	4,002	3,563	3,125	2,686	2,248		
45,000-53,999	5,200	4,762	4,323	3,885	3,446	3,007	2,569	
54,000-64,999	6,720	6,281	5,843	5,404	4,965	4,527	4,088	3,211

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	658							
15,000-20,999	1,417	987						
21,000-26,999	2,177	1,746	1,315					
27,000-32,999	2,937	2,506	2,075	1,644				
33,000-38,999	3,697	3,266	2,835	2,404	1,973			
39,000-44,999	4,456	4,025	3,595	3,164	2,733	2,302		
45,000-53,999	5,216	4,785	4,354	3,923	3,493	3,062	2,631	
54,000-64,999	6,735	6,305	5,874	5,443	5,012	4,581	4,150	3,289

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	667							
15,000-20,999	1,426	1,000						
21,000-26,999	2,186	1,760	1,334					
27,000-32,999	2,946	2,520	2,093	1,667				
33,000-38,999	3,706	3,279	2,853	2,427	2,000			
39,000-44,999	4,465	4,039	3,613	3,186	2,760	2,334		
45,000-53,999	5,225	4,799	4,372	3,946	3,520	3,093	2,667	
54,000-64,999	6,744	6,318	5,892	5,465	5,039	4,613	4,187	3,334

Heading, Early Retirement of an Electric Resistance Furnace

Table 418. Central Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,461							
15,000-20,999	4,224	3,692						
21,000-26,999	5,986	5,454	4,923					
27,000-32,999	7,748	7,217	6,685	6,154				
33,000-38,999	9,510	8,979	8,447	7,916	7,384			
39,000-44,999	11,272	10,741	10,209	9,678	9,147	8,615		
45,000-53,999	13,035	12,503	11,972	11,440	10,909	10,377	9,846	
54,000-64,999	16,559	16,027	15,496	14,965	14,433	13,902	13,370	12,307
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,551							
15,000-20,999	4,313	3,826						
21,000-26,999	6,075	5,588	5,101					
27,000-32,999	7,837	7,350	6,863	6,376				
33,000-38,999	9,599	9,112	8,625	8,139	7,652			
39,000-44,999	11,361	10,875	10,388	9,901	9,414	8,927		
45,000-53,999	13,124	12,637	12,150	11,663	11,176	10,689	10,202	
54,000-64,999	16,648	16,161	15,674	15,187	14,700	14,213	13,727	12,753

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,597							
15,000-20,999	4,359	3,895						
21,000-26,999	6,121	5,657	5,194					
27,000-32,999	7,883	7,420	6,956	6,492				
33,000-38,999	9,646	9,182	8,718	8,254	7,790			
39,000-44,999	11,408	10,944	10,480	10,016	9,553	9,089		
45,000-53,999	13,170	12,706	12,242	11,779	11,315	10,851	10,387	
54,000-64,999	16,694	16,230	15,767	15,303	14,839	14,375	13,912	12,984

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,614							
15,000-20,999	4,376	3,921						
21,000-26,999	6,139	5,684	5,228					
27,000-32,999	7,901	7,446	6,991	6,536				
33,000-38,999	9,663	9,208	8,753	8,298	7,843			
39,000-44,999	11,425	10,970	10,515	10,060	9,605	9,150		
45,000-53,999	13,187	12,732	12,277	11,822	11,367	10,912	10,457	
54,000-64,999	16,712	16,257	15,801	15,346	14,891	14,436	13,981	13,071

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,631							
15,000-20,999	4,393	3,946						
21,000-26,999	6,155	5,709	5,262					
27,000-32,999	7,917	7,471	7,024	6,577				
33,000-38,999	9,680	9,233	8,786	8,340	7,893			
39,000-44,999	11,442	10,995	10,548	10,102	9,655	9,208		
45,000-53,999	13,204	12,757	12,311	11,864	11,417	10,971	10,524	
54,000-64,999	16,728	16,282	15,835	15,388	14,942	14,495	14,048	13,155

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2,647							
15,000-20,999	4,409	3,971						
21,000-26,999	6,171	5,733	5,294					
27,000-32,999	7,934	7,495	7,056	6,618				
33,000-38,999	9,696	9,257	8,819	8,380	7,941			
39,000-44,999	11,458	11,019	10,581	10,142	9,703	9,265		
45,000-53,999	13,220	12,782	12,343	11,904	11,466	11,027	10,588	
54,000-64,999	16,745	16,306	15,867	15,429	14,990	14,551	14,113	13,235

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2,663							
15,000-20,999	4,425	3,994						
21,000-26,999	6,187	5,756	5,325					
27,000-32,999	7,949	7,518	7,087	6,657				
33,000-38,999	9,711	9,281	8,850	8,419	7,988			
39,000-44,999	11,474	11,043	10,612	10,181	9,750	9,319		
45,000-53,999	13,236	12,805	12,374	11,943	11,512	11,081	10,651	
54,000-64,999	16,760	16,329	15,898	15,468	15,037	14,606	14,175	13,313

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2,672							
15,000-20,999	4,434	4,008						
21,000-26,999	6,196	5,770	5,343					
27,000-32,999	7,958	7,532	7,106	6,679				
33,000-38,999	9,720	9,294	8,868	8,441	8,015			
39,000-44,999	11,483	11,056	10,630	10,204	9,777	9,351		
45,000-53,999	13,245	12,818	12,392	11,966	11,540	11,113	10,687	
54,000-64,999	16,769	16,343	15,917	15,490	15,064	14,638	14,211	13,359

Climate Zone 3: South Region, Houston

Cooling, New Construction

Table 419. Central Energy Savings (Cooling kWh) for 14.0 SEER Baseline—Zone 3

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–20.9	21.0-23.9	24.0+
< 15,000	82	157	292	504	586	783	933
15,000-20,999	123	236	438	756	879	1,175	1,400
21,000-26,999	163	314	584	1,008	1,172	1,566	1,866
27,000-32,999	204	393	729	1,260	1,465	1,958	2,333
33,000-38,999	245	471	875	1,512	1,757	2,350	2,799
39,000-44,999	286	550	1,021	1,764	2,050	2,741	3,266
45,000-53,999	327	628	1,167	2,017	2,343	3,133	3,732
54,000-64,999	409	786	1,459	2,521	2,929	3,916	4,665

Cooling, Replace-on-Burnout

Table 420. Central Energy Savings (Cooling kWh) for 13.08 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	225							
15,000-20,999	1,318	338						
21,000-26,999	2,412	1,431	451					
27,000-32,999	3,505	2,524	1,544	563				
33,000-38,999	4,598	3,617	2,637	1,656	676			
39,000-44,999	5,691	4,710	3,730	2,750	1,769	789		
45,000-53,999	6,784	5,803	4,823	3,843	2,862	1,882	901	
54,000-64,999	8,970	7,990	7,009	6,029	5,048	4,068	3,088	1,127

15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	301							
15,000-20,999	1,394	451						
21,000-26,999	2,487	1,544	602					
27,000-32,999	3,580	2,637	1,695	752				
33,000-38,999	4,673	3,730	2,788	1,845	902			
39,000-44,999	5,766	4,823	3,881	2,938	1,995	1,053		
45,000-53,999	6,859	5,917	4,974	4,031	3,089	2,146	1,203	
54,000-64,999	9,045	8,103	7,160	6,217	5,275	4,332	3,389	1,504

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	435							
15,000-20,999	1,529	653						
21,000-26,999	2,622	1,746	871					
27,000-32,999	3,715	2,839	1,964	1,089				
33,000-38,999	4,808	3,932	3,057	2,182	1,306			
39,000-44,999	5,901	5,026	4,150	3,275	2,399	1,524		
45,000-53,999	6,994	6,119	5,243	4,368	3,493	2,617	1,742	
54,000-64,999	9,180	8,305	7,429	6,554	5,679	4,803	3,928	2,177

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	648							
15,000-20,999	1,741	972						
21,000-26,999	2,834	2,065	1,296					
27,000-32,999	3,927	3,158	2,389	1,619				
33,000-38,999	5,020	4,251	3,482	2,713	1,943			
39,000-44,999	6,113	5,344	4,575	3,806	3,036	2,267		
45,000-53,999	7,206	6,437	5,668	4,899	4,130	3,360	2,591	
54,000-64,999	9,392	8,623	7,854	7,085	6,316	5,547	4,777	3,239

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	729							
15,000-20,999	1,823	1,094						
21,000-26,999	2,916	2,187	1,459					
27,000-32,999	4,009	3,280	2,552	1,824				
33,000-38,999	5,102	4,373	3,645	2,917	2,188			
39,000-44,999	6,195	5,467	4,738	4,010	3,282	2,553		
45,000-53,999	7,288	6,560	5,831	5,103	4,375	3,646	2,918	
54,000-64,999	9,474	8,746	8,017	7,289	6,561	5,832	5,104	3,647

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	927							
15,000-20,999	2,020	1,390						
21,000-26,999	3,113	2,483	1,854					
27,000-32,999	4,206	3,576	2,947	2,317				
33,000-38,999	5,299	4,670	4,040	3,410	2,781			
39,000-44,999	6,392	5,763	5,133	4,503	3,874	3,244		
45,000-53,999	7,485	6,856	6,226	5,596	4,967	4,337	3,707	
54,000-64,999	9,672	9,042	8,412	7,783	7,153	6,523	5,894	4,634

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,077							
15,000-20,999	2,170	1,615						
21,000-26,999	3,263	2,708	2,154					
27,000-32,999	4,356	3,801	3,247	2,692				
33,000-38,999	5,449	4,894	4,340	3,785	3,230			
39,000-44,999	6,542	5,987	5,433	4,878	4,323	3,769		
45,000-53,999	7,635	7,081	6,526	5,971	5,416	4,862	4,307	
54,000-64,999	9,821	9,267	8,712	8,157	7,603	7,048	6,493	5,384

Cooling, Early Retirement

Table 421. Central Energy Savings (Cooling kWh) for 12.44 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	338							
15,000-20,999	1,487	507						
21,000-26,999	2,636	1,656	676					
27,000-32,999	3,786	2,805	1,825	845				
33,000-38,999	4,935	3,955	2,974	1,994	1,014			
39,000-44,999	6,084	5,104	4,124	3,143	2,163	1,182		
45,000-53,999	7,234	6,253	5,273	4,293	3,312	2,332	1,351	
54,000-64,999	9,532	8,552	7,572	6,591	5,611	4,630	3,650	1,689
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	413							
15,000-20,999	1,563	620						
21,000-26,999	2,712	1,769	826					
27,000-32,999	3,861	2,919	1,976	1,033				
33,000-38,999	5,011	4,068	3,125	2,182	1,240			
39,000-44,999	6,160	5,217	4,274	3,332	2,389	1,446		
45,000-53,999	7,309	6,366	5,424	4,481	3,538	2,596	1,653	
54,000-64,999	9,608	8,665	7,722	6,780	5,837	4,894	3,952	2,066

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	548							
15,000-20,999	1,697	822						
21,000-26,999	2,847	1,971	1,096					
27,000-32,999	3,996	3,121	2,245	1,370				
33,000-38,999	5,145	4,270	3,394	2,519	1,644			
39,000-44,999	6,295	5,419	4,544	3,668	2,793	1,918		
45,000-53,999	7,444	6,568	5,693	4,818	3,942	3,067	2,192	
54,000-64,999	9,742	8,867	7,992	7,116	6,241	5,366	4,490	2,740

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	760							
15,000-20,999	1,910	1,140						
21,000-26,999	3,059	2,290	1,521					
27,000-32,999	4,208	3,439	2,670	1,901				
33,000-38,999	5,358	4,588	3,819	3,050	2,281			
39,000-44,999	6,507	5,738	4,968	4,199	3,430	2,661		
45,000-53,999	7,656	6,887	6,118	5,349	4,579	3,810	3,041	
54,000-64,999	9,955	9,186	8,416	7,647	6,878	6,109	5,340	3,801

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	842							
15,000-20,999	1,991	1,263						
21,000-26,999	3,141	2,412	1,684					
27,000-32,999	4,290	3,562	2,833	2,105				
33,000-38,999	5,439	4,711	3,983	3,254	2,526			
39,000-44,999	6,589	5,860	5,132	4,404	3,675	2,947		
45,000-53,999	7,738	7,010	6,281	5,553	4,824	4,096	3,368	
54,000-64,999	10,037	9,308	8,580	7,851	7,123	6,395	5,666	4,210

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,039							
15,000-20,999	2,189	1,559						
21,000-26,999	3,338	2,708	2,079					
27,000-32,999	4,487	3,858	3,228	2,598				
33,000-38,999	5,637	5,007	4,377	3,748	3,118			
39,000-44,999	6,786	6,156	5,527	4,897	4,267	3,638		
45,000-53,999	7,935	7,306	6,676	6,046	5,417	4,787	4,157	
54,000-64,999	10,234	9,604	8,975	8,345	7,715	7,086	6,456	5,197

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,189							
15,000-20,999	2,339	1,784						
21,000-26,999	3,488	2,933	2,378					
27,000-32,999	4,637	4,082	3,528	2,973				
33,000-38,999	5,787	5,232	4,677	4,122	3,568			
39,000-44,999	6,936	6,381	5,826	5,272	4,717	4,162		
45,000-53,999	8,085	7,530	6,976	6,421	5,866	5,312	4,757	
54,000-64,999	10,384	9,829	9,274	8,720	8,165	7,610	7,056	5,946

Table 422. Central Energy Savings (Cooling kWh) for 10.0 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	899							
15,000-20,999	2,328	1,348						
21,000-26,999	3,758	2,778	1,797					
27,000-32,999	5,188	4,208	3,227	2,247				
33,000-38,999	6,618	5,637	4,657	3,677	2,696			
39,000-44,999	8,047	7,067	6,087	5,106	4,126	3,145		
45,000-53,999	9,477	8,497	7,516	6,536	5,556	4,575	3,595	
54,000-64,999	12,337	11,356	10,376	9,396	8,415	7,435	6,454	4,494
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	974							
15,000-20,999	2,404	1,461						
21,000-26,999	3,834	2,891	1,948					
27,000-32,999	5,263	4,321	3,378	2,435				
33,000-38,999	6,693	5,750	4,808	3,865	2,922			
39,000-44,999	8,123	7,180	6,237	5,295	4,352	3,409		
45,000-53,999	9,553	8,610	7,667	6,725	5,782	4,839	3,896	
54,000-64,999	12,412	11,469	10,527	9,584	8,641	7,699	6,756	4,871

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,109							
15,000-20,999	2,539	1,663						
21,000-26,999	3,968	3,093	2,218					
27,000-32,999	5,398	4,523	3,647	2,772				
33,000-38,999	6,828	5,952	5,077	4,202	3,326			
39,000-44,999	8,258	7,382	6,507	5,631	4,756	3,881		
45,000-53,999	9,687	8,812	7,937	7,061	6,186	5,311	4,435	
54,000-64,999	12,547	11,671	10,796	9,921	9,045	8,170	7,295	5,544
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,321							
15,000-20,999	2,751	1,982						
21,000-26,999	4,181	3,411	2,642					
27,000-32,999	5,610	4,841	4,072	3,303				
33,000-38,999	7,040	6,271	5,502	4,733	3,963			
39,000-44,999	8,470	7,701	6,932	6,162	5,393	4,624		
45,000-53,999	9,900	9,130	8,361	7,592	6,823	6,054	5,285	
54,000-64,999	12,759	11,990	11,221	10,452	9,682	8,913	8,144	6,606
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,403							
15,000-20,999	2,833	2,104						
21,000-26,999	4,262	3,534	2,806					
27,000-32,999	5,692	4,964	4,235	3,507				
33,000-38,999	7,122	6,393	5,665	4,937	4,208			
39,000-44,999	8,552	7,823	7,095	6,367	5,638	4,910		
45,000-53,999	9,981	9,253	8,525	7,796	7,068	6,340	5,611	
54,000-64,999	12,841	12,112	11,384	10,656	9,927	9,199	8,471	7,014

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,600							
15,000-20,999	3,030	2,400						
21,000-26,999	4,460	3,830	3,200					
27,000-32,999	5,889	5,260	4,630	4,001				
33,000-38,999	7,319	6,690	6,060	5,430	4,801			
39,000-44,999	8,749	8,119	7,490	6,860	6,230	5,601		
45,000-53,999	10,179	9,549	8,919	8,290	7,660	7,030	6,401	
54,000-64,999	13,038	12,409	11,779	11,149	10,520	9,890	9,260	8,001

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,750							
15,000-20,999	3,180	2,625						
21,000-26,999	4,610	4,055	3,500					
27,000-32,999	6,039	5,485	4,930	4,375				
33,000-38,999	7,469	6,914	6,360	5,805	5,250			
39,000-44,999	8,899	8,344	7,789	7,235	6,680	6,125		
45,000-53,999	10,329	9,774	9,219	8,664	8,110	7,555	7,000	
54,000-64,999	13,188	12,633	12,079	11,524	10,969	10,415	9,860	8,750

Heading, New Construction/Replace-on-Burnout

Table 423. Central Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	51							
15,000-20,999	420	77						
21,000-26,999	789	446	102					
27,000-32,999	1,158	815	471	128				
33,000-38,999	1,527	1,184	840	497	154			
39,000-44,999	1,896	1,552	1,209	866	523	179		
45,000-53,999	2,265	1,921	1,578	1,235	892	548	205	
54,000-64,999	3,003	2,659	2,316	1,973	1,629	1,286	943	256
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	109							
15,000-20,999	478	164						
21,000-26,999	847	533	219					
27,000-32,999	1,216	902	588	274				
33,000-38,999	1,585	1,271	957	642	328			
39,000-44,999	1,954	1,640	1,326	1,011	697	383		
45,000-53,999	2,323	2,009	1,694	1,380	1,066	752	438	
54,000-64,999	3,061	2,747	2,432	2,118	1,804	1,490	1,176	547

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	140							
15,000-20,999	509	209						
21,000-26,999	877	578	279					
27,000-32,999	1,246	947	648	349				
33,000-38,999	1,615	1,316	1,017	718	419			
39,000-44,999	1,984	1,685	1,386	1,087	788	489		
45,000-53,999	2,353	2,054	1,755	1,456	1,157	858	559	
54,000-64,999	3,091	2,792	2,493	2,194	1,895	1,595	1,296	698
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	151							
15,000-20,999	520	226						
21,000-26,999	889	595	302					
27,000-32,999	1,258	964	671	377				
33,000-38,999	1,627	1,333	1,040	746	453			
39,000-44,999	1,996	1,702	1,409	1,115	822	528		
45,000-53,999	2,364	2,071	1,778	1,484	1,191	897	604	
54,000-64,999	3,102	2,809	2,515	2,222	1,929	1,635	1,342	755
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	162							
15,000-20,999	531	243						
21,000-26,999	900	612	324					
27,000-32,999	1,269	981	693	405				
33,000-38,999	1,638	1,350	1,062	774	486			
39,000-44,999	2,006	1,719	1,431	1,143	855	567		
45,000-53,999	2,375	2,087	1,800	1,512	1,224	936	648	
54,000-64,999	3,113	2,825	2,537	2,249	1,961	1,674	1,386	810

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	172							
15,000-20,999	541	259						
21,000-26,999	910	628	345					
27,000-32,999	1,279	997	714	431				
33,000-38,999	1,648	1,365	1,083	800	517			
39,000-44,999	2,017	1,734	1,452	1,169	886	604		
45,000-53,999	2,386	2,103	1,821	1,538	1,255	973	690	
54,000-64,999	3,124	2,841	2,558	2,276	1,993	1,710	1,428	862
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	183							
15,000-20,999	552	274						
21,000-26,999	920	643	365					
27,000-32,999	1,289	1,012	734	457				
33,000-38,999	1,658	1,381	1,103	825	548			
39,000-44,999	2,027	1,750	1,472	1,194	917	639		
45,000-53,999	2,396	2,119	1,841	1,563	1,286	1,008	731	
54,000-64,999	3,134	2,856	2,579	2,301	2,024	1,746	1,468	913
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	189							
15,000-20,999	557	283						
21,000-26,999	926	652	377					
27,000-32,999	1,295	1,021	746	471				
33,000-38,999	1,664	1,390	1,115	840	566			
39,000-44,999	2,033	1,758	1,484	1,209	935	660		
45,000-53,999	2,402	2,127	1,853	1,578	1,303	1,029	754	
54,000-64,999	3,140	2,865	2,591	2,316	2,041	1,767	1,492	943

Heading, Early Retirement of a Heat Pump

Table 424. Central Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	124							
15,000-20,999	529	186						
21,000-26,999	934	591	248					
27,000-32,999	1,339	996	653	310				
33,000-38,999	1,745	1,401	1,058	715	371			
39,000-44,999	2,150	1,807	1,463	1,120	777	433		
45,000-53,999	2,555	2,212	1,868	1,525	1,182	839	495	
54,000-64,999	3,365	3,022	2,679	2,336	1,992	1,649	1,306	619
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	182							
15,000-20,999	587	273						
21,000-26,999	992	678	364					
27,000-32,999	1,398	1,083	769	455				
33,000-38,999	1,803	1,489	1,174	860	546			
39,000-44,999	2,208	1,894	1,580	1,265	951	637		
45,000-53,999	2,613	2,299	1,985	1,671	1,356	1,042	728	
54,000-64,999	3,424	3,109	2,795	2,481	2,167	1,853	1,538	910

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	212							
15,000-20,999	617	318						
21,000-26,999	1,023	724	424					
27,000-32,999	1,428	1,129	830	531				
33,000-38,999	1,833	1,534	1,235	936	637			
39,000-44,999	2,238	1,939	1,640	1,341	1,042	743		
45,000-53,999	2,643	2,344	2,045	1,746	1,447	1,148	849	
54,000-64,999	3,454	3,155	2,856	2,557	2,257	1,958	1,659	1,061
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	224							
15,000-20,999	629	335						
21,000-26,999	1,034	741	447					
27,000-32,999	1,439	1,146	852	559				
33,000-38,999	1,844	1,551	1,258	964	671			
39,000-44,999	2,250	1,956	1,663	1,369	1,076	782		
45,000-53,999	2,655	2,361	2,068	1,775	1,481	1,188	894	
54,000-64,999	3,465	3,172	2,878	2,585	2,291	1,998	1,705	1,118
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	235							
15,000-20,999	640	352						
21,000-26,999	1,045	757	469					
27,000-32,999	1,450	1,162	874	586				
33,000-38,999	1,855	1,567	1,279	991	704			
39,000-44,999	2,260	1,973	1,685	1,397	1,109	821		
45,000-53,999	2,666	2,378	2,090	1,802	1,514	1,226	938	
54,000-64,999	3,476	3,188	2,900	2,612	2,324	2,036	1,748	1,173

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	245							
15,000-20,999	650	368						
21,000-26,999	1,055	773	490					
27,000-32,999	1,461	1,178	895	613				
33,000-38,999	1,866	1,583	1,300	1,018	735			
39,000-44,999	2,271	1,988	1,706	1,423	1,140	858		
45,000-53,999	2,676	2,394	2,111	1,828	1,546	1,263	980	
54,000-64,999	3,487	3,204	2,921	2,639	2,356	2,073	1,791	1,225
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	255							
15,000-20,999	660	383						
21,000-26,999	1,066	788	510					
27,000-32,999	1,471	1,193	916	638				
33,000-38,999	1,876	1,598	1,321	1,043	766			
39,000-44,999	2,281	2,004	1,726	1,448	1,171	893		
45,000-53,999	2,686	2,409	2,131	1,854	1,576	1,298	1,021	
54,000-64,999	3,497	3,219	2,942	2,664	2,386	2,109	1,831	1,276
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	261							
15,000-20,999	666	392						
21,000-26,999	1,072	797	522					
27,000-32,999	1,477	1,202	927	653				
33,000-38,999	1,882	1,607	1,333	1,058	783			
39,000-44,999	2,287	2,012	1,738	1,463	1,189	914		
45,000-53,999	2,692	2,418	2,143	1,868	1,594	1,319	1,045	
54,000-64,999	3,503	3,228	2,953	2,679	2,404	2,130	1,855	1,306

Table 425. Central Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	298							
15,000-20,999	791	447						
21,000-26,999	1,283	940	596					
27,000-32,999	1,775	1,432	1,089	745				
33,000-38,999	2,268	1,924	1,581	1,238	894			
39,000-44,999	2,760	2,417	2,073	1,730	1,387	1,044		
45,000-53,999	3,252	2,909	2,566	2,223	1,879	1,536	1,193	
54,000-64,999	4,237	3,894	3,551	3,207	2,864	2,521	2,177	1,491
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	356							
15,000-20,999	849	535						
21,000-26,999	1,341	1,027	713					
27,000-32,999	1,833	1,519	1,205	891				
33,000-38,999	2,326	2,012	1,697	1,383	1,069			
39,000-44,999	2,818	2,504	2,190	1,876	1,561	1,247		
45,000-53,999	3,311	2,996	2,682	2,368	2,054	1,740	1,425	
54,000-64,999	4,295	3,981	3,667	3,353	3,039	2,724	2,410	1,782

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	387							
15,000-20,999	879	580						
21,000-26,999	1,371	1,072	773					
27,000-32,999	1,864	1,565	1,265	966				
33,000-38,999	2,356	2,057	1,758	1,459	1,160			
39,000-44,999	2,848	2,549	2,250	1,951	1,652	1,353		
45,000-53,999	3,341	3,042	2,743	2,444	2,144	1,845	1,546	
54,000-64,999	4,326	4,026	3,727	3,428	3,129	2,830	2,531	1,933
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	398							
15,000-20,999	890	597						
21,000-26,999	1,383	1,089	796					
27,000-32,999	1,875	1,582	1,288	995				
33,000-38,999	2,367	2,074	1,781	1,487	1,194			
39,000-44,999	2,860	2,566	2,273	1,980	1,686	1,393		
45,000-53,999	3,352	3,059	2,765	2,472	2,178	1,885	1,592	
54,000-64,999	4,337	4,043	3,750	3,457	3,163	2,870	2,576	1,990
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	409							
15,000-20,999	901	613						
21,000-26,999	1,394	1,106	818					
27,000-32,999	1,886	1,598	1,310	1,022				
33,000-38,999	2,378	2,090	1,802	1,515	1,227			
39,000-44,999	2,871	2,583	2,295	2,007	1,719	1,431		
45,000-53,999	3,363	3,075	2,787	2,499	2,211	1,923	1,635	
54,000-64,999	4,348	4,060	3,772	3,484	3,196	2,908	2,620	2,044

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	419							
15,000-20,999	912	629						
21,000-26,999	1,404	1,121	839					
27,000-32,999	1,897	1,614	1,331	1,048				
33,000-38,999	2,389	2,106	1,824	1,541	1,258			
39,000-44,999	2,881	2,599	2,316	2,033	1,751	1,468		
45,000-53,999	3,374	3,091	2,808	2,526	2,243	1,960	1,678	
54,000-64,999	4,358	4,076	3,793	3,510	3,228	2,945	2,662	2,097

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	430							
15,000-20,999	922	644						
21,000-26,999	1,414	1,137	859					
27,000-32,999	1,907	1,629	1,351	1,074				
33,000-38,999	2,399	2,121	1,844	1,566	1,289			
39,000-44,999	2,891	2,614	2,336	2,059	1,781	1,503		
45,000-53,999	3,384	3,106	2,829	2,551	2,273	1,996	1,718	
54,000-64,999	4,369	4,091	3,813	3,536	3,258	2,981	2,703	2,148

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	435							
15,000-20,999	928	653						
21,000-26,999	1,420	1,146	871					
27,000-32,999	1,913	1,638	1,363	1,089				
33,000-38,999	2,405	2,130	1,856	1,581	1,306			
39,000-44,999	2,897	2,623	2,348	2,073	1,799	1,524		
45,000-53,999	3,390	3,115	2,840	2,566	2,291	2,017	1,742	
54,000-64,999	4,374	4,100	3,825	3,551	3,276	3,001	2,727	2,177

Heating, Early Retirement of an Electric Resistance Furnace

Table 426. Central Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,613							
15,000-20,999	2,764	2,420						
21,000-26,999	3,914	3,570	3,227					
27,000-32,999	5,064	4,720	4,377	4,034				
33,000-38,999	6,214	5,870	5,527	5,184	4,840			
39,000-44,999	7,364	7,020	6,677	6,334	5,991	5,647		
45,000-53,999	8,514	8,170	7,827	7,484	7,141	6,797	6,454	
54,000-64,999	10,814	10,470	10,127	9,784	9,441	9,097	8,754	8,067
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,672							
15,000-20,999	2,822	2,508						
21,000-26,999	3,972	3,658	3,343					
27,000-32,999	5,122	4,808	4,493	4,179				
33,000-38,999	6,272	5,958	5,643	5,329	5,015			
39,000-44,999	7,422	7,108	6,793	6,479	6,165	5,851		
45,000-53,999	8,572	8,258	7,944	7,629	7,315	7,001	6,687	
54,000-64,999	10,872	10,558	10,244	9,929	9,615	9,301	8,987	8,358

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,702							
15,000-20,999	2,852	2,553						
21,000-26,999	4,002	3,703	3,404					
27,000-32,999	5,152	4,853	4,554	4,255				
33,000-38,999	6,302	6,003	5,704	5,405	5,106			
39,000-44,999	7,452	7,153	6,854	6,555	6,256	5,957		
45,000-53,999	8,602	8,303	8,004	7,705	7,406	7,107	6,808	
54,000-64,999	10,902	10,603	10,304	10,005	9,706	9,407	9,108	8,509

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,713							
15,000-20,999	2,863	2,570						
21,000-26,999	4,013	3,720	3,427					
27,000-32,999	5,163	4,870	4,577	4,283				
33,000-38,999	6,313	6,020	5,727	5,433	5,140			
39,000-44,999	7,463	7,170	6,877	6,583	6,290	5,996		
45,000-53,999	8,613	8,320	8,027	7,733	7,440	7,146	6,853	
54,000-64,999	10,914	10,620	10,327	10,033	9,740	9,446	9,153	8,566

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,724							
15,000-20,999	2,874	2,586						
21,000-26,999	4,024	3,736	3,448					
27,000-32,999	5,174	4,886	4,598	4,310				
33,000-38,999	6,324	6,036	5,748	5,461	5,173			
39,000-44,999	7,474	7,186	6,898	6,611	6,323	6,035		
45,000-53,999	8,624	8,336	8,049	7,761	7,473	7,185	6,897	
54,000-64,999	10,924	10,637	10,349	10,061	9,773	9,485	9,197	8,621

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,735							
15,000-20,999	2,885	2,602						
21,000-26,999	4,035	3,752	3,469					
27,000-32,999	5,185	4,902	4,619	4,337				
33,000-38,999	6,335	6,052	5,770	5,487	5,204			
39,000-44,999	7,485	7,202	6,920	6,637	6,354	6,072		
45,000-53,999	8,635	8,352	8,070	7,787	7,504	7,222	6,939	
54,000-64,999	10,935	10,652	10,370	10,087	9,804	9,522	9,239	8,674
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,745							
15,000-20,999	2,895	2,617						
21,000-26,999	4,045	3,767	3,490					
27,000-32,999	5,195	4,917	4,640	4,362				
33,000-38,999	6,345	6,067	5,790	5,512	5,235			
39,000-44,999	7,495	7,217	6,940	6,662	6,385	6,107		
45,000-53,999	8,645	8,368	8,090	7,812	7,535	7,257	6,980	
54,000-64,999	10,945	10,668	10,390	10,112	9,835	9,557	9,280	8,724
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,751							
15,000-20,999	2,901	2,626						
21,000-26,999	4,051	3,776	3,502					
27,000-32,999	5,201	4,926	4,652	4,377				
33,000-38,999	6,351	6,076	5,802	5,527	5,252			
39,000-44,999	7,501	7,226	6,952	6,677	6,402	6,128		
45,000-53,999	8,651	8,376	8,102	7,827	7,552	7,278	7,003	
54,000-64,999	10,951	10,676	10,402	10,127	9,853	9,578	9,303	8,754

Climate Zone 4: Valley Region, Corpus Christi

Cooling, New Construction

Table 427. Central Energy Savings (Cooling kWh) for 14.0 SEER Baseline—Zone 4

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–20.9	21.0-23.9	24.0+
< 15,000	91	174	324	572	661	882	1,050
15,000-20,999	136	261	485	857	992	1,323	1,574
21,000-26,999	181	348	647	1,143	1,322	1,764	2,099
27,000-32,999	226	436	809	1,429	1,653	2,206	2,624
33,000-38,999	272	523	971	1,715	1,983	2,647	3,149
39,000-44,999	317	610	1,132	2,000	2,314	3,088	3,673
45,000-53,999	362	697	1,294	2,286	2,644	3,529	4,198
54,000-64,999	453	871	1,618	2,858	3,306	4,411	5,248

Cooling, Replace-on-Burnout

Table 428. Central Energy Savings (Cooling kWh) for 13.08 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	250							
15,000-20,999	1,462	375						
21,000-26,999	2,674	1,587	500					
27,000-32,999	3,886	2,799	1,712	625				
33,000-38,999	5,098	4,011	2,924	1,837	750			
39,000-44,999	6,310	5,223	4,136	3,049	1,962	875		
45,000-53,999	7,523	6,435	5,348	4,261	3,174	2,087	1,000	
54,000-64,999	9,947	8,860	7,772	6,685	5,598	4,511	3,424	1,250

15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	334							
15,000-20,999	1,546	500						
21,000-26,999	2,758	1,712	667					
27,000-32,999	3,970	2,924	1,879	834				
33,000-38,999	5,182	4,137	3,091	2,046	1,001			
39,000-44,999	6,394	5,349	4,303	3,258	2,213	1,167		
45,000-53,999	7,606	6,561	5,515	4,470	3,425	2,379	1,334	
54,000-64,999	10,030	8,985	7,940	6,894	5,849	4,804	3,758	1,668

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	483							
15,000-20,999	1,695	724						
21,000-26,999	2,907	1,936	966					
27,000-32,999	4,119	3,148	2,178	1,207				
33,000-38,999	5,331	4,361	3,390	2,419	1,449			
39,000-44,999	6,543	5,573	4,602	3,631	2,661	1,690		
45,000-53,999	7,755	6,785	5,814	4,843	3,873	2,902	1,931	
54,000-64,999	10,180	9,209	8,238	7,268	6,297	5,326	4,356	2,414

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	731							
15,000-20,999	1,943	1,096						
21,000-26,999	3,155	2,308	1,462					
27,000-32,999	4,367	3,520	2,674	1,827				
33,000-38,999	5,579	4,733	3,886	3,039	2,192			
39,000-44,999	6,791	5,945	5,098	4,251	3,405	2,558		
45,000-53,999	8,003	7,157	6,310	5,463	4,617	3,770	2,923	
54,000-64,999	10,428	9,581	8,734	7,888	7,041	6,194	5,347	3,654

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	820							
15,000-20,999	2,033	1,231						
21,000-26,999	3,245	2,443	1,641					
27,000-32,999	4,457	3,655	2,853	2,051				
33,000-38,999	5,669	4,867	4,065	3,263	2,461			
39,000-44,999	6,881	6,079	5,277	4,475	3,673	2,871		
45,000-53,999	8,093	7,291	6,489	5,687	4,885	4,084	3,282	
54,000-64,999	10,517	9,715	8,913	8,112	7,310	6,508	5,706	4,102

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,042							
15,000-20,999	2,254	1,562						
21,000-26,999	3,466	2,774	2,083					
27,000-32,999	4,678	3,986	3,295	2,604				
33,000-38,999	5,890	5,199	4,507	3,816	3,125			
39,000-44,999	7,102	6,411	5,719	5,028	4,337	3,645		
45,000-53,999	8,314	7,623	6,931	6,240	5,549	4,857	4,166	
54,000-64,999	10,738	10,047	9,356	8,664	7,973	7,282	6,590	5,208

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,209							
15,000-20,999	2,421	1,813						
21,000-26,999	3,633	3,025	2,418					
27,000-32,999	4,845	4,237	3,630	3,022				
33,000-38,999	6,057	5,450	4,842	4,234	3,626			
39,000-44,999	7,269	6,662	6,054	5,446	4,839	4,231		
45,000-53,999	8,481	7,874	7,266	6,658	6,051	5,443	4,835	
54,000-64,999	10,906	10,298	9,690	9,083	8,475	7,867	7,259	6,044

Cooling, Early Retirement

Table 429. Central Energy Savings (Cooling kWh) for 12.44 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	375							
15,000-20,999	1,649	562						
21,000-26,999	2,924	1,836	749					
27,000-32,999	4,198	3,111	2,024	937				
33,000-38,999	5,472	4,385	3,298	2,211	1,124			
39,000-44,999	6,747	5,660	4,573	3,485	2,398	1,311		
45,000-53,999	8,021	6,934	5,847	4,760	3,673	2,586	1,498	
54,000-64,999	10,570	9,483	8,396	7,309	6,222	5,135	4,047	1,873
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	458							
15,000-20,999	1,733	687						
21,000-26,999	3,007	1,962	916					
27,000-32,999	4,282	3,236	2,191	1,146				
33,000-38,999	5,556	4,511	3,465	2,420	1,375			
39,000-44,999	6,831	5,785	4,740	3,695	2,649	1,604		
45,000-53,999	8,105	7,060	6,014	4,969	3,924	2,878	1,833	
54,000-64,999	10,654	9,609	8,563	7,518	6,473	5,427	4,382	2,291

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	608							
15,000-20,999	1,882	911						
21,000-26,999	3,156	2,186	1,215					
27,000-32,999	4,431	3,460	2,490	1,519				
33,000-38,999	5,705	4,735	3,764	2,793	1,823			
39,000-44,999	6,980	6,009	5,039	4,068	3,097	2,127		
45,000-53,999	8,254	7,284	6,313	5,342	4,372	3,401	2,430	
54,000-64,999	10,803	9,833	8,862	7,891	6,921	5,950	4,979	3,038
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	856							
15,000-20,999	2,130	1,283						
21,000-26,999	3,404	2,558	1,711					
27,000-32,999	4,679	3,832	2,986	2,139				
33,000-38,999	5,953	5,107	4,260	3,413	2,567			
39,000-44,999	7,228	6,381	5,534	4,688	3,841	2,994		
45,000-53,999	8,502	7,656	6,809	5,962	5,116	4,269	3,422	
54,000-64,999	11,051	10,205	9,358	8,511	7,664	6,818	5,971	4,278
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	945							
15,000-20,999	2,220	1,418						
21,000-26,999	3,494	2,692	1,890					
27,000-32,999	4,769	3,967	3,165	2,363				
33,000-38,999	6,043	5,241	4,439	3,637	2,835			
39,000-44,999	7,317	6,516	5,714	4,912	4,110	3,308		
45,000-53,999	8,592	7,790	6,988	6,186	5,384	4,582	3,781	
54,000-64,999	11,141	10,339	9,537	8,735	7,933	7,131	6,329	4,726

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,166							
15,000-20,999	2,441	1,749						
21,000-26,999	3,715	3,024	2,332					
27,000-32,999	4,990	4,298	3,607	2,916				
33,000-38,999	6,264	5,573	4,881	4,190	3,499			
39,000-44,999	7,539	6,847	6,156	5,464	4,773	4,082		
45,000-53,999	8,813	8,122	7,430	6,739	6,048	5,356	4,665	
54,000-64,999	11,362	10,671	9,979	9,288	8,597	7,905	7,214	5,831

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,334							
15,000-20,999	2,608	2,000						
21,000-26,999	3,882	3,275	2,667					
27,000-32,999	5,157	4,549	3,942	3,334				
33,000-38,999	6,431	5,824	5,216	4,608	4,001			
39,000-44,999	7,706	7,098	6,490	5,883	5,275	4,667		
45,000-53,999	8,980	8,373	7,765	7,157	6,550	5,942	5,334	
54,000-64,999	11,529	10,922	10,314	9,706	9,098	8,491	7,883	6,668

Table 430. Central Energy Savings (Cooling kWh) for 10.0 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	997							
15,000-20,999	2,582	1,495						
21,000-26,999	4,167	3,080	1,993					
27,000-32,999	5,753	4,666	3,579	2,491				
33,000-38,999	7,338	6,251	5,164	4,077	2,990			
39,000-44,999	8,924	7,837	6,749	5,662	4,575	3,488		
45,000-53,999	10,509	9,422	8,335	7,248	6,161	5,073	3,986	
54,000-64,999	13,680	12,593	11,506	10,419	9,331	8,244	7,157	4,983
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,080							
15,000-20,999	2,666	1,620						
21,000-26,999	4,251	3,206	2,160					
27,000-32,999	5,836	4,791	3,746	2,700				
33,000-38,999	7,422	6,377	5,331	4,286	3,241			
39,000-44,999	9,007	7,962	6,917	5,871	4,826	3,781		
45,000-53,999	10,593	9,547	8,502	7,457	6,411	5,366	4,321	
54,000-64,999	13,764	12,718	11,673	10,628	9,582	8,537	7,492	5,401

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,230							
15,000-20,999	2,815	1,844						
21,000-26,999	4,400	3,430	2,459					
27,000-32,999	5,986	5,015	4,044	3,074				
33,000-38,999	7,571	6,601	5,630	4,659	3,689			
39,000-44,999	9,157	8,186	7,215	6,245	5,274	4,303		
45,000-53,999	10,742	9,771	8,801	7,830	6,859	5,889	4,918	
54,000-64,999	13,913	12,942	11,972	11,001	10,030	9,060	8,089	6,148

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,477							
15,000-20,999	3,063	2,216						
21,000-26,999	4,648	3,802	2,955					
27,000-32,999	6,234	5,387	4,540	3,694				
33,000-38,999	7,819	6,972	6,126	5,279	4,432			
39,000-44,999	9,405	8,558	7,711	6,865	6,018	5,171		
45,000-53,999	10,990	10,143	9,297	8,450	7,603	6,757	5,910	
54,000-64,999	14,161	13,314	12,468	11,621	10,774	9,927	9,081	7,387

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,567							
15,000-20,999	3,153	2,351						
21,000-26,999	4,738	3,936	3,134					
27,000-32,999	6,323	5,521	4,720	3,918				
33,000-38,999	7,909	7,107	6,305	5,503	4,701			
39,000-44,999	9,494	8,692	7,890	7,089	6,287	5,485		
45,000-53,999	11,080	10,278	9,476	8,674	7,872	7,070	6,268	
54,000-64,999	14,250	13,449	12,647	11,845	11,043	10,241	9,439	7,835

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,788							
15,000-20,999	3,374	2,682						
21,000-26,999	4,959	4,268	3,576					
27,000-32,999	6,544	5,853	5,162	4,470				
33,000-38,999	8,130	7,439	6,747	6,056	5,364			
39,000-44,999	9,715	9,024	8,333	7,641	6,950	6,259		
45,000-53,999	11,301	10,609	9,918	9,227	8,535	7,844	7,153	
54,000-64,999	14,472	13,780	13,089	12,398	11,706	11,015	10,324	8,941
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,955							
15,000-20,999	3,541	2,933						
21,000-26,999	5,126	4,519	3,911					
27,000-32,999	6,712	6,104	5,496	4,889				
33,000-38,999	8,297	7,689	7,082	6,474	5,866			
39,000-44,999	9,883	9,275	8,667	8,060	7,452	6,844		
45,000-53,999	11,468	10,860	10,253	9,645	9,037	8,430	7,822	
54,000-64,999	14,639	14,031	13,424	12,816	12,208	11,600	10,993	9,777

Heading, New Construction/Replace-on-Burnout

Table 431. Central Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	34							
15,000-20,999	282	52						
21,000-26,999	529	299	69					
27,000-32,999	776	546	316	86				
33,000-38,999	1,024	794	563	333	103			
39,000-44,999	1,271	1,041	811	581	350	120		
45,000-53,999	1,518	1,288	1,058	828	598	368	137	
54,000-64,999	2,013	1,783	1,553	1,323	1,092	862	632	172
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	73							
15,000-20,999	321	110						
21,000-26,999	568	357	147					
27,000-32,999	815	605	394	183				
33,000-38,999	1,063	852	641	431	220			
39,000-44,999	1,310	1,099	889	678	467	257		
45,000-53,999	1,557	1,347	1,136	925	715	504	293	
54,000-64,999	2,052	1,841	1,631	1,420	1,209	999	788	367

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	94							
15,000-20,999	341	140						
21,000-26,999	588	388	187					
27,000-32,999	836	635	435	234				
33,000-38,999	1,083	882	682	481	281			
39,000-44,999	1,330	1,130	929	729	528	328		
45,000-53,999	1,578	1,377	1,177	976	776	575	374	
54,000-64,999	2,072	1,872	1,671	1,471	1,270	1,070	869	468
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	101							
15,000-20,999	349	152						
21,000-26,999	596	399	202					
27,000-32,999	843	647	450	253				
33,000-38,999	1,091	894	697	500	304			
39,000-44,999	1,338	1,141	944	748	551	354		
45,000-53,999	1,585	1,389	1,192	995	798	602	405	
54,000-64,999	2,080	1,883	1,686	1,490	1,293	1,096	900	506
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	109							
15,000-20,999	356	163						
21,000-26,999	603	410	217					
27,000-32,999	851	658	464	271				
33,000-38,999	1,098	905	712	519	326			
39,000-44,999	1,345	1,152	959	766	573	380		
45,000-53,999	1,593	1,400	1,206	1,013	820	627	434	
54,000-64,999	2,087	1,894	1,701	1,508	1,315	1,122	929	543

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	116							
15,000-20,999	363	173						
21,000-26,999	610	421	231					
27,000-32,999	858	668	479	289				
33,000-38,999	1,105	915	726	536	347			
39,000-44,999	1,352	1,163	973	784	594	405		
45,000-53,999	1,600	1,410	1,221	1,031	842	652	463	
54,000-64,999	2,094	1,905	1,715	1,526	1,336	1,147	957	578

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	122							
15,000-20,999	370	184						
21,000-26,999	617	431	245					
27,000-32,999	864	678	492	306				
33,000-38,999	1,112	926	740	553	367			
39,000-44,999	1,359	1,173	987	801	615	429		
45,000-53,999	1,606	1,420	1,234	1,048	862	676	490	
54,000-64,999	2,101	1,915	1,729	1,543	1,357	1,171	984	612

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	126							
15,000-20,999	374	190						
21,000-26,999	621	437	253					
27,000-32,999	868	684	500	316				
33,000-38,999	1,116	932	747	563	379			
39,000-44,999	1,363	1,179	995	811	627	442		
45,000-53,999	1,610	1,426	1,242	1,058	874	690	506	
54,000-64,999	2,105	1,921	1,737	1,553	1,369	1,184	1,000	632

Heating, Early Retirement of a Heat Pump

Table 432. Central Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	83							
15,000-20,999	355	125						
21,000-26,999	626	396	166					
27,000-32,999	898	668	438	208				
33,000-38,999	1,170	939	709	479	249			
39,000-44,999	1,441	1,211	981	751	521	291		
45,000-53,999	1,713	1,483	1,253	1,022	792	562	332	
54,000-64,999	2,256	2,026	1,796	1,566	1,336	1,106	875	415
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	122							
15,000-20,999	394	183						
21,000-26,999	665	455	244					
27,000-32,999	937	726	516	305				
33,000-38,999	1,209	998	787	577	366			
39,000-44,999	1,480	1,270	1,059	848	638	427		
45,000-53,999	1,752	1,541	1,331	1,120	909	699	488	
54,000-64,999	2,295	2,085	1,874	1,663	1,453	1,242	1,031	610

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	142							
15,000-20,999	414	213						
21,000-26,999	686	485	285					
27,000-32,999	957	757	556	356				
33,000-38,999	1,229	1,028	828	627	427			
39,000-44,999	1,501	1,300	1,100	899	698	498		
45,000-53,999	1,772	1,572	1,371	1,171	970	770	569	
54,000-64,999	2,316	2,115	1,915	1,714	1,513	1,313	1,112	711
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	150							
15,000-20,999	422	225						
21,000-26,999	693	496	300					
27,000-32,999	965	768	571	375				
33,000-38,999	1,237	1,040	843	646	450			
39,000-44,999	1,508	1,311	1,115	918	721	525		
45,000-53,999	1,780	1,583	1,386	1,190	993	796	600	
54,000-64,999	2,323	2,126	1,930	1,733	1,536	1,340	1,143	749
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	157							
15,000-20,999	429	236						
21,000-26,999	701	507	314					
27,000-32,999	972	779	586	393				
33,000-38,999	1,244	1,051	858	665	472			
39,000-44,999	1,516	1,322	1,129	936	743	550		
45,000-53,999	1,787	1,594	1,401	1,208	1,015	822	629	
54,000-64,999	2,331	2,137	1,944	1,751	1,558	1,365	1,172	786

