- 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

Not applicable.

Document Revision History

Table 180. Residential 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.

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 considered to be 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.[233] Space heating primarily refers to electric baseboard

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

zonal heaters controlled by thermostats or to portable plug-load heaters.[234] 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.

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

Table 181. 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 182 through Table 186 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 182 through Table 185 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 182 through Table 185 by a factor of 0.24.[235]

Table 182. Floor Insulation—Climate Zone 1: Panhandle Region—Deemed Annual Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated air	Evaporative cooling	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

[235] 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 183. Floor Insulation – Climate Zone 2: North Region—Deemed Annual Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated air	Evaporative cooling	Electric resistance	Heat pump
Site-built Home	-0.12	-	0.96	0.38
Manufactured Home	-0.10	-	0.85	0.33

Table 184. Floor Insulation—Climate Zone 3: South Region—Deemed Annual Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated air	Evaporative cooling	Electric resistance	Heat pump
Site-built Home	-0.12	-	0.63	0.24
Manufactured Home	-0.10	-	0.56	0.21

Table 185. Floor Insulation—Climate Zone 4: Valley Region—Deemed Annual Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated air	Evaporative cooling	Electric resistance	Heat pump
Site-built Home	-0.07	-	0.40	0.15
Manufactured Home	-0.06	-	0.35	0.13

Table 186. Floor Insulation—Climate Zone 5: West Region—Deemed Annual Energy Savings (kWh/sq. ft.)

Home type	Cooling savings		Heating savings	
	Refrigerated air	Evaporative cooling	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 187 through Table 191 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 187 through Table 191 by a factor of 0.6.

Table 187. Floor Insulation—Climate Zone 1: Panhandle Region—Deemed Summer Demand Savings (kW/sq. ft.)

Home type	Refrigerated air	Evaporative cooling
Site-built Home	6.17E-06	-1.52E-05
Manufactured Home	5.48E-06	-1.30E-05

Table 188. Floor Insulation—Climate Zone 2: North Region—Deemed Summer Demand Savings (kW/sq. ft.)

Home type	Refrigerated air	Evaporative cooling
Site-built Home	3.10E-05	-
Manufactured Home	2.75E-05	-

Table 189. Floor Insulation—Climate Zone 3: South Region—Deemed Summer Demand Savings (kW/sq. ft.)

Home type	Refrigerated air	Evaporative cooling
Site-built Home	3.36E-05	-
Manufactured Home	2.77E-05	-

Table 190. Floor Insulation—Climate Zone 4: Valley Region—Deemed Summer Demand Savings (kW/sq. ft.)

Home type	Refrigerated air	Evaporative cooling
Site-built Home	3.58E-05	-
Manufactured Home	3.07E-05	-

Table 191. Floor Insulation—Climate Zone 5: West Region—Deemed Summer Demand Savings (kW/sq. ft.)

Home type	Refrigerated air	Evaporative cooling
Site-built Home	6.29E-06	-1.34E-06
Manufactured Home	8.30E-07	1.85E-07

Deemed Winter Demand Savings Tables

Table 192 through Table 196 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 192 through Table 196 by a factor of 0.24.[236]

Table 192. Floor Insulation—Climate Zone 1: Panhandle Region—Deemed Winter 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

[236] 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 193. Floor Insulation—Climate Zone 2: North Region—Deemed Winter 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

Table 194. Floor Insulation—Climate Zone 3: South Region—Deemed Winter 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 195. Floor Insulation—Climate Zone 4: Valley Region—Deemed Winter 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 196. Floor Insulation—Climate Zone 5: West Region—Deemed Winter 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.

$$kWh\ savings = (-0.06 + 0.97) \times 500 = 455.0\ kWh$$

$$Summer\ kW\ savings = 1.85 \times 10^{-7} \times 500 = 0.00\ kW$$

$$Winter\ kW\ savings = 3.19 \times 10^{-4} \times 500 = 0.16\ kW$$

Example 2. A site-built home in Climate Zone 2 with an air-source heat pump insulates 825 square feet.

$$kWh\ savings = (-0.12 + 0.38) \times 825 = 214.5\ kWh$$

$$Summer\ kW\ savings = 3.10 \times 10^{-5} \times 825 = 0.03\ kW$$

$$Winter\ kW\ savings = 2.88 \times 10^{-4} \times 825 = 0.24\ kW$$

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

Not applicable.

Document Revision History

Table 197. Residential 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.

2.3.6 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

ENERGY STAR® windows 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 198.

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[237] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[238] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this

[237] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.
[238] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

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 198. ENERGY STAR® Windows—Baseline Window Specification

Number of panes	U-factor Btu/(h·ft²·°F)	Solar heat gain coefficient (SHGC)
1	1.16	0.76
2	0.76	0.67

High-Efficiency Condition

For a window to qualify for these deemed savings, it must meet the relevant ENERGY STAR® criteria for the location in the state where the window is to be installed. Table 199 lists the ENERGY STAR® specifications for windows as of January 1, 2015. These values are subject to updates in ENERGY STAR® specifications; energy efficiency service providers are expected to comply with the latest ENERGY STAR® code.