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	164							
15,000-20,999	436	246						
21,000-26,999	708	518	329					
27,000-32,999	979	790	600	411				
33,000-38,999	1,251	1,061	872	682	493			
39,000-44,999	1,523	1,333	1,144	954	765	575		
45,000-53,999	1,794	1,605	1,415	1,226	1,036	847	657	
54,000-64,999	2,338	2,148	1,959	1,769	1,580	1,390	1,200	821
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	171							
15,000-20,999	443	257						
21,000-26,999	714	528	342					
27,000-32,999	986	800	614	428				
33,000-38,999	1,258	1,072	886	699	513			
39,000-44,999	1,529	1,343	1,157	971	785	599		
45,000-53,999	1,801	1,615	1,429	1,243	1,057	871	684	
54,000-64,999	2,344	2,158	1,972	1,786	1,600	1,414	1,228	855
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	175							
15,000-20,999	447	263						
21,000-26,999	718	534	350					
27,000-32,999	990	806	622	438				
33,000-38,999	1,262	1,078	893	709	525			
39,000-44,999	1,533	1,349	1,165	981	797	613		
45,000-53,999	1,805	1,621	1,437	1,253	1,069	884	700	
54,000-64,999	2,348	2,164	1,980	1,796	1,612	1,428	1,244	875

Table 433. Central Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	200							
15,000-20,999	530	300						
21,000-26,999	860	630	400					
27,000-32,999	1,190	960	730	500				
33,000-38,999	1,520	1,290	1,060	830	600			
39,000-44,999	1,850	1,620	1,390	1,160	930	700		
45,000-53,999	2,181	1,950	1,720	1,490	1,260	1,030	800	
54,000-64,999	2,841	2,611	2,380	2,150	1,920	1,690	1,460	999
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	239							
15,000-20,999	569	358						
21,000-26,999	899	688	478					
27,000-32,999	1,229	1,019	808	597				
33,000-38,999	1,559	1,349	1,138	927	717			
39,000-44,999	1,889	1,679	1,468	1,257	1,047	836		
45,000-53,999	2,220	2,009	1,798	1,588	1,377	1,166	956	
54,000-64,999	2,880	2,669	2,458	2,248	2,037	1,826	1,616	1,195

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	259							
15,000-20,999	589	389						
21,000-26,999	919	719	518					
27,000-32,999	1,249	1,049	848	648				
33,000-38,999	1,580	1,379	1,179	978	777			
39,000-44,999	1,910	1,709	1,509	1,308	1,108	907		
45,000-53,999	2,240	2,039	1,839	1,638	1,438	1,237	1,037	
54,000-64,999	2,900	2,699	2,499	2,298	2,098	1,897	1,697	1,296

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	267							
15,000-20,999	597	400						
21,000-26,999	927	730	534					
27,000-32,999	1,257	1,060	864	667				
33,000-38,999	1,587	1,390	1,194	997	800			
39,000-44,999	1,917	1,721	1,524	1,327	1,130	934		
45,000-53,999	2,247	2,051	1,854	1,657	1,461	1,264	1,067	
54,000-64,999	2,908	2,711	2,514	2,317	2,121	1,924	1,727	1,334

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	274							
15,000-20,999	604	411						
21,000-26,999	934	741	548					
27,000-32,999	1,264	1,071	878	685				
33,000-38,999	1,595	1,401	1,208	1,015	822			
39,000-44,999	1,925	1,732	1,539	1,345	1,152	959		
45,000-53,999	2,255	2,062	1,869	1,676	1,483	1,290	1,096	
54,000-64,999	2,915	2,722	2,529	2,336	2,143	1,950	1,757	1,371

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	281							
15,000-20,999	611	422						
21,000-26,999	941	752	562					
27,000-32,999	1,271	1,082	892	703				
33,000-38,999	1,602	1,412	1,223	1,033	844			
39,000-44,999	1,932	1,742	1,553	1,363	1,174	984		
45,000-53,999	2,262	2,072	1,883	1,693	1,504	1,314	1,125	
54,000-64,999	2,922	2,733	2,543	2,353	2,164	1,974	1,785	1,406
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	288							
15,000-20,999	618	432						
21,000-26,999	948	762	576					
27,000-32,999	1,278	1,092	906	720				
33,000-38,999	1,608	1,422	1,236	1,050	864			
39,000-44,999	1,939	1,752	1,566	1,380	1,194	1,008		
45,000-53,999	2,269	2,083	1,896	1,710	1,524	1,338	1,152	
54,000-64,999	2,929	2,743	2,557	2,370	2,184	1,998	1,812	1,440
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	292							
15,000-20,999	622	438						
21,000-26,999	952	768	584					
27,000-32,999	1,282	1,098	914	730				
33,000-38,999	1,612	1,428	1,244	1,060	876			
39,000-44,999	1,942	1,758	1,574	1,390	1,206	1,022		
45,000-53,999	2,273	2,088	1,904	1,720	1,536	1,352	1,168	
54,000-64,999	2,933	2,749	2,565	2,380	2,196	2,012	1,828	1,460

Heating, Early Retirement of an Electric Resistance Furnace

Table 434. Central Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,083							
15,000-20,999	1,855	1,625						
21,000-26,999	2,627	2,397	2,167					
27,000-32,999	3,399	3,169	2,939	2,709				
33,000-38,999	4,171	3,941	3,711	3,481	3,250			
39,000-44,999	4,943	4,713	4,483	4,253	4,022	3,792		
45,000-53,999	5,715	5,485	5,255	5,024	4,794	4,564	4,334	
54,000-64,999	7,259	7,029	6,798	6,568	6,338	6,108	5,878	5,417
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,123							
15,000-20,999	1,894	1,684						
21,000-26,999	2,666	2,456	2,245					
27,000-32,999	3,438	3,228	3,017	2,806				
33,000-38,999	4,210	3,999	3,789	3,578	3,368			
39,000-44,999	4,982	4,771	4,561	4,350	4,139	3,929		
45,000-53,999	5,754	5,543	5,333	5,122	4,911	4,701	4,490	
54,000-64,999	7,298	7,087	6,876	6,666	6,455	6,244	6,034	5,613

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,143							
15,000-20,999	1,915	1,714						
21,000-26,999	2,687	2,486	2,286					
27,000-32,999	3,458	3,258	3,057	2,857				
33,000-38,999	4,230	4,030	3,829	3,629	3,428			
39,000-44,999	5,002	4,802	4,601	4,401	4,200	4,000		
45,000-53,999	5,774	5,574	5,373	5,173	4,972	4,772	4,571	
54,000-64,999	7,318	7,117	6,917	6,716	6,516	6,315	6,115	5,714

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,150							
15,000-20,999	1,922	1,726						
21,000-26,999	2,694	2,497	2,301					
27,000-32,999	3,466	3,269	3,073	2,876				
33,000-38,999	4,238	4,041	3,845	3,648	3,451			
39,000-44,999	5,010	4,813	4,616	4,420	4,223	4,026		
45,000-53,999	5,782	5,585	5,388	5,192	4,995	4,798	4,602	
54,000-64,999	7,326	7,129	6,932	6,735	6,539	6,342	6,145	5,752

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,158							
15,000-20,999	1,930	1,737						
21,000-26,999	2,702	2,508	2,315					
27,000-32,999	3,473	3,280	3,087	2,894				
33,000-38,999	4,245	4,052	3,859	3,666	3,473			
39,000-44,999	5,017	4,824	4,631	4,438	4,245	4,052		
45,000-53,999	5,789	5,596	5,403	5,210	5,017	4,824	4,631	
54,000-64,999	7,333	7,140	6,947	6,754	6,561	6,368	6,175	5,789

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,165							
15,000-20,999	1,937	1,747						
21,000-26,999	2,709	2,519	2,330					
27,000-32,999	3,480	3,291	3,101	2,912				
33,000-38,999	4,252	4,063	3,873	3,684	3,494			
39,000-44,999	5,024	4,835	4,645	4,456	4,266	4,077		
45,000-53,999	5,796	5,607	5,417	5,228	5,038	4,849	4,659	
54,000-64,999	7,340	7,150	6,961	6,771	6,582	6,392	6,203	5,824

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,172							
15,000-20,999	1,943	1,757						
21,000-26,999	2,715	2,529	2,343					
27,000-32,999	3,487	3,301	3,115	2,929				
33,000-38,999	4,259	4,073	3,887	3,701	3,515			
39,000-44,999	5,031	4,845	4,659	4,473	4,287	4,101		
45,000-53,999	5,803	5,617	5,431	5,245	5,059	4,872	4,686	
54,000-64,999	7,347	7,161	6,975	6,788	6,602	6,416	6,230	5,858

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,176							
15,000-20,999	1,947	1,763						
21,000-26,999	2,719	2,535	2,351					
27,000-32,999	3,491	3,307	3,123	2,939				
33,000-38,999	4,263	4,079	3,895	3,711	3,527			
39,000-44,999	5,035	4,851	4,667	4,483	4,299	4,114		
45,000-53,999	5,807	5,623	5,439	5,255	5,070	4,886	4,702	
54,000-64,999	7,351	7,167	6,983	6,798	6,614	6,430	6,246	5,878

Climate Zone 5: West Region, El Paso

Cooling, New Construction

Table 435. Central Energy Savings (Cooling kWh) for 14.0 SEER Baseline—Zone 5

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–20.9	21.0-23.9	24.0+
< 15,000	60	115	213	378	437	582	692
15,000-20,999	90	172	320	566	655	873	1,038
21,000-26,999	119	230	427	755	873	1,164	1,384
27,000-32,999	149	287	533	944	1,092	1,455	1,730
33,000-38,999	179	345	640	1,133	1,310	1,746	2,076
39,000-44,999	209	402	746	1,322	1,528	2,037	2,422
45,000-53,999	239	459	853	1,511	1,747	2,328	2,768
54,000-64,999	299	574	1,066	1,888	2,183	2,910	3,460

Cooling, Replace-on-Burnout

Table 436. Central Energy Savings (Cooling kWh) for 13.08 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	165							
15,000-20,999	964	247						
21,000-26,999	1,763	1,046	329					
27,000-32,999	2,562	1,845	1,128	412				
33,000-38,999	3,361	2,644	1,927	1,211	494			
39,000-44,999	4,160	3,443	2,726	2,010	1,293	577		
45,000-53,999	4,959	4,242	3,525	2,809	2,092	1,376	659	
54,000-64,999	6,557	5,840	5,123	4,407	3,690	2,974	2,257	824

15.0-15.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	220							
15,000-20,999	1,019	330						
21,000-26,999	1,818	1,129	440					
27,000-32,999	2,617	1,928	1,239	550				
33,000-38,999	3,416	2,727	2,038	1,349	660			
39,000-44,999	4,215	3,526	2,837	2,148	1,459	770		
45,000-53,999	5,014	4,325	3,636	2,947	2,258	1,569	879	
54,000-64,999	6,612	5,923	5,234	4,545	3,856	3,167	2,477	1,099

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	318							
15,000-20,999	1,117	477						
21,000-26,999	1,916	1,276	637					
27,000-32,999	2,715	2,075	1,436	796				
33,000-38,999	3,514	2,874	2,235	1,595	955			
39,000-44,999	4,313	3,673	3,034	2,394	1,754	1,114		
45,000-53,999	5,112	4,472	3,833	3,193	2,553	1,913	1,273	
54,000-64,999	6,710	6,070	5,431	4,791	4,151	3,511	2,871	1,591

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	483							
15,000-20,999	1,282	724						
21,000-26,999	2,081	1,523	965					
27,000-32,999	2,880	2,322	1,764	1,207				
33,000-38,999	3,679	3,121	2,563	2,006	1,448			
39,000-44,999	4,478	3,920	3,362	2,805	2,247	1,689		
45,000-53,999	5,277	4,719	4,161	3,604	3,046	2,488	1,931	
54,000-64,999	6,875	6,317	5,759	5,202	4,644	4,086	3,529	2,413

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	542							
15,000-20,999	1,341	813						
21,000-26,999	2,140	1,612	1,083					
27,000-32,999	2,939	2,411	1,882	1,354				
33,000-38,999	3,738	3,210	2,681	2,153	1,625			
39,000-44,999	4,537	4,009	3,480	2,952	2,424	1,896		
45,000-53,999	5,336	4,808	4,279	3,751	3,223	2,695	2,167	
54,000-64,999	6,934	6,406	5,877	5,349	4,821	4,293	3,765	2,708
21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	687							
15,000-20,999	1,486	1,031						
21,000-26,999	2,285	1,830	1,374					
27,000-32,999	3,084	2,629	2,173	1,718				
33,000-38,999	3,883	3,428	2,972	2,517	2,061			
39,000-44,999	4,682	4,227	3,771	3,316	2,860	2,405		
45,000-53,999	5,481	5,026	4,570	4,115	3,659	3,204	2,748	
54,000-64,999	7,079	6,624	6,168	5,713	5,257	4,802	4,346	3,435
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	797							
15,000-20,999	1,596	1,196						
21,000-26,999	2,395	1,995	1,594					
27,000-32,999	3,194	2,794	2,393	1,993				
33,000-38,999	3,993	3,593	3,192	2,792	2,391			
39,000-44,999	4,792	4,392	3,991	3,591	3,190	2,790		
45,000-53,999	5,591	5,191	4,790	4,390	3,989	3,589	3,188	
54,000-64,999	7,189	6,789	6,388	5,988	5,587	5,187	4,786	3,986

Cooling, Early Retirement

Table 437. Central Energy Savings (Cooling kWh) for 12.44 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	247							
15,000-20,999	1,087	370						
21,000-26,999	1,927	1,211	494					
27,000-32,999	2,767	2,051	1,334	617				
33,000-38,999	3,607	2,891	2,174	1,457	741			
39,000-44,999	4,448	3,731	3,014	2,298	1,581	864		
45,000-53,999	5,288	4,571	3,854	3,138	2,421	1,704	988	
54,000-64,999	6,968	6,251	5,535	4,818	4,101	3,385	2,668	1,235
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	302							
15,000-20,999	1,142	453						
21,000-26,999	1,982	1,293	604					
27,000-32,999	2,822	2,133	1,444	755				
33,000-38,999	3,663	2,973	2,284	1,595	906			
39,000-44,999	4,503	3,814	3,124	2,435	1,746	1,057		
45,000-53,999	5,343	4,654	3,965	3,276	2,586	1,897	1,208	
54,000-64,999	7,023	6,334	5,645	4,956	4,267	3,578	2,889	1,510

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	401							
15,000-20,999	1,241	601						
21,000-26,999	2,081	1,441	801					
27,000-32,999	2,921	2,281	1,641	1,001				
33,000-38,999	3,761	3,121	2,481	1,841	1,202			
39,000-44,999	4,601	3,961	3,321	2,681	2,042	1,402		
45,000-53,999	5,441	4,801	4,161	3,522	2,882	2,242	1,602	
54,000-64,999	7,121	6,482	5,842	5,202	4,562	3,922	3,282	2,003
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	565							
15,000-20,999	1,405	847						
21,000-26,999	2,245	1,687	1,130					
27,000-32,999	3,085	2,528	1,970	1,412				
33,000-38,999	3,925	3,368	2,810	2,252	1,695			
39,000-44,999	4,765	4,208	3,650	3,092	2,535	1,977		
45,000-53,999	5,606	5,048	4,490	3,933	3,375	2,817	2,259	
54,000-64,999	7,286	6,728	6,170	5,613	5,055	4,497	3,940	2,824
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	624							
15,000-20,999	1,464	936						
21,000-26,999	2,304	1,776	1,248					
27,000-32,999	3,144	2,616	2,088	1,560				
33,000-38,999	3,984	3,456	2,928	2,400	1,872			
39,000-44,999	4,824	4,296	3,768	3,240	2,712	2,184		
45,000-53,999	5,665	5,136	4,608	4,080	3,552	3,024	2,496	
54,000-64,999	7,345	6,817	6,288	5,760	5,232	4,704	4,176	3,120

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	769							
15,000-20,999	1,609	1,154						
21,000-26,999	2,450	1,994	1,539					
27,000-32,999	3,290	2,834	2,379	1,923				
33,000-38,999	4,130	3,674	3,219	2,763	2,308			
39,000-44,999	4,970	4,514	4,059	3,603	3,148	2,693		
45,000-53,999	5,810	5,354	4,899	4,444	3,988	3,533	3,077	
54,000-64,999	7,490	7,035	6,579	6,124	5,668	5,213	4,757	3,846

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	879							
15,000-20,999	1,719	1,319						
21,000-26,999	2,560	2,159	1,759					
27,000-32,999	3,400	2,999	2,599	2,198				
33,000-38,999	4,240	3,839	3,439	3,038	2,638			
39,000-44,999	5,080	4,679	4,279	3,879	3,478	3,078		
45,000-53,999	5,920	5,520	5,119	4,719	4,318	3,918	3,517	
54,000-64,999	7,600	7,200	6,799	6,399	5,998	5,598	5,198	4,397

Table 438. Central Energy Savings (Cooling kWh) for 10.0 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	657							
15,000-20,999	1,702	985						
21,000-26,999	2,747	2,030	1,314					
27,000-32,999	3,792	3,076	2,359	1,642				
33,000-38,999	4,837	4,121	3,404	2,687	1,971			
39,000-44,999	5,882	5,166	4,449	3,732	3,016	2,299		
45,000-53,999	6,928	6,211	5,494	4,778	4,061	3,344	2,628	
54,000-64,999	9,018	8,301	7,584	6,868	6,151	5,435	4,718	3,285
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	712							
15,000-20,999	1,757	1,068						
21,000-26,999	2,802	2,113	1,424					
27,000-32,999	3,847	3,158	2,469	1,780				
33,000-38,999	4,892	4,203	3,514	2,825	2,136			
39,000-44,999	5,938	5,248	4,559	3,870	3,181	2,492		
45,000-53,999	6,983	6,294	5,604	4,915	4,226	3,537	2,848	
54,000-64,999	9,073	8,384	7,695	7,006	6,317	5,627	4,938	3,560

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	810							
15,000-20,999	1,856	1,216						
21,000-26,999	2,901	2,261	1,621					
27,000-32,999	3,946	3,306	2,666	2,026				
33,000-38,999	4,991	4,351	3,711	3,071	2,431			
39,000-44,999	6,036	5,396	4,756	4,116	3,477	2,837		
45,000-53,999	7,081	6,441	5,801	5,162	4,522	3,882	3,242	
54,000-64,999	9,171	8,531	7,892	7,252	6,612	5,972	5,332	4,052

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	975							
15,000-20,999	2,020	1,462						
21,000-26,999	3,065	2,507	1,950					
27,000-32,999	4,110	3,552	2,995	2,437				
33,000-38,999	5,155	4,598	4,040	3,482	2,925			
39,000-44,999	6,200	5,643	5,085	4,527	3,970	3,412		
45,000-53,999	7,245	6,688	6,130	5,572	5,015	4,457	3,899	
54,000-64,999	9,336	8,778	8,220	7,663	7,105	6,547	5,990	4,874

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,034							
15,000-20,999	2,079	1,551						
21,000-26,999	3,124	2,596	2,068					
27,000-32,999	4,169	3,641	3,113	2,585				
33,000-38,999	5,214	4,686	4,158	3,630	3,102			
39,000-44,999	6,259	5,731	5,203	4,675	4,147	3,619		
45,000-53,999	7,304	6,776	6,248	5,720	5,192	4,664	4,136	
54,000-64,999	9,395	8,867	8,338	7,810	7,282	6,754	6,226	5,169

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,179							
15,000-20,999	2,224	1,769						
21,000-26,999	3,269	2,814	2,359					
27,000-32,999	4,315	3,859	3,404	2,948				
33,000-38,999	5,360	4,904	4,449	3,993	3,538			
39,000-44,999	6,405	5,949	5,494	5,038	4,583	4,127		
45,000-53,999	7,450	6,994	6,539	6,083	5,628	5,173	4,717	
54,000-64,999	9,540	9,085	8,629	8,174	7,718	7,263	6,807	5,896

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,289							
15,000-20,999	2,334	1,934						
21,000-26,999	3,379	2,979	2,579					
27,000-32,999	4,425	4,024	3,624	3,223				
33,000-38,999	5,470	5,069	4,669	4,268	3,868			
39,000-44,999	6,515	6,114	5,714	5,313	4,913	4,513		
45,000-53,999	7,560	7,159	6,759	6,359	5,958	5,558	5,157	
54,000-64,999	9,650	9,250	8,849	8,449	8,048	7,648	7,247	6,446

Heading, New Construction/Replace-on-Burnout

Table 439. Central Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	81							
15,000-20,999	667	122						
21,000-26,999	1,253	708	163					
27,000-32,999	1,839	1,294	749	203				
33,000-38,999	2,425	1,880	1,334	789	244			
39,000-44,999	3,011	2,465	1,920	1,375	830	285		
45,000-53,999	3,596	3,051	2,506	1,961	1,416	871	325	
54,000-64,999	4,768	4,223	3,678	3,133	2,587	2,042	1,497	407
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	174							
15,000-20,999	760	261						
21,000-26,999	1,345	846	348					
27,000-32,999	1,931	1,432	933	434				
33,000-38,999	2,517	2,018	1,519	1,020	521			
39,000-44,999	3,103	2,604	2,105	1,606	1,107	608		
45,000-53,999	3,689	3,190	2,691	2,192	1,693	1,194	695	
54,000-64,999	4,861	4,362	3,863	3,364	2,865	2,366	1,867	869

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	222							
15,000-20,999	808	333						
21,000-26,999	1,393	918	443					
27,000-32,999	1,979	1,504	1,029	554				
33,000-38,999	2,565	2,090	1,615	1,140	665			
39,000-44,999	3,151	2,676	2,201	1,726	1,251	776		
45,000-53,999	3,737	3,262	2,787	2,312	1,837	1,362	887	
54,000-64,999	4,908	4,434	3,959	3,484	3,009	2,534	2,059	1,109

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	240							
15,000-20,999	826	360						
21,000-26,999	1,411	946	480					
27,000-32,999	1,997	1,531	1,065	599				
33,000-38,999	2,583	2,117	1,651	1,185	719			
39,000-44,999	3,169	2,703	2,237	1,771	1,305	839		
45,000-53,999	3,755	3,289	2,823	2,357	1,891	1,425	959	
54,000-64,999	4,927	4,461	3,995	3,529	3,063	2,597	2,131	1,199

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	257							
15,000-20,999	843	386						
21,000-26,999	1,429	972	514					
27,000-32,999	2,015	1,557	1,100	643				
33,000-38,999	2,601	2,143	1,686	1,229	771			
39,000-44,999	3,186	2,729	2,272	1,815	1,357	900		
45,000-53,999	3,772	3,315	2,858	2,400	1,943	1,486	1,029	
54,000-64,999	4,944	4,487	4,029	3,572	3,115	2,658	2,200	1,286

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	274							
15,000-20,999	860	411						
21,000-26,999	1,446	997	548					
27,000-32,999	2,031	1,583	1,134	685				
33,000-38,999	2,617	2,168	1,719	1,271	822			
39,000-44,999	3,203	2,754	2,305	1,856	1,408	959		
45,000-53,999	3,789	3,340	2,891	2,442	1,993	1,544	1,096	
54,000-64,999	4,961	4,512	4,063	3,614	3,165	2,716	2,267	1,369

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	290							
15,000-20,999	876	435						
21,000-26,999	1,462	1,021	580					
27,000-32,999	2,048	1,607	1,166	725				
33,000-38,999	2,633	2,193	1,752	1,311	870			
39,000-44,999	3,219	2,778	2,338	1,897	1,456	1,015		
45,000-53,999	3,805	3,364	2,923	2,483	2,042	1,601	1,160	
54,000-64,999	4,977	4,536	4,095	3,654	3,213	2,773	2,332	1,450

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	299							
15,000-20,999	885	449						
21,000-26,999	1,471	1,035	599					
27,000-32,999	2,057	1,621	1,185	749				
33,000-38,999	2,643	2,207	1,771	1,334	898			
39,000-44,999	3,229	2,793	2,356	1,920	1,484	1,048		
45,000-53,999	3,814	3,378	2,942	2,506	2,070	1,634	1,198	
54,000-64,999	4,986	4,550	4,114	3,678	3,242	2,806	2,369	1,497

Heating, Early Retirement of a Heat Pump

Table 440. Central Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	197							
15,000-20,999	840	295						
21,000-26,999	1,484	938	393					
27,000-32,999	2,127	1,582	1,037	492				
33,000-38,999	2,770	2,225	1,680	1,135	590			
39,000-44,999	3,414	2,869	2,324	1,778	1,233	688		
45,000-53,999	4,057	3,512	2,967	2,422	1,877	1,332	786	
54,000-64,999	5,344	4,799	4,254	3,709	3,164	2,619	2,073	983
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	289							
15,000-20,999	932	434						
21,000-26,999	1,576	1,077	578					
27,000-32,999	2,219	1,720	1,221	723				
33,000-38,999	2,863	2,364	1,865	1,366	867			
39,000-44,999	3,506	3,007	2,508	2,009	1,511	1,012		
45,000-53,999	4,150	3,651	3,152	2,653	2,154	1,655	1,156	
54,000-64,999	5,437	4,938	4,439	3,940	3,441	2,942	2,443	1,445

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	337							
15,000-20,999	980	505						
21,000-26,999	1,624	1,149	674					
27,000-32,999	2,267	1,792	1,317	842				
33,000-38,999	2,911	2,436	1,961	1,486	1,011			
39,000-44,999	3,554	3,079	2,604	2,129	1,654	1,179		
45,000-53,999	4,198	3,723	3,248	2,773	2,298	1,823	1,348	
54,000-64,999	5,485	5,010	4,535	4,060	3,585	3,110	2,635	1,685
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	355							
15,000-20,999	999	533						
21,000-26,999	1,642	1,176	710					
27,000-32,999	2,285	1,819	1,354	888				
33,000-38,999	2,929	2,463	1,997	1,531	1,065			
39,000-44,999	3,572	3,106	2,640	2,175	1,709	1,243		
45,000-53,999	4,216	3,750	3,284	2,818	2,352	1,886	1,420	
54,000-64,999	5,503	5,037	4,571	4,105	3,639	3,173	2,707	1,775
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	372							
15,000-20,999	1,016	559						
21,000-26,999	1,659	1,202	745					
27,000-32,999	2,303	1,846	1,388	931				
33,000-38,999	2,946	2,489	2,032	1,574	1,117			
39,000-44,999	3,590	3,132	2,675	2,218	1,761	1,303		
45,000-53,999	4,233	3,776	3,319	2,861	2,404	1,947	1,490	
54,000-64,999	5,520	5,063	4,606	4,148	3,691	3,234	2,777	1,862

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	389							
15,000-20,999	1,033	584						
21,000-26,999	1,676	1,227	778					
27,000-32,999	2,320	1,871	1,422	973				
33,000-38,999	2,963	2,514	2,065	1,616	1,167			
39,000-44,999	3,606	3,158	2,709	2,260	1,811	1,362		
45,000-53,999	4,250	3,801	3,352	2,903	2,454	2,005	1,557	
54,000-64,999	5,537	5,088	4,639	4,190	3,741	3,292	2,844	1,946
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	405							
15,000-20,999	1,049	608						
21,000-26,999	1,692	1,251	811					
27,000-32,999	2,336	1,895	1,454	1,013				
33,000-38,999	2,979	2,538	2,097	1,657	1,216			
39,000-44,999	3,623	3,182	2,741	2,300	1,859	1,418		
45,000-53,999	4,266	3,825	3,384	2,944	2,503	2,062	1,621	
54,000-64,999	5,553	5,112	4,671	4,231	3,790	3,349	2,908	2,026
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	415							
15,000-20,999	1,058	622						
21,000-26,999	1,702	1,265	829					
27,000-32,999	2,345	1,909	1,473	1,037				
33,000-38,999	2,989	2,552	2,116	1,680	1,244			
39,000-44,999	3,632	3,196	2,760	2,324	1,888	1,451		
45,000-53,999	4,275	3,839	3,403	2,967	2,531	2,095	1,659	
54,000-64,999	5,562	5,126	4,690	4,254	3,818	3,382	2,946	2,073

Table 441. Central Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	473							
15,000-20,999	1,255	710						
21,000-26,999	2,037	1,492	947					
27,000-32,999	2,819	2,274	1,729	1,184				
33,000-38,999	3,601	3,056	2,511	1,966	1,420			
39,000-44,999	4,383	3,838	3,293	2,748	2,202	1,657		
45,000-53,999	5,165	4,620	4,075	3,529	2,984	2,439	1,894	
54,000-64,999	6,729	6,184	5,638	5,093	4,548	4,003	3,458	2,367
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	566							
15,000-20,999	1,348	849						
21,000-26,999	2,130	1,631	1,132					
27,000-32,999	2,912	2,413	1,914	1,415				
33,000-38,999	3,693	3,195	2,696	2,197	1,698			
39,000-44,999	4,475	3,976	3,477	2,979	2,480	1,981		
45,000-53,999	5,257	4,758	4,259	3,760	3,261	2,763	2,264	
54,000-64,999	6,821	6,322	5,823	5,324	4,825	4,326	3,827	2,829

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	614							
15,000-20,999	1,396	921						
21,000-26,999	2,178	1,703	1,228					
27,000-32,999	2,960	2,485	2,010	1,535				
33,000-38,999	3,741	3,267	2,792	2,317	1,842			
39,000-44,999	4,523	4,048	3,573	3,098	2,624	2,149		
45,000-53,999	5,305	4,830	4,355	3,880	3,405	2,930	2,455	
54,000-64,999	6,869	6,394	5,919	5,444	4,969	4,494	4,019	3,069
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	632							
15,000-20,999	1,414	948						
21,000-26,999	2,196	1,730	1,264					
27,000-32,999	2,978	2,512	2,046	1,580				
33,000-38,999	3,760	3,294	2,828	2,362	1,896			
39,000-44,999	4,541	4,075	3,610	3,144	2,678	2,212		
45,000-53,999	5,323	4,857	4,391	3,925	3,460	2,994	2,528	
54,000-64,999	6,887	6,421	5,955	5,489	5,023	4,557	4,091	3,160
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	649							
15,000-20,999	1,431	974						
21,000-26,999	2,213	1,756	1,299					
27,000-32,999	2,995	2,538	2,080	1,623				
33,000-38,999	3,777	3,320	2,862	2,405	1,948			
39,000-44,999	4,559	4,102	3,644	3,187	2,730	2,272		
45,000-53,999	5,341	4,883	4,426	3,969	3,512	3,054	2,597	
54,000-64,999	6,905	6,447	5,990	5,533	5,075	4,618	4,161	3,246

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	666							
15,000-20,999	1,448	999						
21,000-26,999	2,230	1,781	1,332					
27,000-32,999	3,012	2,563	2,114	1,665				
33,000-38,999	3,794	3,345	2,896	2,447	1,998			
39,000-44,999	4,576	4,127	3,678	3,229	2,780	2,331		
45,000-53,999	5,357	4,909	4,460	4,011	3,562	3,113	2,664	
54,000-64,999	6,921	6,472	6,023	5,575	5,126	4,677	4,228	3,330
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	682							
15,000-20,999	1,464	1,023						
21,000-26,999	2,246	1,805	1,364					
27,000-32,999	3,028	2,587	2,146	1,705				
33,000-38,999	3,810	3,369	2,928	2,487	2,046			
39,000-44,999	4,592	4,151	3,710	3,269	2,828	2,388		
45,000-53,999	5,374	4,933	4,492	4,051	3,610	3,169	2,729	
54,000-64,999	6,937	6,497	6,056	5,615	5,174	4,733	4,292	3,411
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	692							
15,000-20,999	1,473	1,037						
21,000-26,999	2,255	1,819	1,383					
27,000-32,999	3,037	2,601	2,165	1,729				
33,000-38,999	3,819	3,383	2,947	2,511	2,075			
39,000-44,999	4,601	4,165	3,729	3,293	2,857	2,420		
45,000-53,999	5,383	4,947	4,511	4,075	3,638	3,202	2,766	
54,000-64,999	6,947	6,511	6,075	5,638	5,202	4,766	4,330	3,458

Heating, Early Retirement of an Electric Resistance Furnace

Table 442. Central Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,563							
15,000-20,999	4,390	3,844						
21,000-26,999	6,216	5,671	5,126					
27,000-32,999	8,043	7,498	6,953	6,407				
33,000-38,999	9,870	9,324	8,779	8,234	7,689			
39,000-44,999	11,696	11,151	10,606	10,061	9,516	8,970		
45,000-53,999	13,523	12,978	12,432	11,887	11,342	10,797	10,252	
54,000-64,999	17,176	16,631	16,086	15,541	14,995	14,450	13,905	12,815
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,655							
15,000-20,999	4,482	3,983						
21,000-26,999	6,309	5,810	5,311					
27,000-32,999	8,135	7,636	7,137	6,638				
33,000-38,999	9,962	9,463	8,964	8,465	7,966			
39,000-44,999	11,789	11,290	10,791	10,292	9,793	9,294		
45,000-53,999	13,615	13,116	12,617	12,118	11,619	11,120	10,621	
54,000-64,999	17,268	16,770	16,271	15,772	15,273	14,774	14,275	13,277

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,703							
15,000-20,999	4,530	4,055						
21,000-26,999	6,357	5,882	5,407					
27,000-32,999	8,183	7,708	7,233	6,758				
33,000-38,999	10,010	9,535	9,060	8,585	8,110			
39,000-44,999	11,837	11,362	10,887	10,412	9,937	9,462		
45,000-53,999	13,663	13,188	12,713	12,238	11,763	11,288	10,813	
54,000-64,999	17,316	16,841	16,367	15,892	15,417	14,942	14,467	13,517

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,721							
15,000-20,999	4,548	4,082						
21,000-26,999	6,375	5,909	5,443					
27,000-32,999	8,201	7,735	7,269	6,803				
33,000-38,999	10,028	9,562	9,096	8,630	8,164			
39,000-44,999	11,855	11,389	10,923	10,457	9,991	9,525		
45,000-53,999	13,681	13,215	12,749	12,283	11,817	11,351	10,886	
54,000-64,999	17,334	16,869	16,403	15,937	15,471	15,005	14,539	13,607

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,739							
15,000-20,999	4,565	4,108						
21,000-26,999	6,392	5,935	5,478					
27,000-32,999	8,219	7,761	7,304	6,847				
33,000-38,999	10,045	9,588	9,131	8,674	8,216			
39,000-44,999	11,872	11,415	10,957	10,500	10,043	9,586		
45,000-53,999	13,699	13,241	12,784	12,327	11,870	11,412	10,955	
54,000-64,999	17,352	16,895	16,437	15,980	15,523	15,066	14,608	13,694

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,755							
15,000-20,999	4,582	4,133						
21,000-26,999	6,409	5,960	5,511					
27,000-32,999	8,235	7,787	7,338	6,889				
33,000-38,999	10,062	9,613	9,164	8,715	8,266			
39,000-44,999	11,889	11,440	10,991	10,542	10,093	9,644		
45,000-53,999	13,715	13,266	12,818	12,369	11,920	11,471	11,022	
54,000-64,999	17,369	16,920	16,471	16,022	15,573	15,124	14,675	13,777
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,772							
15,000-20,999	4,598	4,157						
21,000-26,999	6,425	5,984	5,543					
27,000-32,999	8,252	7,811	7,370	6,929				
33,000-38,999	10,078	9,637	9,197	8,756	8,315			
39,000-44,999	11,905	11,464	11,023	10,582	10,141	9,701		
45,000-53,999	13,731	13,291	12,850	12,409	11,968	11,527	11,086	
54,000-64,999	17,385	16,944	16,503	16,062	15,621	15,181	14,740	13,858
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,781							
15,000-20,999	4,608	4,172						
21,000-26,999	6,434	5,998	5,562					
27,000-32,999	8,261	7,825	7,389	6,953				
33,000-38,999	10,088	9,651	9,215	8,779	8,343			
39,000-44,999	11,914	11,478	11,042	10,606	10,170	9,734		
45,000-53,999	13,741	13,305	12,869	12,432	11,996	11,560	11,124	
54,000-64,999	17,394	16,958	16,522	16,086	15,650	15,213	14,777	13,905

Deemed Summer Demand Savings Tables[560]

Table 443 through Table 462 present the summer demand savings (kW) for all five Texas climate zones. In each table, the capacity of the efficient unit is represented in the columns and the capacity of the existing unit is represented in the rows. The savings are in the intersection of the appropriate efficient and existing capacities. Replacements where there has been to change in capacity are highlighted in light blue.

The rightsizing savings specified in the tables below are only applicable to replace-on-burnout and early retirement projects. New construction projects are not eligible to receive deemed savings for system rightsizing.[561]

Systems rated at 17 SEER or greater are assumed to be two-stage systems, while those under 17 SEER are assumed to be single-stage systems. This results in slightly lower summer demand savings for 17.0-17.9 SEER systems as compared to 16.0-16.9 SEER systems.

Climate Zone 1: Panhandle Region, Amarillo

Cooling, New Construction

Table 443. Central Summer Demand Savings for 14.0 SEER Baseline—Zone 1

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9*	18.0–20.9	21.0-23.9	24.0+
< 15,000	0.04	0.08	0.14	0.11	0.16	0.24	0.30
15,000-20,999	0.06	0.12	0.22	0.16	0.24	0.35	0.45
21,000-26,999	0.08	0.16	0.29	0.21	0.31	0.47	0.60
27,000-32,999	0.10	0.19	0.36	0.27	0.39	0.59	0.75
33,000-38,999	0.12	0.23	0.43	0.32	0.47	0.71	0.90
39,000-44,999	0.14	0.27	0.50	0.37	0.55	0.82	1.05
45,000-53,999	0.16	0.31	0.58	0.42	0.63	0.94	1.20
54,000-64,999	0.20	0.39	0.72	0.53	0.79	1.18	1.50

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[560] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[561] For projects using a custom baseline, see TRM Volume 4.

Cooling, Replace-on-Burnout

Table 444. Central Summer Demand Savings for 13.08 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.65	0.17						
21,000-26,999	1.19	0.71	0.22					
27,000-32,999	1.73	1.25	0.76	0.28				
33,000-38,999	2.27	1.79	1.30	0.82	0.33			
39,000-44,999	2.81	2.33	1.84	1.36	0.87	0.39		
45,000-53,999	3.35	2.87	2.38	1.90	1.41	0.93	0.45	
54,000-64,999	4.43	3.94	3.46	2.98	2.49	2.01	1.52	0.56
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.69	0.22						
21,000-26,999	1.23	0.76	0.30					
27,000-32,999	1.77	1.30	0.84	0.37				
33,000-38,999	2.31	1.84	1.38	0.91	0.45			
39,000-44,999	2.85	2.38	1.92	1.45	0.99	0.52		
45,000-53,999	3.39	2.92	2.46	1.99	1.52	1.06	0.59	
54,000-64,999	4.47	4.00	3.53	3.07	2.60	2.14	1.67	0.74

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.75	0.32						
21,000-26,999	1.29	0.86	0.43					
27,000-32,999	1.83	1.40	0.97	0.54				
33,000-38,999	2.37	1.94	1.51	1.08	0.64			
39,000-44,999	2.91	2.48	2.05	1.62	1.18	0.75		
45,000-53,999	3.45	3.02	2.59	2.16	1.72	1.29	0.86	
54,000-64,999	4.53	4.10	3.67	3.24	2.80	2.37	1.94	1.07
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.72	0.27						
21,000-26,999	1.26	0.81	0.35					
27,000-32,999	1.80	1.34	0.89	0.44				
33,000-38,999	2.34	1.88	1.43	0.98	0.53			
39,000-44,999	2.88	2.42	1.97	1.52	1.07	0.62		
45,000-53,999	3.41	2.96	2.51	2.06	1.61	1.16	0.71	
54,000-64,999	4.49	4.04	3.59	3.14	2.69	2.24	1.79	0.88
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.77	0.34						
21,000-26,999	1.31	0.88	0.46					
27,000-32,999	1.85	1.42	1.00	0.57				
33,000-38,999	2.39	1.96	1.54	1.11	0.68			
39,000-44,999	2.93	2.50	2.08	1.65	1.22	0.80		
45,000-53,999	3.47	3.04	2.61	2.19	1.76	1.34	0.91	
54,000-64,999	4.55	4.12	3.69	3.27	2.84	2.42	1.99	1.14

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.85	0.46						
21,000-26,999	1.39	1.00	0.61					
27,000-32,999	1.92	1.54	1.15	0.76				
33,000-38,999	2.46	2.08	1.69	1.30	0.92			
39,000-44,999	3.00	2.62	2.23	1.84	1.46	1.07		
45,000-53,999	3.54	3.16	2.77	2.38	2.00	1.61	1.22	
54,000-64,999	4.62	4.24	3.85	3.46	3.08	2.69	2.30	1.53

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.37							
15,000-20,999	0.91	0.56						
21,000-26,999	1.45	1.10	0.74					
27,000-32,999	1.99	1.64	1.28	0.93				
33,000-38,999	2.53	2.18	1.82	1.47	1.11			
39,000-44,999	3.07	2.71	2.36	2.01	1.65	1.30		
45,000-53,999	3.61	3.25	2.90	2.55	2.19	1.84	1.48	
54,000-64,999	4.69	4.33	3.98	3.63	3.27	2.92	2.56	1.85

Cooling, Early Retirement

Table 445. Central Summer Demand Savings for 12.44 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.73	0.25						
21,000-26,999	1.30	0.82	0.33					
27,000-32,999	1.87	1.39	0.90	0.42				
33,000-38,999	2.44	1.95	1.47	0.98	0.50			
39,000-44,999	3.00	2.52	2.04	1.55	1.07	0.58		
45,000-53,999	3.57	3.09	2.60	2.12	1.64	1.15	0.67	
54,000-64,999	4.71	4.22	3.74	3.25	2.77	2.29	1.80	0.83
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.77	0.31						
21,000-26,999	1.34	0.87	0.41					
27,000-32,999	1.91	1.44	0.98	0.51				
33,000-38,999	2.47	2.01	1.54	1.08	0.61			
39,000-44,999	3.04	2.58	2.11	1.64	1.18	0.71		
45,000-53,999	3.61	3.14	2.68	2.21	1.75	1.28	0.82	
54,000-64,999	4.74	4.28	3.81	3.35	2.88	2.42	1.95	1.02

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.84	0.41						
21,000-26,999	1.41	0.97	0.54					
27,000-32,999	1.97	1.54	1.11	0.68				
33,000-38,999	2.54	2.11	1.68	1.24	0.81			
39,000-44,999	3.11	2.68	2.24	1.81	1.38	0.95		
45,000-53,999	3.68	3.24	2.81	2.38	1.95	1.51	1.08	
54,000-64,999	4.81	4.38	3.95	3.51	3.08	2.65	2.22	1.35

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.80	0.35						
21,000-26,999	1.37	0.92	0.46					
27,000-32,999	1.93	1.48	1.03	0.58				
33,000-38,999	2.50	2.05	1.60	1.15	0.70			
39,000-44,999	3.07	2.62	2.17	1.72	1.26	0.81		
45,000-53,999	3.64	3.19	2.73	2.28	1.83	1.38	0.93	
54,000-64,999	4.77	4.32	3.87	3.42	2.97	2.52	2.06	1.16

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.85	0.43						
21,000-26,999	1.42	0.99	0.57					
27,000-32,999	1.99	1.56	1.13	0.71				
33,000-38,999	2.55	2.13	1.70	1.28	0.85			
39,000-44,999	3.12	2.70	2.27	1.84	1.42	0.99		
45,000-53,999	3.69	3.26	2.84	2.41	1.99	1.56	1.13	
54,000-64,999	4.82	4.40	3.97	3.55	3.12	2.69	2.27	1.42

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.36							
15,000-20,999	0.93	0.54						
21,000-26,999	1.50	1.11	0.72					
27,000-32,999	2.06	1.68	1.29	0.90				
33,000-38,999	2.63	2.24	1.86	1.47	1.08			
39,000-44,999	3.20	2.81	2.43	2.04	1.65	1.27		
45,000-53,999	3.77	3.38	2.99	2.61	2.22	1.83	1.45	
54,000-64,999	4.90	4.51	4.13	3.74	3.35	2.97	2.58	1.81
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.43							
15,000-20,999	0.99	0.64						
21,000-26,999	1.56	1.21	0.85					
27,000-32,999	2.13	1.77	1.42	1.07				
33,000-38,999	2.70	2.34	1.99	1.63	1.28			
39,000-44,999	3.26	2.91	2.55	2.20	1.85	1.49		
45,000-53,999	3.83	3.48	3.12	2.77	2.41	2.06	1.71	
54,000-64,999	4.97	4.61	4.26	3.90	3.55	3.19	2.84	2.13

Table 446. Central Summer Demand Savings for 10.0 SEER Baseline—Zone 1

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.44							
15,000-20,999	1.15	0.67						
21,000-26,999	1.86	1.37	0.89					
27,000-32,999	2.56	2.08	1.59	1.11				
33,000-38,999	3.27	2.78	2.30	1.82	1.33			
39,000-44,999	3.97	3.49	3.00	2.52	2.04	1.55		
45,000-53,999	4.68	4.19	3.71	3.23	2.74	2.26	1.77	
54,000-64,999	6.09	5.61	5.12	4.64	4.15	3.67	3.19	2.22
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.48							
15,000-20,999	1.19	0.72						
21,000-26,999	1.89	1.43	0.96					
27,000-32,999	2.60	2.13	1.67	1.20				
33,000-38,999	3.30	2.84	2.37	1.91	1.44			
39,000-44,999	4.01	3.54	3.08	2.61	2.15	1.68		
45,000-53,999	4.72	4.25	3.79	3.32	2.85	2.39	1.92	
54,000-64,999	6.13	5.66	5.20	4.73	4.27	3.80	3.34	2.40

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.55							
15,000-20,999	1.25	0.82						
21,000-26,999	1.96	1.53	1.09					
27,000-32,999	2.67	2.23	1.80	1.37				
33,000-38,999	3.37	2.94	2.51	2.07	1.64			
39,000-44,999	4.08	3.64	3.21	2.78	2.35	1.92		
45,000-53,999	4.78	4.35	3.92	3.49	3.05	2.62	2.19	
54,000-64,999	6.19	5.76	5.33	4.90	4.47	4.03	3.60	2.74

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.51							
15,000-20,999	1.22	0.76						
21,000-26,999	1.92	1.47	1.02					
27,000-32,999	2.63	2.18	1.72	1.27				
33,000-38,999	3.33	2.88	2.43	1.98	1.53			
39,000-44,999	4.04	3.59	3.14	2.69	2.23	1.78		
45,000-53,999	4.74	4.29	3.84	3.39	2.94	2.49	2.04	
54,000-64,999	6.16	5.71	5.25	4.80	4.35	3.90	3.45	2.55

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.56							
15,000-20,999	1.27	0.84						
21,000-26,999	1.97	1.55	1.12					
27,000-32,999	2.68	2.25	1.83	1.40				
33,000-38,999	3.38	2.96	2.53	2.11	1.68			
39,000-44,999	4.09	3.66	3.24	2.81	2.39	1.96		
45,000-53,999	4.80	4.37	3.94	3.52	3.09	2.67	2.24	
54,000-64,999	6.21	5.78	5.36	4.93	4.50	4.08	3.65	2.80

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.64							
15,000-20,999	1.34	0.96						
21,000-26,999	2.05	1.66	1.28					
27,000-32,999	2.76	2.37	1.98	1.60				
33,000-38,999	3.46	3.08	2.69	2.30	1.92			
39,000-44,999	4.17	3.78	3.39	3.01	2.62	2.23		
45,000-53,999	4.87	4.49	4.10	3.71	3.33	2.94	2.55	
54,000-64,999	6.29	5.90	5.51	5.13	4.74	4.35	3.97	3.19