Table 199. ENERGY STAR® Windows—High-Efficiency Specification effective January 2015

US region, ENERGY STAR®	U-factor Btu/(h·ft²·°F)	Solar heat gain coefficient (SHGC)
North-Central	≤ 0.30	≤ 0.40
South-Central	≤ 0.30	≤ 0.25
Southern	≤ 0.40	≤ 0.25

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: change 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 200.

Table 200. ENERGY STAR® Windows—TRM and ENERGY STAR® Climate Zones

Texas TRM climate zones	US region, ENERGY STAR® windows
Climate zone 1: Panhandle	North-Central
Climate zone 2: North	South-Central
Climate zone 3: South	Southern
Climate zone 4: Valley	Southern
Climate zone 5: West	South-Central

Deemed Energy Savings Tables

Table 201 and Table 202 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 201 and Table 202 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 201 and Table 202 by a factor of 0.24.[239]

Table 201. ENERGY STAR® Windows—Replacing Single-Pane Windows, Deemed Annual Energy Savings (kWh/sq. ft.)

Climate zone	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	2.83	0.98	0.29	6.70	3.16
Climate zone 2: North	5.42	-	0.10	3.09	1.45
Climate zone 3: South	5.32	-	0.02	0.77	0.41
Climate zone 4: Valley	5.97	-	0.02	0.82	0.34
Climate zone 5: West	5.67	1.90	0.00	0.99	0.69

Table 202. ENERGY STAR® Windows—Replacing Double-Pane Windows Deemed Annual Energy Savings (kWh/sq. ft.)

Climate zone	Cooling savings		Heating savings		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	2.03	0.72	0.18	4.15	2.00
Climate zone 2: North	4.11	-	0.04	1.47	0.76
Climate zone 3: South	3.96	-	-0.01	-0.21	0.01
Climate zone 4: Valley	4.45	-	0.00	-0.01	0.02
Climate zone 5: West	4.24	1.46	-0.03	-0.18	0.16

[239] 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.

Deemed Summer Demand Savings Tables

Table 203 and Table 204 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 cooling values in Table 203 and Table 204 by a factor of 0.6.

Table 203. ENERGY STAR® Windows—Replacing Single-Pane Windows, Deemed Summer Demand Savings (kW/sq. ft.)

Climate zone	Refrigerated air	Evaporative cooling
Climate zone 1: Panhandle	3.09E-03	1.16E-03
Climate zone 2: North	3.89E-03	-
Climate zone 3: South	3.51E-03	-
Climate zone 4: Valley	2.99E-03	-
Climate zone 5: West	3.86E-03	1.05E-03

Table 204. ENERGY STAR® Windows—Replacing Double-Pane Windows, Deemed Summer Demand Savings (kW/sq. ft.)

Climate zone	Refrigerated air	Evaporative cooling
Climate zone 1: Panhandle	2.08E-03	8.36E-04
Climate zone 2: North	2.80E-03	-
Climate zone 3: South	2.40E-03	-
Climate zone 4: Valley	2.15E-03	-
Climate zone 5: West	2.76E-03	8.09E-04

Deemed Winter Demand Savings Tables

Table 205 and Table 206 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 heating values in Table 205 and Table 206 by a factor of 0.24.[240]

[240] 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 205. ENERGY STAR® Windows—Replacing Single-Pane Windows, Deemed Winter Demand Savings by Heat Type (kW/sq. ft.)

Climate zone	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	2.01E-04	4.98E-03	2.43E-03
Climate zone 2: North	1.77E-04	4.73E-03	2.74E-03
Climate zone 3: South	6.89E-05	1.78E-03	3.11E-04
Climate zone 4: Valley	4.78E-05	1.65E-03	6.68E-04
Climate zone 5: West	2.83E-05	1.10E-03	5.00E-04

Table 206. ENERGY STAR® Windows—Replacing Double-Pane Windows, Deemed Winter Demand Savings by Heat Type (kW/sq. ft.)

Climate zone	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	1.32E-04	3.30E-03	1.64E-03
Climate zone 2: North	1.12E-04	3.16E-03	1.89E-03
Climate zone 3: South	2.33E-05	6.68E-04	3.58E-06
Climate zone 4: Valley	1.53E-05	5.62E-04	2.34E-04
Climate zone 5: West	1.31E-05	5.84E-04	2.76E-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.

$$kWh\ savings = (0.98 + 6.70) \times 125 = 960\ kWh$$

$$Summer\ kW\ savings = 1.16x10^{-3} \times 125 = 0.15\ kW$$

$$Winter\ kW\ savings = 4.98x10^{-3} \times 125 = 0.62\ kW$$

Example 2. A home in climate zone 5 with a central air conditioning unit and a gas furnace replaces 250 square feet of double-pane windows with ENERGY STAR® windows.

$$kWh\ savings = \big(4.24 + (-0.03)\big) \times 250 = 1{,}052.5\ kWh$$

$$Summer\ kW\ savings = 2.76 \times 10^{-3} \times 250 = 0.69\ kW$$

$$Winter\ kW\ savings = 1.31 \times 10^{-5} \times 250 = 0.00\ kW$$

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[241].

Program Tracking Data and Evaluation Requirements

It is required that the following list of primary inputs and contextual data 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
- 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 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

Not applicable.

[241] "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.

Document Revision History

Table 207. Residential ENERGY STAR® 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.

2.3.7 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.[242] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[243] 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-ft^2-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. [244]

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.

---

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

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

[244] 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[245] 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.

$$kWh\ savings = \big(6.09 + (-3.21)\big) \times 75 = 216\ kWh$$

$$Summer\ kW\ savings = 3.17 \times 10^{-3} \times 75 = 0.24\ kW$$

$$Winter\ kW\ savings = -2.32 \times 10^{-3} \times 75 = -0.17\ kW$$

Deemed Energy Savings Tables

Table 208 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 208 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 by a factor of 0.24.[246]

---

[245] Residential Windows – A Guide to New Technologies and Energy Performance, 2000.

[246] 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 208. Deemed Energy (kWh) Savings per Square Foot of Solar Screen

Climate zone	Cooling savings (kWh/sq. ft.)		Heating savings (kWh/sq. ft.)		
	Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	3.67	1.34	-0.62	-12.81	-4.54
Climate zone 2: North	5.38	-	-0.29	-7.14	-2.56
Climate zone 3: South	5.33	-	-0.16	-4.69	-1.69
Climate zone 4: Valley	6.09	-	-0.09	-3.21	-1.16
Climate zone 5: West	5.62	1.99	-0.44	-10.48	-3.81

Deemed Summer Demand Savings Tables

Table 209 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 209 by a factor of 0.6.

Table 209. Solar Screens—Deemed Summer Peak Demand (kW) Savings per Square Foot of Solar Screen

Climate zone	Refrigerated air	Evaporative cooling
Climate zone 1: Panhandle	2.89E-03	1.35E-03
Climate zone 2: North	3.42E-03	-
Climate zone 3: South	3.29E-03	-
Climate zone 4: Valley	3.17E-03	-
Climate zone 5: West	3.12E-03	1.07E-03

Deemed Winter Demand Savings Tables

Table 210 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 210 by a factor of 0.24.[247]

[247] 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 210. Solar Screens—Deemed Winter Peak Demand (kW) Savings per Square Foot of Solar Screen

Climate zone	Gas	Electric resistance	Heat pump
Climate zone 1: Panhandle	-1.16E-04	-1.73E-03	-9.45E-04
Climate zone 2: North	-5.20E-05	-1.32E-03	-7.96E-04
Climate zone 3: South	-1.07E-04	-2.65E-03	-1.71E-03
Climate zone 4: Valley	-7.68E-05	-2.32E-03	-1.08E-03
Climate zone 5: West	-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) of solar screens is established at 10 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[248]

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

[248] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com/index.php/deer2013-update-for-2014-codes.

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

Not applicable.

Document Revision History

Table 211. Residential 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.

2.3.8 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 moreenergy 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.[249] Space heating primarily refers to electric baseboard

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

zonal heaters controlled by thermostats or to portable plug-load heaters.[250] 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 measure requires installation of roof products that have been rated by the Cool Roof Rating Council (CRRC) and demonstrate compliance with ENERGY STAR® certified roof product performance specifications for the relevant roof application. ENERGY STAR® test criteria[251] allows for products already participating in the CRRC Product Rating Program[252] 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 212.

Table 212. Cool Roofs—ENERGY STAR®Specification[253]

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

The ENERGY STAR® specification for roof products will sunset effective June 1, 2022.[254] No new roof products will be certified as of June 1, 2021. At this point, ENERGY STAR® legacy or CRRC product certification will be required to demonstrate compliance with the previous ENERGY STAR® specification.

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.

---

[250] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.
[251] ENERGY STAR® Program Requirements for Roof Products v2.1. https://www.energystar.gov/ia/partners/product_specs/program_reqs/roofs_prog_req.pdf.
[252] CRRC Rated Products Directory: https://coolroofs.org/directory.
[253] ENERGY STAR® Roof Products Specification. https://www.energystar.gov/products/building_products/roof_products/key_product_criteria.
[254] ENERGY STAR® Roof Products Sunset Decision Memo. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Roof%20Products%20Sunset%20Decision%20Memo.pdf.

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 213.

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 213. 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
Ceiling (attic floor) Insulation Levels	≤ R8 R9-R14 R15-R22 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 214 through Table 218 by a factor of 0.6.

Homes with Ceiling Insulation

Table 214 through Table 218 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.