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.70							
15,000-20,999	1.41	1.05						
21,000-26,999	2.11	1.76	1.41					
27,000-32,999	2.82	2.47	2.11	1.76				
33,000-38,999	3.53	3.17	2.82	2.46	2.11			
39,000-44,999	4.23	3.88	3.52	3.17	2.82	2.46		
45,000-53,999	4.94	4.58	4.23	3.88	3.52	3.17	2.81	
54,000-64,999	6.35	6.00	5.64	5.29	4.93	4.58	4.22	3.52

Climate Zone 2: North Region, Dallas/Fort Worth

Cooling, New Construction

Table 447. Central Summer Demand Savings for 14.0 SEER Baseline—Zone 2

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9*	18.0–20.9	21.0-23.9	24.0+
< 15,000	0.04	0.08	0.15	0.12	0.17	0.25	0.32
15,000-20,999	0.06	0.12	0.23	0.18	0.26	0.38	0.48
21,000-26,999	0.09	0.16	0.31	0.24	0.34	0.50	0.64
27,000-32,999	0.11	0.21	0.38	0.30	0.43	0.63	0.80
33,000-38,999	0.13	0.25	0.46	0.35	0.52	0.76	0.96
39,000-44,999	0.15	0.29	0.53	0.41	0.60	0.88	1.12
45,000-53,999	0.17	0.33	0.61	0.47	0.69	1.01	1.28
54,000-64,999	0.21	0.41	0.76	0.59	0.86	1.26	1.60

Cooling, Replace-on-Burnout

Table 448. Central Summer Demand Savings for 13.08 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.69	0.18						
21,000-26,999	1.26	0.75	0.24					
27,000-32,999	1.84	1.32	0.81	0.29				
33,000-38,999	2.41	1.89	1.38	0.87	0.35			
39,000-44,999	2.98	2.47	1.95	1.44	0.93	0.41		
45,000-53,999	3.55	3.04	2.53	2.01	1.50	0.99	0.47	
54,000-64,999	4.70	4.18	3.67	3.16	2.64	2.13	1.62	0.59

15.0-15.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.73	0.24						
21,000-26,999	1.30	0.81	0.31					
27,000-32,999	1.87	1.38	0.89	0.39				
33,000-38,999	2.45	1.95	1.46	0.97	0.47			
39,000-44,999	3.02	2.53	2.03	1.54	1.04	0.55		
45,000-53,999	3.59	3.10	2.60	2.11	1.62	1.12	0.63	
54,000-64,999	4.74	4.24	3.75	3.26	2.76	2.27	1.77	0.79

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.80	0.34						
21,000-26,999	1.37	0.91	0.46					
27,000-32,999	1.95	1.49	1.03	0.57				
33,000-38,999	2.52	2.06	1.60	1.14	0.68			
39,000-44,999	3.09	2.63	2.17	1.71	1.26	0.80		
45,000-53,999	3.66	3.20	2.75	2.29	1.83	1.37	0.91	
54,000-64,999	4.81	4.35	3.89	3.43	2.97	2.52	2.06	1.14

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.19							
15,000-20,999	0.77	0.29						
21,000-26,999	1.34	0.86	0.39					
27,000-32,999	1.91	1.43	0.96	0.48				
33,000-38,999	2.48	2.01	1.53	1.06	0.58			
39,000-44,999	3.05	2.58	2.10	1.63	1.15	0.68		
45,000-53,999	3.63	3.15	2.68	2.20	1.72	1.25	0.77	
54,000-64,999	4.77	4.30	3.82	3.34	2.87	2.39	1.92	0.97

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.82	0.37						
21,000-26,999	1.39	0.94	0.49					
27,000-32,999	1.96	1.52	1.07	0.62				
33,000-38,999	2.54	2.09	1.64	1.19	0.74			
39,000-44,999	3.11	2.66	2.21	1.76	1.31	0.87		
45,000-53,999	3.68	3.23	2.78	2.34	1.89	1.44	0.99	
54,000-64,999	4.83	4.38	3.93	3.48	3.03	2.58	2.13	1.24

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.33							
15,000-20,999	0.90	0.49						
21,000-26,999	1.47	1.06	0.66					
27,000-32,999	2.04	1.64	1.23	0.82				
33,000-38,999	2.62	2.21	1.80	1.39	0.98			
39,000-44,999	3.19	2.78	2.37	1.96	1.55	1.15		
45,000-53,999	3.76	3.35	2.94	2.54	2.13	1.72	1.31	
54,000-64,999	4.91	4.50	4.09	3.68	3.27	2.86	2.45	1.64

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.97	0.59						
21,000-26,999	1.54	1.16	0.79					
27,000-32,999	2.11	1.74	1.36	0.99				
33,000-38,999	2.68	2.31	1.93	1.56	1.18			
39,000-44,999	3.26	2.88	2.51	2.13	1.76	1.38		
45,000-53,999	3.83	3.45	3.08	2.70	2.33	1.95	1.58	
54,000-64,999	4.97	4.60	4.22	3.85	3.47	3.10	2.72	1.97

Cooling, Early Retirement

Table 449. Central Summer Demand Savings for 12.44 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.78	0.27						
21,000-26,999	1.38	0.87	0.35					
27,000-32,999	1.98	1.47	0.96	0.44				
33,000-38,999	2.58	2.07	1.56	1.04	0.53			
39,000-44,999	3.19	2.67	2.16	1.65	1.13	0.62		
45,000-53,999	3.79	3.27	2.76	2.25	1.73	1.22	0.71	
54,000-64,999	4.99	4.48	3.96	3.45	2.94	2.42	1.91	0.88
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.82	0.32						
21,000-26,999	1.42	0.93	0.43					
27,000-32,999	2.02	1.53	1.03	0.54				
33,000-38,999	2.62	2.13	1.64	1.14	0.65			
39,000-44,999	3.23	2.73	2.24	1.74	1.25	0.76		
45,000-53,999	3.83	3.33	2.84	2.35	1.85	1.36	0.87	
54,000-64,999	5.03	4.54	4.04	3.55	3.06	2.56	2.07	1.08

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.89	0.43						
21,000-26,999	1.49	1.03	0.57					
27,000-32,999	2.09	1.63	1.18	0.72				
33,000-38,999	2.69	2.24	1.78	1.32	0.86			
39,000-44,999	3.30	2.84	2.38	1.92	1.46	1.00		
45,000-53,999	3.90	3.44	2.98	2.52	2.06	1.61	1.15	
54,000-64,999	5.10	4.64	4.18	3.73	3.27	2.81	2.35	1.43

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.85	0.38						
21,000-26,999	1.46	0.98	0.50					
27,000-32,999	2.06	1.58	1.11	0.63				
33,000-38,999	2.66	2.18	1.71	1.23	0.76			
39,000-44,999	3.26	2.79	2.31	1.83	1.36	0.88		
45,000-53,999	3.86	3.39	2.91	2.44	1.96	1.48	1.01	
54,000-64,999	5.07	4.59	4.11	3.64	3.16	2.69	2.21	1.26

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.91	0.46						
21,000-26,999	1.51	1.06	0.61					
27,000-32,999	2.11	1.66	1.21	0.77				
33,000-38,999	2.71	2.26	1.82	1.37	0.92			
39,000-44,999	3.32	2.87	2.42	1.97	1.52	1.07		
45,000-53,999	3.92	3.47	3.02	2.57	2.12	1.67	1.22	
54,000-64,999	5.12	4.67	4.22	3.77	3.33	2.88	2.43	1.53

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.99	0.58						
21,000-26,999	1.59	1.18	0.77					
27,000-32,999	2.19	1.78	1.37	0.97				
33,000-38,999	2.79	2.38	1.98	1.57	1.16			
39,000-44,999	3.40	2.99	2.58	2.17	1.76	1.35		
45,000-53,999	4.00	3.59	3.18	2.77	2.36	1.95	1.55	
54,000-64,999	5.20	4.79	4.38	3.97	3.57	3.16	2.75	1.93
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.45							
15,000-20,999	1.06	0.68						
21,000-26,999	1.66	1.28	0.91					
27,000-32,999	2.26	1.88	1.51	1.13				
33,000-38,999	2.86	2.49	2.11	1.74	1.36			
39,000-44,999	3.46	3.09	2.71	2.34	1.96	1.59		
45,000-53,999	4.06	3.69	3.31	2.94	2.56	2.19	1.81	
54,000-64,999	5.27	4.89	4.52	4.14	3.77	3.39	3.02	2.27

Table 450. Central Summer Demand Savings for 10.0 SEER Baseline—Zone 2

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.47							
15,000-20,999	1.22	0.71						
21,000-26,999	1.97	1.45	0.94					
27,000-32,999	2.72	2.20	1.69	1.18				
33,000-38,999	3.47	2.95	2.44	1.93	1.41			
39,000-44,999	4.21	3.70	3.19	2.67	2.16	1.65		
45,000-53,999	4.96	4.45	3.94	3.42	2.91	2.40	1.88	
54,000-64,999	6.46	5.95	5.43	4.92	4.41	3.89	3.38	2.35
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.51							
15,000-20,999	1.26	0.77						
21,000-26,999	2.01	1.51	1.02					
27,000-32,999	2.76	2.26	1.77	1.28				
33,000-38,999	3.50	3.01	2.52	2.02	1.53			
39,000-44,999	4.25	3.76	3.27	2.77	2.28	1.79		
45,000-53,999	5.00	4.51	4.01	3.52	3.03	2.53	2.04	
54,000-64,999	6.50	6.01	5.51	5.02	4.52	4.03	3.54	2.55

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.58							
15,000-20,999	1.33	0.87						
21,000-26,999	2.08	1.62	1.16					
27,000-32,999	2.83	2.37	1.91	1.45				
33,000-38,999	3.58	3.12	2.66	2.20	1.74			
39,000-44,999	4.32	3.87	3.41	2.95	2.49	2.03		
45,000-53,999	5.07	4.61	4.16	3.70	3.24	2.78	2.32	
54,000-64,999	6.57	6.11	5.65	5.19	4.74	4.28	3.82	2.90

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.55							
15,000-20,999	1.29	0.82						
21,000-26,999	2.04	1.57	1.09					
27,000-32,999	2.79	2.32	1.84	1.36				
33,000-38,999	3.54	3.06	2.59	2.11	1.64			
39,000-44,999	4.29	3.81	3.34	2.86	2.39	1.91		
45,000-53,999	5.04	4.56	4.09	3.61	3.13	2.66	2.18	
54,000-64,999	6.53	6.06	5.58	5.11	4.63	4.16	3.68	2.73

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.60							
15,000-20,999	1.35	0.90						
21,000-26,999	2.10	1.65	1.20					
27,000-32,999	2.85	2.40	1.95	1.50				
33,000-38,999	3.59	3.15	2.70	2.25	1.80			
39,000-44,999	4.34	3.89	3.45	3.00	2.55	2.10		
45,000-53,999	5.09	4.64	4.19	3.75	3.30	2.85	2.40	
54,000-64,999	6.59	6.14	5.69	5.24	4.79	4.35	3.90	3.00

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.68							
15,000-20,999	1.43	1.02						
21,000-26,999	2.18	1.77	1.36					
27,000-32,999	2.93	2.52	2.11	1.70				
33,000-38,999	3.67	3.27	2.86	2.45	2.04			
39,000-44,999	4.42	4.01	3.61	3.20	2.79	2.38		
45,000-53,999	5.17	4.76	4.35	3.95	3.54	3.13	2.72	
54,000-64,999	6.67	6.26	5.85	5.44	5.03	4.63	4.22	3.40

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.75							
15,000-20,999	1.50	1.12						
21,000-26,999	2.24	1.87	1.49					
27,000-32,999	2.99	2.62	2.24	1.87				
33,000-38,999	3.74	3.37	2.99	2.62	2.24			
39,000-44,999	4.49	4.12	3.74	3.37	2.99	2.61		
45,000-53,999	5.24	4.86	4.49	4.11	3.74	3.36	2.99	
54,000-64,999	6.74	6.36	5.99	5.61	5.24	4.86	4.49	3.74

Climate Zone 3: South Region, Houston

Cooling, New Construction

Table 451. Central Summer Demand Savings for 14.0 SEER Baseline—Zone 3

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9*	18.0–20.9	21.0-23.9	24.0+
< 15,000	0.04	0.08	0.15	0.10	0.16	0.23	0.29
15,000-20,999	0.06	0.12	0.22	0.15	0.23	0.35	0.44
21,000-26,999	0.08	0.16	0.30	0.21	0.31	0.46	0.59
27,000-32,999	0.10	0.20	0.37	0.26	0.39	0.58	0.74
33,000-38,999	0.12	0.24	0.45	0.31	0.47	0.69	0.88
39,000-44,999	0.15	0.28	0.52	0.36	0.55	0.81	1.03
45,000-53,999	0.17	0.32	0.59	0.41	0.62	0.92	1.18
54,000-64,999	0.21	0.40	0.74	0.51	0.78	1.16	1.47

Cooling, Replace-on-Burnout

Table 452. Central Summer Demand Savings for 13.08 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.67	0.17						
21,000-26,999	1.23	0.73	0.23					
27,000-32,999	1.78	1.28	0.79	0.29				
33,000-38,999	2.34	1.84	1.34	0.84	0.34			
39,000-44,999	2.90	2.40	1.90	1.40	0.90	0.40		
45,000-53,999	3.45	2.95	2.45	1.96	1.46	0.96	0.46	
54,000-64,999	4.57	4.07	3.57	3.07	2.57	2.07	1.57	0.57

15.0-15.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.71	0.23						
21,000-26,999	1.27	0.79	0.31					
27,000-32,999	1.82	1.34	0.86	0.38				
33,000-38,999	2.38	1.90	1.42	0.94	0.46			
39,000-44,999	2.93	2.46	1.98	1.50	1.02	0.54		
45,000-53,999	3.49	3.01	2.53	2.05	1.57	1.09	0.61	
54,000-64,999	4.60	4.12	3.64	3.16	2.68	2.20	1.73	0.77

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.78	0.33						
21,000-26,999	1.33	0.89	0.44					
27,000-32,999	1.89	1.45	1.00	0.55				
33,000-38,999	2.45	2.00	1.56	1.11	0.66			
39,000-44,999	3.00	2.56	2.11	1.67	1.22	0.78		
45,000-53,999	3.56	3.11	2.67	2.22	1.78	1.33	0.89	
54,000-64,999	4.67	4.23	3.78	3.34	2.89	2.44	2.00	1.11

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.73	0.26						
21,000-26,999	1.29	0.82	0.35					
27,000-32,999	1.84	1.38	0.91	0.44				
33,000-38,999	2.40	1.93	1.46	1.00	0.53			
39,000-44,999	2.96	2.49	2.02	1.55	1.08	0.62		
45,000-53,999	3.51	3.05	2.58	2.11	1.64	1.17	0.70	
54,000-64,999	4.63	4.16	3.69	3.22	2.75	2.28	1.82	0.88

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.79	0.34						
21,000-26,999	1.34	0.90	0.46					
27,000-32,999	1.90	1.46	1.01	0.57				
33,000-38,999	2.45	2.01	1.57	1.13	0.69			
39,000-44,999	3.01	2.57	2.13	1.69	1.24	0.80		
45,000-53,999	3.57	3.13	2.68	2.24	1.80	1.36	0.92	
54,000-64,999	4.68	4.24	3.80	3.36	2.91	2.47	2.03	1.15
21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.30							
15,000-20,999	0.86	0.46						
21,000-26,999	1.42	1.01	0.61					
27,000-32,999	1.97	1.57	1.17	0.76				
33,000-38,999	2.53	2.13	1.72	1.32	0.91			
39,000-44,999	3.09	2.68	2.28	1.87	1.47	1.07		
45,000-53,999	3.64	3.24	2.83	2.43	2.03	1.62	1.22	
54,000-64,999	4.76	4.35	3.95	3.54	3.14	2.73	2.33	1.52
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.37							
15,000-20,999	0.92	0.55						
21,000-26,999	1.48	1.11	0.74					
27,000-32,999	2.04	1.66	1.29	0.92				
33,000-38,999	2.59	2.22	1.85	1.48	1.10			
39,000-44,999	3.15	2.78	2.40	2.03	1.66	1.29		
45,000-53,999	3.71	3.33	2.96	2.59	2.22	1.84	1.47	
54,000-64,999	4.82	4.45	4.07	3.70	3.33	2.96	2.58	1.84

Cooling, Early Retirement

Table 453. Central Summer Demand Savings for 12.44 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.76	0.26						
21,000-26,999	1.34	0.84	0.34					
27,000-32,999	1.93	1.43	0.93	0.43				
33,000-38,999	2.51	2.01	1.51	1.01	0.52			
39,000-44,999	3.10	2.60	2.10	1.60	1.10	0.60		
45,000-53,999	3.68	3.18	2.68	2.18	1.69	1.19	0.69	
54,000-64,999	4.85	4.35	3.85	3.35	2.86	2.36	1.86	0.86
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.80	0.32						
21,000-26,999	1.38	0.90	0.42					
27,000-32,999	1.97	1.49	1.01	0.53				
33,000-38,999	2.55	2.07	1.59	1.11	0.63			
39,000-44,999	3.14	2.66	2.18	1.70	1.22	0.74		
45,000-53,999	3.72	3.24	2.76	2.28	1.80	1.32	0.84	
54,000-64,999	4.89	4.41	3.93	3.45	2.97	2.49	2.01	1.05

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.86	0.42						
21,000-26,999	1.45	1.00	0.56					
27,000-32,999	2.03	1.59	1.14	0.70				
33,000-38,999	2.62	2.17	1.73	1.28	0.84			
39,000-44,999	3.20	2.76	2.31	1.87	1.42	0.98		
45,000-53,999	3.79	3.34	2.90	2.45	2.01	1.56	1.12	
54,000-64,999	4.96	4.51	4.07	3.62	3.18	2.73	2.29	1.39

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.82	0.35						
21,000-26,999	1.40	0.93	0.47					
27,000-32,999	1.99	1.52	1.05	0.58				
33,000-38,999	2.57	2.10	1.64	1.17	0.70			
39,000-44,999	3.16	2.69	2.22	1.75	1.28	0.82		
45,000-53,999	3.74	3.27	2.81	2.34	1.87	1.40	0.93	
54,000-64,999	4.91	4.44	3.98	3.51	3.04	2.57	2.10	1.17

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.87	0.43						
21,000-26,999	1.46	1.01	0.57					
27,000-32,999	2.04	1.60	1.16	0.72				
33,000-38,999	2.63	2.18	1.74	1.30	0.86			
39,000-44,999	3.21	2.77	2.33	1.89	1.44	1.00		
45,000-53,999	3.80	3.35	2.91	2.47	2.03	1.59	1.15	
54,000-64,999	4.97	4.52	4.08	3.64	3.20	2.76	2.32	1.43

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.36							
15,000-20,999	0.95	0.54						
21,000-26,999	1.53	1.13	0.72					
27,000-32,999	2.12	1.71	1.31	0.90				
33,000-38,999	2.70	2.30	1.89	1.49	1.08			
39,000-44,999	3.29	2.88	2.48	2.07	1.67	1.27		
45,000-53,999	3.87	3.47	3.06	2.66	2.25	1.85	1.45	
54,000-64,999	5.04	4.64	4.23	3.83	3.42	3.02	2.62	1.81
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.42							
15,000-20,999	1.01	0.64						
21,000-26,999	1.59	1.22	0.85					
27,000-32,999	2.18	1.81	1.43	1.06				
33,000-38,999	2.76	2.39	2.02	1.65	1.27			
39,000-44,999	3.35	2.98	2.60	2.23	1.86	1.49		
45,000-53,999	3.93	3.56	3.19	2.82	2.44	2.07	1.70	
54,000-64,999	5.10	4.73	4.36	3.99	3.61	3.24	2.87	2.12

Table 454. Central Summer Demand Savings for 10.0 SEER Baseline—Zone 3

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.46							
15,000-20,999	1.19	0.69						
21,000-26,999	1.91	1.41	0.91					
27,000-32,999	2.64	2.14	1.64	1.14				
33,000-38,999	3.37	2.87	2.37	1.87	1.37			
39,000-44,999	4.10	3.60	3.10	2.60	2.10	1.60		
45,000-53,999	4.82	4.32	3.83	3.33	2.83	2.33	1.83	
54,000-64,999	6.28	5.78	5.28	4.78	4.28	3.78	3.29	2.29
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.50							
15,000-20,999	1.22	0.74						
21,000-26,999	1.95	1.47	0.99					
27,000-32,999	2.68	2.20	1.72	1.24				
33,000-38,999	3.41	2.93	2.45	1.97	1.49			
39,000-44,999	4.13	3.65	3.17	2.69	2.22	1.74		
45,000-53,999	4.86	4.38	3.90	3.42	2.94	2.46	1.98	
54,000-64,999	6.32	5.84	5.36	4.88	4.40	3.92	3.44	2.48

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.56							
15,000-20,999	1.29	0.85						
21,000-26,999	2.02	1.57	1.13					
27,000-32,999	2.75	2.30	1.86	1.41				
33,000-38,999	3.48	3.03	2.58	2.14	1.69			
39,000-44,999	4.20	3.76	3.31	2.87	2.42	1.98		
45,000-53,999	4.93	4.49	4.04	3.59	3.15	2.70	2.26	
54,000-64,999	6.39	5.94	5.50	5.05	4.60	4.16	3.71	2.82

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.52							
15,000-20,999	1.25	0.78						
21,000-26,999	1.97	1.51	1.04					
27,000-32,999	2.70	2.23	1.76	1.30				
33,000-38,999	3.43	2.96	2.49	2.02	1.56			
39,000-44,999	4.16	3.69	3.22	2.75	2.28	1.81		
45,000-53,999	4.88	4.42	3.95	3.48	3.01	2.54	2.07	
54,000-64,999	6.34	5.87	5.40	4.93	4.47	4.00	3.53	2.59

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.57							
15,000-20,999	1.30	0.86						
21,000-26,999	2.03	1.59	1.14					
27,000-32,999	2.76	2.31	1.87	1.43				
33,000-38,999	3.48	3.04	2.60	2.16	1.72			
39,000-44,999	4.21	3.77	3.33	2.89	2.44	2.00		
45,000-53,999	4.94	4.50	4.05	3.61	3.17	2.73	2.29	
54,000-64,999	6.39	5.95	5.51	5.07	4.63	4.19	3.74	2.86

21.0-23.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.65							
15,000-20,999	1.37	0.97						
21,000-26,999	2.10	1.70	1.29					
27,000-32,999	2.83	2.43	2.02	1.62				
33,000-38,999	3.56	3.15	2.75	2.35	1.94			
39,000-44,999	4.29	3.88	3.48	3.07	2.67	2.26		
45,000-53,999	5.01	4.61	4.21	3.80	3.40	2.99	2.59	
54,000-64,999	6.47	6.06	5.66	5.26	4.85	4.45	4.04	3.24
24.0+ SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.71							
15,000-20,999	1.44	1.07						
21,000-26,999	2.17	1.79	1.42					
27,000-32,999	2.89	2.52	2.15	1.78				
33,000-38,999	3.62	3.25	2.88	2.50	2.13			
39,000-44,999	4.35	3.98	3.60	3.23	2.86	2.49		
45,000-53,999	5.08	4.70	4.33	3.96	3.59	3.21	2.84	
54,000-64,999	6.53	6.16	5.79	5.41	5.04	4.67	4.30	3.55

Climate Zone 4: Valley Region, Corpus Christi

Cooling, New Construction

Table 455. Central Summer Demand Savings for 14.0 SEER Baseline—Zone 4

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9*	18.0–20.9	21.0-23.9	24.0+
< 15,000	0.03	0.06	0.12	0.15	0.19	0.27	0.33
15,000-20,999	0.05	0.09	0.17	0.22	0.28	0.40	0.49
21,000-26,999	0.06	0.12	0.23	0.30	0.37	0.53	0.66
27,000-32,999	0.08	0.16	0.29	0.37	0.46	0.66	0.82
33,000-38,999	0.10	0.19	0.35	0.45	0.56	0.80	0.98
39,000-44,999	0.11	0.22	0.41	0.52	0.65	0.93	1.15
45,000-53,999	0.13	0.25	0.46	0.60	0.74	1.06	1.31
54,000-64,999	0.16	0.31	0.58	0.75	0.93	1.33	1.64

Cooling, Replace-on-Burnout

Table 456. Central Summer Demand Savings for 13.08 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.52	0.13						
21,000-26,999	0.96	0.57	0.18					
27,000-32,999	1.39	1.00	0.61	0.22				
33,000-38,999	1.83	1.44	1.05	0.66	0.27			
39,000-44,999	2.26	1.87	1.48	1.09	0.70	0.31		
45,000-53,999	2.70	2.31	1.92	1.53	1.14	0.75	0.36	
54,000-64,999	3.57	3.18	2.79	2.40	2.01	1.62	1.23	0.45

15.0-15.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.55	0.18						
21,000-26,999	0.99	0.61	0.24					
27,000-32,999	1.42	1.05	0.67	0.30				
33,000-38,999	1.86	1.48	1.11	0.73	0.36			
39,000-44,999	2.29	1.92	1.54	1.17	0.79	0.42		
45,000-53,999	2.73	2.35	1.98	1.60	1.23	0.85	0.48	
54,000-64,999	3.60	3.22	2.85	2.47	2.10	1.72	1.35	0.60

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.61	0.26						
21,000-26,999	1.04	0.69	0.35					
27,000-32,999	1.48	1.13	0.78	0.43				
33,000-38,999	1.91	1.56	1.22	0.87	0.52			
39,000-44,999	2.35	2.00	1.65	1.30	0.95	0.61		
45,000-53,999	2.78	2.43	2.09	1.74	1.39	1.04	0.69	
54,000-64,999	3.65	3.30	2.96	2.61	2.26	1.91	1.56	0.87

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.64	0.31						
21,000-26,999	1.08	0.74	0.41					
27,000-32,999	1.51	1.18	0.85	0.52				
33,000-38,999	1.95	1.61	1.28	0.95	0.62			
39,000-44,999	2.38	2.05	1.72	1.39	1.05	0.72		
45,000-53,999	2.82	2.48	2.15	1.82	1.49	1.16	0.83	
54,000-64,999	3.68	3.35	3.02	2.69	2.36	2.03	1.70	1.03

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.68	0.36						
21,000-26,999	1.11	0.80	0.48					
27,000-32,999	1.55	1.23	0.92	0.61				
33,000-38,999	1.98	1.67	1.35	1.04	0.73			
39,000-44,999	2.42	2.10	1.79	1.48	1.16	0.85		
45,000-53,999	2.85	2.54	2.22	1.91	1.60	1.28	0.97	
54,000-64,999	3.72	3.41	3.09	2.78	2.47	2.15	1.84	1.21
21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.32							
15,000-20,999	0.76	0.48						
21,000-26,999	1.19	0.92	0.65					
27,000-32,999	1.63	1.35	1.08	0.81				
33,000-38,999	2.06	1.79	1.52	1.24	0.97			
39,000-44,999	2.50	2.22	1.95	1.68	1.40	1.13		
45,000-53,999	2.93	2.66	2.38	2.11	1.84	1.56	1.29	
54,000-64,999	3.80	3.53	3.25	2.98	2.71	2.43	2.16	1.61
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.82	0.58						
21,000-26,999	1.25	1.01	0.77					
27,000-32,999	1.69	1.45	1.21	0.96				
33,000-38,999	2.12	1.88	1.64	1.40	1.16			
39,000-44,999	2.56	2.32	2.07	1.83	1.59	1.35		
45,000-53,999	2.99	2.75	2.51	2.27	2.02	1.78	1.54	
54,000-64,999	3.86	3.62	3.38	3.14	2.89	2.65	2.41	1.93

Cooling, Early Retirement

Table 457. Central Summer Demand Savings for 12.44 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.59	0.20						
21,000-26,999	1.05	0.66	0.27					
27,000-32,999	1.51	1.12	0.73	0.34				
33,000-38,999	1.96	1.57	1.18	0.79	0.40			
39,000-44,999	2.42	2.03	1.64	1.25	0.86	0.47		
45,000-53,999	2.88	2.49	2.10	1.71	1.32	0.93	0.54	
54,000-64,999	3.79	3.40	3.01	2.62	2.23	1.84	1.45	0.67
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.62	0.25						
21,000-26,999	1.08	0.70	0.33					
27,000-32,999	1.54	1.16	0.79	0.41				
33,000-38,999	1.99	1.62	1.24	0.87	0.49			
39,000-44,999	2.45	2.08	1.70	1.33	0.95	0.58		
45,000-53,999	2.91	2.53	2.16	1.78	1.41	1.03	0.66	
54,000-64,999	3.82	3.45	3.07	2.70	2.32	1.95	1.57	0.82

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.68	0.33						
21,000-26,999	1.13	0.78	0.44					
27,000-32,999	1.59	1.24	0.89	0.54				
33,000-38,999	2.05	1.70	1.35	1.00	0.65			
39,000-44,999	2.50	2.16	1.81	1.46	1.11	0.76		
45,000-53,999	2.96	2.61	2.26	1.92	1.57	1.22	0.87	
54,000-64,999	3.88	3.53	3.18	2.83	2.48	2.13	1.79	1.09

17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.71	0.38						
21,000-26,999	1.17	0.83	0.50					
27,000-32,999	1.62	1.29	0.96	0.63				
33,000-38,999	2.08	1.75	1.42	1.09	0.75			
39,000-44,999	2.54	2.21	1.87	1.54	1.21	0.88		
45,000-53,999	2.99	2.66	2.33	2.00	1.67	1.34	1.01	
54,000-64,999	3.91	3.58	3.25	2.91	2.58	2.25	1.92	1.26

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.74	0.43						
21,000-26,999	1.20	0.89	0.57					
27,000-32,999	1.66	1.34	1.03	0.72				
33,000-38,999	2.12	1.80	1.49	1.17	0.86			
39,000-44,999	2.57	2.26	1.95	1.63	1.32	1.00		
45,000-53,999	3.03	2.72	2.40	2.09	1.78	1.46	1.15	
54,000-64,999	3.94	3.63	3.32	3.00	2.69	2.38	2.06	1.44

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.37							
15,000-20,999	0.82	0.55						
21,000-26,999	1.28	1.01	0.74					
27,000-32,999	1.74	1.47	1.19	0.92				
33,000-38,999	2.20	1.92	1.65	1.38	1.10			
39,000-44,999	2.65	2.38	2.11	1.83	1.56	1.29		
45,000-53,999	3.11	2.84	2.56	2.29	2.02	1.74	1.47	
54,000-64,999	4.02	3.75	3.48	3.20	2.93	2.66	2.38	1.84

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.43							
15,000-20,999	0.89	0.64						
21,000-26,999	1.34	1.10	0.86					
27,000-32,999	1.80	1.56	1.32	1.07				
33,000-38,999	2.26	2.02	1.77	1.53	1.29			
39,000-44,999	2.72	2.47	2.23	1.99	1.75	1.50		
45,000-53,999	3.17	2.93	2.69	2.45	2.20	1.96	1.72	
54,000-64,999	4.09	3.84	3.60	3.36	3.12	2.88	2.63	2.15

Table 458. Central Summer Demand Savings for 10.0 SEER Baseline—Zone 4

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.36							
15,000-20,999	0.93	0.54						
21,000-26,999	1.49	1.10	0.71					
27,000-32,999	2.06	1.67	1.28	0.89				
33,000-38,999	2.63	2.24	1.85	1.46	1.07			
39,000-44,999	3.20	2.81	2.42	2.03	1.64	1.25		
45,000-53,999	3.77	3.38	2.99	2.60	2.21	1.82	1.43	
54,000-64,999	4.91	4.52	4.13	3.74	3.35	2.96	2.57	1.79
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.96	0.58						
21,000-26,999	1.52	1.15	0.77					
27,000-32,999	2.09	1.72	1.34	0.97				
33,000-38,999	2.66	2.29	1.91	1.54	1.16			
39,000-44,999	3.23	2.86	2.48	2.11	1.73	1.36		
45,000-53,999	3.80	3.42	3.05	2.67	2.30	1.92	1.55	
54,000-64,999	4.94	4.56	4.19	3.81	3.44	3.06	2.69	1.94

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.44							
15,000-20,999	1.01	0.66						
21,000-26,999	1.58	1.23	0.88					
27,000-32,999	2.15	1.80	1.45	1.10				
33,000-38,999	2.72	2.37	2.02	1.67	1.32			
39,000-44,999	3.28	2.94	2.59	2.24	1.89	1.54		
45,000-53,999	3.85	3.50	3.16	2.81	2.46	2.11	1.76	
54,000-64,999	4.99	4.64	4.29	3.95	3.60	3.25	2.90	2.21
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.47							
15,000-20,999	1.04	0.71						
21,000-26,999	1.61	1.28	0.95					
27,000-32,999	2.18	1.85	1.52	1.19				
33,000-38,999	2.75	2.42	2.09	1.75	1.42			
39,000-44,999	3.32	2.99	2.66	2.32	1.99	1.66		
45,000-53,999	3.89	3.56	3.22	2.89	2.56	2.23	1.90	
54,000-64,999	5.02	4.69	4.36	4.03	3.70	3.37	3.04	2.37
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.51							
15,000-20,999	1.08	0.77						
21,000-26,999	1.65	1.33	1.02					
27,000-32,999	2.22	1.90	1.59	1.28				
33,000-38,999	2.78	2.47	2.16	1.84	1.53			
39,000-44,999	3.35	3.04	2.73	2.41	2.10	1.79		
45,000-53,999	3.92	3.61	3.29	2.98	2.67	2.35	2.04	
54,000-64,999	5.06	4.75	4.43	4.12	3.81	3.49	3.18	2.55

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.59							
15,000-20,999	1.16	0.89						
21,000-26,999	1.73	1.45	1.18					
27,000-32,999	2.30	2.02	1.75	1.48				
33,000-38,999	2.87	2.59	2.32	2.05	1.77			
39,000-44,999	3.43	3.16	2.89	2.61	2.34	2.07		
45,000-53,999	4.00	3.73	3.46	3.18	2.91	2.64	2.36	
54,000-64,999	5.14	4.87	4.59	4.32	4.05	3.77	3.50	2.95
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.65							
15,000-20,999	1.22	0.98						
21,000-26,999	1.79	1.55	1.31					
27,000-32,999	2.36	2.12	1.87	1.63				
33,000-38,999	2.93	2.69	2.44	2.20	1.96			
39,000-44,999	3.50	3.25	3.01	2.77	2.53	2.29		
45,000-53,999	4.07	3.82	3.58	3.34	3.10	2.85	2.61	
54,000-64,999	5.20	4.96	4.72	4.48	4.23	3.99	3.75	3.26

Climate Zone 5: West Region, El Paso

Cooling, New Construction

Table 459. Central Summer Demand Savings for 14.0 SEER Baseline—Zone 5

Size (Btuh)	SEER Range						
	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9*	18.0–20.9	21.0-23.9	24.0+
< 15,000	0.04	0.08	0.14	0.13	0.17	0.26	0.33
15,000-20,999	0.06	0.11	0.21	0.19	0.26	0.39	0.49
21,000-26,999	0.08	0.15	0.28	0.25	0.35	0.52	0.65
27,000-32,999	0.10	0.19	0.35	0.31	0.43	0.65	0.82
33,000-38,999	0.12	0.23	0.42	0.38	0.52	0.78	0.98
39,000-44,999	0.14	0.27	0.49	0.44	0.61	0.90	1.15
45,000-53,999	0.16	0.30	0.57	0.50	0.70	1.03	1.31
54,000-64,999	0.20	0.38	0.71	0.63	0.87	1.29	1.64

Cooling, Replace-on-Burnout

Table 460. Central Summer Demand Savings for 13.08 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.64	0.16						
21,000-26,999	1.17	0.69	0.22					
27,000-32,999	1.70	1.22	0.75	0.27				
33,000-38,999	2.23	1.75	1.28	0.80	0.33			
39,000-44,999	2.76	2.28	1.81	1.33	0.86	0.38		
45,000-53,999	3.29	2.81	2.34	1.86	1.39	0.91	0.44	
54,000-64,999	4.35	3.87	3.40	2.92	2.45	1.97	1.50	0.55

15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.68	0.22						
21,000-26,999	1.20	0.75	0.29					
27,000-32,999	1.73	1.28	0.82	0.36				
33,000-38,999	2.26	1.81	1.35	0.89	0.44			
39,000-44,999	2.79	2.34	1.88	1.42	0.97	0.51		
45,000-53,999	3.32	2.87	2.41	1.95	1.50	1.04	0.58	
54,000-64,999	4.38	3.93	3.47	3.01	2.56	2.10	1.64	0.73
16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.74	0.32						
21,000-26,999	1.27	0.85	0.42					
27,000-32,999	1.80	1.38	0.95	0.53				
33,000-38,999	2.33	1.90	1.48	1.06	0.63			
39,000-44,999	2.86	2.43	2.01	1.59	1.16	0.74		
45,000-53,999	3.39	2.96	2.54	2.12	1.69	1.27	0.84	
54,000-64,999	4.45	4.02	3.60	3.17	2.75	2.33	1.90	1.05
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.72	0.29						
21,000-26,999	1.25	0.82	0.39					
27,000-32,999	1.78	1.35	0.92	0.49				
33,000-38,999	2.31	1.88	1.45	1.02	0.59			
39,000-44,999	2.84	2.41	1.98	1.55	1.12	0.68		
45,000-53,999	3.37	2.94	2.51	2.08	1.65	1.21	0.78	
54,000-64,999	4.43	4.00	3.57	3.14	2.70	2.27	1.84	0.98

18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.77	0.37						
21,000-26,999	1.30	0.89	0.49					
27,000-32,999	1.83	1.42	1.02	0.61				
33,000-38,999	2.36	1.95	1.55	1.14	0.73			
39,000-44,999	2.89	2.48	2.08	1.67	1.26	0.85		
45,000-53,999	3.42	3.01	2.61	2.20	1.79	1.38	0.97	
54,000-64,999	4.48	4.07	3.66	3.26	2.85	2.44	2.03	1.22

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.33							
15,000-20,999	0.86	0.49						
21,000-26,999	1.39	1.02	0.66					
27,000-32,999	1.92	1.55	1.19	0.82				
33,000-38,999	2.45	2.08	1.72	1.35	0.98			
39,000-44,999	2.98	2.61	2.24	1.88	1.51	1.15		
45,000-53,999	3.51	3.14	2.77	2.41	2.04	1.68	1.31	
54,000-64,999	4.56	4.20	3.83	3.47	3.10	2.74	2.37	1.64

24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.40							
15,000-20,999	0.93	0.60						
21,000-26,999	1.46	1.12	0.79					
27,000-32,999	1.99	1.65	1.32	0.99				
33,000-38,999	2.51	2.18	1.85	1.52	1.19			
39,000-44,999	3.04	2.71	2.38	2.05	1.72	1.39		
45,000-53,999	3.57	3.24	2.91	2.58	2.25	1.92	1.59	
54,000-64,999	4.63	4.30	3.97	3.64	3.31	2.98	2.65	1.98

Cooling, Early Retirement

Table 461. Central Summer Demand Savings for 12.44 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.72	0.25						
21,000-26,999	1.28	0.80	0.33					
27,000-32,999	1.83	1.36	0.88	0.41				
33,000-38,999	2.39	1.92	1.44	0.97	0.49			
39,000-44,999	2.95	2.47	2.00	1.52	1.05	0.57		
45,000-53,999	3.50	3.03	2.55	2.08	1.60	1.13	0.65	
54,000-64,999	4.62	4.14	3.67	3.19	2.72	2.24	1.77	0.82
15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.76	0.30						
21,000-26,999	1.31	0.86	0.40					
27,000-32,999	1.87	1.41	0.96	0.50				
33,000-38,999	2.43	1.97	1.51	1.06	0.60			
39,000-44,999	2.98	2.53	2.07	1.61	1.16	0.70		
45,000-53,999	3.54	3.08	2.63	2.17	1.71	1.26	0.80	
54,000-64,999	4.65	4.20	3.74	3.28	2.83	2.37	1.91	1.00

16.0-16.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.82	0.40						
21,000-26,999	1.38	0.95	0.53					
27,000-32,999	1.94	1.51	1.09	0.66				
33,000-38,999	2.49	2.07	1.64	1.22	0.80			
39,000-44,999	3.05	2.63	2.20	1.78	1.35	0.93		
45,000-53,999	3.61	3.18	2.76	2.33	1.91	1.49	1.06	
54,000-64,999	4.72	4.30	3.87	3.45	3.02	2.60	2.18	1.33
17.0-17.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.81	0.37						
21,000-26,999	1.36	0.93	0.50					
27,000-32,999	1.92	1.49	1.06	0.62				
33,000-38,999	2.48	2.05	1.61	1.18	0.75			
39,000-44,999	3.03	2.60	2.17	1.74	1.31	0.87		
45,000-53,999	3.59	3.16	2.73	2.30	1.86	1.43	1.00	
54,000-64,999	4.70	4.27	3.84	3.41	2.98	2.55	2.11	1.25
18.0-20.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.30							
15,000-20,999	0.85	0.45						
21,000-26,999	1.41	1.00	0.60					
27,000-32,999	1.97	1.56	1.15	0.75				
33,000-38,999	2.53	2.12	1.71	1.30	0.89			
39,000-44,999	3.08	2.67	2.27	1.86	1.45	1.04		
45,000-53,999	3.64	3.23	2.82	2.42	2.01	1.60	1.19	
54,000-64,999	4.75	4.34	3.94	3.53	3.12	2.71	2.31	1.49

21.0-23.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.38							
15,000-20,999	0.94	0.57						
21,000-26,999	1.50	1.13	0.77					
27,000-32,999	2.05	1.69	1.32	0.96				
33,000-38,999	2.61	2.24	1.88	1.51	1.15			
39,000-44,999	3.17	2.80	2.44	2.07	1.70	1.34		
45,000-53,999	3.72	3.36	2.99	2.63	2.26	1.90	1.53	
54,000-64,999	4.84	4.47	4.11	3.74	3.37	3.01	2.64	1.91
24.0+ SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.45							
15,000-20,999	1.01	0.68						
21,000-26,999	1.56	1.23	0.90					
27,000-32,999	2.12	1.79	1.46	1.13				
33,000-38,999	2.68	2.35	2.02	1.69	1.35			
39,000-44,999	3.24	2.90	2.57	2.24	1.91	1.58		
45,000-53,999	3.79	3.46	3.13	2.80	2.47	2.14	1.81	
54,000-64,999	4.91	4.57	4.24	3.91	3.58	3.25	2.92	2.26

Table 462. Central Summer Demand Savings for 10.0 SEER Baseline—Zone 5

14.5-14.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.44							
15,000-20,999	1.13	0.65						
21,000-26,999	1.82	1.35	0.87					
27,000-32,999	2.51	2.04	1.56	1.09				
33,000-38,999	3.21	2.73	2.26	1.78	1.31			
39,000-44,999	3.90	3.42	2.95	2.47	2.00	1.52		
45,000-53,999	4.59	4.12	3.64	3.17	2.69	2.22	1.74	
54,000-64,999	5.98	5.50	5.03	4.55	4.08	3.60	3.13	2.18

15.0-15.9 SEER								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.47							
15,000-20,999	1.16	0.71						
21,000-26,999	1.86	1.40	0.94					
27,000-32,999	2.55	2.09	1.64	1.18				
33,000-38,999	3.24	2.79	2.33	1.87	1.42			
39,000-44,999	3.93	3.48	3.02	2.56	2.11	1.65		
45,000-53,999	4.63	4.17	3.71	3.26	2.80	2.34	1.89	
54,000-64,999	6.01	5.56	5.10	4.64	4.19	3.73	3.27	2.36

16.0-16.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.54							
15,000-20,999	1.23	0.81						
21,000-26,999	1.92	1.50	1.07					
27,000-32,999	2.61	2.19	1.77	1.34				
33,000-38,999	3.31	2.88	2.46	2.04	1.61			
39,000-44,999	4.00	3.58	3.15	2.73	2.30	1.88		
45,000-53,999	4.69	4.27	3.84	3.42	3.00	2.57	2.15	
54,000-64,999	6.08	5.65	5.23	4.81	4.38	3.96	3.53	2.69

17.0-17.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.52							
15,000-20,999	1.21	0.78						
21,000-26,999	1.91	1.48	1.04					
27,000-32,999	2.60	2.17	1.74	1.30				
33,000-38,999	3.29	2.86	2.43	2.00	1.56			
39,000-44,999	3.98	3.55	3.12	2.69	2.26	1.83		
45,000-53,999	4.68	4.25	3.81	3.38	2.95	2.52	2.09	
54,000-64,999	6.06	5.63	5.20	4.77	4.34	3.90	3.47	2.61

18.0-20.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.57							
15,000-20,999	1.26	0.85						
21,000-26,999	1.95	1.55	1.14					
27,000-32,999	2.65	2.24	1.83	1.42				
33,000-38,999	3.34	2.93	2.52	2.12	1.71			
39,000-44,999	4.03	3.62	3.22	2.81	2.40	1.99		
45,000-53,999	4.73	4.32	3.91	3.50	3.09	2.69	2.28	
54,000-64,999	6.11	5.70	5.30	4.89	4.48	4.07	3.66	2.85

21.0-23.9 SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.65							
15,000-20,999	1.35	0.98						
21,000-26,999	2.04	1.67	1.31					
27,000-32,999	2.73	2.37	2.00	1.64				
33,000-38,999	3.42	3.06	2.69	2.33	1.96			
39,000-44,999	4.12	3.75	3.39	3.02	2.66	2.29		
45,000-53,999	4.81	4.44	4.08	3.71	3.35	2.98	2.62	
54,000-64,999	6.20	5.83	5.46	5.10	4.73	4.37	4.00	3.27

24.0+ SEER

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.72							
15,000-20,999	1.42	1.08						
21,000-26,999	2.11	1.78	1.45					
27,000-32,999	2.80	2.47	2.14	1.81				
33,000-38,999	3.49	3.16	2.83	2.50	2.17			
39,000-44,999	4.19	3.85	3.52	3.19	2.86	2.53		
45,000-53,999	4.88	4.55	4.22	3.89	3.55	3.22	2.89	
54,000-64,999	6.26	5.93	5.60	5.27	4.94	4.61	4.28	3.62

Deemed Winter Demand Savings Tables[562]

Table 463 through Table 482 present the winter demand savings (kW) for all five Texas climate zones. In each table, the capacity of the efficient unit is represented in the columns and the capacity of the existing unit is represented in the rows. The savings are in the intersection of the appropriate efficient and existing capacities. Replacements where there has been to change in capacity are highlighted in light blue.

The rightsizing savings specified in the tables below are only applicable to replace-on-burnout and early retirement projects. New construction projects are not eligible to receive deemed savings for system rightsizing.[563]

Climate Zone 1: Panhandle Region, Amarillo

Heating, New Construction/Replace-on-Burnout

Table 463. Central Winter Demand Savings for 8.2 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.06							
15,000-20,999	0.72	0.08						
21,000-26,999	1.39	0.75	0.11					
27,000-32,999	2.06	1.42	0.78	0.14				
33,000-38,999	2.72	2.08	1.44	0.80	0.17			
39,000-44,999	3.39	2.75	2.11	1.47	0.83	0.19		
45,000-53,999	4.06	3.42	2.78	2.14	1.50	0.86	0.22	
54,000-64,999	5.39	4.75	4.11	3.47	2.83	2.19	1.55	0.28

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[562] Rated capacity ranges are specified with a 5 percent tolerance in accordance with AHRI Standard 210/240 to account for systems that are rated slightly below the applicable nominal capacity. AHRI Standard 210/240. Table J1. http://www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_210-240_2017.pdf.

[563] For projects using a custom baseline, see TRM Volume 4.