Climate Zone 1: Panhandle Region

Table 214. Cool Roofs—Climate Zone 1: Panhandle Region –
Deemed Annual 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 air	Evaporative cooling	Gas	Electric resistance	Heat pump
Steep slope						
≤ R-8	0.15 - 0.29	0.02	0.01	0.00	-0.04	-0.01
≤ R-8	0.3 – 0.49	0.12	0.04	-0.02	-0.20	-0.07
≤ R-8	0.5 – 0.69	0.21	0.08	-0.03	-0.36	-0.14
≤ 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

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Low slope						
≤ R-8	0.5 – 0.69	0.23	0.09	-0.03	-0.40	-0.15
≤ 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
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

Climate Zone 2: North Region

Table 215. Cool Roofs—Climate Zone 2: North Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
≤ R-8	0.15 - 0.29	0.04	0.00	-0.03	-0.01
≤ R-8	0.3 – 0.49	0.18	-0.01	-0.13	-0.05
≤ R-8	0.5 – 0.69	0.34	-0.01	-0.24	-0.09
≤ 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

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Electric resistance	Heat pump
Low slope					
≤ R-8	0.5 – 0.69	0.37	-0.01	-0.27	-0.10
≤ 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

Climate Zone 3: South Region

Table 216. Cool Roofs—Climate Zone 3: South Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed oof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Electric resistance	Heat pump
Steep slope					
≤ R-8	0.15 - 0.29	0.04	0.00	-0.02	-0.01
≤ R-8	0.3 – 0.49	0.20	0.00	-0.10	-0.04
≤ R-8	0.5 – 0.69	0.37	-0.01	-0.18	-0.07
≤ 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
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

Ceiling insulation R-value	Installed oof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Electric resistance	Heat pump
Low slope					
≤ R-8	0.5 – 0.69	0.42	-0.01	-0.21	-0.08
≤ 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

Climate Zone 4: Valley Region

Table 217. Cool Roofs—Climate Zone 4: Valley Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating Savings		
			Gas	Electric resistance	Heat pump
Steep slope					
≤ R-8	0.15 - 0.29	0.03	0.00	-0.01	0.00
≤ R-8	0.3 – 0.49	0.14	0.00	-0.06	-0.02
≤ R-8	0.5 – 0.69	0.26	0.00	-0.11	-0.04
≤ 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
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

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating Savings		
			Gas	Electric resistance	Heat pump
Low slope					
≤ R-8	0.5 – 0.69	0.28	0.00	-0.13	-0.05
≤ 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

Climate Zone 5: West Region

Table 218. Cool Roofs—Climate Zone 5: West Region –
Deemed Annual 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 air	Evaporative cooling	Gas	Electric resistance	Heat pump
Steep slope						
≤ R-8	0.15 - 0.29	0.04	0.02	0.00	-0.04	-0.01
≤ R-8	0.3 – 0.49	0.21	0.08	-0.01	-0.20	-0.07
≤ R-8	0.5 – 0.69	0.39	0.15	-0.02	-0.38	-0.14
≤ R-8	>= 0.7	0.58	0.23	-0.03	-0.59	-0.22
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

Ceiling insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
Low slope						
≤ R-8	0.5 – 0.69	0.45	0.18	-0.02	-0.44	-0.16
≤ 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 219 through Table 223 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.

Climate Zone 1: Panhandle Region

Table 219. Cool Roofs—Climate Zone 1: Panhandle Region – Deemed Annual 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 air	Evaporative cooling	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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated air	Evaporative cooling	Gas	Electric resistance	Heat pump
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

Climate Zone 2: North Region

Table 220. Cool Roofs—Climate Zone 2: North Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	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
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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Electric resistance	Heat pump
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

Climate Zone 3: South Region

Table 221. Cool Roofs—Climate Zone 3: South Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	Heating savings		
			Gas	Gas heat	Gas heat
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
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

Climate Zone 4: Valley Region

**Table 222. Cool Roofs—Climate Zone 4: Valley Region –
Deemed Annual Energy Savings for Residential Reflective Roof Installation (kWh/sq. ft.)**

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings (refrigerated air)	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

Climate Zone 5: West Region

**Table 223. Cool Roofs—Climate Zone 5: West Region –
Deemed Annual 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 air	Evaporative cooling	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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Cooling savings		Heating savings		
		Refrigerated air	Evaporative cooling	Gas	Electric Resistance	Heat Pump
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 224 through Table 228 by a factor of 0.6.

Homes with Ceiling Insulation

Table 224 through Table 228 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.

Climate Zone 1: Panhandle Region

Table 224. Cool Roofs—Climate Zone 1: Panhandle Region – Deemed Summer 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 air	Evaporative cooling	Refrigerated air	Evaporative cooling
≤ R-8	0.15 - 0.29	N/A	N/A	1.48 x 10-5	6.69 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	8.09 x 10-5	4.47 x 10-5
≤ 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-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	N/A	N/A	6.05 x 10-6	7.93 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	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	N/A	N/A	2.30 x 10-6	-8.73 x 10-7
R-15 to R-22	0.3 – 0.49	N/A	N/A	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	N/A	N/A	-8.06 x 10-7	3.42 x 10-6

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated air	Evaporative cooling	Refrigerated air	Evaporative cooling
R-30	0.3 – 0.49	N/A	N/A	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

Climate Zone 2: North Region

Table 225. Cool Roofs—Climate Zone 2: North Region – Deemed Summer 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-8	0.15 - 0.29	N/A	2.63 x 10-5
≤ R-8	0.3 – 0.49	N/A	1.36 x 10-4
≤ R-8	0.5 – 0.69	2.83 x 10-4	2.64 x 10-4
≤ R-8	>= 0.7	4.10 x 10-4	4.06 x 10-4
R-9 to R-14	0.15 - 0.29	N/A	1.78 x 10-5
R-9 to R-14	0.3 – 0.49	N/A	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	N/A	9.26 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	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	N/A	1.34 x 10-5
R-30	0.3 – 0.49	N/A	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

Climate Zone 3: South Region

Table 226. Cool Roofs—Climate Zone 3: South Region – Deemed Summer 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-8	0.15 - 0.29	N/A	2.38 x 10-5
≤ R-8	0.3 – 0.49	N/A	1.33 x 10-4
≤ R-8	0.5 – 0.69	2.76 x 10-4	2.72 x 10-4
≤ R-8	>= 0.7	4.64 x 10-4	4.28 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	N/A	1.55 x 10-5
R-9 to R-14	0.3 – 0.49	N/A	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	N/A	1.75 x 10-5
R-15 to R-22	0.3 – 0.49	N/A	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	N/A	9.44 x 10-6
R-30	0.3 – 0.49	N/A	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

Climate Zone 4: Valley Region

Table 227. Cool Roofs—Climate Zone 4: Valley Region – Deemed Summer 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-8	0.15 - 0.29	N/A	1.46 x 10-5
≤ R-8	0.3 – 0.49	N/A	6.97 x 10-5
≤ R-8	0.5 – 0.69	1.22 x 10-4	1.23 x 10-4
≤ R-8	>= 0.7	2.02 x 10-4	2.01 x 10-4
R-9 to R-14	0.15 - 0.29	N/A	6.80 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	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	N/A	4.71 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	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	N/A	2.50 x 10-6
R-30	0.3 – 0.49	N/A	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

Climate Zone 5: West Region

**Table 228. Cool Roofs—Climate Zone 5: West Region –
Deemed Summer 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 air	Evaporative cooling	Refrigerated air	Evaporative cooling
≤ R-8	0.15 - 0.29	N/A	N/A	2.72 x 10-5	8.96 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	1.27 x 10-4	6.00 x 10-5
≤ 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-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	N/A	N/A	1.25 x 10-5	9.26 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	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	N/A	N/A	6.16 x 10-6	3.73 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	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	N/A	N/A	6.64 x 10-6	5.65 x 10-7
R-30	0.3 – 0.49	N/A	N/A	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 229 through Table 233 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.

Climate Zone 1: Panhandle Region

**Table 229. Cool Roofs—Climate Zone 1: Panhandle Region –
Deemed Summer 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 air	Evaporative cooling	Refrigerated air	Evaporative cooling
R-19	0.15 - 0.29	N/A	N/A	-	-
R-19	0.3 – 0.49	N/A	N/A	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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope		Steep slope	
		Refrigerated air	Evaporative cooling	Refrigerated air	Evaporative cooling
R-30	0.15 - 0.29	N/A	N/A	3.37 x 10-6	3.42 x 10-6
R-30	0.3 – 0.49	N/A	N/A	1.97 x 10-5	7.38 x 10-6
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	N/A	N/A	5.82 x 10-6	5.90 x 10-6
R-38	0.3 – 0.49	N/A	N/A	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

Climate Zone 2: North Region

Table 230. Cool Roofs—Climate Zone 2: North Region –
Deemed Summer 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 air	Refrigerated air
R-19	0.15 - 0.29	N/A	5.45 x 10-5
R-19	0.3 – 0.49	N/A	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	N/A	2.22 x 10-5
R-30	0.3 – 0.49	N/A	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	N/A	-1.31 x 10-6
R-38	0.3 – 0.49	N/A	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	N/A	5.45 x 10-5

Climate Zone 3: South Region

Table 231. Cool Roofs—Climate Zone 3: South Region – Deemed Summer 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 air	Refrigerated air
R-19	0.15 - 0.29	N/A	-
R-19	0.3 – 0.49	N/A	4.30 x 10-5
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	N/A	-1.46 x 10-6
R-30	0.3 – 0.49	N/A	2.60 x 10-5
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	N/A	-2.53 x 10-6
R-38	0.3 – 0.49	N/A	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