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.78	0.18						
21,000-26,999	1.45	0.84	0.24					
27,000-32,999	2.12	1.51	0.90	0.29				
33,000-38,999	2.79	2.18	1.57	0.96	0.35			
39,000-44,999	3.45	2.85	2.24	1.63	1.02	0.41		
45,000-53,999	4.12	3.51	2.90	2.30	1.69	1.08	0.47	
54,000-64,999	5.46	4.85	4.24	3.63	3.02	2.41	1.81	0.59

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.82	0.23						
21,000-26,999	1.48	0.89	0.30					
27,000-32,999	2.15	1.56	0.97	0.38				
33,000-38,999	2.82	2.23	1.63	1.04	0.45			
39,000-44,999	3.49	2.89	2.30	1.71	1.12	0.53		
45,000-53,999	4.15	3.56	2.97	2.38	1.79	1.19	0.60	
54,000-64,999	5.49	4.90	4.30	3.71	3.12	2.53	1.94	0.75

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.83	0.24						
21,000-26,999	1.50	0.91	0.32					
27,000-32,999	2.16	1.58	0.99	0.41				
33,000-38,999	2.83	2.25	1.66	1.07	0.49			
39,000-44,999	3.50	2.91	2.33	1.74	1.15	0.57		
45,000-53,999	4.17	3.58	2.99	2.41	1.82	1.24	0.65	
54,000-64,999	5.50	4.91	4.33	3.74	3.16	2.57	1.98	0.81

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.84	0.26						
21,000-26,999	1.51	0.93	0.35					
27,000-32,999	2.18	1.60	1.02	0.44				
33,000-38,999	2.84	2.26	1.68	1.10	0.52			
39,000-44,999	3.51	2.93	2.35	1.77	1.19	0.61		
45,000-53,999	4.18	3.60	3.02	2.44	1.86	1.28	0.70	
54,000-64,999	5.51	4.93	4.35	3.77	3.19	2.61	2.03	0.87
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.19							
15,000-20,999	0.85	0.28						
21,000-26,999	1.52	0.95	0.37					
27,000-32,999	2.19	1.61	1.04	0.46				
33,000-38,999	2.85	2.28	1.71	1.13	0.56			
39,000-44,999	3.52	2.95	2.37	1.80	1.22	0.65		
45,000-53,999	4.19	3.61	3.04	2.47	1.89	1.32	0.74	
54,000-64,999	5.52	4.95	4.37	3.80	3.23	2.65	2.08	0.93
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.86	0.29						
21,000-26,999	1.53	0.96	0.39					
27,000-32,999	2.20	1.63	1.06	0.49				
33,000-38,999	2.87	2.30	1.73	1.16	0.59			
39,000-44,999	3.53	2.96	2.39	1.83	1.26	0.69		
45,000-53,999	4.20	3.63	3.06	2.49	1.92	1.35	0.79	
54,000-64,999	5.53	4.96	4.40	3.83	3.26	2.69	2.12	0.98

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.87	0.30						
21,000-26,999	1.54	0.97	0.41					
27,000-32,999	2.20	1.64	1.07	0.51				
33,000-38,999	2.87	2.31	1.74	1.17	0.61			
39,000-44,999	3.54	2.97	2.41	1.84	1.28	0.71		
45,000-53,999	4.21	3.64	3.07	2.51	1.94	1.38	0.81	
54,000-64,999	5.54	4.97	4.41	3.84	3.28	2.71	2.15	1.01

Heating, Early Retirement of a Heat Pump

Table 464. Central Winter Demand Savings for 7.7 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.84	0.20						
21,000-26,999	1.55	0.91	0.27					
27,000-32,999	2.25	1.61	0.97	0.33				
33,000-38,999	2.96	2.32	1.68	1.04	0.40			
39,000-44,999	3.66	3.02	2.39	1.75	1.11	0.47		
45,000-53,999	4.37	3.73	3.09	2.45	1.81	1.17	0.53	
54,000-64,999	5.78	5.14	4.50	3.86	3.22	2.58	1.95	0.67

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.90	0.29						
21,000-26,999	1.61	1.00	0.39					
27,000-32,999	2.31	1.71	1.10	0.49				
33,000-38,999	3.02	2.41	1.80	1.20	0.59			
39,000-44,999	3.73	3.12	2.51	1.90	1.29	0.69		
45,000-53,999	4.43	3.82	3.22	2.61	2.00	1.39	0.78	
54,000-64,999	5.85	5.24	4.63	4.02	3.41	2.80	2.20	0.98
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.93	0.34						
21,000-26,999	1.64	1.05	0.46					
27,000-32,999	2.35	1.75	1.16	0.57				
33,000-38,999	3.05	2.46	1.87	1.28	0.68			
39,000-44,999	3.76	3.17	2.58	1.98	1.39	0.80		
45,000-53,999	4.47	3.87	3.28	2.69	2.10	1.51	0.91	
54,000-64,999	5.88	5.29	4.69	4.10	3.51	2.92	2.33	1.14
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.95	0.36						
21,000-26,999	1.65	1.07	0.48					
27,000-32,999	2.36	1.77	1.19	0.60				
33,000-38,999	3.07	2.48	1.89	1.31	0.72			
39,000-44,999	3.77	3.19	2.60	2.01	1.43	0.84		
45,000-53,999	4.48	3.89	3.31	2.72	2.13	1.55	0.96	
54,000-64,999	5.89	5.30	4.72	4.13	3.55	2.96	2.37	1.20

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.96	0.38						
21,000-26,999	1.66	1.08	0.50					
27,000-32,999	2.37	1.79	1.21	0.63				
33,000-38,999	3.08	2.50	1.92	1.34	0.76			
39,000-44,999	3.78	3.20	2.62	2.04	1.46	0.88		
45,000-53,999	4.49	3.91	3.33	2.75	2.17	1.59	1.01	
54,000-64,999	5.90	5.32	4.74	4.16	3.58	3.00	2.42	1.26
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.97	0.40						
21,000-26,999	1.68	1.10	0.53					
27,000-32,999	2.38	1.81	1.23	0.66				
33,000-38,999	3.09	2.51	1.94	1.37	0.79			
39,000-44,999	3.79	3.22	2.65	2.07	1.50	0.92		
45,000-53,999	4.50	3.93	3.35	2.78	2.20	1.63	1.05	
54,000-64,999	5.91	5.34	4.76	4.19	3.62	3.04	2.47	1.32
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.98	0.41						
21,000-26,999	1.69	1.12	0.55					
27,000-32,999	2.39	1.82	1.26	0.69				
33,000-38,999	3.10	2.53	1.96	1.39	0.82			
39,000-44,999	3.81	3.24	2.67	2.10	1.53	0.96		
45,000-53,999	4.51	3.94	3.37	2.81	2.24	1.67	1.10	
54,000-64,999	5.92	5.36	4.79	4.22	3.65	3.08	2.51	1.37

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.99	0.42						
21,000-26,999	1.69	1.13	0.56					
27,000-32,999	2.40	1.83	1.27	0.70				
33,000-38,999	3.11	2.54	1.97	1.41	0.84			
39,000-44,999	3.81	3.25	2.68	2.11	1.55	0.98		
45,000-53,999	4.52	3.95	3.39	2.82	2.26	1.69	1.12	
54,000-64,999	5.93	5.36	4.80	4.23	3.67	3.10	2.54	1.40

Table 465. Central Winter Demand Savings for 6.8 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.32							
15,000-20,999	1.12	0.48						
21,000-26,999	1.92	1.28	0.64					
27,000-32,999	2.72	2.08	1.44	0.80				
33,000-38,999	3.52	2.88	2.24	1.60	0.96			
39,000-44,999	4.32	3.68	3.04	2.40	1.76	1.12		
45,000-53,999	5.12	4.48	3.84	3.20	2.56	1.92	1.28	
54,000-64,999	6.72	6.08	5.44	4.80	4.16	3.52	2.88	1.60

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.38							
15,000-20,999	1.18	0.58						
21,000-26,999	1.98	1.38	0.77					
27,000-32,999	2.78	2.18	1.57	0.96				
33,000-38,999	3.58	2.98	2.37	1.76	1.15			
39,000-44,999	4.38	3.78	3.17	2.56	1.95	1.34		
45,000-53,999	5.18	4.58	3.97	3.36	2.75	2.14	1.53	
54,000-64,999	6.78	6.18	5.57	4.96	4.35	3.74	3.13	1.92

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.42							
15,000-20,999	1.22	0.62						
21,000-26,999	2.02	1.42	0.83					
27,000-32,999	2.82	2.22	1.63	1.04				
33,000-38,999	3.62	3.02	2.43	1.84	1.25			
39,000-44,999	4.42	3.82	3.23	2.64	2.05	1.46		
45,000-53,999	5.22	4.62	4.03	3.44	2.85	2.26	1.66	
54,000-64,999	6.82	6.22	5.63	5.04	4.45	3.86	3.26	2.08

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.43							
15,000-20,999	1.23	0.64						
21,000-26,999	2.03	1.44	0.86					
27,000-32,999	2.83	2.24	1.66	1.07				
33,000-38,999	3.63	3.04	2.46	1.87	1.28			
39,000-44,999	4.43	3.84	3.26	2.67	2.08	1.50		
45,000-53,999	5.23	4.64	4.06	3.47	2.88	2.30	1.71	
54,000-64,999	6.83	6.24	5.66	5.07	4.48	3.90	3.31	2.14

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.44							
15,000-20,999	1.24	0.66						
21,000-26,999	2.04	1.46	0.88					
27,000-32,999	2.84	2.26	1.68	1.10				
33,000-38,999	3.64	3.06	2.48	1.90	1.32			
39,000-44,999	4.44	3.86	3.28	2.70	2.12	1.54		
45,000-53,999	5.24	4.66	4.08	3.50	2.92	2.34	1.76	
54,000-64,999	6.84	6.26	5.68	5.10	4.52	3.94	3.36	2.20

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.45							
15,000-20,999	1.25	0.68						
21,000-26,999	2.05	1.48	0.90					
27,000-32,999	2.85	2.28	1.70	1.13				
33,000-38,999	3.65	3.08	2.50	1.93	1.35			
39,000-44,999	4.45	3.88	3.30	2.73	2.15	1.58		
45,000-53,999	5.25	4.68	4.10	3.53	2.95	2.38	1.80	
54,000-64,999	6.85	6.28	5.70	5.13	4.55	3.98	3.40	2.26

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.46							
15,000-20,999	1.26	0.69						
21,000-26,999	2.06	1.49	0.92					
27,000-32,999	2.86	2.29	1.72	1.16				
33,000-38,999	3.66	3.09	2.52	1.96	1.39			
39,000-44,999	4.46	3.89	3.32	2.76	2.19	1.62		
45,000-53,999	5.26	4.69	4.12	3.56	2.99	2.42	1.85	
54,000-64,999	6.86	6.29	5.72	5.16	4.59	4.02	3.45	2.31

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.47							
15,000-20,999	1.27	0.70						
21,000-26,999	2.07	1.50	0.94					
27,000-32,999	2.87	2.30	1.74	1.17				
33,000-38,999	3.67	3.10	2.54	1.97	1.41			
39,000-44,999	4.47	3.90	3.34	2.77	2.21	1.64		
45,000-53,999	5.27	4.70	4.14	3.57	3.01	2.44	1.87	
54,000-64,999	6.87	6.30	5.74	5.17	4.61	4.04	3.47	2.34

Heating, Early Retirement of an Electric Resistance Furnace

Table 466. Central Winter Demand Savings for 3.412 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.52							
15,000-20,999	2.92	2.28						
21,000-26,999	4.32	3.68	3.04					
27,000-32,999	5.72	5.08	4.44	3.80				
33,000-38,999	7.12	6.48	5.84	5.20	4.56			
39,000-44,999	8.52	7.88	7.24	6.60	5.96	5.32		
45,000-53,999	9.91	9.27	8.63	8.00	7.36	6.72	6.08	
54,000-64,999	12.71	12.07	11.43	10.79	10.15	9.51	8.87	7.60

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.58							
15,000-20,999	2.98	2.37						
21,000-26,999	4.38	3.77	3.16					
27,000-32,999	5.78	5.17	4.56	3.95				
33,000-38,999	7.18	6.57	5.96	5.35	4.75			
39,000-44,999	8.58	7.97	7.36	6.75	6.14	5.54		
45,000-53,999	9.98	9.37	8.76	8.15	7.54	6.94	6.33	
54,000-64,999	12.78	12.17	11.56	10.95	10.34	9.73	9.13	7.91

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.61							
15,000-20,999	3.01	2.42						
21,000-26,999	4.41	3.82	3.23					
27,000-32,999	5.81	5.22	4.63	4.04				
33,000-38,999	7.21	6.62	6.03	5.43	4.84			
39,000-44,999	8.61	8.02	7.43	6.83	6.24	5.65		
45,000-53,999	10.01	9.42	8.83	8.23	7.64	7.05	6.46	
54,000-64,999	12.81	12.22	11.62	11.03	10.44	9.85	9.26	8.07

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.63							
15,000-20,999	3.03	2.44						
21,000-26,999	4.42	3.84	3.25					
27,000-32,999	5.82	5.24	4.65	4.07				
33,000-38,999	7.22	6.64	6.05	5.47	4.88			
39,000-44,999	8.62	8.04	7.45	6.86	6.28	5.69		
45,000-53,999	10.02	9.44	8.85	8.26	7.68	7.09	6.51	
54,000-64,999	12.82	12.23	11.65	11.06	10.48	9.89	9.30	8.13

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.64							
15,000-20,999	3.04	2.46						
21,000-26,999	4.44	3.86	3.28					
27,000-32,999	5.84	5.26	4.68	4.10				
33,000-38,999	7.23	6.65	6.07	5.49	4.91			
39,000-44,999	8.63	8.05	7.47	6.89	6.31	5.73		
45,000-53,999	10.03	9.45	8.87	8.29	7.71	7.13	6.55	
54,000-64,999	12.83	12.25	11.67	11.09	10.51	9.93	9.35	8.19

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.65							
15,000-20,999	3.05	2.47						
21,000-26,999	4.45	3.87	3.30					
27,000-32,999	5.85	5.27	4.70	4.12				
33,000-38,999	7.25	6.67	6.10	5.52	4.95			
39,000-44,999	8.65	8.07	7.50	6.92	6.35	5.77		
45,000-53,999	10.04	9.47	8.90	8.32	7.75	7.17	6.60	
54,000-64,999	12.84	12.27	11.69	11.12	10.55	9.97	9.40	8.25

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.66							
15,000-20,999	3.06	2.49						
21,000-26,999	4.46	3.89	3.32					
27,000-32,999	5.86	5.29	4.72	4.15				
33,000-38,999	7.26	6.69	6.12	5.55	4.98			
39,000-44,999	8.66	8.09	7.52	6.95	6.38	5.81		
45,000-53,999	10.06	9.49	8.92	8.35	7.78	7.21	6.64	
54,000-64,999	12.85	12.28	11.72	11.15	10.58	10.01	9.44	8.30

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.67							
15,000-20,999	3.07	2.50						
21,000-26,999	4.47	3.90	3.33					
27,000-32,999	5.86	5.30	4.73	4.17				
33,000-38,999	7.26	6.70	6.13	5.57	5.00			
39,000-44,999	8.66	8.10	7.53	6.97	6.40	5.83		
45,000-53,999	10.06	9.50	8.93	8.36	7.80	7.23	6.67	
54,000-64,999	12.86	12.29	11.73	11.16	10.60	10.03	9.47	8.33

Climate Zone 2: North Region, Dallas/Fort Worth

Heating, New Construction/Replace-on-Burnout

Table 467. Central Winter Demand Savings for 8.2 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.06							
15,000-20,999	0.68	0.08						
21,000-26,999	1.30	0.70	0.11					
27,000-32,999	1.92	1.33	0.73	0.14				
33,000-38,999	2.54	1.95	1.35	0.76	0.17			
39,000-44,999	3.16	2.57	1.97	1.38	0.79	0.19		
45,000-53,999	3.78	3.19	2.60	2.00	1.41	0.82	0.22	
54,000-64,999	5.03	4.43	3.84	3.24	2.65	2.06	1.46	0.28

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.74	0.18						
21,000-26,999	1.36	0.80	0.24					
27,000-32,999	1.98	1.42	0.86	0.30				
33,000-38,999	2.60	2.04	1.48	0.92	0.35			
39,000-44,999	3.22	2.66	2.10	1.54	0.98	0.41		
45,000-53,999	3.85	3.28	2.72	2.16	1.60	1.04	0.47	
54,000-64,999	5.09	4.53	3.96	3.40	2.84	2.28	1.72	0.59

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.77	0.23						
21,000-26,999	1.39	0.85	0.30					
27,000-32,999	2.01	1.47	0.92	0.38				
33,000-38,999	2.64	2.09	1.54	1.00	0.45			
39,000-44,999	3.26	2.71	2.17	1.62	1.07	0.53		
45,000-53,999	3.88	3.33	2.79	2.24	1.70	1.15	0.60	
54,000-64,999	5.12	4.57	4.03	3.48	2.94	2.39	1.85	0.75

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.78	0.24						
21,000-26,999	1.41	0.87	0.33					
27,000-32,999	2.03	1.49	0.95	0.41				
33,000-38,999	2.65	2.11	1.57	1.03	0.49			
39,000-44,999	3.27	2.73	2.19	1.65	1.11	0.57		
45,000-53,999	3.89	3.35	2.81	2.27	1.73	1.19	0.65	
54,000-64,999	5.13	4.59	4.05	3.51	2.97	2.44	1.90	0.82

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.80	0.26						
21,000-26,999	1.42	0.88	0.35					
27,000-32,999	2.04	1.51	0.97	0.44				
33,000-38,999	2.66	2.13	1.59	1.06	0.53			
39,000-44,999	3.28	2.75	2.21	1.68	1.15	0.61		
45,000-53,999	3.90	3.37	2.84	2.30	1.77	1.23	0.70	
54,000-64,999	5.14	4.61	4.08	3.54	3.01	2.48	1.94	0.88
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.19							
15,000-20,999	0.81	0.28						
21,000-26,999	1.43	0.90	0.37					
27,000-32,999	2.05	1.52	0.99	0.47				
33,000-38,999	2.67	2.14	1.62	1.09	0.56			
39,000-44,999	3.29	2.76	2.24	1.71	1.18	0.65		
45,000-53,999	3.91	3.39	2.86	2.33	1.80	1.27	0.75	
54,000-64,999	5.16	4.63	4.10	3.57	3.04	2.52	1.99	0.93
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.82	0.30						
21,000-26,999	1.44	0.92	0.39					
27,000-32,999	2.06	1.54	1.02	0.49				
33,000-38,999	2.68	2.16	1.64	1.11	0.59			
39,000-44,999	3.30	2.78	2.26	1.74	1.21	0.69		
45,000-53,999	3.92	3.40	2.88	2.36	1.83	1.31	0.79	
54,000-64,999	5.17	4.64	4.12	3.60	3.08	2.55	2.03	0.99

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.83	0.31						
21,000-26,999	1.45	0.93	0.41					
27,000-32,999	2.07	1.55	1.03	0.51				
33,000-38,999	2.69	2.17	1.65	1.13	0.61			
39,000-44,999	3.31	2.79	2.27	1.75	1.23	0.71		
45,000-53,999	3.93	3.41	2.89	2.37	1.85	1.33	0.82	
54,000-64,999	5.17	4.65	4.14	3.62	3.10	2.58	2.06	1.02

Heating, Early Retirement of a Heat Pump

Table 468. Central Winter Demand Savings for 7.7 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.79	0.20						
21,000-26,999	1.45	0.86	0.27					
27,000-32,999	2.12	1.52	0.93	0.33				
33,000-38,999	2.78	2.18	1.59	1.00	0.40			
39,000-44,999	3.44	2.84	2.25	1.66	1.06	0.47		
45,000-53,999	4.10	3.50	2.91	2.32	1.72	1.13	0.54	
54,000-64,999	5.42	4.82	4.23	3.64	3.04	2.45	1.86	0.67

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.86	0.30						
21,000-26,999	1.52	0.96	0.39					
27,000-32,999	2.18	1.62	1.05	0.49				
33,000-38,999	2.84	2.28	1.71	1.15	0.59			
39,000-44,999	3.50	2.94	2.37	1.81	1.25	0.69		
45,000-53,999	4.16	3.60	3.04	2.47	1.91	1.35	0.79	
54,000-64,999	5.48	4.92	4.36	3.79	3.23	2.67	2.11	0.98
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.89	0.34						
21,000-26,999	1.55	1.00	0.46					
27,000-32,999	2.21	1.67	1.12	0.57				
33,000-38,999	2.87	2.33	1.78	1.23	0.69			
39,000-44,999	3.53	2.99	2.44	1.89	1.35	0.80		
45,000-53,999	4.19	3.65	3.10	2.56	2.01	1.46	0.92	
54,000-64,999	5.51	4.97	4.42	3.88	3.33	2.78	2.24	1.15
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.90	0.36						
21,000-26,999	1.56	1.02	0.48					
27,000-32,999	2.22	1.68	1.14	0.60				
33,000-38,999	2.88	2.34	1.80	1.26	0.73			
39,000-44,999	3.54	3.00	2.46	1.93	1.39	0.85		
45,000-53,999	4.20	3.66	3.13	2.59	2.05	1.51	0.97	
54,000-64,999	5.53	4.99	4.45	3.91	3.37	2.83	2.29	1.21

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.91	0.38						
21,000-26,999	1.57	1.04	0.51					
27,000-32,999	2.23	1.70	1.17	0.63				
33,000-38,999	2.90	2.36	1.83	1.29	0.76			
39,000-44,999	3.56	3.02	2.49	1.95	1.42	0.89		
45,000-53,999	4.22	3.68	3.15	2.62	2.08	1.55	1.01	
54,000-64,999	5.54	5.00	4.47	3.94	3.40	2.87	2.34	1.27

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.93	0.40						
21,000-26,999	1.59	1.06	0.53					
27,000-32,999	2.25	1.72	1.19	0.66				
33,000-38,999	2.91	2.38	1.85	1.32	0.79			
39,000-44,999	3.57	3.04	2.51	1.98	1.46	0.93		
45,000-53,999	4.23	3.70	3.17	2.64	2.12	1.59	1.06	
54,000-64,999	5.55	5.02	4.49	3.96	3.44	2.91	2.38	1.32

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.94	0.41						
21,000-26,999	1.60	1.07	0.55					
27,000-32,999	2.26	1.73	1.21	0.69				
33,000-38,999	2.92	2.40	1.87	1.35	0.83			
39,000-44,999	3.58	3.06	2.53	2.01	1.49	0.97		
45,000-53,999	4.24	3.72	3.19	2.67	2.15	1.63	1.10	
54,000-64,999	5.56	5.04	4.51	3.99	3.47	2.95	2.42	1.38

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.94	0.42						
21,000-26,999	1.60	1.08	0.56					
27,000-32,999	2.26	1.74	1.23	0.71				
33,000-38,999	2.92	2.40	1.89	1.37	0.85			
39,000-44,999	3.58	3.07	2.55	2.03	1.51	0.99		
45,000-53,999	4.25	3.73	3.21	2.69	2.17	1.65	1.13	
54,000-64,999	5.57	5.05	4.53	4.01	3.49	2.97	2.45	1.41

Table 469. Central Winter Demand Savings for 6.8 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.32							
15,000-20,999	1.08	0.48						
21,000-26,999	1.83	1.24	0.64					
27,000-32,999	2.59	1.99	1.40	0.81				
33,000-38,999	3.34	2.75	2.15	1.56	0.97			
39,000-44,999	4.10	3.50	2.91	2.32	1.72	1.13		
45,000-53,999	4.85	4.26	3.66	3.07	2.48	1.88	1.29	
54,000-64,999	6.36	5.77	5.17	4.58	3.99	3.39	2.80	1.61

9.0-9.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	1.14	0.58						
21,000-26,999	1.89	1.33	0.77					
27,000-32,999	2.65	2.09	1.53	0.96				
33,000-38,999	3.40	2.84	2.28	1.72	1.16			
39,000-44,999	4.16	3.60	3.03	2.47	1.91	1.35		
45,000-53,999	4.91	4.35	3.79	3.23	2.67	2.10	1.54	
54,000-64,999	6.42	5.86	5.30	4.74	4.17	3.61	3.05	1.93
9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.42							
15,000-20,999	1.17	0.63						
21,000-26,999	1.93	1.38	0.84					
27,000-32,999	2.68	2.14	1.59	1.04				
33,000-38,999	3.44	2.89	2.35	1.80	1.25			
39,000-44,999	4.19	3.65	3.10	2.55	2.01	1.46		
45,000-53,999	4.95	4.40	3.85	3.31	2.76	2.22	1.67	
54,000-64,999	6.46	5.91	5.36	4.82	4.27	3.73	3.18	2.09
10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.43							
15,000-20,999	1.18	0.65						
21,000-26,999	1.94	1.40	0.86					
27,000-32,999	2.69	2.15	1.62	1.08				
33,000-38,999	3.45	2.91	2.37	1.83	1.29			
39,000-44,999	4.20	3.66	3.12	2.59	2.05	1.51		
45,000-53,999	4.96	4.42	3.88	3.34	2.80	2.26	1.72	
54,000-64,999	6.47	5.93	5.39	4.85	4.31	3.77	3.23	2.15

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.44							
15,000-20,999	1.20	0.66						
21,000-26,999	1.95	1.42	0.88					
27,000-32,999	2.71	2.17	1.64	1.11				
33,000-38,999	3.46	2.93	2.39	1.86	1.33			
39,000-44,999	4.22	3.68	3.15	2.61	2.08	1.55		
45,000-53,999	4.97	4.44	3.90	3.37	2.84	2.30	1.77	
54,000-64,999	6.48	5.95	5.41	4.88	4.35	3.81	3.28	2.21

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.45							
15,000-20,999	1.21	0.68						
21,000-26,999	1.96	1.43	0.91					
27,000-32,999	2.72	2.19	1.66	1.13				
33,000-38,999	3.47	2.94	2.42	1.89	1.36			
39,000-44,999	4.23	3.70	3.17	2.64	2.12	1.59		
45,000-53,999	4.98	4.45	3.93	3.40	2.87	2.34	1.81	
54,000-64,999	6.49	5.96	5.44	4.91	4.38	3.85	3.32	2.27

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.46							
15,000-20,999	1.22	0.70						
21,000-26,999	1.97	1.45	0.93					
27,000-32,999	2.73	2.21	1.68	1.16				
33,000-38,999	3.48	2.96	2.44	1.92	1.39			
39,000-44,999	4.24	3.72	3.19	2.67	2.15	1.63		
45,000-53,999	4.99	4.47	3.95	3.43	2.90	2.38	1.86	
54,000-64,999	6.50	5.98	5.46	4.93	4.41	3.89	3.37	2.32

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.47							
15,000-20,999	1.23	0.71						
21,000-26,999	1.98	1.46	0.94					
27,000-32,999	2.74	2.22	1.70	1.18				
33,000-38,999	3.49	2.97	2.45	1.93	1.41			
39,000-44,999	4.24	3.73	3.21	2.69	2.17	1.65		
45,000-53,999	5.00	4.48	3.96	3.44	2.92	2.40	1.88	
54,000-64,999	6.51	5.99	5.47	4.95	4.43	3.91	3.39	2.35

Heating, Early Retirement of an Electric Resistance Furnace

Table 470. Central Winter Demand Savings for 3.412 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.55							
15,000-20,999	2.92	2.33						
21,000-26,999	4.30	3.70	3.11					
27,000-32,999	5.67	5.07	4.48	3.89				
33,000-38,999	7.04	6.44	5.85	5.26	4.66			
39,000-44,999	8.41	7.81	7.22	6.63	6.03	5.44		
45,000-53,999	9.78	9.18	8.59	8.00	7.40	6.81	6.22	
54,000-64,999	12.52	11.93	11.33	10.74	10.15	9.55	8.96	7.77

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.62							
15,000-20,999	2.99	2.43						
21,000-26,999	4.36	3.80	3.23					
27,000-32,999	5.73	5.17	4.60	4.04				
33,000-38,999	7.10	6.54	5.98	5.41	4.85			
39,000-44,999	8.47	7.91	7.35	6.78	6.22	5.66		
45,000-53,999	9.84	9.28	8.72	8.15	7.59	7.03	6.47	
54,000-64,999	12.58	12.02	11.46	10.90	10.33	9.77	9.21	8.09

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.65							
15,000-20,999	3.02	2.47						
21,000-26,999	4.39	3.85	3.30					
27,000-32,999	5.76	5.22	4.67	4.12				
33,000-38,999	7.13	6.59	6.04	5.50	4.95			
39,000-44,999	8.50	7.96	7.41	6.87	6.32	5.77		
45,000-53,999	9.87	9.33	8.78	8.24	7.69	7.14	6.60	
54,000-64,999	12.61	12.07	11.52	10.98	10.43	9.89	9.34	8.25

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.66							
15,000-20,999	3.03	2.49						
21,000-26,999	4.40	3.86	3.32					
27,000-32,999	5.77	5.23	4.69	4.16				
33,000-38,999	7.14	6.60	6.07	5.53	4.99			
39,000-44,999	8.52	7.98	7.44	6.90	6.36	5.82		
45,000-53,999	9.89	9.35	8.81	8.27	7.73	7.19	6.65	
54,000-64,999	12.63	12.09	11.55	11.01	10.47	9.93	9.39	8.31

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.67							
15,000-20,999	3.04	2.51						
21,000-26,999	4.42	3.88	3.35					
27,000-32,999	5.79	5.25	4.72	4.18				
33,000-38,999	7.16	6.62	6.09	5.56	5.02			
39,000-44,999	8.53	7.99	7.46	6.93	6.39	5.86		
45,000-53,999	9.90	9.36	8.83	8.30	7.76	7.23	6.70	
54,000-64,999	12.64	12.11	11.57	11.04	10.50	9.97	9.44	8.37
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.69							
15,000-20,999	3.06	2.53						
21,000-26,999	4.43	3.90	3.37					
27,000-32,999	5.80	5.27	4.74	4.21				
33,000-38,999	7.17	6.64	6.11	5.58	5.06			
39,000-44,999	8.54	8.01	7.48	6.95	6.43	5.90		
45,000-53,999	9.91	9.38	8.85	8.33	7.80	7.27	6.74	
54,000-64,999	12.65	12.12	11.59	11.07	10.54	10.01	9.48	8.43
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.70							
15,000-20,999	3.07	2.54						
21,000-26,999	4.44	3.92	3.39					
27,000-32,999	5.81	5.29	4.76	4.24				
33,000-38,999	7.18	6.66	6.13	5.61	5.09			
39,000-44,999	8.55	8.03	7.50	6.98	6.46	5.94		
45,000-53,999	9.92	9.40	8.88	8.35	7.83	7.31	6.79	
54,000-64,999	12.66	12.14	11.62	11.09	10.57	10.05	9.53	8.48

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.70							
15,000-20,999	3.07	2.55						
21,000-26,999	4.44	3.92	3.41					
27,000-32,999	5.81	5.30	4.78	4.26				
33,000-38,999	7.19	6.67	6.15	5.63	5.11			
39,000-44,999	8.56	8.04	7.52	7.00	6.48	5.96		
45,000-53,999	9.93	9.41	8.89	8.37	7.85	7.33	6.81	
54,000-64,999	12.67	12.15	11.63	11.11	10.59	10.07	9.55	8.51

Climate Zone 3: South Region, Houston

Heating, New Construction/Replace-on-Burnout

Table 471. Central Winter Demand Savings for 8.2 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.05							
15,000-20,999	0.40	0.07						
21,000-26,999	0.76	0.43	0.10					
27,000-32,999	1.11	0.78	0.45	0.12				
33,000-38,999	1.47	1.14	0.81	0.48	0.15			
39,000-44,999	1.82	1.49	1.16	0.83	0.50	0.17		
45,000-53,999	2.17	1.84	1.51	1.19	0.86	0.53	0.20	
54,000-64,999	2.88	2.55	2.22	1.89	1.56	1.23	0.90	0.25

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.46	0.16						
21,000-26,999	0.81	0.51	0.21					
27,000-32,999	1.17	0.87	0.56	0.26				
33,000-38,999	1.52	1.22	0.92	0.62	0.32			
39,000-44,999	1.88	1.57	1.27	0.97	0.67	0.37		
45,000-53,999	2.23	1.93	1.63	1.32	1.02	0.72	0.42	
54,000-64,999	2.94	2.64	2.33	2.03	1.73	1.43	1.13	0.53
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.49	0.20						
21,000-26,999	0.84	0.56	0.27					
27,000-32,999	1.20	0.91	0.62	0.34				
33,000-38,999	1.55	1.26	0.98	0.69	0.40			
39,000-44,999	1.90	1.62	1.33	1.04	0.76	0.47		
45,000-53,999	2.26	1.97	1.68	1.40	1.11	0.82	0.54	
54,000-64,999	2.97	2.68	2.39	2.11	1.82	1.53	1.24	0.67
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.50	0.22						
21,000-26,999	0.85	0.57	0.29					
27,000-32,999	1.21	0.93	0.64	0.36				
33,000-38,999	1.56	1.28	1.00	0.72	0.43			
39,000-44,999	1.92	1.63	1.35	1.07	0.79	0.51		
45,000-53,999	2.27	1.99	1.71	1.42	1.14	0.86	0.58	
54,000-64,999	2.98	2.70	2.41	2.13	1.85	1.57	1.29	0.72

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.51	0.23						
21,000-26,999	0.86	0.59	0.31					
27,000-32,999	1.22	0.94	0.66	0.39				
33,000-38,999	1.57	1.30	1.02	0.74	0.47			
39,000-44,999	1.93	1.65	1.37	1.10	0.82	0.54		
45,000-53,999	2.28	2.00	1.73	1.45	1.17	0.90	0.62	
54,000-64,999	2.99	2.71	2.44	2.16	1.88	1.61	1.33	0.78

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.52	0.25						
21,000-26,999	0.87	0.60	0.33					
27,000-32,999	1.23	0.96	0.69	0.41				
33,000-38,999	1.58	1.31	1.04	0.77	0.50			
39,000-44,999	1.94	1.66	1.39	1.12	0.85	0.58		
45,000-53,999	2.29	2.02	1.75	1.48	1.20	0.93	0.66	
54,000-64,999	3.00	2.73	2.46	2.18	1.91	1.64	1.37	0.83

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.53	0.26						
21,000-26,999	0.88	0.62	0.35					
27,000-32,999	1.24	0.97	0.70	0.44				
33,000-38,999	1.59	1.33	1.06	0.79	0.53			
39,000-44,999	1.95	1.68	1.41	1.15	0.88	0.61		
45,000-53,999	2.30	2.03	1.77	1.50	1.23	0.97	0.70	
54,000-64,999	3.01	2.74	2.47	2.21	1.94	1.68	1.41	0.88

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.53	0.27						
21,000-26,999	0.89	0.63	0.36					
27,000-32,999	1.24	0.98	0.72	0.45				
33,000-38,999	1.60	1.33	1.07	0.81	0.54			
39,000-44,999	1.95	1.69	1.42	1.16	0.90	0.63		
45,000-53,999	2.31	2.04	1.78	1.51	1.25	0.99	0.72	
54,000-64,999	3.01	2.75	2.49	2.22	1.96	1.70	1.43	0.90

Heating, Early Retirement of a Heat Pump

Table 472. Central Winter Demand Savings for 7.7 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.51	0.18						
21,000-26,999	0.90	0.57	0.24					
27,000-32,999	1.29	0.96	0.63	0.30				
33,000-38,999	1.67	1.34	1.02	0.69	0.36			
39,000-44,999	2.06	1.73	1.40	1.07	0.75	0.42		
45,000-53,999	2.45	2.12	1.79	1.46	1.13	0.80	0.48	
54,000-64,999	3.23	2.90	2.57	2.24	1.91	1.58	1.25	0.59

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.56	0.26						
21,000-26,999	0.95	0.65	0.35					
27,000-32,999	1.34	1.04	0.74	0.44				
33,000-38,999	1.73	1.43	1.13	0.83	0.52			
39,000-44,999	2.12	1.82	1.52	1.21	0.91	0.61		
45,000-53,999	2.51	2.21	1.90	1.60	1.30	1.00	0.70	
54,000-64,999	3.29	2.98	2.68	2.38	2.08	1.78	1.48	0.87

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.59	0.31						
21,000-26,999	0.98	0.69	0.41					
27,000-32,999	1.37	1.08	0.80	0.51				
33,000-38,999	1.76	1.47	1.19	0.90	0.61			
39,000-44,999	2.15	1.86	1.57	1.29	1.00	0.71		
45,000-53,999	2.54	2.25	1.96	1.68	1.39	1.10	0.81	
54,000-64,999	3.31	3.03	2.74	2.45	2.17	1.88	1.59	1.02

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.60	0.32						
21,000-26,999	0.99	0.71	0.43					
27,000-32,999	1.38	1.10	0.82	0.54				
33,000-38,999	1.77	1.49	1.21	0.93	0.64			
39,000-44,999	2.16	1.88	1.60	1.31	1.03	0.75		
45,000-53,999	2.55	2.27	1.98	1.70	1.42	1.14	0.86	
54,000-64,999	3.33	3.04	2.76	2.48	2.20	1.92	1.64	1.07

10.5-10.9 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.61	0.34						
21,000-26,999	1.00	0.73	0.45					
27,000-32,999	1.39	1.12	0.84	0.56				
33,000-38,999	1.78	1.50	1.23	0.95	0.68			
39,000-44,999	2.17	1.89	1.62	1.34	1.06	0.79		
45,000-53,999	2.56	2.28	2.01	1.73	1.45	1.18	0.90	
54,000-64,999	3.34	3.06	2.78	2.51	2.23	1.95	1.68	1.13

11.0-11.4 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.62	0.35						
21,000-26,999	1.01	0.74	0.47					
27,000-32,999	1.40	1.13	0.86	0.59				
33,000-38,999	1.79	1.52	1.25	0.98	0.71			
39,000-44,999	2.18	1.91	1.64	1.37	1.09	0.82		
45,000-53,999	2.57	2.30	2.03	1.75	1.48	1.21	0.94	
54,000-64,999	3.35	3.07	2.80	2.53	2.26	1.99	1.72	1.18

11.5-11.9 HSPF

Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.63	0.37						
21,000-26,999	1.02	0.76	0.49					
27,000-32,999	1.41	1.15	0.88	0.61				
33,000-38,999	1.80	1.53	1.27	1.00	0.73			
39,000-44,999	2.19	1.92	1.66	1.39	1.12	0.86		
45,000-53,999	2.58	2.31	2.05	1.78	1.51	1.25	0.98	
54,000-64,999	3.36	3.09	2.82	2.56	2.29	2.02	1.76	1.22

12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.64	0.38						
21,000-26,999	1.03	0.76	0.50					
27,000-32,999	1.42	1.15	0.89	0.63				
33,000-38,999	1.81	1.54	1.28	1.02	0.75			
39,000-44,999	2.19	1.93	1.67	1.40	1.14	0.88		
45,000-53,999	2.58	2.32	2.06	1.79	1.53	1.27	1.00	
54,000-64,999	3.36	3.10	2.83	2.57	2.31	2.04	1.78	1.25

Table 473. Central Winter Demand Savings for 6.8 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.76	0.43						
21,000-26,999	1.23	0.90	0.57					
27,000-32,999	1.70	1.37	1.04	0.72				
33,000-38,999	2.18	1.85	1.52	1.19	0.86			
39,000-44,999	2.65	2.32	1.99	1.66	1.33	1.00		
45,000-53,999	3.12	2.79	2.46	2.13	1.80	1.47	1.14	
54,000-64,999	4.07	3.74	3.41	3.08	2.75	2.42	2.09	1.43

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.34							
15,000-20,999	0.81	0.51						
21,000-26,999	1.29	0.99	0.68					
27,000-32,999	1.76	1.46	1.16	0.85				
33,000-38,999	2.23	1.93	1.63	1.33	1.03			
39,000-44,999	2.70	2.40	2.10	1.80	1.50	1.20		
45,000-53,999	3.18	2.88	2.57	2.27	1.97	1.67	1.37	
54,000-64,999	4.12	3.82	3.52	3.22	2.92	2.61	2.31	1.71
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.37							
15,000-20,999	0.84	0.56						
21,000-26,999	1.32	1.03	0.74					
27,000-32,999	1.79	1.50	1.21	0.93				
33,000-38,999	2.26	1.97	1.69	1.40	1.11			
39,000-44,999	2.73	2.45	2.16	1.87	1.59	1.30		
45,000-53,999	3.21	2.92	2.63	2.34	2.06	1.77	1.48	
54,000-64,999	4.15	3.86	3.58	3.29	3.00	2.72	2.43	1.85
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.38							
15,000-20,999	0.85	0.57						
21,000-26,999	1.33	1.05	0.76					
27,000-32,999	1.80	1.52	1.24	0.95				
33,000-38,999	2.27	1.99	1.71	1.43	1.15			
39,000-44,999	2.74	2.46	2.18	1.90	1.62	1.34		
45,000-53,999	3.22	2.94	2.65	2.37	2.09	1.81	1.53	
54,000-64,999	4.16	3.88	3.60	3.32	3.04	2.75	2.47	1.91

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.86	0.59						
21,000-26,999	1.34	1.06	0.78					
27,000-32,999	1.81	1.53	1.26	0.98				
33,000-38,999	2.28	2.01	1.73	1.45	1.18			
39,000-44,999	2.75	2.48	2.20	1.93	1.65	1.37		
45,000-53,999	3.23	2.95	2.67	2.40	2.12	1.85	1.57	
54,000-64,999	4.17	3.90	3.62	3.34	3.07	2.79	2.51	1.96
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.40							
15,000-20,999	0.87	0.60						
21,000-26,999	1.35	1.08	0.80					
27,000-32,999	1.82	1.55	1.28	1.01				
33,000-38,999	2.29	2.02	1.75	1.48	1.21			
39,000-44,999	2.77	2.49	2.22	1.95	1.68	1.41		
45,000-53,999	3.24	2.97	2.70	2.42	2.15	1.88	1.61	
54,000-64,999	4.18	3.91	3.64	3.37	3.10	2.83	2.55	2.01
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.41							
15,000-20,999	0.88	0.62						
21,000-26,999	1.36	1.09	0.82					
27,000-32,999	1.83	1.56	1.30	1.03				
33,000-38,999	2.30	2.04	1.77	1.50	1.24			
39,000-44,999	2.77	2.51	2.24	1.98	1.71	1.44		
45,000-53,999	3.25	2.98	2.71	2.45	2.18	1.92	1.65	
54,000-64,999	4.19	3.93	3.66	3.39	3.13	2.86	2.59	2.06

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.42							
15,000-20,999	0.89	0.63						
21,000-26,999	1.36	1.10	0.84					
27,000-32,999	1.84	1.57	1.31	1.04				
33,000-38,999	2.31	2.04	1.78	1.52	1.25			
39,000-44,999	2.78	2.52	2.25	1.99	1.73	1.46		
45,000-53,999	3.25	2.99	2.73	2.46	2.20	1.94	1.67	
54,000-64,999	4.20	3.93	3.67	3.41	3.14	2.88	2.62	2.09

Heating, Early Retirement of an Electric Resistance Furnace

Table 474. Central Winter Demand Savings for 3.412 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.51							
15,000-20,999	2.60	2.27						
21,000-26,999	3.68	3.35	3.02					
27,000-32,999	4.77	4.44	4.11	3.78				
33,000-38,999	5.85	5.52	5.19	4.86	4.53			
39,000-44,999	6.94	6.61	6.28	5.95	5.62	5.29		
45,000-53,999	8.02	7.69	7.36	7.03	6.70	6.37	6.05	
54,000-64,999	10.19	9.86	9.53	9.20	8.87	8.54	8.22	7.56

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.57							
15,000-20,999	2.65	2.35						
21,000-26,999	3.74	3.44	3.13					
27,000-32,999	4.82	4.52	4.22	3.92				
33,000-38,999	5.91	5.61	5.30	5.00	4.70			
39,000-44,999	6.99	6.69	6.39	6.09	5.79	5.48		
45,000-53,999	8.08	7.78	7.47	7.17	6.87	6.57	6.27	
54,000-64,999	10.25	9.95	9.64	9.34	9.04	8.74	8.44	7.84

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.60							
15,000-20,999	2.68	2.39						
21,000-26,999	3.77	3.48	3.19					
27,000-32,999	4.85	4.56	4.28	3.99				
33,000-38,999	5.94	5.65	5.36	5.08	4.79			
39,000-44,999	7.02	6.73	6.45	6.16	5.87	5.59		
45,000-53,999	8.11	7.82	7.53	7.25	6.96	6.67	6.38	
54,000-64,999	10.28	9.99	9.70	9.42	9.13	8.84	8.55	7.98

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.61							
15,000-20,999	2.69	2.41						
21,000-26,999	3.78	3.50	3.21					
27,000-32,999	4.86	4.58	4.30	4.02				
33,000-38,999	5.95	5.67	5.38	5.10	4.82			
39,000-44,999	7.03	6.75	6.47	6.19	5.91	5.62		
45,000-53,999	8.12	7.84	7.55	7.27	6.99	6.71	6.43	
54,000-64,999	10.29	10.01	9.72	9.44	9.16	8.88	8.60	8.03

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.62							
15,000-20,999	2.70	2.43						
21,000-26,999	3.79	3.51	3.23					
27,000-32,999	4.87	4.60	4.32	4.04				
33,000-38,999	5.96	5.68	5.41	5.13	4.85			
39,000-44,999	7.04	6.77	6.49	6.21	5.94	5.66		
45,000-53,999	8.13	7.85	7.58	7.30	7.02	6.75	6.47	
54,000-64,999	10.30	10.02	9.75	9.47	9.19	8.92	8.64	8.09
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.63							
15,000-20,999	2.71	2.44						
21,000-26,999	3.80	3.53	3.26					
27,000-32,999	4.88	4.61	4.34	4.07				
33,000-38,999	5.97	5.70	5.43	5.15	4.88			
39,000-44,999	7.05	6.78	6.51	6.24	5.97	5.70		
45,000-53,999	8.14	7.87	7.60	7.32	7.05	6.78	6.51	
54,000-64,999	10.31	10.04	9.77	9.49	9.22	8.95	8.68	8.14
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.64							
15,000-20,999	2.72	2.46						
21,000-26,999	3.81	3.54	3.27					
27,000-32,999	4.89	4.63	4.36	4.09				
33,000-38,999	5.98	5.71	5.44	5.18	4.91			
39,000-44,999	7.06	6.80	6.53	6.26	6.00	5.73		
45,000-53,999	8.15	7.88	7.62	7.35	7.08	6.82	6.55	
54,000-64,999	10.32	10.05	9.79	9.52	9.25	8.99	8.72	8.19

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.64							
15,000-20,999	2.73	2.46						
21,000-26,999	3.81	3.55	3.29					
27,000-32,999	4.90	4.63	4.37	4.11				
33,000-38,999	5.98	5.72	5.46	5.19	4.93			
39,000-44,999	7.07	6.80	6.54	6.28	6.01	5.75		
45,000-53,999	8.15	7.89	7.63	7.36	7.10	6.84	6.57	
54,000-64,999	10.32	10.06	9.80	9.53	9.27	9.01	8.74	8.22

Climate Zone 4: Valley Region, Corpus Christi

Heating, New Construction/Replace-on-Burnout

Table 475. Central Winter Demand Savings for 8.2 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.04							
15,000-20,999	0.30	0.06						
21,000-26,999	0.57	0.32	0.07					
27,000-32,999	0.84	0.59	0.34	0.09				
33,000-38,999	1.10	0.85	0.61	0.36	0.11			
39,000-44,999	1.37	1.12	0.87	0.62	0.38	0.13		
45,000-53,999	1.63	1.39	1.14	0.89	0.64	0.40	0.15	
54,000-64,999	2.17	1.92	1.67	1.42	1.18	0.93	0.68	0.18

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.08							
15,000-20,999	0.35	0.12						
21,000-26,999	0.61	0.38	0.16					
27,000-32,999	0.88	0.65	0.42	0.20				
33,000-38,999	1.14	0.92	0.69	0.46	0.24			
39,000-44,999	1.41	1.18	0.96	0.73	0.50	0.28		
45,000-53,999	1.68	1.45	1.22	1.00	0.77	0.54	0.32	
54,000-64,999	2.21	1.98	1.75	1.53	1.30	1.07	0.85	0.39