Climate Zone 4: Valley Region

Table 232. Cool Roofs—Climate Zone 4: Valley Region – Deemed Summer 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 air	Refrigerated air
R-19	0.15 - 0.29	N/A	-
R-19	0.3 – 0.49	N/A	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	N/A	3.36 x 10-6
R-30	0.3 – 0.49	N/A	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	N/A	5.81 x 10-6
R-38	0.3 – 0.49	N/A	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

Climate Zone 5: West Region

Table 233. Cool Roofs—Climate Zone 5: West Region – Deemed Summer 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 air	Evaporative cooling	Refrigerated air	Evaporative cooling
R-19	0.15 - 0.29	N/A	N/A	-	-
R-19	0.3 – 0.49	N/A	N/A	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	N/A	N/A	6.66 x 10-6	1.11 x 10-6
R-30	0.3 – 0.49	N/A	N/A	3.01 x 10-5	5.29 x 10-6
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	N/A	N/A	1.15 x 10-5	1.91 x 10-6
R-38	0.3 – 0.49	N/A	N/A	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 234 through Table 238 by a factor of 0.24.[255]

Homes with Ceiling Insulation

Table 234 through Table 238 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.

[255] 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.

Climate Zone 1: Panhandle Region

Table 234. Cool Roofs—Climate Zone 1: Panhandle Region – Deemed Winter 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 Heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
≤ R-8	0.15 - 0.29	N/A	N/A	N/A	-1.01 x 10-6	-9.53 x 10-6	-4.74 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	N/A	-4.25 x 10-6	-4.66 x 10-5	-2.12 x 10-5
≤ 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-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
R-9 to R-14	0.15 - 0.29	N/A	N/A	N/A	-8.59 x 10-7	-7.63 x 10-6	-3.69 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-8.96 x 10-7	-5.40 x 10-6	-2.51 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-8.09 x 10-7	-3.58 x 10-6	-1.64 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 2: North Region

Table 235. Cool Roofs—Climate Zone 2: North Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
≤ R-8	0.15 - 0.29	N/A	N/A	N/A	4.57 x 10-6	-1.03 x 10-5	-5.30 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	N/A	1.59 x 10-6	-4.70 x 10-5	-2.68 x 10-5
≤ 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-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	N/A	N/A	N/A	-7.26 x 10-7	-8.09 x 10-6	-3.86 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	3.23 x 10-7	-5.84 x 10-6	-2.76 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	N/A	-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
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	N/A	N/A	N/A	-3.74 x 10-7	2.81 x 10-6	8.71 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 3: South Region

**Table 236. Cool Roofs—Climate Zone 3: South Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
≤ R-8	0.15 - 0.29	N/A	N/A	N/A	-7.39 x 10-7	-1.25 x 10-5	-6.46 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	N/A	-2.67 x 10-6	-6.28 x 10-5	-3.05 x 10-5
≤ 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-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	N/A	N/A	N/A	-6.93 x 10-7	-9.35 x 10-6	-4.68 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-7.06 x 10-7	-6.48 x 10-6	-3.22 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-6.32 x 10-7	-4.54 x 10-6	-2.25 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 4: Valley Region

**Table 237. Cool Roofs—Climate Zone 4: Valley Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
≤ R-8	0.15 - 0.29	N/A	N/A	N/A	-4.02 x 10-7	-1.19 x 10-5	-5.71 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	N/A	-2.13 x 10-6	-5.99 x 10-5	-2.89 x 10-5
≤ 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-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	N/A	N/A	N/A	-6.35 x 10-7	-8.94 x 10-6	-4.36 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	N/A	-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

Ceiling insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-15 to R-22	0.15 - 0.29	N/A	N/A	N/A	-1.73 x 10-6	-6.16 x 10-6	-2.94 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-1.34 x 10-7	-4.03 x 10-6	-1.87 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 5: West Region

Table 238. Cool Roofs—Climate Zone 5: West Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
≤ R-8	0.15 - 0.29	N/A	N/A	N/A	-2.41 x 10-7	-1.98 x 10-5	-7.98 x 10-6
≤ R-8	0.3 – 0.49	N/A	N/A	N/A	-4.83 x 10-6	-1.03 x 10-4	-4.14 x 10-5
≤ 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-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	N/A	N/A	N/A	-5.77 x 10-7	-1.35 x 10-5	-5.48 x 10-6
R-9 to R-14	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-4.29 x 10-7	-9.41 x 10-6	-4.20 x 10-6
R-15 to R-22	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-2.85 x 10-7	-6.26 x 10-6	-2.54 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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 239 through Table 243 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.