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.10							
15,000-20,999	0.37	0.15						
21,000-26,999	0.63	0.42	0.20					
27,000-32,999	0.90	0.68	0.47	0.25				
33,000-38,999	1.17	0.95	0.73	0.52	0.30			
39,000-44,999	1.43	1.22	1.00	0.78	0.57	0.35		
45,000-53,999	1.70	1.48	1.27	1.05	0.83	0.62	0.40	
54,000-64,999	2.23	2.01	1.80	1.58	1.37	1.15	0.94	0.50

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.38	0.16						
21,000-26,999	0.64	0.43	0.22					
27,000-32,999	0.91	0.70	0.48	0.27				
33,000-38,999	1.17	0.96	0.75	0.54	0.33			
39,000-44,999	1.44	1.23	1.02	0.80	0.59	0.38		
45,000-53,999	1.71	1.49	1.28	1.07	0.86	0.65	0.44	
54,000-64,999	2.24	2.03	1.81	1.60	1.39	1.18	0.97	0.54

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.38	0.18						
21,000-26,999	0.65	0.44	0.23					
27,000-32,999	0.92	0.71	0.50	0.29				
33,000-38,999	1.18	0.97	0.77	0.56	0.35			
39,000-44,999	1.45	1.24	1.03	0.82	0.62	0.41		
45,000-53,999	1.71	1.51	1.30	1.09	0.88	0.67	0.47	
54,000-64,999	2.25	2.04	1.83	1.62	1.41	1.21	1.00	0.58

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.39	0.19						
21,000-26,999	0.66	0.45	0.25					
27,000-32,999	0.92	0.72	0.51	0.31				
33,000-38,999	1.19	0.98	0.78	0.58	0.37			
39,000-44,999	1.45	1.25	1.05	0.84	0.64	0.44		
45,000-53,999	1.72	1.52	1.31	1.11	0.91	0.70	0.50	
54,000-64,999	2.25	2.05	1.85	1.64	1.44	1.23	1.03	0.62

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.40	0.20						
21,000-26,999	0.66	0.46	0.26					
27,000-32,999	0.93	0.73	0.53	0.33				
33,000-38,999	1.20	1.00	0.80	0.60	0.40			
39,000-44,999	1.46	1.26	1.06	0.86	0.66	0.46		
45,000-53,999	1.73	1.53	1.33	1.13	0.93	0.73	0.53	
54,000-64,999	2.26	2.06	1.86	1.66	1.46	1.26	1.06	0.66

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.40	0.20						
21,000-26,999	0.67	0.47	0.27					
27,000-32,999	0.93	0.74	0.54	0.34				
33,000-38,999	1.20	1.00	0.80	0.61	0.41			
39,000-44,999	1.47	1.27	1.07	0.87	0.67	0.48		
45,000-53,999	1.73	1.53	1.34	1.14	0.94	0.74	0.54	
54,000-64,999	2.26	2.07	1.87	1.67	1.47	1.27	1.08	0.68

Heating, Early Retirement of a Heat Pump

Table 476. Central Winter Demand Savings for 7.7 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.38	0.13						
21,000-26,999	0.67	0.43	0.18					
27,000-32,999	0.97	0.72	0.47	0.22				
33,000-38,999	1.26	1.01	0.76	0.52	0.27			
39,000-44,999	1.55	1.30	1.06	0.81	0.56	0.31		
45,000-53,999	1.84	1.60	1.35	1.10	0.85	0.60	0.36	
54,000-64,999	2.43	2.18	1.93	1.68	1.44	1.19	0.94	0.45

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.42	0.20						
21,000-26,999	0.72	0.49	0.26					
27,000-32,999	1.01	0.78	0.55	0.33				
33,000-38,999	1.30	1.07	0.85	0.62	0.39			
39,000-44,999	1.59	1.37	1.14	0.91	0.69	0.46		
45,000-53,999	1.89	1.66	1.43	1.21	0.98	0.75	0.53	
54,000-64,999	2.47	2.24	2.02	1.79	1.56	1.34	1.11	0.66

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.45	0.23						
21,000-26,999	0.74	0.52	0.31					
27,000-32,999	1.03	0.81	0.60	0.38				
33,000-38,999	1.32	1.11	0.89	0.67	0.46			
39,000-44,999	1.61	1.40	1.18	0.97	0.75	0.54		
45,000-53,999	1.91	1.69	1.48	1.26	1.04	0.83	0.61	
54,000-64,999	2.49	2.28	2.06	1.84	1.63	1.41	1.20	0.77

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.45	0.24						
21,000-26,999	0.75	0.53	0.32					
27,000-32,999	1.04	0.83	0.61	0.40				
33,000-38,999	1.33	1.12	0.91	0.70	0.48			
39,000-44,999	1.62	1.41	1.20	0.99	0.78	0.56		
45,000-53,999	1.92	1.70	1.49	1.28	1.07	0.86	0.65	
54,000-64,999	2.50	2.29	2.08	1.86	1.65	1.44	1.23	0.81

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.46	0.25						
21,000-26,999	0.75	0.55	0.34					
27,000-32,999	1.05	0.84	0.63	0.42				
33,000-38,999	1.34	1.13	0.92	0.72	0.51			
39,000-44,999	1.63	1.42	1.22	1.01	0.80	0.59		
45,000-53,999	1.92	1.72	1.51	1.30	1.09	0.88	0.68	
54,000-64,999	2.51	2.30	2.09	1.88	1.68	1.47	1.26	0.85
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.47	0.27						
21,000-26,999	0.76	0.56	0.35					
27,000-32,999	1.05	0.85	0.65	0.44				
33,000-38,999	1.35	1.14	0.94	0.73	0.53			
39,000-44,999	1.64	1.43	1.23	1.03	0.82	0.62		
45,000-53,999	1.93	1.73	1.52	1.32	1.11	0.91	0.71	
54,000-64,999	2.52	2.31	2.11	1.90	1.70	1.50	1.29	0.88
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.48	0.28						
21,000-26,999	0.77	0.57	0.37					
27,000-32,999	1.06	0.86	0.66	0.46				
33,000-38,999	1.35	1.15	0.95	0.75	0.55			
39,000-44,999	1.65	1.45	1.25	1.04	0.84	0.64		
45,000-53,999	1.94	1.74	1.54	1.34	1.14	0.94	0.74	
54,000-64,999	2.52	2.32	2.12	1.92	1.72	1.52	1.32	0.92

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.19							
15,000-20,999	0.48	0.28						
21,000-26,999	0.77	0.57	0.38					
27,000-32,999	1.07	0.87	0.67	0.47				
33,000-38,999	1.36	1.16	0.96	0.76	0.57			
39,000-44,999	1.65	1.45	1.25	1.06	0.86	0.66		
45,000-53,999	1.94	1.74	1.55	1.35	1.15	0.95	0.75	
54,000-64,999	2.53	2.33	2.13	1.93	1.73	1.54	1.34	0.94

Table 477. Central Winter Demand Savings for 6.8 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.57	0.32						
21,000-26,999	0.93	0.68	0.43					
27,000-32,999	1.28	1.03	0.79	0.54				
33,000-38,999	1.64	1.39	1.14	0.89	0.65			
39,000-44,999	1.99	1.74	1.50	1.25	1.00	0.75		
45,000-53,999	2.35	2.10	1.85	1.60	1.36	1.11	0.86	
54,000-64,999	3.06	2.81	2.56	2.31	2.07	1.82	1.57	1.08

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.61	0.39						
21,000-26,999	0.97	0.74	0.51					
27,000-32,999	1.32	1.10	0.87	0.64				
33,000-38,999	1.68	1.45	1.22	1.00	0.77			
39,000-44,999	2.03	1.81	1.58	1.35	1.13	0.90		
45,000-53,999	2.39	2.16	1.93	1.71	1.48	1.25	1.03	
54,000-64,999	3.10	2.87	2.65	2.42	2.19	1.97	1.74	1.29

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.63	0.42						
21,000-26,999	0.99	0.77	0.56					
27,000-32,999	1.34	1.13	0.91	0.70				
33,000-38,999	1.70	1.48	1.27	1.05	0.84			
39,000-44,999	2.05	1.84	1.62	1.41	1.19	0.98		
45,000-53,999	2.41	2.19	1.98	1.76	1.55	1.33	1.12	
54,000-64,999	3.12	2.90	2.69	2.47	2.26	2.04	1.83	1.39

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.64	0.43						
21,000-26,999	1.00	0.79	0.57					
27,000-32,999	1.35	1.14	0.93	0.72				
33,000-38,999	1.71	1.50	1.28	1.07	0.86			
39,000-44,999	2.06	1.85	1.64	1.43	1.22	1.00		
45,000-53,999	2.42	2.21	1.99	1.78	1.57	1.36	1.15	
54,000-64,999	3.13	2.92	2.71	2.49	2.28	2.07	1.86	1.44

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.65	0.44						
21,000-26,999	1.01	0.80	0.59					
27,000-32,999	1.36	1.15	0.95	0.74				
33,000-38,999	1.72	1.51	1.30	1.09	0.88			
39,000-44,999	2.07	1.86	1.66	1.45	1.24	1.03		
45,000-53,999	2.43	2.22	2.01	1.80	1.60	1.39	1.18	
54,000-64,999	3.14	2.93	2.72	2.51	2.31	2.10	1.89	1.47
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.30							
15,000-20,999	0.66	0.45						
21,000-26,999	1.01	0.81	0.61					
27,000-32,999	1.37	1.16	0.96	0.76				
33,000-38,999	1.72	1.52	1.32	1.11	0.91			
39,000-44,999	2.08	1.87	1.67	1.47	1.26	1.06		
45,000-53,999	2.43	2.23	2.03	1.82	1.62	1.41	1.21	
54,000-64,999	3.14	2.94	2.74	2.53	2.33	2.12	1.92	1.51
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.67	0.46						
21,000-26,999	1.02	0.82	0.62					
27,000-32,999	1.38	1.18	0.97	0.77				
33,000-38,999	1.73	1.53	1.33	1.13	0.93			
39,000-44,999	2.09	1.89	1.69	1.48	1.28	1.08		
45,000-53,999	2.44	2.24	2.04	1.84	1.64	1.44	1.24	
54,000-64,999	3.15	2.95	2.75	2.55	2.35	2.15	1.95	1.55

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.67	0.47						
21,000-26,999	1.02	0.83	0.63					
27,000-32,999	1.38	1.18	0.98	0.79				
33,000-38,999	1.73	1.54	1.34	1.14	0.94			
39,000-44,999	2.09	1.89	1.69	1.50	1.30	1.10		
45,000-53,999	2.45	2.25	2.05	1.85	1.65	1.45	1.26	
54,000-64,999	3.16	2.96	2.76	2.56	2.36	2.16	1.97	1.57

Heating, Early Retirement of an Electric Resistance Furnace

Table 478. Central Winter Demand Savings for 3.412 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.16							
15,000-20,999	1.99	1.74						
21,000-26,999	2.82	2.57	2.32					
27,000-32,999	3.65	3.40	3.15	2.90				
33,000-38,999	4.47	4.23	3.98	3.73	3.48			
39,000-44,999	5.30	5.05	4.81	4.56	4.31	4.06		
45,000-53,999	6.13	5.88	5.63	5.39	5.14	4.89	4.64	
54,000-64,999	7.79	7.54	7.29	7.04	6.80	6.55	6.30	5.80

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.20							
15,000-20,999	2.03	1.80						
21,000-26,999	2.86	2.63	2.41					
27,000-32,999	3.69	3.46	3.23	3.01				
33,000-38,999	4.52	4.29	4.06	3.84	3.61			
39,000-44,999	5.34	5.12	4.89	4.66	4.44	4.21		
45,000-53,999	6.17	5.94	5.72	5.49	5.26	5.04	4.81	
54,000-64,999	7.83	7.60	7.37	7.15	6.92	6.69	6.47	6.01
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.22							
15,000-20,999	2.05	1.84						
21,000-26,999	2.88	2.67	2.45					
27,000-32,999	3.71	3.49	3.28	3.06				
33,000-38,999	4.54	4.32	4.11	3.89	3.67			
39,000-44,999	5.37	5.15	4.93	4.72	4.50	4.29		
45,000-53,999	6.19	5.98	5.76	5.55	5.33	5.11	4.90	
54,000-64,999	7.85	7.63	7.42	7.20	6.99	6.77	6.55	6.12
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.23							
15,000-20,999	2.06	1.85						
21,000-26,999	2.89	2.68	2.47					
27,000-32,999	3.72	3.51	3.29	3.08				
33,000-38,999	4.55	4.33	4.12	3.91	3.70			
39,000-44,999	5.37	5.16	4.95	4.74	4.53	4.32		
45,000-53,999	6.20	5.99	5.78	5.57	5.35	5.14	4.93	
54,000-64,999	7.86	7.65	7.43	7.22	7.01	6.80	6.59	6.16

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.24							
15,000-20,999	2.07	1.86						
21,000-26,999	2.90	2.69	2.48					
27,000-32,999	3.73	3.52	3.31	3.10				
33,000-38,999	4.55	4.35	4.14	3.93	3.72			
39,000-44,999	5.38	5.17	4.97	4.76	4.55	4.34		
45,000-53,999	6.21	6.00	5.79	5.59	5.38	5.17	4.96	
54,000-64,999	7.87	7.66	7.45	7.24	7.03	6.83	6.62	6.20
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.25							
15,000-20,999	2.08	1.87						
21,000-26,999	2.90	2.70	2.50					
27,000-32,999	3.73	3.53	3.32	3.12				
33,000-38,999	4.56	4.36	4.15	3.95	3.75			
39,000-44,999	5.39	5.18	4.98	4.78	4.57	4.37		
45,000-53,999	6.22	6.01	5.81	5.61	5.40	5.20	4.99	
54,000-64,999	7.87	7.67	7.47	7.26	7.06	6.85	6.65	6.24
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.26							
15,000-20,999	2.08	1.88						
21,000-26,999	2.91	2.71	2.51					
27,000-32,999	3.74	3.54	3.34	3.14				
33,000-38,999	4.57	4.37	4.17	3.97	3.77			
39,000-44,999	5.40	5.20	5.00	4.80	4.60	4.39		
45,000-53,999	6.22	6.02	5.82	5.62	5.42	5.22	5.02	
54,000-64,999	7.88	7.68	7.48	7.28	7.08	6.88	6.68	6.28

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.26							
15,000-20,999	2.09	1.89						
21,000-26,999	2.92	2.72	2.52					
27,000-32,999	3.74	3.55	3.35	3.15				
33,000-38,999	4.57	4.37	4.18	3.98	3.78			
39,000-44,999	5.40	5.20	5.00	4.81	4.61	4.41		
45,000-53,999	6.23	6.03	5.83	5.63	5.44	5.24	5.04	
54,000-64,999	7.88	7.69	7.49	7.29	7.09	6.89	6.70	6.30

Climate Zone 5: West Region, El Paso

Heating, New Construction/Replace-on-Burnout

Table 479. Central Winter Demand Savings for 8.2 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.03							
15,000-20,999	0.26	0.05						
21,000-26,999	0.49	0.28	0.06					
27,000-32,999	0.72	0.50	0.29	0.08				
33,000-38,999	0.95	0.73	0.52	0.31	0.10			
39,000-44,999	1.17	0.96	0.75	0.54	0.32	0.11		
45,000-53,999	1.40	1.19	0.98	0.77	0.55	0.34	0.13	
54,000-64,999	1.86	1.65	1.43	1.22	1.01	0.80	0.58	0.16

9.0-9.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.07							
15,000-20,999	0.30	0.10						
21,000-26,999	0.52	0.33	0.14					
27,000-32,999	0.75	0.56	0.36	0.17				
33,000-38,999	0.98	0.79	0.59	0.40	0.20			
39,000-44,999	1.21	1.02	0.82	0.63	0.43	0.24		
45,000-53,999	1.44	1.24	1.05	0.86	0.66	0.47	0.27	
54,000-64,999	1.90	1.70	1.51	1.31	1.12	0.92	0.73	0.34
9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.32	0.13						
21,000-26,999	0.54	0.36	0.17					
27,000-32,999	0.77	0.59	0.40	0.22				
33,000-38,999	1.00	0.82	0.63	0.44	0.26			
39,000-44,999	1.23	1.04	0.86	0.67	0.49	0.30		
45,000-53,999	1.46	1.27	1.09	0.90	0.72	0.53	0.35	
54,000-64,999	1.92	1.73	1.54	1.36	1.17	0.99	0.80	0.43
10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.32	0.14						
21,000-26,999	0.55	0.37	0.19					
27,000-32,999	0.78	0.60	0.42	0.23				
33,000-38,999	1.01	0.83	0.64	0.46	0.28			
39,000-44,999	1.24	1.05	0.87	0.69	0.51	0.33		
45,000-53,999	1.46	1.28	1.10	0.92	0.74	0.56	0.37	
54,000-64,999	1.92	1.74	1.56	1.38	1.19	1.01	0.83	0.47

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.10							
15,000-20,999	0.33	0.15						
21,000-26,999	0.56	0.38	0.20					
27,000-32,999	0.79	0.61	0.43	0.25				
33,000-38,999	1.01	0.84	0.66	0.48	0.30			
39,000-44,999	1.24	1.06	0.89	0.71	0.53	0.35		
45,000-53,999	1.47	1.29	1.11	0.94	0.76	0.58	0.40	
54,000-64,999	1.93	1.75	1.57	1.39	1.22	1.04	0.86	0.50

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.34	0.16						
21,000-26,999	0.56	0.39	0.21					
27,000-32,999	0.79	0.62	0.44	0.27				
33,000-38,999	1.02	0.85	0.67	0.50	0.32			
39,000-44,999	1.25	1.07	0.90	0.72	0.55	0.37		
45,000-53,999	1.48	1.30	1.13	0.95	0.78	0.60	0.43	
54,000-64,999	1.94	1.76	1.59	1.41	1.23	1.06	0.88	0.53

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.34	0.17						
21,000-26,999	0.57	0.40	0.23					
27,000-32,999	0.80	0.63	0.45	0.28				
33,000-38,999	1.03	0.86	0.68	0.51	0.34			
39,000-44,999	1.26	1.08	0.91	0.74	0.57	0.40		
45,000-53,999	1.48	1.31	1.14	0.97	0.80	0.62	0.45	
54,000-64,999	1.94	1.77	1.60	1.43	1.25	1.08	0.91	0.57

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.35	0.18						
21,000-26,999	0.57	0.40	0.23					
27,000-32,999	0.80	0.63	0.46	0.29				
33,000-38,999	1.03	0.86	0.69	0.52	0.35			
39,000-44,999	1.26	1.09	0.92	0.75	0.58	0.41		
45,000-53,999	1.49	1.32	1.15	0.98	0.81	0.64	0.47	
54,000-64,999	1.95	1.78	1.61	1.43	1.26	1.09	0.92	0.58

Heating, Early Retirement of a Heat Pump

Table 480. Central Winter Demand Savings for 7.7 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.08							
15,000-20,999	0.33	0.12						
21,000-26,999	0.58	0.37	0.15					
27,000-32,999	0.83	0.62	0.40	0.19				
33,000-38,999	1.08	0.87	0.66	0.44	0.23			
39,000-44,999	1.33	1.12	0.91	0.69	0.48	0.27		
45,000-53,999	1.58	1.37	1.16	0.94	0.73	0.52	0.31	
54,000-64,999	2.09	1.87	1.66	1.45	1.23	1.02	0.81	0.38

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.36	0.17						
21,000-26,999	0.61	0.42	0.23					
27,000-32,999	0.87	0.67	0.48	0.28				
33,000-38,999	1.12	0.92	0.73	0.53	0.34			
39,000-44,999	1.37	1.17	0.98	0.78	0.59	0.39		
45,000-53,999	1.62	1.42	1.23	1.04	0.84	0.65	0.45	
54,000-64,999	2.12	1.93	1.73	1.54	1.34	1.15	0.95	0.56

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.38	0.20						
21,000-26,999	0.63	0.45	0.26					
27,000-32,999	0.88	0.70	0.51	0.33				
33,000-38,999	1.14	0.95	0.77	0.58	0.39			
39,000-44,999	1.39	1.20	1.02	0.83	0.65	0.46		
45,000-53,999	1.64	1.45	1.27	1.08	0.90	0.71	0.53	
54,000-64,999	2.14	1.95	1.77	1.58	1.40	1.21	1.03	0.66

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.39	0.21						
21,000-26,999	0.64	0.46	0.28					
27,000-32,999	0.89	0.71	0.53	0.35				
33,000-38,999	1.14	0.96	0.78	0.60	0.42			
39,000-44,999	1.39	1.21	1.03	0.85	0.67	0.48		
45,000-53,999	1.64	1.46	1.28	1.10	0.92	0.74	0.55	
54,000-64,999	2.15	1.97	1.78	1.60	1.42	1.24	1.06	0.69

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.40	0.22						
21,000-26,999	0.65	0.47	0.29					
27,000-32,999	0.90	0.72	0.54	0.36				
33,000-38,999	1.15	0.97	0.79	0.61	0.44			
39,000-44,999	1.40	1.22	1.04	0.87	0.69	0.51		
45,000-53,999	1.65	1.47	1.29	1.12	0.94	0.76	0.58	
54,000-64,999	2.15	1.98	1.80	1.62	1.44	1.26	1.08	0.73

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.40	0.23						
21,000-26,999	0.65	0.48	0.30					
27,000-32,999	0.90	0.73	0.55	0.38				
33,000-38,999	1.16	0.98	0.81	0.63	0.46			
39,000-44,999	1.41	1.23	1.06	0.88	0.71	0.53		
45,000-53,999	1.66	1.48	1.31	1.13	0.96	0.78	0.61	
54,000-64,999	2.16	1.99	1.81	1.63	1.46	1.28	1.11	0.76

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.41	0.24						
21,000-26,999	0.66	0.49	0.32					
27,000-32,999	0.91	0.74	0.57	0.40				
33,000-38,999	1.16	0.99	0.82	0.65	0.47			
39,000-44,999	1.41	1.24	1.07	0.90	0.73	0.55		
45,000-53,999	1.66	1.49	1.32	1.15	0.98	0.80	0.63	
54,000-64,999	2.17	1.99	1.82	1.65	1.48	1.31	1.13	0.79

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.41	0.24						
21,000-26,999	0.66	0.49	0.32					
27,000-32,999	0.91	0.74	0.57	0.40				
33,000-38,999	1.17	1.00	0.83	0.66	0.49			
39,000-44,999	1.42	1.25	1.08	0.91	0.74	0.57		
45,000-53,999	1.67	1.50	1.33	1.16	0.99	0.82	0.65	
54,000-64,999	2.17	2.00	1.83	1.66	1.49	1.32	1.15	0.81

Table 481. Central Winter Demand Savings for 6.8 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.49	0.28						
21,000-26,999	0.79	0.58	0.37					
27,000-32,999	1.10	0.89	0.67	0.46				
33,000-38,999	1.40	1.19	0.98	0.77	0.55			
39,000-44,999	1.71	1.50	1.28	1.07	0.86	0.65		
45,000-53,999	2.02	1.80	1.59	1.38	1.16	0.95	0.74	
54,000-64,999	2.63	2.41	2.20	1.99	1.77	1.56	1.35	0.92

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.53	0.33						
21,000-26,999	0.83	0.64	0.44					
27,000-32,999	1.14	0.94	0.75	0.55				
33,000-38,999	1.44	1.25	1.05	0.86	0.66			
39,000-44,999	1.75	1.55	1.36	1.16	0.97	0.77		
45,000-53,999	2.05	1.86	1.66	1.47	1.27	1.08	0.88	
54,000-64,999	2.66	2.47	2.27	2.08	1.88	1.69	1.49	1.10

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.54	0.36						
21,000-26,999	0.85	0.66	0.48					
27,000-32,999	1.15	0.97	0.78	0.60				
33,000-38,999	1.46	1.27	1.09	0.90	0.72			
39,000-44,999	1.76	1.58	1.39	1.21	1.02	0.84		
45,000-53,999	2.07	1.88	1.70	1.51	1.33	1.14	0.96	
54,000-64,999	2.68	2.49	2.31	2.12	1.94	1.75	1.57	1.20

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.55	0.37						
21,000-26,999	0.86	0.67	0.49					
27,000-32,999	1.16	0.98	0.80	0.62				
33,000-38,999	1.47	1.28	1.10	0.92	0.74			
39,000-44,999	1.77	1.59	1.41	1.23	1.04	0.86		
45,000-53,999	2.08	1.90	1.71	1.53	1.35	1.17	0.99	
54,000-64,999	2.69	2.51	2.32	2.14	1.96	1.78	1.60	1.23

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.56	0.38						
21,000-26,999	0.86	0.69	0.51					
27,000-32,999	1.17	0.99	0.81	0.63				
33,000-38,999	1.47	1.30	1.12	0.94	0.76			
39,000-44,999	1.78	1.60	1.42	1.24	1.06	0.89		
45,000-53,999	2.08	1.91	1.73	1.55	1.37	1.19	1.01	
54,000-64,999	2.69	2.52	2.34	2.16	1.98	1.80	1.62	1.27

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.56	0.39						
21,000-26,999	0.87	0.69	0.52					
27,000-32,999	1.18	1.00	0.82	0.65				
33,000-38,999	1.48	1.30	1.13	0.95	0.78			
39,000-44,999	1.79	1.61	1.43	1.26	1.08	0.91		
45,000-53,999	2.09	1.92	1.74	1.56	1.39	1.21	1.04	
54,000-64,999	2.70	2.53	2.35	2.17	2.00	1.82	1.65	1.30

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.57	0.40						
21,000-26,999	0.88	0.70	0.53					
27,000-32,999	1.18	1.01	0.84	0.67				
33,000-38,999	1.49	1.31	1.14	0.97	0.80			
39,000-44,999	1.79	1.62	1.45	1.28	1.10	0.93		
45,000-53,999	2.10	1.92	1.75	1.58	1.41	1.24	1.06	
54,000-64,999	2.71	2.53	2.36	2.19	2.02	1.85	1.67	1.33

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.57	0.40						
21,000-26,999	0.88	0.71	0.54					
27,000-32,999	1.18	1.01	0.84	0.67				
33,000-38,999	1.49	1.32	1.15	0.98	0.81			
39,000-44,999	1.80	1.62	1.45	1.28	1.11	0.94		
45,000-53,999	2.10	1.93	1.76	1.59	1.42	1.25	1.08	
54,000-64,999	2.71	2.54	2.37	2.20	2.03	1.86	1.69	1.35

Heating, Early Retirement of an Electric Resistance Furnace

Table 482. Central Winter Demand Savings for 3.412 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.00							
15,000-20,999	1.72	1.50						
21,000-26,999	2.43	2.22	2.00					
27,000-32,999	3.14	2.93	2.72	2.51				
33,000-38,999	3.86	3.65	3.43	3.22	3.01			
39,000-44,999	4.57	4.36	4.15	3.93	3.72	3.51		
45,000-53,999	5.29	5.07	4.86	4.65	4.43	4.22	4.01	
54,000-64,999	6.71	6.50	6.29	6.08	5.86	5.65	5.44	5.01

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.04							
15,000-20,999	1.75	1.56						
21,000-26,999	2.47	2.27	2.08					
27,000-32,999	3.18	2.99	2.79	2.60				
33,000-38,999	3.89	3.70	3.50	3.31	3.12			
39,000-44,999	4.61	4.41	4.22	4.02	3.83	3.63		
45,000-53,999	5.32	5.13	4.93	4.74	4.54	4.35	4.15	
54,000-64,999	6.75	6.55	6.36	6.17	5.97	5.78	5.58	5.19

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.06							
15,000-20,999	1.77	1.59						
21,000-26,999	2.48	2.30	2.11					
27,000-32,999	3.20	3.01	2.83	2.64				
33,000-38,999	3.91	3.73	3.54	3.36	3.17			
39,000-44,999	4.63	4.44	4.26	4.07	3.89	3.70		
45,000-53,999	5.34	5.16	4.97	4.78	4.60	4.41	4.23	
54,000-64,999	6.77	6.58	6.40	6.21	6.03	5.84	5.66	5.29

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.06							
15,000-20,999	1.78	1.60						
21,000-26,999	2.49	2.31	2.13					
27,000-32,999	3.21	3.02	2.84	2.66				
33,000-38,999	3.92	3.74	3.56	3.37	3.19			
39,000-44,999	4.63	4.45	4.27	4.09	3.91	3.72		
45,000-53,999	5.35	5.17	4.98	4.80	4.62	4.44	4.26	
54,000-64,999	6.78	6.59	6.41	6.23	6.05	5.87	5.68	5.32

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.07							
15,000-20,999	1.78	1.61						
21,000-26,999	2.50	2.32	2.14					
27,000-32,999	3.21	3.03	2.86	2.68				
33,000-38,999	3.93	3.75	3.57	3.39	3.21			
39,000-44,999	4.64	4.46	4.28	4.11	3.93	3.75		
45,000-53,999	5.35	5.18	5.00	4.82	4.64	4.46	4.28	
54,000-64,999	6.78	6.60	6.43	6.25	6.07	5.89	5.71	5.35
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.08							
15,000-20,999	1.79	1.62						
21,000-26,999	2.51	2.33	2.15					
27,000-32,999	3.22	3.04	2.87	2.69				
33,000-38,999	3.93	3.76	3.58	3.41	3.23			
39,000-44,999	4.65	4.47	4.30	4.12	3.95	3.77		
45,000-53,999	5.36	5.19	5.01	4.84	4.66	4.48	4.31	
54,000-64,999	6.79	6.61	6.44	6.26	6.09	5.91	5.74	5.39
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.08							
15,000-20,999	1.80	1.63						
21,000-26,999	2.51	2.34	2.17					
27,000-32,999	3.23	3.05	2.88	2.71				
33,000-38,999	3.94	3.77	3.60	3.42	3.25			
39,000-44,999	4.65	4.48	4.31	4.14	3.97	3.79		
45,000-53,999	5.37	5.19	5.02	4.85	4.68	4.51	4.34	
54,000-64,999	6.79	6.62	6.45	6.28	6.11	5.93	5.76	5.42

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.09							
15,000-20,999	1.80	1.63						
21,000-26,999	2.52	2.35	2.17					
27,000-32,999	3.23	3.06	2.89	2.72				
33,000-38,999	3.94	3.77	3.60	3.43	3.26			
39,000-44,999	4.66	4.49	4.32	4.15	3.98	3.81		
45,000-53,999	5.37	5.20	5.03	4.86	4.69	4.52	4.35	
54,000-64,999	6.80	6.63	6.46	6.29	6.12	5.95	5.78	5.44

APPENDIX B: MINI-SPLIT HEAT PUMPS WITHOUT SEER2 RATINGS DEEMED SAVINGS TABLES

Deemed Energy Savings Tables[564]

Table 483 through Table 502 present the energy savings (kWh) for all five Texas climate zones. In each table, the capacity of the efficient unit is represented in the columns and the capacity of the existing unit is represented in the rows. The savings are in the intersection of the appropriate efficient and existing capacities. Replacements where there has been to change in capacity are highlighted in light blue.

The rightsizing savings specified in the tables below are only applicable to replace-on-burnout and early retirement projects. New construction projects are not eligible to receive deemed savings for system rightsizing.[565]

For cooling savings, refer to Appendix A. The following heating savings assume no back-up electric resistance heat for the efficient case.

Climate Zone 1: Panhandle Region, Amarillo

Heating, New Construction/Replace-on-Burnout

Table 483. Mini-Split Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	216							
15,000-20,999	1,255	325						
21,000-26,999	2,293	1,363	433					
27,000-32,999	3,332	2,402	1,471	541				
33,000-38,999	4,370	3,440	2,510	1,580	649			
39,000-44,999	5,409	4,479	3,548	2,618	1,688	757		
45,000-53,999	6,447	5,517	4,587	3,656	2,726	1,796	866	
54,000-64,999	8,524	7,594	6,664	5,733	4,803	3,873	2,943	1,082

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[564] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[565] For projects using a custom baseline, see TRM Volume 4.

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	374							
15,000-20,999	1,413	561						
21,000-26,999	2,451	1,600	748					
27,000-32,999	3,490	2,638	1,787	935				
33,000-38,999	4,528	3,677	2,825	1,974	1,122			
39,000-44,999	5,566	4,715	3,864	3,012	2,161	1,309		
45,000-53,999	6,605	5,754	4,902	4,051	3,199	2,348	1,496	
54,000-64,999	8,682	7,830	6,979	6,128	5,276	4,425	3,573	1,870
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	456							
15,000-20,999	1,494	684						
21,000-26,999	2,533	1,722	912					
27,000-32,999	3,571	2,761	1,950	1,140				
33,000-38,999	4,610	3,799	2,989	2,178	1,368			
39,000-44,999	5,648	4,838	4,027	3,217	2,406	1,596		
45,000-53,999	6,687	5,876	5,066	4,255	3,445	2,634	1,824	
54,000-64,999	8,764	7,953	7,143	6,332	5,522	4,711	3,901	2,280
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	487							
15,000-20,999	1,525	730						
21,000-26,999	2,564	1,769	974					
27,000-32,999	3,602	2,807	2,012	1,217				
33,000-38,999	4,641	3,846	3,050	2,255	1,460			
39,000-44,999	5,679	4,884	4,089	3,294	2,499	1,704		
45,000-53,999	6,718	5,923	5,127	4,332	3,537	2,742	1,947	
54,000-64,999	8,795	7,999	7,204	6,409	5,614	4,819	4,024	2,434

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	516							
15,000-20,999	1,555	775						
21,000-26,999	2,593	1,813	1,033					
27,000-32,999	3,632	2,852	2,071	1,291				
33,000-38,999	4,670	3,890	3,110	2,329	1,549			
39,000-44,999	5,709	4,928	4,148	3,368	2,588	1,807		
45,000-53,999	6,747	5,967	5,187	4,406	3,626	2,846	2,066	
54,000-64,999	8,824	8,044	7,264	6,483	5,703	4,923	4,143	2,582
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	545							
15,000-20,999	1,583	817						
21,000-26,999	2,622	1,856	1,090					
27,000-32,999	3,660	2,894	2,128	1,362				
33,000-38,999	4,699	3,933	3,167	2,401	1,635			
39,000-44,999	5,737	4,971	4,205	3,439	2,673	1,907		
45,000-53,999	6,776	6,010	5,244	4,478	3,712	2,946	2,180	
54,000-64,999	8,853	8,087	7,321	6,555	5,789	5,023	4,257	2,725
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	572							
15,000-20,999	1,611	859						
21,000-26,999	2,649	1,897	1,145					
27,000-32,999	3,688	2,936	2,183	1,431				
33,000-38,999	4,726	3,974	3,222	2,470	1,717			
39,000-44,999	5,765	5,013	4,260	3,508	2,756	2,004		
45,000-53,999	6,803	6,051	5,299	4,547	3,794	3,042	2,290	
54,000-64,999	8,880	8,128	7,376	6,624	5,871	5,119	4,367	2,862

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	589							
15,000-20,999	1,627	883						
21,000-26,999	2,665	1,921	1,177					
27,000-32,999	3,704	2,960	2,216	1,471				
33,000-38,999	4,742	3,998	3,254	2,510	1,766			
39,000-44,999	5,781	5,037	4,292	3,548	2,804	2,060		
45,000-53,999	6,819	6,075	5,331	4,587	3,843	3,098	2,354	
54,000-64,999	8,896	8,152	7,408	6,664	5,919	5,175	4,431	2,943

Heating, Early Retirement of a Heat Pump

Table 484. Mini-Split Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	413							
15,000-20,999	1,550	620						
21,000-26,999	2,687	1,756	826					
27,000-32,999	3,823	2,893	1,963	1,033				
33,000-38,999	4,960	4,030	3,100	2,170	1,239			
39,000-44,999	6,097	5,167	4,237	3,306	2,376	1,446		
45,000-53,999	7,234	6,304	5,373	4,443	3,513	2,583	1,652	
54,000-64,999	9,508	8,577	7,647	6,717	5,786	4,856	3,926	2,065

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	571							
15,000-20,999	1,708	856						
21,000-26,999	2,844	1,993	1,142					
27,000-32,999	3,981	3,130	2,278	1,427				
33,000-38,999	5,118	4,267	3,415	2,564	1,712			
39,000-44,999	6,255	5,403	4,552	3,700	2,849	1,998		
45,000-53,999	7,392	6,540	5,689	4,837	3,986	3,134	2,283	
54,000-64,999	9,665	8,814	7,962	7,111	6,259	5,408	4,557	2,854

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	653							
15,000-20,999	1,789	979						
21,000-26,999	2,926	2,116	1,305					
27,000-32,999	4,063	3,253	2,442	1,632				
33,000-38,999	5,200	4,389	3,579	2,768	1,958			
39,000-44,999	6,337	5,526	4,716	3,905	3,095	2,284		
45,000-53,999	7,473	6,663	5,852	5,042	4,231	3,421	2,611	
54,000-64,999	9,747	8,937	8,126	7,316	6,505	5,695	4,884	3,263

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	683							
15,000-20,999	1,820	1,025						
21,000-26,999	2,957	2,162	1,367					
27,000-32,999	4,094	3,299	2,504	1,709				
33,000-38,999	5,231	4,436	3,640	2,845	2,050			
39,000-44,999	6,367	5,572	4,777	3,982	3,187	2,392		
45,000-53,999	7,504	6,709	5,914	5,119	4,324	3,529	2,734	
54,000-64,999	9,778	8,983	8,188	7,393	6,597	5,802	5,007	3,417

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	713							
15,000-20,999	1,850	1,070						
21,000-26,999	2,987	2,206	1,426					
27,000-32,999	4,123	3,343	2,563	1,783				
33,000-38,999	5,260	4,480	3,700	2,919	2,139			
39,000-44,999	6,397	5,617	4,837	4,056	3,276	2,496		
45,000-53,999	7,534	6,754	5,973	5,193	4,413	3,632	2,852	
54,000-64,999	9,807	9,027	8,247	7,467	6,686	5,906	5,126	3,565
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	742							
15,000-20,999	1,878	1,112						
21,000-26,999	3,015	2,249	1,483					
27,000-32,999	4,152	3,386	2,620	1,854				
33,000-38,999	5,289	4,523	3,757	2,991	2,225			
39,000-44,999	6,426	5,660	4,894	4,128	3,362	2,596		
45,000-53,999	7,562	6,796	6,030	5,264	4,498	3,732	2,966	
54,000-64,999	9,836	9,070	8,304	7,538	6,772	6,006	5,240	3,708
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	769							
15,000-20,999	1,906	1,154						
21,000-26,999	3,043	2,291	1,538					
27,000-32,999	4,180	3,427	2,675	1,923				
33,000-38,999	5,316	4,564	3,812	3,060	2,307			
39,000-44,999	6,453	5,701	4,949	4,196	3,444	2,692		
45,000-53,999	7,590	6,838	6,085	5,333	4,581	3,829	3,077	
54,000-64,999	9,864	9,111	8,359	7,607	6,855	6,102	5,350	3,846

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	785							
15,000-20,999	1,922	1,178						
21,000-26,999	3,059	2,315	1,570					
27,000-32,999	4,196	3,451	2,707	1,963				
33,000-38,999	5,332	4,588	3,844	3,100	2,356			
39,000-44,999	6,469	5,725	4,981	4,237	3,492	2,748		
45,000-53,999	7,606	6,862	6,118	5,373	4,629	3,885	3,141	
54,000-64,999	9,880	9,135	8,391	7,647	6,903	6,159	5,414	3,926

Table 485. Mini-Split Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	886							
15,000-20,999	2,259	1,328						
21,000-26,999	3,632	2,701	1,771					
27,000-32,999	5,005	4,074	3,144	2,214				
33,000-38,999	6,378	5,447	4,517	3,587	2,657			
39,000-44,999	7,751	6,820	5,890	4,960	4,030	3,099		
45,000-53,999	9,124	8,193	7,263	6,333	5,403	4,472	3,542	
54,000-64,999	11,870	10,940	10,009	9,079	8,149	7,218	6,288	4,428

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,043							
15,000-20,999	2,416	1,565						
21,000-26,999	3,789	2,938	2,086					
27,000-32,999	5,162	4,311	3,459	2,608				
33,000-38,999	6,535	5,684	4,832	3,981	3,130			
39,000-44,999	7,908	7,057	6,206	5,354	4,503	3,651		
45,000-53,999	9,281	8,430	7,579	6,727	5,876	5,024	4,173	
54,000-64,999	12,027	11,176	10,325	9,473	8,622	7,770	6,919	5,216

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,125							
15,000-20,999	2,498	1,688						
21,000-26,999	3,871	3,061	2,250					
27,000-32,999	5,244	4,434	3,623	2,813				
33,000-38,999	6,617	5,807	4,996	4,186	3,375			
39,000-44,999	7,990	7,180	6,369	5,559	4,748	3,938		
45,000-53,999	9,363	8,553	7,742	6,932	6,121	5,311	4,500	
54,000-64,999	12,109	11,299	10,488	9,678	8,867	8,057	7,246	5,625

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,156							
15,000-20,999	2,529	1,734						
21,000-26,999	3,902	3,107	2,312					
27,000-32,999	5,275	4,480	3,685	2,890				
33,000-38,999	6,648	5,853	5,058	4,263	3,468			
39,000-44,999	8,021	7,226	6,431	5,636	4,841	4,046		
45,000-53,999	9,394	8,599	7,804	7,009	6,214	5,419	4,623	
54,000-64,999	12,140	11,345	10,550	9,755	8,960	8,165	7,370	5,779

10.5-10.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,186							
15,000-20,999	2,559	1,778						
21,000-26,999	3,932	3,151	2,371					
27,000-32,999	5,305	4,524	3,744	2,964				
33,000-38,999	6,678	5,897	5,117	4,337	3,557			
39,000-44,999	8,051	7,270	6,490	5,710	4,930	4,149		
45,000-53,999	9,424	8,643	7,863	7,083	6,303	5,522	4,742	
54,000-64,999	12,170	11,389	10,609	9,829	9,049	8,268	7,488	5,928

11.0-11.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,214							
15,000-20,999	2,587	1,821						
21,000-26,999	3,960	3,194	2,428					
27,000-32,999	5,333	4,567	3,801	3,035				
33,000-38,999	6,706	5,940	5,174	4,408	3,642			
39,000-44,999	8,079	7,313	6,547	5,781	5,015	4,249		
45,000-53,999	9,452	8,686	7,920	7,154	6,388	5,622	4,856	
54,000-64,999	12,198	11,432	10,666	9,900	9,134	8,368	7,602	6,070

11.5-11.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,242							
15,000-20,999	2,615	1,862						
21,000-26,999	3,988	3,235	2,483					
27,000-32,999	5,361	4,608	3,856	3,104				
33,000-38,999	6,734	5,981	5,229	4,477	3,725			
39,000-44,999	8,107	7,355	6,602	5,850	5,098	4,346		
45,000-53,999	9,480	8,728	7,975	7,223	6,471	5,719	4,966	
54,000-64,999	12,226	11,474	10,721	9,969	9,217	8,465	7,712	6,208

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,258							
15,000-20,999	2,631	1,886						
21,000-26,999	4,004	3,259	2,515					
27,000-32,999	5,377	4,633	3,888	3,144				
33,000-38,999	6,750	6,006	5,261	4,517	3,773			
39,000-44,999	8,123	7,379	6,634	5,890	5,146	4,402		
45,000-53,999	9,496	8,752	8,007	7,263	6,519	5,775	5,031	
54,000-64,999	12,242	11,498	10,753	10,009	9,265	8,521	7,777	6,288

Heading, Early Retirement of an Electric Resistance Furnace

Table 486. Mini-Split Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,390							
15,000-20,999	7,516	6,586						
21,000-26,999	10,641	9,711	8,781					
27,000-32,999	13,767	12,836	11,906	10,976				
33,000-38,999	16,892	15,962	15,032	14,101	13,171			
39,000-44,999	20,018	19,087	18,157	17,227	16,297	15,366		
45,000-53,999	23,143	22,213	21,283	20,352	19,422	18,492	17,561	
54,000-64,999	29,394	28,464	27,533	26,603	25,673	24,743	23,812	21,952

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,548							
15,000-20,999	7,673	6,822						
21,000-26,999	10,799	9,947	9,096					
27,000-32,999	13,924	13,073	12,222	11,370				
33,000-38,999	17,050	16,198	15,347	14,496	13,644			
39,000-44,999	20,175	19,324	18,472	17,621	16,770	15,918		
45,000-53,999	23,301	22,449	21,598	20,746	19,895	19,044	18,192	
54,000-64,999	29,552	28,700	27,849	26,997	26,146	25,294	24,443	22,740

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,630							
15,000-20,999	7,755	6,945						
21,000-26,999	10,881	10,070	9,260					
27,000-32,999	14,006	13,196	12,385	11,575				
33,000-38,999	17,132	16,321	15,511	14,700	13,890			
39,000-44,999	20,257	19,447	18,636	17,826	17,015	16,205		
45,000-53,999	23,383	22,572	21,762	20,951	20,141	19,330	18,520	
54,000-64,999	29,633	28,823	28,012	27,202	26,392	25,581	24,771	23,150

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,661							
15,000-20,999	7,786	6,991						
21,000-26,999	10,912	10,116	9,321					
27,000-32,999	14,037	13,242	12,447	11,652				
33,000-38,999	17,162	16,367	15,572	14,777	13,982			
39,000-44,999	20,288	19,493	18,698	17,903	17,108	16,312		
45,000-53,999	23,413	22,618	21,823	21,028	20,233	19,438	18,643	
54,000-64,999	29,664	28,869	28,074	27,279	26,484	25,689	24,894	23,303

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,690							
15,000-20,999	7,816	7,036						
21,000-26,999	10,941	10,161	9,381					
27,000-32,999	14,067	13,286	12,506	11,726				
33,000-38,999	17,192	16,412	15,632	14,851	14,071			
39,000-44,999	20,318	19,537	18,757	17,977	17,196	16,416		
45,000-53,999	23,443	22,663	21,882	21,102	20,322	19,542	18,761	
54,000-64,999	29,694	28,914	28,133	27,353	26,573	25,793	25,012	23,452
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,719							
15,000-20,999	7,844	7,078						
21,000-26,999	10,970	10,204	9,438					
27,000-32,999	14,095	13,329	12,563	11,797				
33,000-38,999	17,221	16,455	15,689	14,923	14,157			
39,000-44,999	20,346	19,580	18,814	18,048	17,282	16,516		
45,000-53,999	23,472	22,706	21,940	21,174	20,408	19,642	18,876	
54,000-64,999	29,722	28,956	28,190	27,424	26,658	25,892	25,126	23,594
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,746							
15,000-20,999	7,872	7,120						
21,000-26,999	10,997	10,245	9,493					
27,000-32,999	14,123	13,371	12,618	11,866				
33,000-38,999	17,248	16,496	15,744	14,991	14,239			
39,000-44,999	20,374	19,621	18,869	18,117	17,365	16,612		
45,000-53,999	23,499	22,747	21,995	21,242	20,490	19,738	18,986	
54,000-64,999	29,750	28,998	28,246	27,493	26,741	25,989	25,237	23,732

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	4,762							
15,000-20,999	7,888	7,144						
21,000-26,999	11,013	10,269	9,525					
27,000-32,999	14,139	13,395	12,650	11,906				
33,000-38,999	17,264	16,520	15,776	15,032	14,287			
39,000-44,999	20,390	19,645	18,901	18,157	17,413	16,669		
45,000-53,999	23,515	22,771	22,027	21,283	20,538	19,794	19,050	
54,000-64,999	29,766	29,022	28,278	27,533	26,789	26,045	25,301	23,812

Climate Zone 2: North Region, Dallas/Fort Worth

Heating, New Construction/Replace-on-Burnout

Table 487. Mini-Split Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	90							
15,000-20,999	661	135						
21,000-26,999	1,231	706	180					
27,000-32,999	1,802	1,276	751	225				
33,000-38,999	2,373	1,847	1,321	796	270			
39,000-44,999	2,943	2,418	1,892	1,367	841	315		
45,000-53,999	3,514	2,988	2,463	1,937	1,412	886	360	
54,000-64,999	4,655	4,130	3,604	3,079	2,553	2,027	1,502	450

9.0-9.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	179							
15,000-20,999	750	269						
21,000-26,999	1,321	839	358					
27,000-32,999	1,891	1,410	929	448				
33,000-38,999	2,462	1,981	1,500	1,019	537			
39,000-44,999	3,033	2,551	2,070	1,589	1,108	627		
45,000-53,999	3,603	3,122	2,641	2,160	1,679	1,198	717	
54,000-64,999	4,745	4,263	3,782	3,301	2,820	2,339	1,858	896

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	225							
15,000-20,999	796	338						
21,000-26,999	1,367	909	451					
27,000-32,999	1,937	1,479	1,022	564				
33,000-38,999	2,508	2,050	1,592	1,134	676			
39,000-44,999	3,079	2,621	2,163	1,705	1,247	789		
45,000-53,999	3,649	3,191	2,734	2,276	1,818	1,360	902	
54,000-64,999	4,791	4,333	3,875	3,417	2,959	2,501	2,043	1,127

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	243							
15,000-20,999	813	364						
21,000-26,999	1,384	935	486					
27,000-32,999	1,955	1,506	1,056	607				
33,000-38,999	2,526	2,076	1,627	1,178	728			
39,000-44,999	3,096	2,647	2,198	1,748	1,299	850		
45,000-53,999	3,667	3,218	2,768	2,319	1,870	1,421	971	
54,000-64,999	4,808	4,359	3,910	3,460	3,011	2,562	2,113	1,214

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	260							
15,000-20,999	830	389						
21,000-26,999	1,401	960	519					
27,000-32,999	1,972	1,531	1,090	649				
33,000-38,999	2,542	2,101	1,660	1,220	779			
39,000-44,999	3,113	2,672	2,231	1,790	1,349	909		
45,000-53,999	3,684	3,243	2,802	2,361	1,920	1,479	1,038	
54,000-64,999	4,825	4,384	3,943	3,502	3,061	2,621	2,180	1,298
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	276							
15,000-20,999	846	414						
21,000-26,999	1,417	984	551					
27,000-32,999	1,988	1,555	1,122	689				
33,000-38,999	2,558	2,126	1,693	1,260	827			
39,000-44,999	3,129	2,696	2,263	1,831	1,398	965		
45,000-53,999	3,700	3,267	2,834	2,401	1,968	1,536	1,103	
54,000-64,999	4,841	4,408	3,975	3,543	3,110	2,677	2,244	1,379
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	291							
15,000-20,999	862	437						
21,000-26,999	1,433	1,008	583					
27,000-32,999	2,003	1,578	1,153	728				
33,000-38,999	2,574	2,149	1,724	1,299	874			
39,000-44,999	3,145	2,720	2,295	1,869	1,444	1,019		
45,000-53,999	3,715	3,290	2,865	2,440	2,015	1,590	1,165	
54,000-64,999	4,857	4,432	4,007	3,582	3,156	2,731	2,306	1,456

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	300							
15,000-20,999	871	450						
21,000-26,999	1,442	1,021	601					
27,000-32,999	2,012	1,592	1,171	751				
33,000-38,999	2,583	2,163	1,742	1,321	901			
39,000-44,999	3,154	2,733	2,313	1,892	1,472	1,051		
45,000-53,999	3,724	3,304	2,883	2,463	2,042	1,622	1,201	
54,000-64,999	4,866	4,445	4,025	3,604	3,184	2,763	2,343	1,502

Heating, Early Retirement of a Heat Pump

Table 488. Mini-Split Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	201							
15,000-20,999	827	302						
21,000-26,999	1,454	928	402					
27,000-32,999	2,080	1,554	1,029	503				
33,000-38,999	2,706	2,180	1,655	1,129	604			
39,000-44,999	3,332	2,807	2,281	1,755	1,230	704		
45,000-53,999	3,959	3,433	2,907	2,382	1,856	1,330	805	
54,000-64,999	5,211	4,685	4,160	3,634	3,109	2,583	2,057	1,006

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	290							
15,000-20,999	917	435						
21,000-26,999	1,543	1,062	581					
27,000-32,999	2,169	1,688	1,207	726				
33,000-38,999	2,795	2,314	1,833	1,352	871			
39,000-44,999	3,421	2,940	2,459	1,978	1,497	1,016		
45,000-53,999	4,048	3,567	3,085	2,604	2,123	1,642	1,161	
54,000-64,999	5,300	4,819	4,338	3,857	3,376	2,895	2,414	1,451

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	337							
15,000-20,999	963	505						
21,000-26,999	1,589	1,131	673					
27,000-32,999	2,215	1,757	1,299	841				
33,000-38,999	2,841	2,384	1,926	1,468	1,010			
39,000-44,999	3,468	3,010	2,552	2,094	1,636	1,178		
45,000-53,999	4,094	3,636	3,178	2,720	2,262	1,804	1,346	
54,000-64,999	5,346	4,888	4,430	3,973	3,515	3,057	2,599	1,683

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	354							
15,000-20,999	980	531						
21,000-26,999	1,606	1,157	708					
27,000-32,999	2,233	1,783	1,334	885				
33,000-38,999	2,859	2,410	1,960	1,511	1,062			
39,000-44,999	3,485	3,036	2,587	2,137	1,688	1,239		
45,000-53,999	4,111	3,662	3,213	2,764	2,314	1,865	1,416	
54,000-64,999	5,364	4,915	4,465	4,016	3,567	3,117	2,668	1,770

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	371							
15,000-20,999	997	556						
21,000-26,999	1,623	1,182	741					
27,000-32,999	2,249	1,808	1,368	927				
33,000-38,999	2,876	2,435	1,994	1,553	1,112			
39,000-44,999	3,502	3,061	2,620	2,179	1,738	1,297		
45,000-53,999	4,128	3,687	3,246	2,805	2,365	1,924	1,483	
54,000-64,999	5,381	4,940	4,499	4,058	3,617	3,176	2,735	1,853
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	387							
15,000-20,999	1,013	580						
21,000-26,999	1,639	1,206	774					
27,000-32,999	2,266	1,833	1,400	967				
33,000-38,999	2,892	2,459	2,026	1,593	1,160			
39,000-44,999	3,518	3,085	2,652	2,220	1,787	1,354		
45,000-53,999	4,144	3,711	3,279	2,846	2,413	1,980	1,547	
54,000-64,999	5,397	4,964	4,531	4,098	3,665	3,233	2,800	1,934
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	402							
15,000-20,999	1,029	604						
21,000-26,999	1,655	1,230	805					
27,000-32,999	2,281	1,856	1,431	1,006				
33,000-38,999	2,907	2,482	2,057	1,632	1,207			
39,000-44,999	3,534	3,108	2,683	2,258	1,833	1,408		
45,000-53,999	4,160	3,735	3,310	2,885	2,460	2,035	1,610	
54,000-64,999	5,412	4,987	4,562	4,137	3,712	3,287	2,862	2,012

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	411							
15,000-20,999	1,038	617						
21,000-26,999	1,664	1,243	823					
27,000-32,999	2,290	1,870	1,449	1,029				
33,000-38,999	2,916	2,496	2,075	1,655	1,234			
39,000-44,999	3,543	3,122	2,702	2,281	1,861	1,440		
45,000-53,999	4,169	3,748	3,328	2,907	2,487	2,066	1,646	
54,000-64,999	5,421	5,001	4,580	4,160	3,739	3,319	2,898	2,057

Table 489. Mini-Split Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	468							
15,000-20,999	1,228	702						
21,000-26,999	1,988	1,462	936					
27,000-32,999	2,747	2,222	1,696	1,170				
33,000-38,999	3,507	2,981	2,456	1,930	1,404			
39,000-44,999	4,267	3,741	3,215	2,690	2,164	1,639		
45,000-53,999	5,026	4,501	3,975	3,449	2,924	2,398	1,873	
54,000-64,999	6,546	6,020	5,495	4,969	4,443	3,918	3,392	2,341

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	557							
15,000-20,999	1,317	836						
21,000-26,999	2,077	1,596	1,114					
27,000-32,999	2,836	2,355	1,874	1,393				
33,000-38,999	3,596	3,115	2,634	2,153	1,672			
39,000-44,999	4,356	3,875	3,394	2,913	2,431	1,950		
45,000-53,999	5,115	4,634	4,153	3,672	3,191	2,710	2,229	
54,000-64,999	6,635	6,154	5,673	5,192	4,711	4,229	3,748	2,786

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	603							
15,000-20,999	1,363	905						
21,000-26,999	2,123	1,665	1,207					
27,000-32,999	2,883	2,425	1,967	1,509				
33,000-38,999	3,642	3,184	2,726	2,268	1,810			
39,000-44,999	4,402	3,944	3,486	3,028	2,570	2,112		
45,000-53,999	5,162	4,704	4,246	3,788	3,330	2,872	2,414	
54,000-64,999	6,681	6,223	5,765	5,307	4,849	4,391	3,933	3,017

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	621							
15,000-20,999	1,381	931						
21,000-26,999	2,140	1,691	1,242					
27,000-32,999	2,900	2,451	2,001	1,552				
33,000-38,999	3,660	3,210	2,761	2,312	1,863			
39,000-44,999	4,419	3,970	3,521	3,072	2,622	2,173		
45,000-53,999	5,179	4,730	4,281	3,831	3,382	2,933	2,484	
54,000-64,999	6,699	6,249	5,800	5,351	4,902	4,452	4,003	3,104

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	638							
15,000-20,999	1,397	956						
21,000-26,999	2,157	1,716	1,275					
27,000-32,999	2,917	2,476	2,035	1,594				
33,000-38,999	3,676	3,236	2,795	2,354	1,913			
39,000-44,999	4,436	3,995	3,554	3,114	2,673	2,232		
45,000-53,999	5,196	4,755	4,314	3,873	3,432	2,991	2,551	
54,000-64,999	6,715	6,274	5,834	5,393	4,952	4,511	4,070	3,188

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	654							
15,000-20,999	1,413	981						
21,000-26,999	2,173	1,740	1,308					
27,000-32,999	2,933	2,500	2,067	1,634				
33,000-38,999	3,693	3,260	2,827	2,394	1,961			
39,000-44,999	4,452	4,019	3,587	3,154	2,721	2,288		
45,000-53,999	5,212	4,779	4,346	3,914	3,481	3,048	2,615	
54,000-64,999	6,731	6,299	5,866	5,433	5,000	4,567	4,135	3,269

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	669							
15,000-20,999	1,429	1,004						
21,000-26,999	2,189	1,764	1,339					
27,000-32,999	2,948	2,523	2,098	1,673				
33,000-38,999	3,708	3,283	2,858	2,433	2,008			
39,000-44,999	4,468	4,043	3,618	3,193	2,768	2,343		
45,000-53,999	5,228	4,803	4,377	3,952	3,527	3,102	2,677	
54,000-64,999	6,747	6,322	5,897	5,472	5,047	4,622	4,197	3,347

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	678							
15,000-20,999	1,438	1,018						
21,000-26,999	2,198	1,777	1,357					
27,000-32,999	2,958	2,537	2,117	1,696				
33,000-38,999	3,717	3,297	2,876	2,456	2,035			
39,000-44,999	4,477	4,056	3,636	3,215	2,795	2,374		
45,000-53,999	5,237	4,816	4,396	3,975	3,555	3,134	2,714	
54,000-64,999	6,756	6,336	5,915	5,495	5,074	4,654	4,233	3,392

Heating, Early Retirement of an Electric Resistance Furnace

Table 490. Mini-Split Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,473							
15,000-20,999	4,235	3,710						
21,000-26,999	5,997	5,472	4,946					
27,000-32,999	7,760	7,234	6,708	6,183				
33,000-38,999	9,522	8,996	8,471	7,945	7,419			
39,000-44,999	11,284	10,758	10,233	9,707	9,181	8,656		
45,000-53,999	13,046	12,521	11,995	11,469	10,944	10,418	9,892	
54,000-64,999	16,571	16,045	15,519	14,994	14,468	13,942	13,417	12,365

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,562							
15,000-20,999	4,324	3,843						
21,000-26,999	6,087	5,605	5,124					
27,000-32,999	7,849	7,368	6,887	6,405				
33,000-38,999	9,611	9,130	8,649	8,168	7,687			
39,000-44,999	11,373	10,892	10,411	9,930	9,449	8,968		
45,000-53,999	13,135	12,654	12,173	11,692	11,211	10,730	10,249	
54,000-64,999	16,660	16,179	15,697	15,216	14,735	14,254	13,773	12,811
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,608							
15,000-20,999	4,371	3,913						
21,000-26,999	6,133	5,675	5,217					
27,000-32,999	7,895	7,437	6,979	6,521				
33,000-38,999	9,657	9,199	8,741	8,283	7,825			
39,000-44,999	11,419	10,961	10,503	10,045	9,588	9,130		
45,000-53,999	13,182	12,724	12,266	11,808	11,350	10,892	10,434	
54,000-64,999	16,706	16,248	15,790	15,332	14,874	14,416	13,958	13,042
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,626							
15,000-20,999	4,388	3,939						
21,000-26,999	6,150	5,701	5,252					
27,000-32,999	7,912	7,463	7,014	6,565				
33,000-38,999	9,675	9,225	8,776	8,327	7,878			
39,000-44,999	11,437	10,987	10,538	10,089	9,640	9,190		
45,000-53,999	13,199	12,750	12,300	11,851	11,402	10,953	10,503	
54,000-64,999	16,723	16,274	15,825	15,375	14,926	14,477	14,028	13,129

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,643							
15,000-20,999	4,405	3,964						
21,000-26,999	6,167	5,726	5,285					
27,000-32,999	7,929	7,488	7,047	6,606				
33,000-38,999	9,691	9,250	8,810	8,369	7,928			
39,000-44,999	11,453	11,013	10,572	10,131	9,690	9,249		
45,000-53,999	13,216	12,775	12,334	11,893	11,452	11,011	10,570	
54,000-64,999	16,740	16,299	15,858	15,417	14,976	14,536	14,095	13,213

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,659							
15,000-20,999	4,421	3,988						
21,000-26,999	6,183	5,750	5,317					
27,000-32,999	7,945	7,512	7,080	6,647				
33,000-38,999	9,707	9,275	8,842	8,409	7,976			
39,000-44,999	11,470	11,037	10,604	10,171	9,738	9,306		
45,000-53,999	13,232	12,799	12,366	11,933	11,501	11,068	10,635	
54,000-64,999	16,756	16,323	15,891	15,458	15,025	14,592	14,159	13,294

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,674							
15,000-20,999	4,436	4,011						
21,000-26,999	6,199	5,774	5,349					
27,000-32,999	7,961	7,536	7,111	6,686				
33,000-38,999	9,723	9,298	8,873	8,448	8,023			
39,000-44,999	11,485	11,060	10,635	10,210	9,785	9,360		
45,000-53,999	13,247	12,822	12,397	11,972	11,547	11,122	10,697	
54,000-64,999	16,772	16,347	15,922	15,497	15,072	14,647	14,221	13,371

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,683							
15,000-20,999	4,446	4,025						
21,000-26,999	6,208	5,787	5,367					
27,000-32,999	7,970	7,549	7,129	6,708				
33,000-38,999	9,732	9,312	8,891	8,471	8,050			
39,000-44,999	11,494	11,074	10,653	10,233	9,812	9,392		
45,000-53,999	13,256	12,836	12,415	11,995	11,574	11,154	10,733	
54,000-64,999	16,781	16,360	15,940	15,519	15,099	14,678	14,258	13,417

Climate Zone 3: South Region, Houston

Heating, New Construction/Replace-on-Burnout

Table 491. Mini-Split Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	51							
15,000-20,999	420	77						
21,000-26,999	789	446	102					
27,000-32,999	1,158	815	471	128				
33,000-38,999	1,527	1,184	840	497	154			
39,000-44,999	1,896	1,552	1,209	866	523	179		
45,000-53,999	2,265	1,921	1,578	1,235	892	548	205	
54,000-64,999	3,003	2,659	2,316	1,973	1,629	1,286	943	256

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	109							
15,000-20,999	478	164						
21,000-26,999	847	533	219					
27,000-32,999	1,216	902	588	274				
33,000-38,999	1,585	1,271	957	642	328			
39,000-44,999	1,954	1,640	1,326	1,011	697	383		
45,000-53,999	2,323	2,009	1,694	1,380	1,066	752	438	
54,000-64,999	3,061	2,747	2,432	2,118	1,804	1,490	1,176	547
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	140							
15,000-20,999	509	209						
21,000-26,999	877	578	279					
27,000-32,999	1,246	947	648	349				
33,000-38,999	1,615	1,316	1,017	718	419			
39,000-44,999	1,984	1,685	1,386	1,087	788	489		
45,000-53,999	2,353	2,054	1,755	1,456	1,157	858	559	
54,000-64,999	3,091	2,792	2,493	2,194	1,895	1,595	1,296	698
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	151							
15,000-20,999	520	226						
21,000-26,999	889	595	302					
27,000-32,999	1,258	964	671	377				
33,000-38,999	1,627	1,333	1,040	746	453			
39,000-44,999	1,996	1,702	1,409	1,115	822	528		
45,000-53,999	2,364	2,071	1,778	1,484	1,191	897	604	
54,000-64,999	3,102	2,809	2,515	2,222	1,929	1,635	1,342	755

10.5-10.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	162							
15,000-20,999	531	243						
21,000-26,999	900	612	324					
27,000-32,999	1,269	981	693	405				
33,000-38,999	1,638	1,350	1,062	774	486			
39,000-44,999	2,006	1,719	1,431	1,143	855	567		
45,000-53,999	2,375	2,087	1,800	1,512	1,224	936	648	
54,000-64,999	3,113	2,825	2,537	2,249	1,961	1,674	1,386	810

11.0-11.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	172							
15,000-20,999	541	259						
21,000-26,999	910	628	345					
27,000-32,999	1,279	997	714	431				
33,000-38,999	1,648	1,365	1,083	800	517			
39,000-44,999	2,017	1,734	1,452	1,169	886	604		
45,000-53,999	2,386	2,103	1,821	1,538	1,255	973	690	
54,000-64,999	3,124	2,841	2,558	2,276	1,993	1,710	1,428	862

11.5-11.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	183							
15,000-20,999	552	274						
21,000-26,999	920	643	365					
27,000-32,999	1,289	1,012	734	457				
33,000-38,999	1,658	1,381	1,103	825	548			
39,000-44,999	2,027	1,750	1,472	1,194	917	639		
45,000-53,999	2,396	2,119	1,841	1,563	1,286	1,008	731	
54,000-64,999	3,134	2,856	2,579	2,301	2,024	1,746	1,468	913

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	189							
15,000-20,999	557	283						
21,000-26,999	926	652	377					
27,000-32,999	1,295	1,021	746	471				
33,000-38,999	1,664	1,390	1,115	840	566			
39,000-44,999	2,033	1,758	1,484	1,209	935	660		
45,000-53,999	2,402	2,127	1,853	1,578	1,303	1,029	754	
54,000-64,999	3,140	2,865	2,591	2,316	2,041	1,767	1,492	943

Heating, Early Retirement of a Heat Pump

Table 492. Mini-Split Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	124							
15,000-20,999	529	186						
21,000-26,999	934	591	248					
27,000-32,999	1,339	996	653	310				
33,000-38,999	1,745	1,401	1,058	715	371			
39,000-44,999	2,150	1,807	1,463	1,120	777	433		
45,000-53,999	2,555	2,212	1,868	1,525	1,182	839	495	
54,000-64,999	3,365	3,022	2,679	2,336	1,992	1,649	1,306	619

9.0-9.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	182							
15,000-20,999	587	273						
21,000-26,999	992	678	364					
27,000-32,999	1,398	1,083	769	455				
33,000-38,999	1,803	1,489	1,174	860	546			
39,000-44,999	2,208	1,894	1,580	1,265	951	637		
45,000-53,999	2,613	2,299	1,985	1,671	1,356	1,042	728	
54,000-64,999	3,424	3,109	2,795	2,481	2,167	1,853	1,538	910
9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	212							
15,000-20,999	617	318						
21,000-26,999	1,023	724	424					
27,000-32,999	1,428	1,129	830	531				
33,000-38,999	1,833	1,534	1,235	936	637			
39,000-44,999	2,238	1,939	1,640	1,341	1,042	743		
45,000-53,999	2,643	2,344	2,045	1,746	1,447	1,148	849	
54,000-64,999	3,454	3,155	2,856	2,557	2,257	1,958	1,659	1,061
10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	224							
15,000-20,999	629	335						
21,000-26,999	1,034	741	447					
27,000-32,999	1,439	1,146	852	559				
33,000-38,999	1,844	1,551	1,258	964	671			
39,000-44,999	2,250	1,956	1,663	1,369	1,076	782		
45,000-53,999	2,655	2,361	2,068	1,775	1,481	1,188	894	
54,000-64,999	3,465	3,172	2,878	2,585	2,291	1,998	1,705	1,118

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	235							
15,000-20,999	640	352						
21,000-26,999	1,045	757	469					
27,000-32,999	1,450	1,162	874	586				
33,000-38,999	1,855	1,567	1,279	991	704			
39,000-44,999	2,260	1,973	1,685	1,397	1,109	821		
45,000-53,999	2,666	2,378	2,090	1,802	1,514	1,226	938	
54,000-64,999	3,476	3,188	2,900	2,612	2,324	2,036	1,748	1,173

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	245							
15,000-20,999	650	368						
21,000-26,999	1,055	773	490					
27,000-32,999	1,461	1,178	895	613				
33,000-38,999	1,866	1,583	1,300	1,018	735			
39,000-44,999	2,271	1,988	1,706	1,423	1,140	858		
45,000-53,999	2,676	2,394	2,111	1,828	1,546	1,263	980	
54,000-64,999	3,487	3,204	2,921	2,639	2,356	2,073	1,791	1,225

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	255							
15,000-20,999	660	383						
21,000-26,999	1,066	788	510					
27,000-32,999	1,471	1,193	916	638				
33,000-38,999	1,876	1,598	1,321	1,043	766			
39,000-44,999	2,281	2,004	1,726	1,448	1,171	893		
45,000-53,999	2,686	2,409	2,131	1,854	1,576	1,298	1,021	
54,000-64,999	3,497	3,219	2,942	2,664	2,386	2,109	1,831	1,276

12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	261							
15,000-20,999	666	392						
21,000-26,999	1,072	797	522					
27,000-32,999	1,477	1,202	927	653				
33,000-38,999	1,882	1,607	1,333	1,058	783			
39,000-44,999	2,287	2,012	1,738	1,463	1,189	914		
45,000-53,999	2,692	2,418	2,143	1,868	1,594	1,319	1,045	
54,000-64,999	3,503	3,228	2,953	2,679	2,404	2,130	1,855	1,306

Table 493. Mini-Split Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	298							
15,000-20,999	791	447						
21,000-26,999	1,283	940	596					
27,000-32,999	1,775	1,432	1,089	745				
33,000-38,999	2,268	1,924	1,581	1,238	894			
39,000-44,999	2,760	2,417	2,073	1,730	1,387	1,044		
45,000-53,999	3,252	2,909	2,566	2,223	1,879	1,536	1,193	
54,000-64,999	4,237	3,894	3,551	3,207	2,864	2,521	2,177	1,491

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	356							
15,000-20,999	849	535						
21,000-26,999	1,341	1,027	713					
27,000-32,999	1,833	1,519	1,205	891				
33,000-38,999	2,326	2,012	1,697	1,383	1,069			
39,000-44,999	2,818	2,504	2,190	1,876	1,561	1,247		
45,000-53,999	3,311	2,996	2,682	2,368	2,054	1,740	1,425	
54,000-64,999	4,295	3,981	3,667	3,353	3,039	2,724	2,410	1,782
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	387							
15,000-20,999	879	580						
21,000-26,999	1,371	1,072	773					
27,000-32,999	1,864	1,565	1,265	966				
33,000-38,999	2,356	2,057	1,758	1,459	1,160			
39,000-44,999	2,848	2,549	2,250	1,951	1,652	1,353		
45,000-53,999	3,341	3,042	2,743	2,444	2,144	1,845	1,546	
54,000-64,999	4,326	4,026	3,727	3,428	3,129	2,830	2,531	1,933
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	398							
15,000-20,999	890	597						
21,000-26,999	1,383	1,089	796					
27,000-32,999	1,875	1,582	1,288	995				
33,000-38,999	2,367	2,074	1,781	1,487	1,194			
39,000-44,999	2,860	2,566	2,273	1,980	1,686	1,393		
45,000-53,999	3,352	3,059	2,765	2,472	2,178	1,885	1,592	
54,000-64,999	4,337	4,043	3,750	3,457	3,163	2,870	2,576	1,990

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	409							
15,000-20,999	901	613						
21,000-26,999	1,394	1,106	818					
27,000-32,999	1,886	1,598	1,310	1,022				
33,000-38,999	2,378	2,090	1,802	1,515	1,227			
39,000-44,999	2,871	2,583	2,295	2,007	1,719	1,431		
45,000-53,999	3,363	3,075	2,787	2,499	2,211	1,923	1,635	
54,000-64,999	4,348	4,060	3,772	3,484	3,196	2,908	2,620	2,044
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	419							
15,000-20,999	912	629						
21,000-26,999	1,404	1,121	839					
27,000-32,999	1,897	1,614	1,331	1,048				
33,000-38,999	2,389	2,106	1,824	1,541	1,258			
39,000-44,999	2,881	2,599	2,316	2,033	1,751	1,468		
45,000-53,999	3,374	3,091	2,808	2,526	2,243	1,960	1,678	
54,000-64,999	4,358	4,076	3,793	3,510	3,228	2,945	2,662	2,097
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	430							
15,000-20,999	922	644						
21,000-26,999	1,414	1,137	859					
27,000-32,999	1,907	1,629	1,351	1,074				
33,000-38,999	2,399	2,121	1,844	1,566	1,289			
39,000-44,999	2,891	2,614	2,336	2,059	1,781	1,503		
45,000-53,999	3,384	3,106	2,829	2,551	2,273	1,996	1,718	
54,000-64,999	4,369	4,091	3,813	3,536	3,258	2,981	2,703	2,148

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	435							
15,000-20,999	928	653						
21,000-26,999	1,420	1,146	871					
27,000-32,999	1,913	1,638	1,363	1,089				
33,000-38,999	2,405	2,130	1,856	1,581	1,306			
39,000-44,999	2,897	2,623	2,348	2,073	1,799	1,524		
45,000-53,999	3,390	3,115	2,840	2,566	2,291	2,017	1,742	
54,000-64,999	4,374	4,100	3,825	3,551	3,276	3,001	2,727	2,177

Heating, Early Retirement of an Electric Resistance Furnace

Table 494. Mini-Split Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,613							
15,000-20,999	2,764	2,420						
21,000-26,999	3,914	3,570	3,227					
27,000-32,999	5,064	4,720	4,377	4,034				
33,000-38,999	6,214	5,870	5,527	5,184	4,840			
39,000-44,999	7,364	7,020	6,677	6,334	5,991	5,647		
45,000-53,999	8,514	8,170	7,827	7,484	7,141	6,797	6,454	
54,000-64,999	10,814	10,470	10,127	9,784	9,441	9,097	8,754	8,067

9.0-9.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,672							
15,000-20,999	2,822	2,508						
21,000-26,999	3,972	3,658	3,343					
27,000-32,999	5,122	4,808	4,493	4,179				
33,000-38,999	6,272	5,958	5,643	5,329	5,015			
39,000-44,999	7,422	7,108	6,793	6,479	6,165	5,851		
45,000-53,999	8,572	8,258	7,944	7,629	7,315	7,001	6,687	
54,000-64,999	10,872	10,558	10,244	9,929	9,615	9,301	8,987	8,358

9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,702							
15,000-20,999	2,852	2,553						
21,000-26,999	4,002	3,703	3,404					
27,000-32,999	5,152	4,853	4,554	4,255				
33,000-38,999	6,302	6,003	5,704	5,405	5,106			
39,000-44,999	7,452	7,153	6,854	6,555	6,256	5,957		
45,000-53,999	8,602	8,303	8,004	7,705	7,406	7,107	6,808	
54,000-64,999	10,902	10,603	10,304	10,005	9,706	9,407	9,108	8,509

10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,713							
15,000-20,999	2,863	2,570						
21,000-26,999	4,013	3,720	3,427					
27,000-32,999	5,163	4,870	4,577	4,283				
33,000-38,999	6,313	6,020	5,727	5,433	5,140			
39,000-44,999	7,463	7,170	6,877	6,583	6,290	5,996		
45,000-53,999	8,613	8,320	8,027	7,733	7,440	7,146	6,853	
54,000-64,999	10,914	10,620	10,327	10,033	9,740	9,446	9,153	8,566

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,724							
15,000-20,999	2,874	2,586						
21,000-26,999	4,024	3,736	3,448					
27,000-32,999	5,174	4,886	4,598	4,310				
33,000-38,999	6,324	6,036	5,748	5,461	5,173			
39,000-44,999	7,474	7,186	6,898	6,611	6,323	6,035		
45,000-53,999	8,624	8,336	8,049	7,761	7,473	7,185	6,897	
54,000-64,999	10,924	10,637	10,349	10,061	9,773	9,485	9,197	8,621

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,735							
15,000-20,999	2,885	2,602						
21,000-26,999	4,035	3,752	3,469					
27,000-32,999	5,185	4,902	4,619	4,337				
33,000-38,999	6,335	6,052	5,770	5,487	5,204			
39,000-44,999	7,485	7,202	6,920	6,637	6,354	6,072		
45,000-53,999	8,635	8,352	8,070	7,787	7,504	7,222	6,939	
54,000-64,999	10,935	10,652	10,370	10,087	9,804	9,522	9,239	8,674

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,745							
15,000-20,999	2,895	2,617						
21,000-26,999	4,045	3,767	3,490					
27,000-32,999	5,195	4,917	4,640	4,362				
33,000-38,999	6,345	6,067	5,790	5,512	5,235			
39,000-44,999	7,495	7,217	6,940	6,662	6,385	6,107		
45,000-53,999	8,645	8,368	8,090	7,812	7,535	7,257	6,980	
54,000-64,999	10,945	10,668	10,390	10,112	9,835	9,557	9,280	8,724

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,751							
15,000-20,999	2,901	2,626						
21,000-26,999	4,051	3,776	3,502					
27,000-32,999	5,201	4,926	4,652	4,377				
33,000-38,999	6,351	6,076	5,802	5,527	5,252			
39,000-44,999	7,501	7,226	6,952	6,677	6,402	6,128		
45,000-53,999	8,651	8,376	8,102	7,827	7,552	7,278	7,003	
54,000-64,999	10,951	10,676	10,402	10,127	9,853	9,578	9,303	8,754

Climate Zone 4: Valley Region, Corpus Christi

Table 495 through Table 498 present the energy savings (kWh) for heating load types associated with a mini-split heat pump being installed during new construction or replacing a burned-out central heat pump for all five Texas climate zones.

The following deemed savings assume no back-up electric resistance heat for the efficient case.

Heating, New Construction/Replace-on-Burnout

Table 495. Mini-Split Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	34							
15,000-20,999	282	52						
21,000-26,999	529	299	69					
27,000-32,999	776	546	316	86				
33,000-38,999	1,024	794	563	333	103			
39,000-44,999	1,271	1,041	811	581	350	120		
45,000-53,999	1,518	1,288	1,058	828	598	368	137	
54,000-64,999	2,013	1,783	1,553	1,323	1,092	862	632	172

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	73							
15,000-20,999	321	110						
21,000-26,999	568	357	147					
27,000-32,999	815	605	394	183				
33,000-38,999	1,063	852	641	431	220			
39,000-44,999	1,310	1,099	889	678	467	257		
45,000-53,999	1,557	1,347	1,136	925	715	504	293	
54,000-64,999	2,052	1,841	1,631	1,420	1,209	999	788	367

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	94							
15,000-20,999	341	140						
21,000-26,999	588	388	187					
27,000-32,999	836	635	435	234				
33,000-38,999	1,083	882	682	481	281			
39,000-44,999	1,330	1,130	929	729	528	328		
45,000-53,999	1,578	1,377	1,177	976	776	575	374	
54,000-64,999	2,072	1,872	1,671	1,471	1,270	1,070	869	468

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	101							
15,000-20,999	349	152						
21,000-26,999	596	399	202					
27,000-32,999	843	647	450	253				
33,000-38,999	1,091	894	697	500	304			
39,000-44,999	1,338	1,141	944	748	551	354		
45,000-53,999	1,585	1,389	1,192	995	798	602	405	
54,000-64,999	2,080	1,883	1,686	1,490	1,293	1,096	900	506

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	109							
15,000-20,999	356	163						
21,000-26,999	603	410	217					
27,000-32,999	851	658	464	271				
33,000-38,999	1,098	905	712	519	326			
39,000-44,999	1,345	1,152	959	766	573	380		
45,000-53,999	1,593	1,400	1,206	1,013	820	627	434	
54,000-64,999	2,087	1,894	1,701	1,508	1,315	1,122	929	543

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	116							
15,000-20,999	363	173						
21,000-26,999	610	421	231					
27,000-32,999	858	668	479	289				
33,000-38,999	1,105	915	726	536	347			
39,000-44,999	1,352	1,163	973	784	594	405		
45,000-53,999	1,600	1,410	1,221	1,031	842	652	463	
54,000-64,999	2,094	1,905	1,715	1,526	1,336	1,147	957	578

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	122							
15,000-20,999	370	184						
21,000-26,999	617	431	245					
27,000-32,999	864	678	492	306				
33,000-38,999	1,112	926	740	553	367			
39,000-44,999	1,359	1,173	987	801	615	429		
45,000-53,999	1,606	1,420	1,234	1,048	862	676	490	
54,000-64,999	2,101	1,915	1,729	1,543	1,357	1,171	984	612

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	126							
15,000-20,999	374	190						
21,000-26,999	621	437	253					
27,000-32,999	868	684	500	316				
33,000-38,999	1,116	932	747	563	379			
39,000-44,999	1,363	1,179	995	811	627	442		
45,000-53,999	1,610	1,426	1,242	1,058	874	690	506	
54,000-64,999	2,105	1,921	1,737	1,553	1,369	1,184	1,000	632

Heating, Early Retirement of a Heat Pump

Table 496. Mini-Split Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	83							
15,000-20,999	355	125						
21,000-26,999	626	396	166					
27,000-32,999	898	668	438	208				
33,000-38,999	1,170	939	709	479	249			
39,000-44,999	1,441	1,211	981	751	521	291		
45,000-53,999	1,713	1,483	1,253	1,022	792	562	332	
54,000-64,999	2,256	2,026	1,796	1,566	1,336	1,106	875	415

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	122							
15,000-20,999	394	183						
21,000-26,999	665	455	244					
27,000-32,999	937	726	516	305				
33,000-38,999	1,209	998	787	577	366			
39,000-44,999	1,480	1,270	1,059	848	638	427		
45,000-53,999	1,752	1,541	1,331	1,120	909	699	488	
54,000-64,999	2,295	2,085	1,874	1,663	1,453	1,242	1,031	610
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	142							
15,000-20,999	414	213						
21,000-26,999	686	485	285					
27,000-32,999	957	757	556	356				
33,000-38,999	1,229	1,028	828	627	427			
39,000-44,999	1,501	1,300	1,100	899	698	498		
45,000-53,999	1,772	1,572	1,371	1,171	970	770	569	
54,000-64,999	2,316	2,115	1,915	1,714	1,513	1,313	1,112	711
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	150							
15,000-20,999	422	225						
21,000-26,999	693	496	300					
27,000-32,999	965	768	571	375				
33,000-38,999	1,237	1,040	843	646	450			
39,000-44,999	1,508	1,311	1,115	918	721	525		
45,000-53,999	1,780	1,583	1,386	1,190	993	796	600	
54,000-64,999	2,323	2,126	1,930	1,733	1,536	1,340	1,143	749

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	157							
15,000-20,999	429	236						
21,000-26,999	701	507	314					
27,000-32,999	972	779	586	393				
33,000-38,999	1,244	1,051	858	665	472			
39,000-44,999	1,516	1,322	1,129	936	743	550		
45,000-53,999	1,787	1,594	1,401	1,208	1,015	822	629	
54,000-64,999	2,331	2,137	1,944	1,751	1,558	1,365	1,172	786

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	164							
15,000-20,999	436	246						
21,000-26,999	708	518	329					
27,000-32,999	979	790	600	411				
33,000-38,999	1,251	1,061	872	682	493			
39,000-44,999	1,523	1,333	1,144	954	765	575		
45,000-53,999	1,794	1,605	1,415	1,226	1,036	847	657	
54,000-64,999	2,338	2,148	1,959	1,769	1,580	1,390	1,200	821

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	171							
15,000-20,999	443	257						
21,000-26,999	714	528	342					
27,000-32,999	986	800	614	428				
33,000-38,999	1,258	1,072	886	699	513			
39,000-44,999	1,529	1,343	1,157	971	785	599		
45,000-53,999	1,801	1,615	1,429	1,243	1,057	871	684	
54,000-64,999	2,344	2,158	1,972	1,786	1,600	1,414	1,228	855

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	175							
15,000-20,999	447	263						
21,000-26,999	718	534	350					
27,000-32,999	990	806	622	438				
33,000-38,999	1,262	1,078	893	709	525			
39,000-44,999	1,533	1,349	1,165	981	797	613		
45,000-53,999	1,805	1,621	1,437	1,253	1,069	884	700	
54,000-64,999	2,348	2,164	1,980	1,796	1,612	1,428	1,244	875

Table 497. Mini-Split Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	200							
15,000-20,999	530	300						
21,000-26,999	860	630	400					
27,000-32,999	1,190	960	730	500				
33,000-38,999	1,520	1,290	1,060	830	600			
39,000-44,999	1,850	1,620	1,390	1,160	930	700		
45,000-53,999	2,181	1,950	1,720	1,490	1,260	1,030	800	
54,000-64,999	2,841	2,611	2,380	2,150	1,920	1,690	1,460	999

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	239							
15,000-20,999	569	358						
21,000-26,999	899	688	478					
27,000-32,999	1,229	1,019	808	597				
33,000-38,999	1,559	1,349	1,138	927	717			
39,000-44,999	1,889	1,679	1,468	1,257	1,047	836		
45,000-53,999	2,220	2,009	1,798	1,588	1,377	1,166	956	
54,000-64,999	2,880	2,669	2,458	2,248	2,037	1,826	1,616	1,195

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	259							
15,000-20,999	589	389						
21,000-26,999	919	719	518					
27,000-32,999	1,249	1,049	848	648				
33,000-38,999	1,580	1,379	1,179	978	777			
39,000-44,999	1,910	1,709	1,509	1,308	1,108	907		
45,000-53,999	2,240	2,039	1,839	1,638	1,438	1,237	1,037	
54,000-64,999	2,900	2,699	2,499	2,298	2,098	1,897	1,697	1,296

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	267							
15,000-20,999	597	400						
21,000-26,999	927	730	534					
27,000-32,999	1,257	1,060	864	667				
33,000-38,999	1,587	1,390	1,194	997	800			
39,000-44,999	1,917	1,721	1,524	1,327	1,130	934		
45,000-53,999	2,247	2,051	1,854	1,657	1,461	1,264	1,067	
54,000-64,999	2,908	2,711	2,514	2,317	2,121	1,924	1,727	1,334

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	274							
15,000-20,999	604	411						
21,000-26,999	934	741	548					
27,000-32,999	1,264	1,071	878	685				
33,000-38,999	1,595	1,401	1,208	1,015	822			
39,000-44,999	1,925	1,732	1,539	1,345	1,152	959		
45,000-53,999	2,255	2,062	1,869	1,676	1,483	1,290	1,096	
54,000-64,999	2,915	2,722	2,529	2,336	2,143	1,950	1,757	1,371

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	281							
15,000-20,999	611	422						
21,000-26,999	941	752	562					
27,000-32,999	1,271	1,082	892	703				
33,000-38,999	1,602	1,412	1,223	1,033	844			
39,000-44,999	1,932	1,742	1,553	1,363	1,174	984		
45,000-53,999	2,262	2,072	1,883	1,693	1,504	1,314	1,125	
54,000-64,999	2,922	2,733	2,543	2,353	2,164	1,974	1,785	1,406

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	288							
15,000-20,999	618	432						
21,000-26,999	948	762	576					
27,000-32,999	1,278	1,092	906	720				
33,000-38,999	1,608	1,422	1,236	1,050	864			
39,000-44,999	1,939	1,752	1,566	1,380	1,194	1,008		
45,000-53,999	2,269	2,083	1,896	1,710	1,524	1,338	1,152	
54,000-64,999	2,929	2,743	2,557	2,370	2,184	1,998	1,812	1,440

12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	292							
15,000-20,999	622	438						
21,000-26,999	952	768	584					
27,000-32,999	1,282	1,098	914	730				
33,000-38,999	1,612	1,428	1,244	1,060	876			
39,000-44,999	1,942	1,758	1,574	1,390	1,206	1,022		
45,000-53,999	2,273	2,088	1,904	1,720	1,536	1,352	1,168	
54,000-64,999	2,933	2,749	2,565	2,380	2,196	2,012	1,828	1,460

Heating, Early Retirement of an Electric Resistance Furnace

Table 498. Mini-Split Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1,083							
15,000-20,999	1,855	1,625						
21,000-26,999	2,627	2,397	2,167					
27,000-32,999	3,399	3,169	2,939	2,709				
33,000-38,999	4,171	3,941	3,711	3,481	3,250			
39,000-44,999	4,943	4,713	4,483	4,253	4,022	3,792		
45,000-53,999	5,715	5,485	5,255	5,024	4,794	4,564	4,334	
54,000-64,999	7,259	7,029	6,798	6,568	6,338	6,108	5,878	5,417

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,123							
15,000-20,999	1,894	1,684						
21,000-26,999	2,666	2,456	2,245					
27,000-32,999	3,438	3,228	3,017	2,806				
33,000-38,999	4,210	3,999	3,789	3,578	3,368			
39,000-44,999	4,982	4,771	4,561	4,350	4,139	3,929		
45,000-53,999	5,754	5,543	5,333	5,122	4,911	4,701	4,490	
54,000-64,999	7,298	7,087	6,876	6,666	6,455	6,244	6,034	5,613

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,143							
15,000-20,999	1,915	1,714						
21,000-26,999	2,687	2,486	2,286					
27,000-32,999	3,458	3,258	3,057	2,857				
33,000-38,999	4,230	4,030	3,829	3,629	3,428			
39,000-44,999	5,002	4,802	4,601	4,401	4,200	4,000		
45,000-53,999	5,774	5,574	5,373	5,173	4,972	4,772	4,571	
54,000-64,999	7,318	7,117	6,917	6,716	6,516	6,315	6,115	5,714

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,150							
15,000-20,999	1,922	1,726						
21,000-26,999	2,694	2,497	2,301					
27,000-32,999	3,466	3,269	3,073	2,876				
33,000-38,999	4,238	4,041	3,845	3,648	3,451			
39,000-44,999	5,010	4,813	4,616	4,420	4,223	4,026		
45,000-53,999	5,782	5,585	5,388	5,192	4,995	4,798	4,602	
54,000-64,999	7,326	7,129	6,932	6,735	6,539	6,342	6,145	5,752

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,158							
15,000-20,999	1,930	1,737						
21,000-26,999	2,702	2,508	2,315					
27,000-32,999	3,473	3,280	3,087	2,894				
33,000-38,999	4,245	4,052	3,859	3,666	3,473			
39,000-44,999	5,017	4,824	4,631	4,438	4,245	4,052		
45,000-53,999	5,789	5,596	5,403	5,210	5,017	4,824	4,631	
54,000-64,999	7,333	7,140	6,947	6,754	6,561	6,368	6,175	5,789

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,165							
15,000-20,999	1,937	1,747						
21,000-26,999	2,709	2,519	2,330					
27,000-32,999	3,480	3,291	3,101	2,912				
33,000-38,999	4,252	4,063	3,873	3,684	3,494			
39,000-44,999	5,024	4,835	4,645	4,456	4,266	4,077		
45,000-53,999	5,796	5,607	5,417	5,228	5,038	4,849	4,659	
54,000-64,999	7,340	7,150	6,961	6,771	6,582	6,392	6,203	5,824

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,172							
15,000-20,999	1,943	1,757						
21,000-26,999	2,715	2,529	2,343					
27,000-32,999	3,487	3,301	3,115	2,929				
33,000-38,999	4,259	4,073	3,887	3,701	3,515			
39,000-44,999	5,031	4,845	4,659	4,473	4,287	4,101		
45,000-53,999	5,803	5,617	5,431	5,245	5,059	4,872	4,686	
54,000-64,999	7,347	7,161	6,975	6,788	6,602	6,416	6,230	5,858

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1,176							
15,000-20,999	1,947	1,763						
21,000-26,999	2,719	2,535	2,351					
27,000-32,999	3,491	3,307	3,123	2,939				
33,000-38,999	4,263	4,079	3,895	3,711	3,527			
39,000-44,999	5,035	4,851	4,667	4,483	4,299	4,114		
45,000-53,999	5,807	5,623	5,439	5,255	5,070	4,886	4,702	
54,000-64,999	7,351	7,167	6,983	6,798	6,614	6,430	6,246	5,878

Climate Zone 5: West Region, El Paso

See Table 499 through Table 502 for the energy savings (kWh) per heating load type associated with a mini-split heat pump replacing another heat pump for all five Texas climate zones.

The following deemed savings assume no back-up electric resistance heat for the efficient case.