Climate Zone 1: Panhandle Region

Table 239. Cool Roofs—Climate Zone 1: Panhandle Region – Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-19	0.15 - 0.29	N/A	N/A	N/A	-	-	-
R-19	0.3 – 0.49	N/A	N/A	N/A	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	N/A	N/A	N/A	-1.08 x 10-7	-3.00 x 10-6	-1.52 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	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
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	N/A	N/A	N/A	-1.87 x 10-7	-5.19 x 10-6	-2.62 x 10-6
R-38	0.3 – 0.49	N/A	N/A	N/A	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

Climate Zone 2: North Region

Table 240. Cool Roofs—Climate Zone 2: North Region – Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-19	0.15 - 0.29	N/A	N/A	N/A	-	-	-
R-19	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-7.35 x 10-8	-3.36 x 10-6	-1.70 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
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	N/A	N/A	N/A	-1.27 x 10-7	-5.81 x 10-6	-2.93 x 10-6
R-38	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 3: South Region

Table 241. Cool Roofs—Climate Zone 3: South Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-19	0.15 - 0.29	N/A	N/A	N/A	-	-	-
R-19	0.3 – 0.49	N/A	N/A	N/A	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	N/A	N/A	N/A	2.41 x 10-8	-3.94 x 10-6	-2.10 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	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	N/A	N/A	N/A	4.96 x 10-8	-6.80 x 10-6	-3.63 x 10-6
R-38	0.3 – 0.49	N/A	N/A	N/A	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

Climate Zone 4: Valley Region

Table 242. Cool Roofs—Climate Zone 4: Valley Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-19	0.15 - 0.29	N/A	N/A	N/A	-	-	-
R-19	0.3 – 0.49	N/A	N/A	N/A	-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

Roof deck insulation R-value	Installed roof material 3-year reflectance	Low slope			Steep slope		
		Gas heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
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	N/A	N/A	N/A	-1.08 x 10-7	-3.76 x 10-6	-1.77 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	-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	N/A	N/A	N/A	-1.87 x 10-7	-6.50 x 10-6	-3.06 x 10-6
R-38	0.3 – 0.49	N/A	N/A	N/A	-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

Climate Zone 5: West Region

Table 243. Cool Roofs—Climate Zone 5: West Region –
Deemed Winter 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 heat	Electric resistance	Heat pump	Gas heat	Electric resistance	Heat pump
R-19	0.15 - 0.29	N/A	N/A	N/A	-	-	-
R-19	0.3 – 0.49	N/A	N/A	N/A	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
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	N/A	N/A	N/A	-1.04 x 10-7	-4.45 x 10-6	-1.81 x 10-6
R-30	0.3 – 0.49	N/A	N/A	N/A	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	N/A	N/A	N/A	-1.79 x 10-7	-7.68 x 10-6	-3.13 x 10-6
R-38	0.3 – 0.49	N/A	N/A	N/A	-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.

$$kWh\ savings = (0.26 - 0.01) \times 1500 = 375\ kWh$$

$$Summer\ kW\ savings = 2.03x10^{-4} \times 1500 = 0.30\ kW$$

$$Winter\ kW\ savings = -6.46x10^{-6} \times 1500 = -0.01\ kW$$

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.

$$kWh\ savings = (0.32 - 0.11) \times 1200 = 252\ kWh$$

$$Summer\ kW\ savings = N/A$$

$$Winter\ kW\ savings = -5.96x10^{-5} \times 1200 = -0.07\ kW$$

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) for a cool roof measure is 15 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[256]

Program Tracking Data and Evaluation Requirements

It is required that the following list of primary inputs and contextual data 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)

[256] 2014 California Database for Energy Efficiency Resources. Accessed via the READI database v2.4.7 which can be downloaded from the California Public Utilities Commission Website at http://www.deeresources.com/.

- 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 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

Not applicable.

Document Revision History

Table 244. Residential 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.

2.4 RESIDENTIAL: WATER HEATING

2.4.1 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 installationsof 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 on the Department of Energy (DOE) maximum flow rate standard[257]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.[258]

Table 245. Faucet Aerators—Baseline and Efficiency Standard

Baseline	Efficiency standard
2.2 GPM maximum	1.5 GPM maximum

[257] DOE maximum flow rate for faucet aerators. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=40. Accessed August 2020.

[258] https://www.epa.gov/watersense/bathroom-faucets.

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.

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:

$$Energy\ Savings\ (per\ aerator) = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times 365 \times (T_{FaucetAvg} - T_{SupplyAvg})}{FPH \times RE \times Conversion\ Factor}$$

Equation 63

Where:

ρ	=	*Water density, 8.33 lbs/gallon*
C_P	=	*Specific heat of water, 1 Btu/lb°F*
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 = 2.86 persons*[259]
t	=	*Average time in minutes of hot water usage per person per day; default = 2.34 min/person/day*[260]

[259] Occupants per home for Texas from US Census Bureau, "Persons per household,

[260] 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.