Heating, New Construction/Replace-on-Burnout

Table 499. Mini-Split Energy Savings (Heating kWh) for 8.2 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	81							
15,000-20,999	667	122						
21,000-26,999	1,253	708	163					
27,000-32,999	1,839	1,294	749	203				
33,000-38,999	2,425	1,880	1,334	789	244			
39,000-44,999	3,011	2,465	1,920	1,375	830	285		
45,000-53,999	3,596	3,051	2,506	1,961	1,416	871	325	
54,000-64,999	4,768	4,223	3,678	3,133	2,587	2,042	1,497	407

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	174							
15,000-20,999	760	261						
21,000-26,999	1,345	846	348					
27,000-32,999	1,931	1,432	933	434				
33,000-38,999	2,517	2,018	1,519	1,020	521			
39,000-44,999	3,103	2,604	2,105	1,606	1,107	608		
45,000-53,999	3,689	3,190	2,691	2,192	1,693	1,194	695	
54,000-64,999	4,861	4,362	3,863	3,364	2,865	2,366	1,867	869
9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	222							
15,000-20,999	808	333						
21,000-26,999	1,393	918	443					
27,000-32,999	1,979	1,504	1,029	554				
33,000-38,999	2,565	2,090	1,615	1,140	665			
39,000-44,999	3,151	2,676	2,201	1,726	1,251	776		
45,000-53,999	3,737	3,262	2,787	2,312	1,837	1,362	887	
54,000-64,999	4,908	4,434	3,959	3,484	3,009	2,534	2,059	1,109
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	240							
15,000-20,999	826	360						
21,000-26,999	1,411	946	480					
27,000-32,999	1,997	1,531	1,065	599				
33,000-38,999	2,583	2,117	1,651	1,185	719			
39,000-44,999	3,169	2,703	2,237	1,771	1,305	839		
45,000-53,999	3,755	3,289	2,823	2,357	1,891	1,425	959	
54,000-64,999	4,927	4,461	3,995	3,529	3,063	2,597	2,131	1,199

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	257							
15,000-20,999	843	386						
21,000-26,999	1,429	972	514					
27,000-32,999	2,015	1,557	1,100	643				
33,000-38,999	2,601	2,143	1,686	1,229	771			
39,000-44,999	3,186	2,729	2,272	1,815	1,357	900		
45,000-53,999	3,772	3,315	2,858	2,400	1,943	1,486	1,029	
54,000-64,999	4,944	4,487	4,029	3,572	3,115	2,658	2,200	1,286

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	274							
15,000-20,999	860	411						
21,000-26,999	1,446	997	548					
27,000-32,999	2,031	1,583	1,134	685				
33,000-38,999	2,617	2,168	1,719	1,271	822			
39,000-44,999	3,203	2,754	2,305	1,856	1,408	959		
45,000-53,999	3,789	3,340	2,891	2,442	1,993	1,544	1,096	
54,000-64,999	4,961	4,512	4,063	3,614	3,165	2,716	2,267	1,369

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	290							
15,000-20,999	876	435						
21,000-26,999	1,462	1,021	580					
27,000-32,999	2,048	1,607	1,166	725				
33,000-38,999	2,633	2,193	1,752	1,311	870			
39,000-44,999	3,219	2,778	2,338	1,897	1,456	1,015		
45,000-53,999	3,805	3,364	2,923	2,483	2,042	1,601	1,160	
54,000-64,999	4,977	4,536	4,095	3,654	3,213	2,773	2,332	1,450

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	299							
15,000-20,999	885	449						
21,000-26,999	1,471	1,035	599					
27,000-32,999	2,057	1,621	1,185	749				
33,000-38,999	2,643	2,207	1,771	1,334	898			
39,000-44,999	3,229	2,793	2,356	1,920	1,484	1,048		
45,000-53,999	3,814	3,378	2,942	2,506	2,070	1,634	1,198	
54,000-64,999	4,986	4,550	4,114	3,678	3,242	2,806	2,369	1,497

Heating, Early Retirement of a Heat Pump

Table 500. Mini-Split Energy Savings (Heating kWh) for 7.7 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	197							
15,000-20,999	840	295						
21,000-26,999	1,484	938	393					
27,000-32,999	2,127	1,582	1,037	492				
33,000-38,999	2,770	2,225	1,680	1,135	590			
39,000-44,999	3,414	2,869	2,324	1,778	1,233	688		
45,000-53,999	4,057	3,512	2,967	2,422	1,877	1,332	786	
54,000-64,999	5,344	4,799	4,254	3,709	3,164	2,619	2,073	983

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	289							
15,000-20,999	932	434						
21,000-26,999	1,576	1,077	578					
27,000-32,999	2,219	1,720	1,221	723				
33,000-38,999	2,863	2,364	1,865	1,366	867			
39,000-44,999	3,506	3,007	2,508	2,009	1,511	1,012		
45,000-53,999	4,150	3,651	3,152	2,653	2,154	1,655	1,156	
54,000-64,999	5,437	4,938	4,439	3,940	3,441	2,942	2,443	1,445

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	337							
15,000-20,999	980	505						
21,000-26,999	1,624	1,149	674					
27,000-32,999	2,267	1,792	1,317	842				
33,000-38,999	2,911	2,436	1,961	1,486	1,011			
39,000-44,999	3,554	3,079	2,604	2,129	1,654	1,179		
45,000-53,999	4,198	3,723	3,248	2,773	2,298	1,823	1,348	
54,000-64,999	5,485	5,010	4,535	4,060	3,585	3,110	2,635	1,685

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	355							
15,000-20,999	999	533						
21,000-26,999	1,642	1,176	710					
27,000-32,999	2,285	1,819	1,354	888				
33,000-38,999	2,929	2,463	1,997	1,531	1,065			
39,000-44,999	3,572	3,106	2,640	2,175	1,709	1,243		
45,000-53,999	4,216	3,750	3,284	2,818	2,352	1,886	1,420	
54,000-64,999	5,503	5,037	4,571	4,105	3,639	3,173	2,707	1,775

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	372							
15,000-20,999	1,016	559						
21,000-26,999	1,659	1,202	745					
27,000-32,999	2,303	1,846	1,388	931				
33,000-38,999	2,946	2,489	2,032	1,574	1,117			
39,000-44,999	3,590	3,132	2,675	2,218	1,761	1,303		
45,000-53,999	4,233	3,776	3,319	2,861	2,404	1,947	1,490	
54,000-64,999	5,520	5,063	4,606	4,148	3,691	3,234	2,777	1,862
11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	389							
15,000-20,999	1,033	584						
21,000-26,999	1,676	1,227	778					
27,000-32,999	2,320	1,871	1,422	973				
33,000-38,999	2,963	2,514	2,065	1,616	1,167			
39,000-44,999	3,606	3,158	2,709	2,260	1,811	1,362		
45,000-53,999	4,250	3,801	3,352	2,903	2,454	2,005	1,557	
54,000-64,999	5,537	5,088	4,639	4,190	3,741	3,292	2,844	1,946
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	405							
15,000-20,999	1,049	608						
21,000-26,999	1,692	1,251	811					
27,000-32,999	2,336	1,895	1,454	1,013				
33,000-38,999	2,979	2,538	2,097	1,657	1,216			
39,000-44,999	3,623	3,182	2,741	2,300	1,859	1,418		
45,000-53,999	4,266	3,825	3,384	2,944	2,503	2,062	1,621	
54,000-64,999	5,553	5,112	4,671	4,231	3,790	3,349	2,908	2,026

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	415							
15,000-20,999	1,058	622						
21,000-26,999	1,702	1,265	829					
27,000-32,999	2,345	1,909	1,473	1,037				
33,000-38,999	2,989	2,552	2,116	1,680	1,244			
39,000-44,999	3,632	3,196	2,760	2,324	1,888	1,451		
45,000-53,999	4,275	3,839	3,403	2,967	2,531	2,095	1,659	
54,000-64,999	5,562	5,126	4,690	4,254	3,818	3,382	2,946	2,073

Table 501. Mini-Split Energy Savings (Heating kWh) for 6.8 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	473							
15,000-20,999	1,255	710						
21,000-26,999	2,037	1,492	947					
27,000-32,999	2,819	2,274	1,729	1,184				
33,000-38,999	3,601	3,056	2,511	1,966	1,420			
39,000-44,999	4,383	3,838	3,293	2,748	2,202	1,657		
45,000-53,999	5,165	4,620	4,075	3,529	2,984	2,439	1,894	
54,000-64,999	6,729	6,184	5,638	5,093	4,548	4,003	3,458	2,367

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	566							
15,000-20,999	1,348	849						
21,000-26,999	2,130	1,631	1,132					
27,000-32,999	2,912	2,413	1,914	1,415				
33,000-38,999	3,693	3,195	2,696	2,197	1,698			
39,000-44,999	4,475	3,976	3,477	2,979	2,480	1,981		
45,000-53,999	5,257	4,758	4,259	3,760	3,261	2,763	2,264	
54,000-64,999	6,821	6,322	5,823	5,324	4,825	4,326	3,827	2,829

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	614							
15,000-20,999	1,396	921						
21,000-26,999	2,178	1,703	1,228					
27,000-32,999	2,960	2,485	2,010	1,535				
33,000-38,999	3,741	3,267	2,792	2,317	1,842			
39,000-44,999	4,523	4,048	3,573	3,098	2,624	2,149		
45,000-53,999	5,305	4,830	4,355	3,880	3,405	2,930	2,455	
54,000-64,999	6,869	6,394	5,919	5,444	4,969	4,494	4,019	3,069

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	632							
15,000-20,999	1,414	948						
21,000-26,999	2,196	1,730	1,264					
27,000-32,999	2,978	2,512	2,046	1,580				
33,000-38,999	3,760	3,294	2,828	2,362	1,896			
39,000-44,999	4,541	4,075	3,610	3,144	2,678	2,212		
45,000-53,999	5,323	4,857	4,391	3,925	3,460	2,994	2,528	
54,000-64,999	6,887	6,421	5,955	5,489	5,023	4,557	4,091	3,160

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	649							
15,000-20,999	1,431	974						
21,000-26,999	2,213	1,756	1,299					
27,000-32,999	2,995	2,538	2,080	1,623				
33,000-38,999	3,777	3,320	2,862	2,405	1,948			
39,000-44,999	4,559	4,102	3,644	3,187	2,730	2,272		
45,000-53,999	5,341	4,883	4,426	3,969	3,512	3,054	2,597	
54,000-64,999	6,905	6,447	5,990	5,533	5,075	4,618	4,161	3,246

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	666							
15,000-20,999	1,448	999						
21,000-26,999	2,230	1,781	1,332					
27,000-32,999	3,012	2,563	2,114	1,665				
33,000-38,999	3,794	3,345	2,896	2,447	1,998			
39,000-44,999	4,576	4,127	3,678	3,229	2,780	2,331		
45,000-53,999	5,357	4,909	4,460	4,011	3,562	3,113	2,664	
54,000-64,999	6,921	6,472	6,023	5,575	5,126	4,677	4,228	3,330

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	682							
15,000-20,999	1,464	1,023						
21,000-26,999	2,246	1,805	1,364					
27,000-32,999	3,028	2,587	2,146	1,705				
33,000-38,999	3,810	3,369	2,928	2,487	2,046			
39,000-44,999	4,592	4,151	3,710	3,269	2,828	2,388		
45,000-53,999	5,374	4,933	4,492	4,051	3,610	3,169	2,729	
54,000-64,999	6,937	6,497	6,056	5,615	5,174	4,733	4,292	3,411

12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	692							
15,000-20,999	1,473	1,037						
21,000-26,999	2,255	1,819	1,383					
27,000-32,999	3,037	2,601	2,165	1,729				
33,000-38,999	3,819	3,383	2,947	2,511	2,075			
39,000-44,999	4,601	4,165	3,729	3,293	2,857	2,420		
45,000-53,999	5,383	4,947	4,511	4,075	3,638	3,202	2,766	
54,000-64,999	6,947	6,511	6,075	5,638	5,202	4,766	4,330	3,458

Heading, Early Retirement of an Electric Resistance Furnace

Table 502. Mini-Split Energy Savings (Heating kWh) for 3.412 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2,563							
15,000-20,999	4,390	3,844						
21,000-26,999	6,216	5,671	5,126					
27,000-32,999	8,043	7,498	6,953	6,407				
33,000-38,999	9,870	9,324	8,779	8,234	7,689			
39,000-44,999	11,696	11,151	10,606	10,061	9,516	8,970		
45,000-53,999	13,523	12,978	12,432	11,887	11,342	10,797	10,252	
54,000-64,999	17,176	16,631	16,086	15,541	14,995	14,450	13,905	12,815

9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,655							
15,000-20,999	4,482	3,983						
21,000-26,999	6,309	5,810	5,311					
27,000-32,999	8,135	7,636	7,137	6,638				
33,000-38,999	9,962	9,463	8,964	8,465	7,966			
39,000-44,999	11,789	11,290	10,791	10,292	9,793	9,294		
45,000-53,999	13,615	13,116	12,617	12,118	11,619	11,120	10,621	
54,000-64,999	17,268	16,770	16,271	15,772	15,273	14,774	14,275	13,277

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,703							
15,000-20,999	4,530	4,055						
21,000-26,999	6,357	5,882	5,407					
27,000-32,999	8,183	7,708	7,233	6,758				
33,000-38,999	10,010	9,535	9,060	8,585	8,110			
39,000-44,999	11,837	11,362	10,887	10,412	9,937	9,462		
45,000-53,999	13,663	13,188	12,713	12,238	11,763	11,288	10,813	
54,000-64,999	17,316	16,841	16,367	15,892	15,417	14,942	14,467	13,517

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,721							
15,000-20,999	4,548	4,082						
21,000-26,999	6,375	5,909	5,443					
27,000-32,999	8,201	7,735	7,269	6,803				
33,000-38,999	10,028	9,562	9,096	8,630	8,164			
39,000-44,999	11,855	11,389	10,923	10,457	9,991	9,525		
45,000-53,999	13,681	13,215	12,749	12,283	11,817	11,351	10,886	
54,000-64,999	17,334	16,869	16,403	15,937	15,471	15,005	14,539	13,607

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,739							
15,000-20,999	4,565	4,108						
21,000-26,999	6,392	5,935	5,478					
27,000-32,999	8,219	7,761	7,304	6,847				
33,000-38,999	10,045	9,588	9,131	8,674	8,216			
39,000-44,999	11,872	11,415	10,957	10,500	10,043	9,586		
45,000-53,999	13,699	13,241	12,784	12,327	11,870	11,412	10,955	
54,000-64,999	17,352	16,895	16,437	15,980	15,523	15,066	14,608	13,694

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,755							
15,000-20,999	4,582	4,133						
21,000-26,999	6,409	5,960	5,511					
27,000-32,999	8,235	7,787	7,338	6,889				
33,000-38,999	10,062	9,613	9,164	8,715	8,266			
39,000-44,999	11,889	11,440	10,991	10,542	10,093	9,644		
45,000-53,999	13,715	13,266	12,818	12,369	11,920	11,471	11,022	
54,000-64,999	17,369	16,920	16,471	16,022	15,573	15,124	14,675	13,777

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,772							
15,000-20,999	4,598	4,157						
21,000-26,999	6,425	5,984	5,543					
27,000-32,999	8,252	7,811	7,370	6,929				
33,000-38,999	10,078	9,637	9,197	8,756	8,315			
39,000-44,999	11,905	11,464	11,023	10,582	10,141	9,701		
45,000-53,999	13,731	13,291	12,850	12,409	11,968	11,527	11,086	
54,000-64,999	17,385	16,944	16,503	16,062	15,621	15,181	14,740	13,858

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2,781							
15,000-20,999	4,608	4,172						
21,000-26,999	6,434	5,998	5,562					
27,000-32,999	8,261	7,825	7,389	6,953				
33,000-38,999	10,088	9,651	9,215	8,779	8,343			
39,000-44,999	11,914	11,478	11,042	10,606	10,170	9,734		
45,000-53,999	13,741	13,305	12,869	12,432	11,996	11,560	11,124	
54,000-64,999	17,394	16,958	16,522	16,086	15,650	15,213	14,777	13,905

Deemed Summer Demand Savings Tables[566]

Refer to Appendix A, Table 443 through Table 462.

Deemed Winter Demand Savings Tables[567]

Table 503 through Table 522 present the winter demand savings (kW) for all five Texas climate zones. In each table, the capacity of the efficient unit is represented in the columns and the capacity of the existing unit is represented in the rows. The savings are in the intersection of the appropriate efficient and existing capacities. Replacements where there has been to change in capacity are highlighted in light blue.

The rightsizing savings specified in the tables below are only applicable to replace-on-burnout and early retirement projects. New construction projects are not eligible to receive deemed savings for system rightsizing.[568]

The following heating savings assume no back-up electric resistance heat for the efficient case.

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[566] Rated capacity ranges are specified based on normal rounding convention between capacity categories (values at and above the midpoint round up, while values below the midpoint round down).

[567] Rated capacity ranges are specified with a 5 percent tolerance in accordance with AHRI Standard 210/240 to account for systems that are rated slightly below the applicable nominal capacity. AHRI Standard 210/240. Table J1. http://www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_210-240_2017.pdf.

[568] For projects using a custom baseline, see TRM Volume 4.

Climate Zone 1: Panhandle Region, Amarillo

Heating, New Construction/Replace-on-Burnout

Table 503. Mini-Split Winter Demand Savings for 8.2 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.60							
15,000-20,999	1.26	0.89						
21,000-26,999	1.93	1.56	1.19					
27,000-32,999	2.60	2.23	1.86	1.49				
33,000-38,999	3.26	2.89	2.53	2.16	1.79			
39,000-44,999	3.93	3.56	3.19	2.82	2.45	2.08		
45,000-53,999	4.60	4.23	3.86	3.49	3.12	2.75	2.38	
54,000-64,999	5.93	5.56	5.19	4.82	4.46	4.09	3.72	2.98
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.66							
15,000-20,999	1.33	0.99						
21,000-26,999	1.99	1.65	1.32					
27,000-32,999	2.66	2.32	1.98	1.65				
33,000-38,999	3.33	2.99	2.65	2.31	1.97			
39,000-44,999	3.99	3.66	3.32	2.98	2.64	2.30		
45,000-53,999	4.66	4.32	3.99	3.65	3.31	2.97	2.63	
54,000-64,999	6.00	5.66	5.32	4.98	4.64	4.31	3.97	3.29

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.69							
15,000-20,999	1.36	1.04						
21,000-26,999	2.03	1.70	1.38					
27,000-32,999	2.69	2.37	2.05	1.73				
33,000-38,999	3.36	3.04	2.72	2.39	2.07			
39,000-44,999	4.03	3.70	3.38	3.06	2.74	2.42		
45,000-53,999	4.69	4.37	4.05	3.73	3.41	3.08	2.76	
54,000-64,999	6.03	5.71	5.38	5.06	4.74	4.42	4.10	3.45

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.70							
15,000-20,999	1.37	1.05						
21,000-26,999	2.04	1.72	1.41					
27,000-32,999	2.70	2.39	2.07	1.76				
33,000-38,999	3.37	3.06	2.74	2.42	2.11			
39,000-44,999	4.04	3.72	3.41	3.09	2.78	2.46		
45,000-53,999	4.71	4.39	4.07	3.76	3.44	3.13	2.81	
54,000-64,999	6.04	5.72	5.41	5.09	4.78	4.46	4.15	3.51

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.71							
15,000-20,999	1.38	1.07						
21,000-26,999	2.05	1.74	1.43					
27,000-32,999	2.72	2.41	2.10	1.79				
33,000-38,999	3.38	3.07	2.76	2.45	2.14			
39,000-44,999	4.05	3.74	3.43	3.12	2.81	2.50		
45,000-53,999	4.72	4.41	4.10	3.79	3.48	3.17	2.86	
54,000-64,999	6.05	5.74	5.43	5.12	4.81	4.50	4.19	3.57

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.73							
15,000-20,999	1.39	1.09						
21,000-26,999	2.06	1.76	1.45					
27,000-32,999	2.73	2.42	2.12	1.82				
33,000-38,999	3.39	3.09	2.79	2.48	2.18			
39,000-44,999	4.06	3.76	3.45	3.15	2.85	2.54		
45,000-53,999	4.73	4.42	4.12	3.82	3.51	3.21	2.90	
54,000-64,999	6.06	5.76	5.46	5.15	4.85	4.54	4.24	3.63
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.74							
15,000-20,999	1.40	1.11						
21,000-26,999	2.07	1.77	1.47					
27,000-32,999	2.74	2.44	2.14	1.84				
33,000-38,999	3.41	3.11	2.81	2.51	2.21			
39,000-44,999	4.07	3.77	3.48	3.18	2.88	2.58		
45,000-53,999	4.74	4.44	4.14	3.84	3.55	3.25	2.95	
54,000-64,999	6.07	5.78	5.48	5.18	4.88	4.58	4.28	3.69
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.74							
15,000-20,999	1.41	1.12						
21,000-26,999	2.08	1.78	1.49					
27,000-32,999	2.74	2.45	2.15	1.86				
33,000-38,999	3.41	3.12	2.82	2.53	2.23			
39,000-44,999	4.08	3.78	3.49	3.19	2.90	2.60		
45,000-53,999	4.75	4.45	4.16	3.86	3.56	3.27	2.97	
54,000-64,999	6.08	5.79	5.49	5.19	4.90	4.60	4.31	3.72

Heating, Early Retirement of a Heat Pump

Table 504. Mini-Split Winter Demand Savings for 7.7 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.67							
15,000-20,999	1.38	1.01						
21,000-26,999	2.09	1.72	1.35					
27,000-32,999	2.79	2.42	2.05	1.68				
33,000-38,999	3.50	3.13	2.76	2.39	2.02			
39,000-44,999	4.20	3.84	3.47	3.10	2.73	2.36		
45,000-53,999	4.91	4.54	4.17	3.80	3.43	3.06	2.69	
54,000-64,999	6.32	5.95	5.58	5.22	4.85	4.48	4.11	3.37
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.74							
15,000-20,999	1.44	1.10						
21,000-26,999	2.15	1.81	1.47					
27,000-32,999	2.85	2.52	2.18	1.84				
33,000-38,999	3.56	3.22	2.89	2.55	2.21			
39,000-44,999	4.27	3.93	3.59	3.25	2.92	2.58		
45,000-53,999	4.97	4.64	4.30	3.96	3.62	3.28	2.95	
54,000-64,999	6.39	6.05	5.71	5.37	5.03	4.70	4.36	3.68

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.77							
15,000-20,999	1.48	1.15						
21,000-26,999	2.18	1.86	1.54					
27,000-32,999	2.89	2.57	2.24	1.92				
33,000-38,999	3.59	3.27	2.95	2.63	2.31			
39,000-44,999	4.30	3.98	3.66	3.33	3.01	2.69		
45,000-53,999	5.01	4.68	4.36	4.04	3.72	3.40	3.08	
54,000-64,999	6.42	6.10	5.77	5.45	5.13	4.81	4.49	3.84
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.78							
15,000-20,999	1.49	1.17						
21,000-26,999	2.19	1.88	1.56					
27,000-32,999	2.90	2.58	2.27	1.95				
33,000-38,999	3.61	3.29	2.97	2.66	2.34			
39,000-44,999	4.31	4.00	3.68	3.37	3.05	2.73		
45,000-53,999	5.02	4.70	4.39	4.07	3.76	3.44	3.12	
54,000-64,999	6.43	6.12	5.80	5.48	5.17	4.85	4.54	3.91
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.79							
15,000-20,999	1.50	1.19						
21,000-26,999	2.21	1.90	1.59					
27,000-32,999	2.91	2.60	2.29	1.98				
33,000-38,999	3.62	3.31	3.00	2.69	2.38			
39,000-44,999	4.32	4.01	3.70	3.39	3.08	2.77		
45,000-53,999	5.03	4.72	4.41	4.10	3.79	3.48	3.17	
54,000-64,999	6.44	6.13	5.82	5.51	5.20	4.89	4.58	3.96

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.80							
15,000-20,999	1.51	1.21						
21,000-26,999	2.22	1.91	1.61					
27,000-32,999	2.92	2.62	2.31	2.01				
33,000-38,999	3.63	3.32	3.02	2.72	2.41			
39,000-44,999	4.34	4.03	3.73	3.42	3.12	2.81		
45,000-53,999	5.04	4.74	4.43	4.13	3.82	3.52	3.22	
54,000-64,999	6.45	6.15	5.85	5.54	5.24	4.93	4.63	4.02

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.82							
15,000-20,999	1.52	1.22						
21,000-26,999	2.23	1.93	1.63					
27,000-32,999	2.93	2.64	2.34	2.04				
33,000-38,999	3.64	3.34	3.04	2.74	2.45			
39,000-44,999	4.35	4.05	3.75	3.45	3.15	2.85		
45,000-53,999	5.05	4.75	4.46	4.16	3.86	3.56	3.26	
54,000-64,999	6.46	6.17	5.87	5.57	5.27	4.97	4.67	4.08

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.82							
15,000-20,999	1.53	1.23						
21,000-26,999	2.23	1.94	1.64					
27,000-32,999	2.94	2.64	2.35	2.05				
33,000-38,999	3.65	3.35	3.06	2.76	2.46			
39,000-44,999	4.35	4.06	3.76	3.47	3.17	2.88		
45,000-53,999	5.06	4.76	4.47	4.17	3.88	3.58	3.29	
54,000-64,999	6.47	6.18	5.88	5.58	5.29	4.99	4.70	4.11

Table 505. Mini-Split Winter Demand Savings for 6.8 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.86							
15,000-20,999	1.66	1.29						
21,000-26,999	2.46	2.09	1.72					
27,000-32,999	3.26	2.89	2.52	2.15				
33,000-38,999	4.06	3.69	3.32	2.95	2.58			
39,000-44,999	4.86	4.49	4.12	3.75	3.38	3.01		
45,000-53,999	5.66	5.29	4.92	4.55	4.18	3.81	3.45	
54,000-64,999	7.26	6.89	6.52	6.15	5.78	5.41	5.05	4.31
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.92							
15,000-20,999	1.72	1.39						
21,000-26,999	2.52	2.19	1.85					
27,000-32,999	3.32	2.99	2.65	2.31				
33,000-38,999	4.12	3.79	3.45	3.11	2.77			
39,000-44,999	4.92	4.59	4.25	3.91	3.57	3.23		
45,000-53,999	5.72	5.39	5.05	4.71	4.37	4.03	3.70	
54,000-64,999	7.32	6.99	6.65	6.31	5.97	5.63	5.30	4.62

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.96							
15,000-20,999	1.76	1.43						
21,000-26,999	2.56	2.23	1.91					
27,000-32,999	3.36	3.03	2.71	2.39				
33,000-38,999	4.16	3.83	3.51	3.19	2.87			
39,000-44,999	4.96	4.63	4.31	3.99	3.67	3.35		
45,000-53,999	5.76	5.43	5.11	4.79	4.47	4.15	3.83	
54,000-64,999	7.36	7.03	6.71	6.39	6.07	5.75	5.43	4.78

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.97							
15,000-20,999	1.77	1.45						
21,000-26,999	2.57	2.25	1.94					
27,000-32,999	3.37	3.05	2.74	2.42				
33,000-38,999	4.17	3.85	3.54	3.22	2.91			
39,000-44,999	4.97	4.65	4.34	4.02	3.71	3.39		
45,000-53,999	5.77	5.45	5.14	4.82	4.51	4.19	3.87	
54,000-64,999	7.37	7.05	6.74	6.42	6.11	5.79	5.47	4.84

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.98							
15,000-20,999	1.78	1.47						
21,000-26,999	2.58	2.27	1.96					
27,000-32,999	3.38	3.07	2.76	2.45				
33,000-38,999	4.18	3.87	3.56	3.25	2.94			
39,000-44,999	4.98	4.67	4.36	4.05	3.74	3.43		
45,000-53,999	5.78	5.47	5.16	4.85	4.54	4.23	3.92	
54,000-64,999	7.38	7.07	6.76	6.45	6.14	5.83	5.52	4.90

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.99							
15,000-20,999	1.79	1.49						
21,000-26,999	2.59	2.29	1.98					
27,000-32,999	3.39	3.09	2.78	2.48				
33,000-38,999	4.19	3.89	3.58	3.28	2.98			
39,000-44,999	4.99	4.69	4.38	4.08	3.78	3.47		
45,000-53,999	5.79	5.49	5.18	4.88	4.58	4.27	3.97	
54,000-64,999	7.39	7.09	6.78	6.48	6.18	5.87	5.57	4.96

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.00							
15,000-20,999	1.80	1.50						
21,000-26,999	2.60	2.30	2.01					
27,000-32,999	3.40	3.10	2.81	2.51				
33,000-38,999	4.20	3.90	3.61	3.31	3.01			
39,000-44,999	5.00	4.70	4.41	4.11	3.81	3.51		
45,000-53,999	5.80	5.50	5.21	4.91	4.61	4.31	4.01	
54,000-64,999	7.40	7.10	6.81	6.51	6.21	5.91	5.61	5.01

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.01							
15,000-20,999	1.81	1.51						
21,000-26,999	2.61	2.31	2.02					
27,000-32,999	3.41	3.11	2.82	2.52				
33,000-38,999	4.21	3.91	3.62	3.32	3.03			
39,000-44,999	5.01	4.71	4.42	4.12	3.83	3.53		
45,000-53,999	5.81	5.51	5.22	4.92	4.63	4.33	4.04	
54,000-64,999	7.41	7.11	6.82	6.52	6.23	5.93	5.64	5.05

Heading, Early Retirement of an Electric Resistance Furnace

Table 506. Mini-Split Winter Demand Savings for 3.412 HSPF Baseline—Zone 1

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.06							
15,000-20,999	3.46	3.09						
21,000-26,999	4.86	4.49	4.12					
27,000-32,999	6.26	5.89	5.52	5.15				
33,000-38,999	7.66	7.29	6.92	6.55	6.18			
39,000-44,999	9.06	8.69	8.32	7.95	7.58	7.21		
45,000-53,999	10.45	10.09	9.72	9.35	8.98	8.61	8.24	
54,000-64,999	13.25	12.88	12.51	12.14	11.78	11.41	11.04	10.30
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.12							
15,000-20,999	3.52	3.18						
21,000-26,999	4.92	4.58	4.24					
27,000-32,999	6.32	5.98	5.64	5.31				
33,000-38,999	7.72	7.38	7.04	6.70	6.37			
39,000-44,999	9.12	8.78	8.44	8.10	7.77	7.43		
45,000-53,999	10.52	10.18	9.84	9.50	9.17	8.83	8.49	
54,000-64,999	13.32	12.98	12.64	12.30	11.96	11.63	11.29	10.61

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.15							
15,000-20,999	3.55	3.23						
21,000-26,999	4.95	4.63	4.31					
27,000-32,999	6.35	6.03	5.71	5.39				
33,000-38,999	7.75	7.43	7.11	6.79	6.46			
39,000-44,999	9.15	8.83	8.51	8.19	7.86	7.54		
45,000-53,999	10.55	10.23	9.91	9.58	9.26	8.94	8.62	
54,000-64,999	13.35	13.03	12.70	12.38	12.06	11.74	11.42	10.77

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.17							
15,000-20,999	3.57	3.25						
21,000-26,999	4.97	4.65	4.33					
27,000-32,999	6.36	6.05	5.73	5.42				
33,000-38,999	7.76	7.45	7.13	6.82	6.50			
39,000-44,999	9.16	8.85	8.53	8.22	7.90	7.58		
45,000-53,999	10.56	10.25	9.93	9.61	9.30	8.98	8.67	
54,000-64,999	13.36	13.04	12.73	12.41	12.10	11.78	11.47	10.83

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.18							
15,000-20,999	3.58	3.27						
21,000-26,999	4.98	4.67	4.36					
27,000-32,999	6.38	6.07	5.76	5.45				
33,000-38,999	7.78	7.47	7.16	6.85	6.54			
39,000-44,999	9.17	8.86	8.56	8.25	7.94	7.63		
45,000-53,999	10.57	10.26	9.95	9.64	9.33	9.02	8.71	
54,000-64,999	13.37	13.06	12.75	12.44	12.13	11.82	11.51	10.89

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.19							
15,000-20,999	3.59	3.29						
21,000-26,999	4.99	4.68	4.38					
27,000-32,999	6.39	6.08	5.78	5.48				
33,000-38,999	7.79	7.48	7.18	6.87	6.57			
39,000-44,999	9.19	8.88	8.58	8.27	7.97	7.67		
45,000-53,999	10.59	10.28	9.98	9.67	9.37	9.06	8.76	
54,000-64,999	13.38	13.08	12.78	12.47	12.17	11.86	11.56	10.95

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.20							
15,000-20,999	3.60	3.30						
21,000-26,999	5.00	4.70	4.40					
27,000-32,999	6.40	6.10	5.80	5.50				
33,000-38,999	7.80	7.50	7.20	6.90	6.60			
39,000-44,999	9.20	8.90	8.60	8.30	8.00	7.70		
45,000-53,999	10.60	10.30	10.00	9.70	9.40	9.10	8.80	
54,000-64,999	13.39	13.10	12.80	12.50	12.20	11.90	11.60	11.01

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.21							
15,000-20,999	3.61	3.31						
21,000-26,999	5.01	4.71	4.41					
27,000-32,999	6.40	6.11	5.81	5.52				
33,000-38,999	7.80	7.51	7.21	6.92	6.62			
39,000-44,999	9.20	8.91	8.61	8.32	8.02	7.73		
45,000-53,999	10.60	10.31	10.01	9.72	9.42	9.13	8.83	
54,000-64,999	13.40	13.11	12.81	12.51	12.22	11.92	11.63	11.04

Climate Zone 2: North Region, Dallas/Fort Worth

Heating, New Construction/Replace-on-Burnout

Table 507. Mini-Split Winter Demand Savings for 8.2 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.50							
15,000-20,999	1.12	0.75						
21,000-26,999	1.74	1.37	1.00					
27,000-32,999	2.36	1.99	1.62	1.25				
33,000-38,999	2.98	2.61	2.24	1.87	1.50			
39,000-44,999	3.61	3.23	2.86	2.49	2.12	1.75		
45,000-53,999	4.23	3.86	3.48	3.11	2.74	2.37	2.00	
54,000-64,999	5.47	5.10	4.73	4.36	3.98	3.61	3.24	2.50
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.56							
15,000-20,999	1.18	0.84						
21,000-26,999	1.81	1.47	1.13					
27,000-32,999	2.43	2.09	1.75	1.41				
33,000-38,999	3.05	2.71	2.37	2.03	1.69			
39,000-44,999	3.67	3.33	2.99	2.65	2.31	1.97		
45,000-53,999	4.29	3.95	3.61	3.27	2.93	2.59	2.25	
54,000-64,999	5.53	5.19	4.85	4.51	4.17	3.83	3.49	2.81

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.60							
15,000-20,999	1.22	0.89						
21,000-26,999	1.84	1.51	1.19					
27,000-32,999	2.46	2.14	1.81	1.49				
33,000-38,999	3.08	2.76	2.43	2.11	1.79			
39,000-44,999	3.70	3.38	3.05	2.73	2.41	2.08		
45,000-53,999	4.32	4.00	3.68	3.35	3.03	2.71	2.38	
54,000-64,999	5.57	5.24	4.92	4.60	4.27	3.95	3.62	2.98

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.61							
15,000-20,999	1.23	0.91						
21,000-26,999	1.85	1.53	1.22					
27,000-32,999	2.47	2.15	1.84	1.52				
33,000-38,999	3.09	2.78	2.46	2.14	1.82			
39,000-44,999	3.71	3.40	3.08	2.76	2.44	2.13		
45,000-53,999	4.34	4.02	3.70	3.38	3.07	2.75	2.43	
54,000-64,999	5.58	5.26	4.94	4.63	4.31	3.99	3.67	3.04

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.62							
15,000-20,999	1.24	0.93						
21,000-26,999	1.86	1.55	1.24					
27,000-32,999	2.48	2.17	1.86	1.55				
33,000-38,999	3.10	2.79	2.48	2.17	1.86			
39,000-44,999	3.73	3.41	3.10	2.79	2.48	2.17		
45,000-53,999	4.35	4.04	3.72	3.41	3.10	2.79	2.48	
54,000-64,999	5.59	5.28	4.97	4.66	4.34	4.03	3.72	3.10

11.0-11.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.63							
15,000-20,999	1.25	0.95						
21,000-26,999	1.87	1.57	1.26					
27,000-32,999	2.49	2.19	1.88	1.58				
33,000-38,999	3.12	2.81	2.50	2.20	1.89			
39,000-44,999	3.74	3.43	3.13	2.82	2.51	2.21		
45,000-53,999	4.36	4.05	3.75	3.44	3.14	2.83	2.52	
54,000-64,999	5.60	5.30	4.99	4.68	4.38	4.07	3.77	3.16

11.5-11.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.64							
15,000-20,999	1.26	0.96						
21,000-26,999	1.88	1.58	1.28					
27,000-32,999	2.51	2.21	1.91	1.61				
33,000-38,999	3.13	2.83	2.53	2.23	1.93			
39,000-44,999	3.75	3.45	3.15	2.85	2.55	2.25		
45,000-53,999	4.37	4.07	3.77	3.47	3.17	2.87	2.57	
54,000-64,999	5.61	5.31	5.01	4.71	4.41	4.11	3.81	3.21

12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.65							
15,000-20,999	1.27	0.97						
21,000-26,999	1.89	1.59	1.30					
27,000-32,999	2.51	2.22	1.92	1.62				
33,000-38,999	3.13	2.84	2.54	2.24	1.95			
39,000-44,999	3.75	3.46	3.16	2.86	2.57	2.27		
45,000-53,999	4.38	4.08	3.78	3.48	3.19	2.89	2.59	
54,000-64,999	5.62	5.32	5.02	4.73	4.43	4.13	3.84	3.24

Heating, Early Retirement of a Heat Pump

Table 508. Mini-Split Winter Demand Savings for 7.7 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.58							
15,000-20,999	1.24	0.87						
21,000-26,999	1.90	1.53	1.16					
27,000-32,999	2.56	2.19	1.82	1.45				
33,000-38,999	3.22	2.85	2.48	2.11	1.74			
39,000-44,999	3.88	3.51	3.14	2.77	2.40	2.02		
45,000-53,999	4.54	4.17	3.80	3.43	3.06	2.69	2.31	
54,000-64,999	5.86	5.49	5.12	4.75	4.38	4.01	3.63	2.89
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.64							
15,000-20,999	1.30	0.96						
21,000-26,999	1.96	1.62	1.28					
27,000-32,999	2.62	2.28	1.94	1.60				
33,000-38,999	3.28	2.94	2.60	2.26	1.92			
39,000-44,999	3.94	3.60	3.26	2.92	2.58	2.24		
45,000-53,999	4.60	4.26	3.92	3.58	3.25	2.91	2.57	
54,000-64,999	5.93	5.59	5.25	4.91	4.57	4.23	3.89	3.21

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.67							
15,000-20,999	1.33	1.01						
21,000-26,999	1.99	1.67	1.35					
27,000-32,999	2.66	2.33	2.01	1.69				
33,000-38,999	3.32	2.99	2.67	2.35	2.02			
39,000-44,999	3.98	3.65	3.33	3.01	2.68	2.36		
45,000-53,999	4.64	4.31	3.99	3.67	3.34	3.02	2.70	
54,000-64,999	5.96	5.63	5.31	4.99	4.66	4.34	4.02	3.37

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.69							
15,000-20,999	1.35	1.03						
21,000-26,999	2.01	1.69	1.37					
27,000-32,999	2.67	2.35	2.03	1.72				
33,000-38,999	3.33	3.01	2.69	2.38	2.06			
39,000-44,999	3.99	3.67	3.35	3.04	2.72	2.40		
45,000-53,999	4.65	4.33	4.01	3.70	3.38	3.06	2.75	
54,000-64,999	5.97	5.65	5.34	5.02	4.70	4.38	4.07	3.43

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.70							
15,000-20,999	1.36	1.05						
21,000-26,999	2.02	1.71	1.40					
27,000-32,999	2.68	2.37	2.06	1.75				
33,000-38,999	3.34	3.03	2.72	2.41	2.09			
39,000-44,999	4.00	3.69	3.38	3.07	2.76	2.44		
45,000-53,999	4.66	4.35	4.04	3.73	3.42	3.10	2.79	
54,000-64,999	5.98	5.67	5.36	5.05	4.74	4.43	4.11	3.49

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.71							
15,000-20,999	1.37	1.06						
21,000-26,999	2.03	1.72	1.42					
27,000-32,999	2.69	2.39	2.08	1.77				
33,000-38,999	3.35	3.05	2.74	2.43	2.13			
39,000-44,999	4.01	3.71	3.40	3.09	2.79	2.48		
45,000-53,999	4.67	4.37	4.06	3.76	3.45	3.14	2.84	
54,000-64,999	5.99	5.69	5.38	5.08	4.77	4.46	4.16	3.55

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.72							
15,000-20,999	1.38	1.08						
21,000-26,999	2.04	1.74	1.44					
27,000-32,999	2.70	2.40	2.10	1.80				
33,000-38,999	3.36	3.06	2.76	2.46	2.16			
39,000-44,999	4.02	3.72	3.42	3.12	2.82	2.52		
45,000-53,999	4.68	4.38	4.08	3.78	3.48	3.18	2.88	
54,000-64,999	6.00	5.70	5.40	5.10	4.80	4.50	4.20	3.60

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.73							
15,000-20,999	1.39	1.09						
21,000-26,999	2.05	1.75	1.45					
27,000-32,999	2.71	2.41	2.11	1.82				
33,000-38,999	3.37	3.07	2.77	2.48	2.18			
39,000-44,999	4.03	3.73	3.44	3.14	2.84	2.54		
45,000-53,999	4.69	4.39	4.10	3.80	3.50	3.20	2.91	
54,000-64,999	6.01	5.71	5.42	5.12	4.82	4.53	4.23	3.63

Table 509. Mini-Split Winter Demand Savings for 6.8 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.77							
15,000-20,999	1.52	1.15						
21,000-26,999	2.28	1.91	1.53					
27,000-32,999	3.03	2.66	2.29	1.92				
33,000-38,999	3.79	3.41	3.04	2.67	2.30			
39,000-44,999	4.54	4.17	3.80	3.43	3.06	2.68		
45,000-53,999	5.30	4.92	4.55	4.18	3.81	3.44	3.07	
54,000-64,999	6.80	6.43	6.06	5.69	5.32	4.95	4.58	3.84
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.83							
15,000-20,999	1.58	1.24						
21,000-26,999	2.34	2.00	1.66					
27,000-32,999	3.09	2.75	2.41	2.07				
33,000-38,999	3.85	3.51	3.17	2.83	2.49			
39,000-44,999	4.60	4.26	3.92	3.58	3.24	2.90		
45,000-53,999	5.36	5.02	4.68	4.34	4.00	3.66	3.32	
54,000-64,999	6.87	6.53	6.19	5.85	5.51	5.17	4.83	4.15

9.5-9.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.86							
15,000-20,999	1.62	1.29						
21,000-26,999	2.37	2.05	1.73					
27,000-32,999	3.13	2.80	2.48	2.16				
33,000-38,999	3.88	3.56	3.23	2.91	2.59			
39,000-44,999	4.64	4.31	3.99	3.67	3.34	3.02		
45,000-53,999	5.39	5.07	4.74	4.42	4.10	3.77	3.45	
54,000-64,999	6.90	6.58	6.25	5.93	5.61	5.28	4.96	4.31

10.0-10.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.87							
15,000-20,999	1.63	1.31						
21,000-26,999	2.38	2.07	1.75					
27,000-32,999	3.14	2.82	2.50	2.19				
33,000-38,999	3.89	3.58	3.26	2.94	2.62			
39,000-44,999	4.65	4.33	4.01	3.70	3.38	3.06		
45,000-53,999	5.40	5.09	4.77	4.45	4.13	3.82	3.50	
54,000-64,999	6.91	6.60	6.28	5.96	5.64	5.33	5.01	4.37

10.5-10.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.89							
15,000-20,999	1.64	1.33						
21,000-26,999	2.40	2.08	1.77					
27,000-32,999	3.15	2.84	2.53	2.22				
33,000-38,999	3.91	3.59	3.28	2.97	2.66			
39,000-44,999	4.66	4.35	4.04	3.73	3.41	3.10		
45,000-53,999	5.42	5.10	4.79	4.48	4.17	3.86	3.55	
54,000-64,999	6.92	6.61	6.30	5.99	5.68	5.37	5.06	4.43

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.90							
15,000-20,999	1.65	1.35						
21,000-26,999	2.41	2.10	1.80					
27,000-32,999	3.16	2.86	2.55	2.25				
33,000-38,999	3.92	3.61	3.31	3.00	2.69			
39,000-44,999	4.67	4.37	4.06	3.75	3.45	3.14		
45,000-53,999	5.43	5.12	4.82	4.51	4.20	3.90	3.59	
54,000-64,999	6.94	6.63	6.32	6.02	5.71	5.41	5.10	4.49

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.91							
15,000-20,999	1.66	1.36						
21,000-26,999	2.42	2.12	1.82					
27,000-32,999	3.17	2.87	2.57	2.27				
33,000-38,999	3.93	3.63	3.33	3.03	2.73			
39,000-44,999	4.68	4.38	4.08	3.78	3.48	3.18		
45,000-53,999	5.44	5.14	4.84	4.54	4.24	3.94	3.64	
54,000-64,999	6.95	6.65	6.35	6.05	5.75	5.45	5.15	4.55

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.92							
15,000-20,999	1.67	1.37						
21,000-26,999	2.42	2.13	1.83					
27,000-32,999	3.18	2.88	2.59	2.29				
33,000-38,999	3.93	3.64	3.34	3.04	2.75			
39,000-44,999	4.69	4.39	4.10	3.80	3.50	3.20		
45,000-53,999	5.44	5.15	4.85	4.55	4.26	3.96	3.66	
54,000-64,999	6.95	6.66	6.36	6.06	5.77	5.47	5.17	4.58

Heading, Early Retirement of an Electric Resistance Furnace

Table 510. Mini-Split Winter Demand Savings for 3.412 HSPF Baseline—Zone 2

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.00							
15,000-20,999	3.37	3.00						
21,000-26,999	4.74	4.37	4.00					
27,000-32,999	6.11	5.74	5.37	5.00				
33,000-38,999	7.48	7.11	6.74	6.37	6.00			
39,000-44,999	8.85	8.48	8.11	7.74	7.37	7.00		
45,000-53,999	10.22	9.85	9.48	9.11	8.74	8.37	8.00	
54,000-64,999	12.96	12.59	12.22	11.85	11.48	11.11	10.74	9.99
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.06							
15,000-20,999	3.43	3.09						
21,000-26,999	4.80	4.46	4.12					
27,000-32,999	6.17	5.83	5.49	5.15				
33,000-38,999	7.54	7.20	6.86	6.52	6.19			
39,000-44,999	8.91	8.58	8.24	7.90	7.56	7.22		
45,000-53,999	10.29	9.95	9.61	9.27	8.93	8.59	8.25	
54,000-64,999	13.03	12.69	12.35	12.01	11.67	11.33	10.99	10.31

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2.09							
15,000-20,999	3.47	3.14						
21,000-26,999	4.84	4.51	4.19					
27,000-32,999	6.21	5.88	5.56	5.24				
33,000-38,999	7.58	7.25	6.93	6.61	6.28			
39,000-44,999	8.95	8.62	8.30	7.98	7.65	7.33		
45,000-53,999	10.32	9.99	9.67	9.35	9.02	8.70	8.38	
54,000-64,999	13.06	12.74	12.41	12.09	11.77	11.44	11.12	10.47

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2.11							
15,000-20,999	3.48	3.16						
21,000-26,999	4.85	4.53	4.21					
27,000-32,999	6.22	5.90	5.58	5.27				
33,000-38,999	7.59	7.27	6.95	6.64	6.32			
39,000-44,999	8.96	8.64	8.33	8.01	7.69	7.37		
45,000-53,999	10.33	10.01	9.70	9.38	9.06	8.74	8.43	
54,000-64,999	13.07	12.75	12.44	12.12	11.80	11.49	11.17	10.53

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	2.12							
15,000-20,999	3.49	3.18						
21,000-26,999	4.86	4.55	4.24					
27,000-32,999	6.23	5.92	5.61	5.30				
33,000-38,999	7.60	7.29	6.98	6.67	6.36			
39,000-44,999	8.97	8.66	8.35	8.04	7.73	7.41		
45,000-53,999	10.34	10.03	9.72	9.41	9.10	8.79	8.47	
54,000-64,999	13.08	12.77	12.46	12.15	11.84	11.53	11.22	10.59

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.13							
15,000-20,999	3.50	3.19						
21,000-26,999	4.87	4.57	4.26					
27,000-32,999	6.24	5.94	5.63	5.32				
33,000-38,999	7.61	7.31	7.00	6.70	6.39			
39,000-44,999	8.98	8.68	8.37	8.07	7.76	7.45		
45,000-53,999	10.35	10.05	9.74	9.44	9.13	8.83	8.52	
54,000-64,999	13.09	12.79	12.48	12.18	11.87	11.57	11.26	10.65
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.14							
15,000-20,999	3.51	3.21						
21,000-26,999	4.88	4.58	4.28					
27,000-32,999	6.25	5.95	5.65	5.35				
33,000-38,999	7.62	7.32	7.02	6.72	6.42			
39,000-44,999	8.99	8.69	8.39	8.09	7.79	7.49		
45,000-53,999	10.36	10.06	9.76	9.46	9.16	8.86	8.56	
54,000-64,999	13.11	12.81	12.51	12.21	11.91	11.61	11.30	10.70
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	2.15							
15,000-20,999	3.52	3.22						
21,000-26,999	4.89	4.59	4.29					
27,000-32,999	6.26	5.96	5.67	5.37				
33,000-38,999	7.63	7.33	7.04	6.74	6.44			
39,000-44,999	9.00	8.70	8.41	8.11	7.81	7.52		
45,000-53,999	10.37	10.07	9.78	9.48	9.18	8.89	8.59	
54,000-64,999	13.11	12.82	12.52	12.22	11.92	11.63	11.33	10.74

Climate Zone 3: South Region, Houston

Heating, New Construction/Replace-on-Burnout

Table 511. Mini-Split Winter Demand Savings for 8.2 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.05							
15,000-20,999	0.40	0.07						
21,000-26,999	0.76	0.43	0.10					
27,000-32,999	1.11	0.78	0.45	0.12				
33,000-38,999	1.47	1.14	0.81	0.48	0.15			
39,000-44,999	1.82	1.49	1.16	0.83	0.50	0.17		
45,000-53,999	2.17	1.84	1.51	1.19	0.86	0.53	0.20	
54,000-64,999	2.88	2.55	2.22	1.89	1.56	1.23	0.90	0.25
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.46	0.16						
21,000-26,999	0.81	0.51	0.21					
27,000-32,999	1.17	0.87	0.56	0.26				
33,000-38,999	1.52	1.22	0.92	0.62	0.32			
39,000-44,999	1.88	1.57	1.27	0.97	0.67	0.37		
45,000-53,999	2.23	1.93	1.63	1.32	1.02	0.72	0.42	
54,000-64,999	2.94	2.64	2.33	2.03	1.73	1.43	1.13	0.53

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.49	0.20						
21,000-26,999	0.84	0.56	0.27					
27,000-32,999	1.20	0.91	0.62	0.34				
33,000-38,999	1.55	1.26	0.98	0.69	0.40			
39,000-44,999	1.90	1.62	1.33	1.04	0.76	0.47		
45,000-53,999	2.26	1.97	1.68	1.40	1.11	0.82	0.54	
54,000-64,999	2.97	2.68	2.39	2.11	1.82	1.53	1.24	0.67

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.50	0.22						
21,000-26,999	0.85	0.57	0.29					
27,000-32,999	1.21	0.93	0.64	0.36				
33,000-38,999	1.56	1.28	1.00	0.72	0.43			
39,000-44,999	1.92	1.63	1.35	1.07	0.79	0.51		
45,000-53,999	2.27	1.99	1.71	1.42	1.14	0.86	0.58	
54,000-64,999	2.98	2.70	2.41	2.13	1.85	1.57	1.29	0.72

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.51	0.23						
21,000-26,999	0.86	0.59	0.31					
27,000-32,999	1.22	0.94	0.66	0.39				
33,000-38,999	1.57	1.30	1.02	0.74	0.47			
39,000-44,999	1.93	1.65	1.37	1.10	0.82	0.54		
45,000-53,999	2.28	2.00	1.73	1.45	1.17	0.90	0.62	
54,000-64,999	2.99	2.71	2.44	2.16	1.88	1.61	1.33	0.78

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.52	0.25						
21,000-26,999	0.87	0.60	0.33					
27,000-32,999	1.23	0.96	0.69	0.41				
33,000-38,999	1.58	1.31	1.04	0.77	0.50			
39,000-44,999	1.94	1.66	1.39	1.12	0.85	0.58		
45,000-53,999	2.29	2.02	1.75	1.48	1.20	0.93	0.66	
54,000-64,999	3.00	2.73	2.46	2.18	1.91	1.64	1.37	0.83
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.53	0.26						
21,000-26,999	0.88	0.62	0.35					
27,000-32,999	1.24	0.97	0.70	0.44				
33,000-38,999	1.59	1.33	1.06	0.79	0.53			
39,000-44,999	1.95	1.68	1.41	1.15	0.88	0.61		
45,000-53,999	2.30	2.03	1.77	1.50	1.23	0.97	0.70	
54,000-64,999	3.01	2.74	2.47	2.21	1.94	1.68	1.41	0.88
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.53	0.27						
21,000-26,999	0.89	0.63	0.36					
27,000-32,999	1.24	0.98	0.72	0.45				
33,000-38,999	1.60	1.33	1.07	0.81	0.54			
39,000-44,999	1.95	1.69	1.42	1.16	0.90	0.63		
45,000-53,999	2.31	2.04	1.78	1.51	1.25	0.99	0.72	
54,000-64,999	3.01	2.75	2.49	2.22	1.96	1.70	1.43	0.90

Heating, Early Retirement of a Heat Pump

Table 512. Mini-Split Winter Demand Savings for 7.7 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.51	0.18						
21,000-26,999	0.90	0.57	0.24					
27,000-32,999	1.29	0.96	0.63	0.30				
33,000-38,999	1.67	1.34	1.02	0.69	0.36			
39,000-44,999	2.06	1.73	1.40	1.07	0.75	0.42		
45,000-53,999	2.45	2.12	1.79	1.46	1.13	0.80	0.48	
54,000-64,999	3.23	2.90	2.57	2.24	1.91	1.58	1.25	0.59
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.56	0.26						
21,000-26,999	0.95	0.65	0.35					
27,000-32,999	1.34	1.04	0.74	0.44				
33,000-38,999	1.73	1.43	1.13	0.83	0.52			
39,000-44,999	2.12	1.82	1.52	1.21	0.91	0.61		
45,000-53,999	2.51	2.21	1.90	1.60	1.30	1.00	0.70	
54,000-64,999	3.29	2.98	2.68	2.38	2.08	1.78	1.48	0.87

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.20							
15,000-20,999	0.59	0.31						
21,000-26,999	0.98	0.69	0.41					
27,000-32,999	1.37	1.08	0.80	0.51				
33,000-38,999	1.76	1.47	1.19	0.90	0.61			
39,000-44,999	2.15	1.86	1.57	1.29	1.00	0.71		
45,000-53,999	2.54	2.25	1.96	1.68	1.39	1.10	0.81	
54,000-64,999	3.31	3.03	2.74	2.45	2.17	1.88	1.59	1.02
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.21							
15,000-20,999	0.60	0.32						
21,000-26,999	0.99	0.71	0.43					
27,000-32,999	1.38	1.10	0.82	0.54				
33,000-38,999	1.77	1.49	1.21	0.93	0.64			
39,000-44,999	2.16	1.88	1.60	1.31	1.03	0.75		
45,000-53,999	2.55	2.27	1.98	1.70	1.42	1.14	0.86	
54,000-64,999	3.33	3.04	2.76	2.48	2.20	1.92	1.64	1.07
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.23							
15,000-20,999	0.61	0.34						
21,000-26,999	1.00	0.73	0.45					
27,000-32,999	1.39	1.12	0.84	0.56				
33,000-38,999	1.78	1.50	1.23	0.95	0.68			
39,000-44,999	2.17	1.89	1.62	1.34	1.06	0.79		
45,000-53,999	2.56	2.28	2.01	1.73	1.45	1.18	0.90	
54,000-64,999	3.34	3.06	2.78	2.51	2.23	1.95	1.68	1.13

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.62	0.35						
21,000-26,999	1.01	0.74	0.47					
27,000-32,999	1.40	1.13	0.86	0.59				
33,000-38,999	1.79	1.52	1.25	0.98	0.71			
39,000-44,999	2.18	1.91	1.64	1.37	1.09	0.82		
45,000-53,999	2.57	2.30	2.03	1.75	1.48	1.21	0.94	
54,000-64,999	3.35	3.07	2.80	2.53	2.26	1.99	1.72	1.18

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.63	0.37						
21,000-26,999	1.02	0.76	0.49					
27,000-32,999	1.41	1.15	0.88	0.61				
33,000-38,999	1.80	1.53	1.27	1.00	0.73			
39,000-44,999	2.19	1.92	1.66	1.39	1.12	0.86		
45,000-53,999	2.58	2.31	2.05	1.78	1.51	1.25	0.98	
54,000-64,999	3.36	3.09	2.82	2.56	2.29	2.02	1.76	1.22

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.64	0.38						
21,000-26,999	1.03	0.76	0.50					
27,000-32,999	1.42	1.15	0.89	0.63				
33,000-38,999	1.81	1.54	1.28	1.02	0.75			
39,000-44,999	2.19	1.93	1.67	1.40	1.14	0.88		
45,000-53,999	2.58	2.32	2.06	1.79	1.53	1.27	1.00	
54,000-64,999	3.36	3.10	2.83	2.57	2.31	2.04	1.78	1.25

Table 513. Mini-Split Winter Demand Savings for 6.8 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.76	0.43						
21,000-26,999	1.23	0.90	0.57					
27,000-32,999	1.70	1.37	1.04	0.72				
33,000-38,999	2.18	1.85	1.52	1.19	0.86			
39,000-44,999	2.65	2.32	1.99	1.66	1.33	1.00		
45,000-53,999	3.12	2.79	2.46	2.13	1.80	1.47	1.14	
54,000-64,999	4.07	3.74	3.41	3.08	2.75	2.42	2.09	1.43
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.34							
15,000-20,999	0.81	0.51						
21,000-26,999	1.29	0.99	0.68					
27,000-32,999	1.76	1.46	1.16	0.85				
33,000-38,999	2.23	1.93	1.63	1.33	1.03			
39,000-44,999	2.70	2.40	2.10	1.80	1.50	1.20		
45,000-53,999	3.18	2.88	2.57	2.27	1.97	1.67	1.37	
54,000-64,999	4.12	3.82	3.52	3.22	2.92	2.61	2.31	1.71

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.37							
15,000-20,999	0.84	0.56						
21,000-26,999	1.32	1.03	0.74					
27,000-32,999	1.79	1.50	1.21	0.93				
33,000-38,999	2.26	1.97	1.69	1.40	1.11			
39,000-44,999	2.73	2.45	2.16	1.87	1.59	1.30		
45,000-53,999	3.21	2.92	2.63	2.34	2.06	1.77	1.48	
54,000-64,999	4.15	3.86	3.58	3.29	3.00	2.72	2.43	1.85
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.38							
15,000-20,999	0.85	0.57						
21,000-26,999	1.33	1.05	0.76					
27,000-32,999	1.80	1.52	1.24	0.95				
33,000-38,999	2.27	1.99	1.71	1.43	1.15			
39,000-44,999	2.74	2.46	2.18	1.90	1.62	1.34		
45,000-53,999	3.22	2.94	2.65	2.37	2.09	1.81	1.53	
54,000-64,999	4.16	3.88	3.60	3.32	3.04	2.75	2.47	1.91
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.39							
15,000-20,999	0.86	0.59						
21,000-26,999	1.34	1.06	0.78					
27,000-32,999	1.81	1.53	1.26	0.98				
33,000-38,999	2.28	2.01	1.73	1.45	1.18			
39,000-44,999	2.75	2.48	2.20	1.93	1.65	1.37		
45,000-53,999	3.23	2.95	2.67	2.40	2.12	1.85	1.57	
54,000-64,999	4.17	3.90	3.62	3.34	3.07	2.79	2.51	1.96

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.40							
15,000-20,999	0.87	0.60						
21,000-26,999	1.35	1.08	0.80					
27,000-32,999	1.82	1.55	1.28	1.01				
33,000-38,999	2.29	2.02	1.75	1.48	1.21			
39,000-44,999	2.77	2.49	2.22	1.95	1.68	1.41		
45,000-53,999	3.24	2.97	2.70	2.42	2.15	1.88	1.61	
54,000-64,999	4.18	3.91	3.64	3.37	3.10	2.83	2.55	2.01
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.41							
15,000-20,999	0.88	0.62						
21,000-26,999	1.36	1.09	0.82					
27,000-32,999	1.83	1.56	1.30	1.03				
33,000-38,999	2.30	2.04	1.77	1.50	1.24			
39,000-44,999	2.77	2.51	2.24	1.98	1.71	1.44		
45,000-53,999	3.25	2.98	2.71	2.45	2.18	1.92	1.65	
54,000-64,999	4.19	3.93	3.66	3.39	3.13	2.86	2.59	2.06
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.42							
15,000-20,999	0.89	0.63						
21,000-26,999	1.36	1.10	0.84					
27,000-32,999	1.84	1.57	1.31	1.04				
33,000-38,999	2.31	2.04	1.78	1.52	1.25			
39,000-44,999	2.78	2.52	2.25	1.99	1.73	1.46		
45,000-53,999	3.25	2.99	2.73	2.46	2.20	1.94	1.67	
54,000-64,999	4.20	3.93	3.67	3.41	3.14	2.88	2.62	2.09

Heating, Early Retirement of an Electric Resistance Furnace

Table 514. Mini-Split Winter Demand Savings for 3.412 HSPF Baseline—Zone 3

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.51							
15,000-20,999	2.60	2.27						
21,000-26,999	3.68	3.35	3.02					
27,000-32,999	4.77	4.44	4.11	3.78				
33,000-38,999	5.85	5.52	5.19	4.86	4.53			
39,000-44,999	6.94	6.61	6.28	5.95	5.62	5.29		
45,000-53,999	8.02	7.69	7.36	7.03	6.70	6.37	6.05	
54,000-64,999	10.19	9.86	9.53	9.20	8.87	8.54	8.22	7.56
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.57							
15,000-20,999	2.65	2.35						
21,000-26,999	3.74	3.44	3.13					
27,000-32,999	4.82	4.52	4.22	3.92				
33,000-38,999	5.91	5.61	5.30	5.00	4.70			
39,000-44,999	6.99	6.69	6.39	6.09	5.79	5.48		
45,000-53,999	8.08	7.78	7.47	7.17	6.87	6.57	6.27	
54,000-64,999	10.25	9.95	9.64	9.34	9.04	8.74	8.44	7.84

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.60							
15,000-20,999	2.68	2.39						
21,000-26,999	3.77	3.48	3.19					
27,000-32,999	4.85	4.56	4.28	3.99				
33,000-38,999	5.94	5.65	5.36	5.08	4.79			
39,000-44,999	7.02	6.73	6.45	6.16	5.87	5.59		
45,000-53,999	8.11	7.82	7.53	7.25	6.96	6.67	6.38	
54,000-64,999	10.28	9.99	9.70	9.42	9.13	8.84	8.55	7.98
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.61							
15,000-20,999	2.69	2.41						
21,000-26,999	3.78	3.50	3.21					
27,000-32,999	4.86	4.58	4.30	4.02				
33,000-38,999	5.95	5.67	5.38	5.10	4.82			
39,000-44,999	7.03	6.75	6.47	6.19	5.91	5.62		
45,000-53,999	8.12	7.84	7.55	7.27	6.99	6.71	6.43	
54,000-64,999	10.29	10.01	9.72	9.44	9.16	8.88	8.60	8.03
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.62							
15,000-20,999	2.70	2.43						
21,000-26,999	3.79	3.51	3.23					
27,000-32,999	4.87	4.60	4.32	4.04				
33,000-38,999	5.96	5.68	5.41	5.13	4.85			
39,000-44,999	7.04	6.77	6.49	6.21	5.94	5.66		
45,000-53,999	8.13	7.85	7.58	7.30	7.02	6.75	6.47	
54,000-64,999	10.30	10.02	9.75	9.47	9.19	8.92	8.64	8.09

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.63							
15,000-20,999	2.71	2.44						
21,000-26,999	3.80	3.53	3.26					
27,000-32,999	4.88	4.61	4.34	4.07				
33,000-38,999	5.97	5.70	5.43	5.15	4.88			
39,000-44,999	7.05	6.78	6.51	6.24	5.97	5.70		
45,000-53,999	8.14	7.87	7.60	7.32	7.05	6.78	6.51	
54,000-64,999	10.31	10.04	9.77	9.49	9.22	8.95	8.68	8.14

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.64							
15,000-20,999	2.72	2.46						
21,000-26,999	3.81	3.54	3.27					
27,000-32,999	4.89	4.63	4.36	4.09				
33,000-38,999	5.98	5.71	5.44	5.18	4.91			
39,000-44,999	7.06	6.80	6.53	6.26	6.00	5.73		
45,000-53,999	8.15	7.88	7.62	7.35	7.08	6.82	6.55	
54,000-64,999	10.32	10.05	9.79	9.52	9.25	8.99	8.72	8.19

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.64							
15,000-20,999	2.73	2.46						
21,000-26,999	3.81	3.55	3.29					
27,000-32,999	4.90	4.63	4.37	4.11				
33,000-38,999	5.98	5.72	5.46	5.19	4.93			
39,000-44,999	7.07	6.80	6.54	6.28	6.01	5.75		
45,000-53,999	8.15	7.89	7.63	7.36	7.10	6.84	6.57	
54,000-64,999	10.32	10.06	9.80	9.53	9.27	9.01	8.74	8.22

Climate Zone 4: Valley Region, Corpus Christi

Heating, New Construction/Replace-on-Burnout

Table 515. Mini-Split Winter Demand Savings for 8.2 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.04							
15,000-20,999	0.30	0.06						
21,000-26,999	0.57	0.32	0.07					
27,000-32,999	0.84	0.59	0.34	0.09				
33,000-38,999	1.10	0.85	0.61	0.36	0.11			
39,000-44,999	1.37	1.12	0.87	0.62	0.38	0.13		
45,000-53,999	1.63	1.39	1.14	0.89	0.64	0.40	0.15	
54,000-64,999	2.17	1.92	1.67	1.42	1.18	0.93	0.68	0.18
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.08							
15,000-20,999	0.35	0.12						
21,000-26,999	0.61	0.38	0.16					
27,000-32,999	0.88	0.65	0.42	0.20				
33,000-38,999	1.14	0.92	0.69	0.46	0.24			
39,000-44,999	1.41	1.18	0.96	0.73	0.50	0.28		
45,000-53,999	1.68	1.45	1.22	1.00	0.77	0.54	0.32	
54,000-64,999	2.21	1.98	1.75	1.53	1.30	1.07	0.85	0.39

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.10							
15,000-20,999	0.37	0.15						
21,000-26,999	0.63	0.42	0.20					
27,000-32,999	0.90	0.68	0.47	0.25				
33,000-38,999	1.17	0.95	0.73	0.52	0.30			
39,000-44,999	1.43	1.22	1.00	0.78	0.57	0.35		
45,000-53,999	1.70	1.48	1.27	1.05	0.83	0.62	0.40	
54,000-64,999	2.23	2.01	1.80	1.58	1.37	1.15	0.94	0.50

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.38	0.16						
21,000-26,999	0.64	0.43	0.22					
27,000-32,999	0.91	0.70	0.48	0.27				
33,000-38,999	1.17	0.96	0.75	0.54	0.33			
39,000-44,999	1.44	1.23	1.02	0.80	0.59	0.38		
45,000-53,999	1.71	1.49	1.28	1.07	0.86	0.65	0.44	
54,000-64,999	2.24	2.03	1.81	1.60	1.39	1.18	0.97	0.54

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.38	0.18						
21,000-26,999	0.65	0.44	0.23					
27,000-32,999	0.92	0.71	0.50	0.29				
33,000-38,999	1.18	0.97	0.77	0.56	0.35			
39,000-44,999	1.45	1.24	1.03	0.82	0.62	0.41		
45,000-53,999	1.71	1.51	1.30	1.09	0.88	0.67	0.47	
54,000-64,999	2.25	2.04	1.83	1.62	1.41	1.21	1.00	0.58

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.39	0.19						
21,000-26,999	0.66	0.45	0.25					
27,000-32,999	0.92	0.72	0.51	0.31				
33,000-38,999	1.19	0.98	0.78	0.58	0.37			
39,000-44,999	1.45	1.25	1.05	0.84	0.64	0.44		
45,000-53,999	1.72	1.52	1.31	1.11	0.91	0.70	0.50	
54,000-64,999	2.25	2.05	1.85	1.64	1.44	1.23	1.03	0.62

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.40	0.20						
21,000-26,999	0.66	0.46	0.26					
27,000-32,999	0.93	0.73	0.53	0.33				
33,000-38,999	1.20	1.00	0.80	0.60	0.40			
39,000-44,999	1.46	1.26	1.06	0.86	0.66	0.46		
45,000-53,999	1.73	1.53	1.33	1.13	0.93	0.73	0.53	
54,000-64,999	2.26	2.06	1.86	1.66	1.46	1.26	1.06	0.66

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.40	0.20						
21,000-26,999	0.67	0.47	0.27					
27,000-32,999	0.93	0.74	0.54	0.34				
33,000-38,999	1.20	1.00	0.80	0.61	0.41			
39,000-44,999	1.47	1.27	1.07	0.87	0.67	0.48		
45,000-53,999	1.73	1.53	1.34	1.14	0.94	0.74	0.54	
54,000-64,999	2.26	2.07	1.87	1.67	1.47	1.27	1.08	0.68

Heating, Early Retirement of a Heat Pump

Table 516. Mini-Split Winter Demand Savings for 7.7 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.38	0.13						
21,000-26,999	0.67	0.43	0.18					
27,000-32,999	0.97	0.72	0.47	0.22				
33,000-38,999	1.26	1.01	0.76	0.52	0.27			
39,000-44,999	1.55	1.30	1.06	0.81	0.56	0.31		
45,000-53,999	1.84	1.60	1.35	1.10	0.85	0.60	0.36	
54,000-64,999	2.43	2.18	1.93	1.68	1.44	1.19	0.94	0.45
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.42	0.20						
21,000-26,999	0.72	0.49	0.26					
27,000-32,999	1.01	0.78	0.55	0.33				
33,000-38,999	1.30	1.07	0.85	0.62	0.39			
39,000-44,999	1.59	1.37	1.14	0.91	0.69	0.46		
45,000-53,999	1.89	1.66	1.43	1.21	0.98	0.75	0.53	
54,000-64,999	2.47	2.24	2.02	1.79	1.56	1.34	1.11	0.66

9.5-9.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.45	0.23						
21,000-26,999	0.74	0.52	0.31					
27,000-32,999	1.03	0.81	0.60	0.38				
33,000-38,999	1.32	1.11	0.89	0.67	0.46			
39,000-44,999	1.61	1.40	1.18	0.97	0.75	0.54		
45,000-53,999	1.91	1.69	1.48	1.26	1.04	0.83	0.61	
54,000-64,999	2.49	2.28	2.06	1.84	1.63	1.41	1.20	0.77

10.0-10.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.45	0.24						
21,000-26,999	0.75	0.53	0.32					
27,000-32,999	1.04	0.83	0.61	0.40				
33,000-38,999	1.33	1.12	0.91	0.70	0.48			
39,000-44,999	1.62	1.41	1.20	0.99	0.78	0.56		
45,000-53,999	1.92	1.70	1.49	1.28	1.07	0.86	0.65	
54,000-64,999	2.50	2.29	2.08	1.86	1.65	1.44	1.23	0.81

10.5-10.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.17							
15,000-20,999	0.46	0.25						
21,000-26,999	0.75	0.55	0.34					
27,000-32,999	1.05	0.84	0.63	0.42				
33,000-38,999	1.34	1.13	0.92	0.72	0.51			
39,000-44,999	1.63	1.42	1.22	1.01	0.80	0.59		
45,000-53,999	1.92	1.72	1.51	1.30	1.09	0.88	0.68	
54,000-64,999	2.51	2.30	2.09	1.88	1.68	1.47	1.26	0.85

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.47	0.27						
21,000-26,999	0.76	0.56	0.35					
27,000-32,999	1.05	0.85	0.65	0.44				
33,000-38,999	1.35	1.14	0.94	0.73	0.53			
39,000-44,999	1.64	1.43	1.23	1.03	0.82	0.62		
45,000-53,999	1.93	1.73	1.52	1.32	1.11	0.91	0.71	
54,000-64,999	2.52	2.31	2.11	1.90	1.70	1.50	1.29	0.88

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.48	0.28						
21,000-26,999	0.77	0.57	0.37					
27,000-32,999	1.06	0.86	0.66	0.46				
33,000-38,999	1.35	1.15	0.95	0.75	0.55			
39,000-44,999	1.65	1.45	1.25	1.04	0.84	0.64		
45,000-53,999	1.94	1.74	1.54	1.34	1.14	0.94	0.74	
54,000-64,999	2.52	2.32	2.12	1.92	1.72	1.52	1.32	0.92

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.19							
15,000-20,999	0.48	0.28						
21,000-26,999	0.77	0.57	0.38					
27,000-32,999	1.07	0.87	0.67	0.47				
33,000-38,999	1.36	1.16	0.96	0.76	0.57			
39,000-44,999	1.65	1.45	1.25	1.06	0.86	0.66		
45,000-53,999	1.94	1.74	1.55	1.35	1.15	0.95	0.75	
54,000-64,999	2.53	2.33	2.13	1.93	1.73	1.54	1.34	0.94

Table 517. Mini-Split Winter Demand Savings for 6.8 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.57	0.32						
21,000-26,999	0.93	0.68	0.43					
27,000-32,999	1.28	1.03	0.79	0.54				
33,000-38,999	1.64	1.39	1.14	0.89	0.65			
39,000-44,999	1.99	1.74	1.50	1.25	1.00	0.75		
45,000-53,999	2.35	2.10	1.85	1.60	1.36	1.11	0.86	
54,000-64,999	3.06	2.81	2.56	2.31	2.07	1.82	1.57	1.08
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.61	0.39						
21,000-26,999	0.97	0.74	0.51					
27,000-32,999	1.32	1.10	0.87	0.64				
33,000-38,999	1.68	1.45	1.22	1.00	0.77			
39,000-44,999	2.03	1.81	1.58	1.35	1.13	0.90		
45,000-53,999	2.39	2.16	1.93	1.71	1.48	1.25	1.03	
54,000-64,999	3.10	2.87	2.65	2.42	2.19	1.97	1.74	1.29

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.28							
15,000-20,999	0.63	0.42						
21,000-26,999	0.99	0.77	0.56					
27,000-32,999	1.34	1.13	0.91	0.70				
33,000-38,999	1.70	1.48	1.27	1.05	0.84			
39,000-44,999	2.05	1.84	1.62	1.41	1.19	0.98		
45,000-53,999	2.41	2.19	1.98	1.76	1.55	1.33	1.12	
54,000-64,999	3.12	2.90	2.69	2.47	2.26	2.04	1.83	1.39
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.64	0.43						
21,000-26,999	1.00	0.79	0.57					
27,000-32,999	1.35	1.14	0.93	0.72				
33,000-38,999	1.71	1.50	1.28	1.07	0.86			
39,000-44,999	2.06	1.85	1.64	1.43	1.22	1.00		
45,000-53,999	2.42	2.21	1.99	1.78	1.57	1.36	1.15	
54,000-64,999	3.13	2.92	2.71	2.49	2.28	2.07	1.86	1.44
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.29							
15,000-20,999	0.65	0.44						
21,000-26,999	1.01	0.80	0.59					
27,000-32,999	1.36	1.15	0.95	0.74				
33,000-38,999	1.72	1.51	1.30	1.09	0.88			
39,000-44,999	2.07	1.86	1.66	1.45	1.24	1.03		
45,000-53,999	2.43	2.22	2.01	1.80	1.60	1.39	1.18	
54,000-64,999	3.14	2.93	2.72	2.51	2.31	2.10	1.89	1.47

11.0-11.4 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.30							
15,000-20,999	0.66	0.45						
21,000-26,999	1.01	0.81	0.61					
27,000-32,999	1.37	1.16	0.96	0.76				
33,000-38,999	1.72	1.52	1.32	1.11	0.91			
39,000-44,999	2.08	1.87	1.67	1.47	1.26	1.06		
45,000-53,999	2.43	2.23	2.03	1.82	1.62	1.41	1.21	
54,000-64,999	3.14	2.94	2.74	2.53	2.33	2.12	1.92	1.51
11.5-11.9 HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.67	0.46						
21,000-26,999	1.02	0.82	0.62					
27,000-32,999	1.38	1.18	0.97	0.77				
33,000-38,999	1.73	1.53	1.33	1.13	0.93			
39,000-44,999	2.09	1.89	1.69	1.48	1.28	1.08		
45,000-53,999	2.44	2.24	2.04	1.84	1.64	1.44	1.24	
54,000-64,999	3.15	2.95	2.75	2.55	2.35	2.15	1.95	1.55
12.0+ HSPF								
Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	0.31							
15,000-20,999	0.67	0.47						
21,000-26,999	1.02	0.83	0.63					
27,000-32,999	1.38	1.18	0.98	0.79				
33,000-38,999	1.73	1.54	1.34	1.14	0.94			
39,000-44,999	2.09	1.89	1.69	1.50	1.30	1.10		
45,000-53,999	2.45	2.25	2.05	1.85	1.65	1.45	1.26	
54,000-64,999	3.16	2.96	2.76	2.56	2.36	2.16	1.97	1.57

Heading, Early Retirement of an Electric Resistance Furnace

Table 518. Mini-Split Winter Demand Savings for 3.412 HSPF Baseline—Zone 4

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.16							
15,000-20,999	1.99	1.74						
21,000-26,999	2.82	2.57	2.32					
27,000-32,999	3.65	3.40	3.15	2.90				
33,000-38,999	4.47	4.23	3.98	3.73	3.48			
39,000-44,999	5.30	5.05	4.81	4.56	4.31	4.06		
45,000-53,999	6.13	5.88	5.63	5.39	5.14	4.89	4.64	
54,000-64,999	7.79	7.54	7.29	7.04	6.80	6.55	6.30	5.80
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.20							
15,000-20,999	2.03	1.80						
21,000-26,999	2.86	2.63	2.41					
27,000-32,999	3.69	3.46	3.23	3.01				
33,000-38,999	4.52	4.29	4.06	3.84	3.61			
39,000-44,999	5.34	5.12	4.89	4.66	4.44	4.21		
45,000-53,999	6.17	5.94	5.72	5.49	5.26	5.04	4.81	
54,000-64,999	7.83	7.60	7.37	7.15	6.92	6.69	6.47	6.01

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.22							
15,000-20,999	2.05	1.84						
21,000-26,999	2.88	2.67	2.45					
27,000-32,999	3.71	3.49	3.28	3.06				
33,000-38,999	4.54	4.32	4.11	3.89	3.67			
39,000-44,999	5.37	5.15	4.93	4.72	4.50	4.29		
45,000-53,999	6.19	5.98	5.76	5.55	5.33	5.11	4.90	
54,000-64,999	7.85	7.63	7.42	7.20	6.99	6.77	6.55	6.12

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.23							
15,000-20,999	2.06	1.85						
21,000-26,999	2.89	2.68	2.47					
27,000-32,999	3.72	3.51	3.29	3.08				
33,000-38,999	4.55	4.33	4.12	3.91	3.70			
39,000-44,999	5.37	5.16	4.95	4.74	4.53	4.32		
45,000-53,999	6.20	5.99	5.78	5.57	5.35	5.14	4.93	
54,000-64,999	7.86	7.65	7.43	7.22	7.01	6.80	6.59	6.16

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.24							
15,000-20,999	2.07	1.86						
21,000-26,999	2.90	2.69	2.48					
27,000-32,999	3.73	3.52	3.31	3.10				
33,000-38,999	4.55	4.35	4.14	3.93	3.72			
39,000-44,999	5.38	5.17	4.97	4.76	4.55	4.34		
45,000-53,999	6.21	6.00	5.79	5.59	5.38	5.17	4.96	
54,000-64,999	7.87	7.66	7.45	7.24	7.03	6.83	6.62	6.20

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.25							
15,000-20,999	2.08	1.87						
21,000-26,999	2.90	2.70	2.50					
27,000-32,999	3.73	3.53	3.32	3.12				
33,000-38,999	4.56	4.36	4.15	3.95	3.75			
39,000-44,999	5.39	5.18	4.98	4.78	4.57	4.37		
45,000-53,999	6.22	6.01	5.81	5.61	5.40	5.20	4.99	
54,000-64,999	7.87	7.67	7.47	7.26	7.06	6.85	6.65	6.24

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.26							
15,000-20,999	2.08	1.88						
21,000-26,999	2.91	2.71	2.51					
27,000-32,999	3.74	3.54	3.34	3.14				
33,000-38,999	4.57	4.37	4.17	3.97	3.77			
39,000-44,999	5.40	5.20	5.00	4.80	4.60	4.39		
45,000-53,999	6.22	6.02	5.82	5.62	5.42	5.22	5.02	
54,000-64,999	7.88	7.68	7.48	7.28	7.08	6.88	6.68	6.28

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.26							
15,000-20,999	2.09	1.89						
21,000-26,999	2.92	2.72	2.52					
27,000-32,999	3.74	3.55	3.35	3.15				
33,000-38,999	4.57	4.37	4.18	3.98	3.78			
39,000-44,999	5.40	5.20	5.00	4.81	4.61	4.41		
45,000-53,999	6.23	6.03	5.83	5.63	5.44	5.24	5.04	
54,000-64,999	7.88	7.69	7.49	7.29	7.09	6.89	6.70	6.30

Climate Zone 5: West Region, El Paso

Heating, New Construction/Replace-on-Burnout

Table 519. Mini-Split Winter Demand Savings for 8.2 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.03							
15,000-20,999	0.26	0.05						
21,000-26,999	0.49	0.28	0.06					
27,000-32,999	0.72	0.50	0.29	0.08				
33,000-38,999	0.95	0.73	0.52	0.31	0.10			
39,000-44,999	1.17	0.96	0.75	0.54	0.32	0.11		
45,000-53,999	1.40	1.19	0.98	0.77	0.55	0.34	0.13	
54,000-64,999	1.86	1.65	1.43	1.22	1.01	0.80	0.58	0.16
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.07							
15,000-20,999	0.30	0.10						
21,000-26,999	0.52	0.33	0.14					
27,000-32,999	0.75	0.56	0.36	0.17				
33,000-38,999	0.98	0.79	0.59	0.40	0.20			
39,000-44,999	1.21	1.02	0.82	0.63	0.43	0.24		
45,000-53,999	1.44	1.24	1.05	0.86	0.66	0.47	0.27	
54,000-64,999	1.90	1.70	1.51	1.31	1.12	0.92	0.73	0.34

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.32	0.13						
21,000-26,999	0.54	0.36	0.17					
27,000-32,999	0.77	0.59	0.40	0.22				
33,000-38,999	1.00	0.82	0.63	0.44	0.26			
39,000-44,999	1.23	1.04	0.86	0.67	0.49	0.30		
45,000-53,999	1.46	1.27	1.09	0.90	0.72	0.53	0.35	
54,000-64,999	1.92	1.73	1.54	1.36	1.17	0.99	0.80	0.43

10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.09							
15,000-20,999	0.32	0.14						
21,000-26,999	0.55	0.37	0.19					
27,000-32,999	0.78	0.60	0.42	0.23				
33,000-38,999	1.01	0.83	0.64	0.46	0.28			
39,000-44,999	1.24	1.05	0.87	0.69	0.51	0.33		
45,000-53,999	1.46	1.28	1.10	0.92	0.74	0.56	0.37	
54,000-64,999	1.92	1.74	1.56	1.38	1.19	1.01	0.83	0.47

10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.10							
15,000-20,999	0.33	0.15						
21,000-26,999	0.56	0.38	0.20					
27,000-32,999	0.79	0.61	0.43	0.25				
33,000-38,999	1.01	0.84	0.66	0.48	0.30			
39,000-44,999	1.24	1.06	0.89	0.71	0.53	0.35		
45,000-53,999	1.47	1.29	1.11	0.94	0.76	0.58	0.40	
54,000-64,999	1.93	1.75	1.57	1.39	1.22	1.04	0.86	0.50

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.34	0.16						
21,000-26,999	0.56	0.39	0.21					
27,000-32,999	0.79	0.62	0.44	0.27				
33,000-38,999	1.02	0.85	0.67	0.50	0.32			
39,000-44,999	1.25	1.07	0.90	0.72	0.55	0.37		
45,000-53,999	1.48	1.30	1.13	0.95	0.78	0.60	0.43	
54,000-64,999	1.94	1.76	1.59	1.41	1.23	1.06	0.88	0.53
11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.34	0.17						
21,000-26,999	0.57	0.40	0.23					
27,000-32,999	0.80	0.63	0.45	0.28				
33,000-38,999	1.03	0.86	0.68	0.51	0.34			
39,000-44,999	1.26	1.08	0.91	0.74	0.57	0.40		
45,000-53,999	1.48	1.31	1.14	0.97	0.80	0.62	0.45	
54,000-64,999	1.94	1.77	1.60	1.43	1.25	1.08	0.91	0.57
12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.12							
15,000-20,999	0.35	0.18						
21,000-26,999	0.57	0.40	0.23					
27,000-32,999	0.80	0.63	0.46	0.29				
33,000-38,999	1.03	0.86	0.69	0.52	0.35			
39,000-44,999	1.26	1.09	0.92	0.75	0.58	0.41		
45,000-53,999	1.49	1.32	1.15	0.98	0.81	0.64	0.47	
54,000-64,999	1.95	1.78	1.61	1.43	1.26	1.09	0.92	0.58

Heading, Early Retirement of a Heat Pump

Table 520. Mini-Split Winter Demand Savings for 7.7 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.08							
15,000-20,999	0.33	0.12						
21,000-26,999	0.58	0.37	0.15					
27,000-32,999	0.83	0.62	0.40	0.19				
33,000-38,999	1.08	0.87	0.66	0.44	0.23			
39,000-44,999	1.33	1.12	0.91	0.69	0.48	0.27		
45,000-53,999	1.58	1.37	1.16	0.94	0.73	0.52	0.31	
54,000-64,999	2.09	1.87	1.66	1.45	1.23	1.02	0.81	0.38
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.11							
15,000-20,999	0.36	0.17						
21,000-26,999	0.61	0.42	0.23					
27,000-32,999	0.87	0.67	0.48	0.28				
33,000-38,999	1.12	0.92	0.73	0.53	0.34			
39,000-44,999	1.37	1.17	0.98	0.78	0.59	0.39		
45,000-53,999	1.62	1.42	1.23	1.04	0.84	0.65	0.45	
54,000-64,999	2.12	1.93	1.73	1.54	1.34	1.15	0.95	0.56

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.13							
15,000-20,999	0.38	0.20						
21,000-26,999	0.63	0.45	0.26					
27,000-32,999	0.88	0.70	0.51	0.33				
33,000-38,999	1.14	0.95	0.77	0.58	0.39			
39,000-44,999	1.39	1.20	1.02	0.83	0.65	0.46		
45,000-53,999	1.64	1.45	1.27	1.08	0.90	0.71	0.53	
54,000-64,999	2.14	1.95	1.77	1.58	1.40	1.21	1.03	0.66
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.14							
15,000-20,999	0.39	0.21						
21,000-26,999	0.64	0.46	0.28					
27,000-32,999	0.89	0.71	0.53	0.35				
33,000-38,999	1.14	0.96	0.78	0.60	0.42			
39,000-44,999	1.39	1.21	1.03	0.85	0.67	0.48		
45,000-53,999	1.64	1.46	1.28	1.10	0.92	0.74	0.55	
54,000-64,999	2.15	1.97	1.78	1.60	1.42	1.24	1.06	0.69
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.40	0.22						
21,000-26,999	0.65	0.47	0.29					
27,000-32,999	0.90	0.72	0.54	0.36				
33,000-38,999	1.15	0.97	0.79	0.61	0.44			
39,000-44,999	1.40	1.22	1.04	0.87	0.69	0.51		
45,000-53,999	1.65	1.47	1.29	1.12	0.94	0.76	0.58	
54,000-64,999	2.15	1.98	1.80	1.62	1.44	1.26	1.08	0.73

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.15							
15,000-20,999	0.40	0.23						
21,000-26,999	0.65	0.48	0.30					
27,000-32,999	0.90	0.73	0.55	0.38				
33,000-38,999	1.16	0.98	0.81	0.63	0.46			
39,000-44,999	1.41	1.23	1.06	0.88	0.71	0.53		
45,000-53,999	1.66	1.48	1.31	1.13	0.96	0.78	0.61	
54,000-64,999	2.16	1.99	1.81	1.63	1.46	1.28	1.11	0.76

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.41	0.24						
21,000-26,999	0.66	0.49	0.32					
27,000-32,999	0.91	0.74	0.57	0.40				
33,000-38,999	1.16	0.99	0.82	0.65	0.47			
39,000-44,999	1.41	1.24	1.07	0.90	0.73	0.55		
45,000-53,999	1.66	1.49	1.32	1.15	0.98	0.80	0.63	
54,000-64,999	2.17	1.99	1.82	1.65	1.48	1.31	1.13	0.79

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.16							
15,000-20,999	0.41	0.24						
21,000-26,999	0.66	0.49	0.32					
27,000-32,999	0.91	0.74	0.57	0.40				
33,000-38,999	1.17	1.00	0.83	0.66	0.49			
39,000-44,999	1.42	1.25	1.08	0.91	0.74	0.57		
45,000-53,999	1.67	1.50	1.33	1.16	0.99	0.82	0.65	
54,000-64,999	2.17	2.00	1.83	1.66	1.49	1.32	1.15	0.81

Table 521. Mini-Split Winter Demand Savings for 6.8 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.18							
15,000-20,999	0.49	0.28						
21,000-26,999	0.79	0.58	0.37					
27,000-32,999	1.10	0.89	0.67	0.46				
33,000-38,999	1.40	1.19	0.98	0.77	0.55			
39,000-44,999	1.71	1.50	1.28	1.07	0.86	0.65		
45,000-53,999	2.02	1.80	1.59	1.38	1.16	0.95	0.74	
54,000-64,999	2.63	2.41	2.20	1.99	1.77	1.56	1.35	0.92
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.22							
15,000-20,999	0.53	0.33						
21,000-26,999	0.83	0.64	0.44					
27,000-32,999	1.14	0.94	0.75	0.55				
33,000-38,999	1.44	1.25	1.05	0.86	0.66			
39,000-44,999	1.75	1.55	1.36	1.16	0.97	0.77		
45,000-53,999	2.05	1.86	1.66	1.47	1.27	1.08	0.88	
54,000-64,999	2.66	2.47	2.27	2.08	1.88	1.69	1.49	1.10

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.24							
15,000-20,999	0.54	0.36						
21,000-26,999	0.85	0.66	0.48					
27,000-32,999	1.15	0.97	0.78	0.60				
33,000-38,999	1.46	1.27	1.09	0.90	0.72			
39,000-44,999	1.76	1.58	1.39	1.21	1.02	0.84		
45,000-53,999	2.07	1.88	1.70	1.51	1.33	1.14	0.96	
54,000-64,999	2.68	2.49	2.31	2.12	1.94	1.75	1.57	1.20
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.55	0.37						
21,000-26,999	0.86	0.67	0.49					
27,000-32,999	1.16	0.98	0.80	0.62				
33,000-38,999	1.47	1.28	1.10	0.92	0.74			
39,000-44,999	1.77	1.59	1.41	1.23	1.04	0.86		
45,000-53,999	2.08	1.90	1.71	1.53	1.35	1.17	0.99	
54,000-64,999	2.69	2.51	2.32	2.14	1.96	1.78	1.60	1.23
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.25							
15,000-20,999	0.56	0.38						
21,000-26,999	0.86	0.69	0.51					
27,000-32,999	1.17	0.99	0.81	0.63				
33,000-38,999	1.47	1.30	1.12	0.94	0.76			
39,000-44,999	1.78	1.60	1.42	1.24	1.06	0.89		
45,000-53,999	2.08	1.91	1.73	1.55	1.37	1.19	1.01	
54,000-64,999	2.69	2.52	2.34	2.16	1.98	1.80	1.62	1.27

11.0-11.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.26							
15,000-20,999	0.56	0.39						
21,000-26,999	0.87	0.69	0.52					
27,000-32,999	1.18	1.00	0.82	0.65				
33,000-38,999	1.48	1.30	1.13	0.95	0.78			
39,000-44,999	1.79	1.61	1.43	1.26	1.08	0.91		
45,000-53,999	2.09	1.92	1.74	1.56	1.39	1.21	1.04	
54,000-64,999	2.70	2.53	2.35	2.17	2.00	1.82	1.65	1.30

11.5-11.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.57	0.40						
21,000-26,999	0.88	0.70	0.53					
27,000-32,999	1.18	1.01	0.84	0.67				
33,000-38,999	1.49	1.31	1.14	0.97	0.80			
39,000-44,999	1.79	1.62	1.45	1.28	1.10	0.93		
45,000-53,999	2.10	1.92	1.75	1.58	1.41	1.24	1.06	
54,000-64,999	2.71	2.53	2.36	2.19	2.02	1.85	1.67	1.33

12.0+ HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	0.27							
15,000-20,999	0.57	0.40						
21,000-26,999	0.88	0.71	0.54					
27,000-32,999	1.18	1.01	0.84	0.67				
33,000-38,999	1.49	1.32	1.15	0.98	0.81			
39,000-44,999	1.80	1.62	1.45	1.28	1.11	0.94		
45,000-53,999	2.10	1.93	1.76	1.59	1.42	1.25	1.08	
54,000-64,999	2.71	2.54	2.37	2.20	2.03	1.86	1.69	1.35

Heating, Early Retirement of an Electric Resistance Furnace

Table 522. Mini-Split Winter Demand Savings for 3.412 HSPF Baseline—Zone 5

8.5-8.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.00							
15,000-20,999	1.72	1.50						
21,000-26,999	2.43	2.22	2.00					
27,000-32,999	3.14	2.93	2.72	2.51				
33,000-38,999	3.86	3.65	3.43	3.22	3.01			
39,000-44,999	4.57	4.36	4.15	3.93	3.72	3.51		
45,000-53,999	5.29	5.07	4.86	4.65	4.43	4.22	4.01	
54,000-64,999	6.71	6.50	6.29	6.08	5.86	5.65	5.44	5.01
9.0-9.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.04							
15,000-20,999	1.75	1.56						
21,000-26,999	2.47	2.27	2.08					
27,000-32,999	3.18	2.99	2.79	2.60				
33,000-38,999	3.89	3.70	3.50	3.31	3.12			
39,000-44,999	4.61	4.41	4.22	4.02	3.83	3.63		
45,000-53,999	5.32	5.13	4.93	4.74	4.54	4.35	4.15	
54,000-64,999	6.75	6.55	6.36	6.17	5.97	5.78	5.58	5.19

9.5-9.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.06							
15,000-20,999	1.77	1.59						
21,000-26,999	2.48	2.30	2.11					
27,000-32,999	3.20	3.01	2.83	2.64				
33,000-38,999	3.91	3.73	3.54	3.36	3.17			
39,000-44,999	4.63	4.44	4.26	4.07	3.89	3.70		
45,000-53,999	5.34	5.16	4.97	4.78	4.60	4.41	4.23	
54,000-64,999	6.77	6.58	6.40	6.21	6.03	5.84	5.66	5.29
10.0-10.4 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.06							
15,000-20,999	1.78	1.60						
21,000-26,999	2.49	2.31	2.13					
27,000-32,999	3.21	3.02	2.84	2.66				
33,000-38,999	3.92	3.74	3.56	3.37	3.19			
39,000-44,999	4.63	4.45	4.27	4.09	3.91	3.72		
45,000-53,999	5.35	5.17	4.98	4.80	4.62	4.44	4.26	
54,000-64,999	6.78	6.59	6.41	6.23	6.05	5.87	5.68	5.32
10.5-10.9 HSPF								
Size (Btuh) Post	**< 15,000**	**15,000-20,999**	**21,000-26,999**	**27,000-32,999**	**33,000-38,999**	**39,000-44,999**	**45,000-53,999**	**54,000-64,999**
Size (Btuh) Pre								
< 15,000	1.07							
15,000-20,999	1.78	1.61						
21,000-26,999	2.50	2.32	2.14					
27,000-32,999	3.21	3.03	2.86	2.68				
33,000-38,999	3.93	3.75	3.57	3.39	3.21			
39,000-44,999	4.64	4.46	4.28	4.11	3.93	3.75		
45,000-53,999	5.35	5.18	5.00	4.82	4.64	4.46	4.28	
54,000-64,999	6.78	6.60	6.43	6.25	6.07	5.89	5.71	5.35

11.0-11.4 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.08							
15,000-20,999	1.79	1.62						
21,000-26,999	2.51	2.33	2.15					
27,000-32,999	3.22	3.04	2.87	2.69				
33,000-38,999	3.93	3.76	3.58	3.41	3.23			
39,000-44,999	4.65	4.47	4.30	4.12	3.95	3.77		
45,000-53,999	5.36	5.19	5.01	4.84	4.66	4.48	4.31	
54,000-64,999	6.79	6.61	6.44	6.26	6.09	5.91	5.74	5.39

11.5-11.9 HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.08							
15,000-20,999	1.80	1.63						
21,000-26,999	2.51	2.34	2.17					
27,000-32,999	3.23	3.05	2.88	2.71				
33,000-38,999	3.94	3.77	3.60	3.42	3.25			
39,000-44,999	4.65	4.48	4.31	4.14	3.97	3.79		
45,000-53,999	5.37	5.19	5.02	4.85	4.68	4.51	4.34	
54,000-64,999	6.79	6.62	6.45	6.28	6.11	5.93	5.76	5.42

12.0+ HSPF

Size (Btuh) Post	< 15,000	15,000-20,999	21,000-26,999	27,000-32,999	33,000-38,999	39,000-44,999	45,000-53,999	54,000-64,999
Size (Btuh) Pre								
< 15,000	1.09							
15,000-20,999	1.80	1.63						
21,000-26,999	2.52	2.35	2.17					
27,000-32,999	3.23	3.06	2.89	2.72				
33,000-38,999	3.94	3.77	3.60	3.43	3.26			
39,000-44,999	4.66	4.49	4.32	4.15	3.98	3.81		
45,000-53,999	5.37	5.20	5.03	4.86	4.69	4.52	4.35	
54,000-64,999	6.80	6.63	6.46	6.29	6.12	5.95	5.78	5.44