$T_{SetPoint}$ = *Average faucet temperature = 88°F*[261]

$T_{SupplyAverage}$ = *Average supply water temperature (see Table 246)*

FPH = *Average number of faucets per household = 3.87 faucets*[262]

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.*[263]

ConversionFactor = *3,412 Btu/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.

$$Demand\ Savings\ (per\ aerator) = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times (T_{FaucetAvg} - T_{SupplySeasonal})}{FPH \times RE \times Conversion\ Factor} \times CF$$

Equation 64

Where:

$T_{SupplySeasonal}$ = *Seasonal supply water temperature (Table 246)*

CF = *Peak coincidence factor (Table 247)*

[261] 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.

[262] Faucets per home assumed to be equal to one per kitchen and each half-bath plus 1.5 per each 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 West South Central region.

[263] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, https://www.ahridirectory.org/.

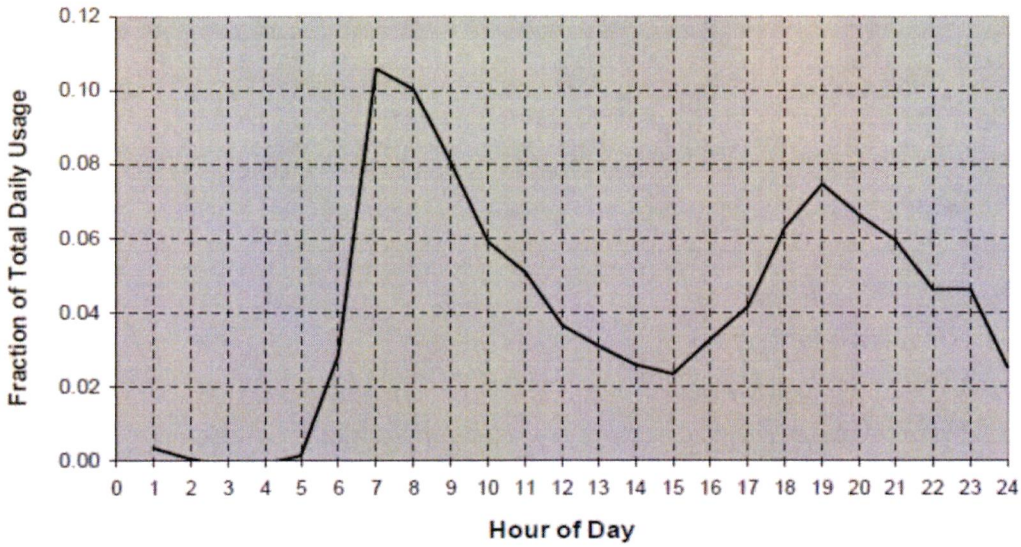
Table 246. Faucet Aerators—Water Mains Temperature

Climate zone	Water mains temperature °F[264]		
		$T_{SupplySeasonal}$	
	$T_{SupplyAverage}$	Summer	Winter
Climate zone 1: Panhandle	62.9	73.8	53.7
Climate zone 2: North	71.8	84.0	60.6
Climate zone 3: South	74.7	84.5	65.5
Climate zone 4: Valley	77.2	86.1	68.5
Climate zone 5: West	70.4	81.5	60.4

Table 247. Faucet Aerators—Peak Coincidence Factors

Climate zones	Summer	Winter
Climate zone 1: Panhandle	0.039	0.073
Climate zone 2: North	0.035	0.075
Climate zone 3: South	0.038	0.080
Climate zone 4: Valley	0.038	0.068
Climate zone 5: West	0.028	0.069

Figure 8. Shower, Bath, and Sink Hot Water Use Profile[265]



[264] Based on typical meteorological year (TMY) dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer, https://nsrdb.nrel.gov/data-sets/archives.html. Accessed August 2020.

[265] 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.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a faucet aerator is established at 10 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[266]

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)

[266] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com/..

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

Not applicable.

Document Revision History

Table 248. Residential 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.

2.4.2 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,[267] while the US Environmental Protection Agency (EPA) WaterSense Program has implemented efficiency standards for showerheads requiring a maximum flow rate of 2.0 GPM.[268]

Table 249. Low-Flow Showerheads—Baseline and Efficiency Standards

Existing showerhead baseline flow rate	New showerhead flow rate[269]
2.5 GPM maximum	2.0 GPM maximum

[267] http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/37. Accessed August 2020

[268] http://www.epa.gov/watersense/products/showerheads.html. Accessed August 2020

[269] All flow rate requirements listed here are the rated flow of the showerhead measured at 80 pounds per square inch of pressure (psi).

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.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Energy savings for this measure are calculated as follows:

$$Energy\ Savings\ (per\ showerhead) = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times 365 \times (T_{ShowerAvg} - T_{SupplyAvg})}{SPH \times RE \times Conversion\ Factor}$$

Equation 65

Where:

ρ	=	*Water density, 8.33 lbs/gallon*
C_P	=	*Specific heat of water, 1 Btu/lb°F*
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 = 2.86 persons*[270]
t	=	*Average time in minutes of hot water usage per person per day; default = 7.8 min/person/day*[271]
$T_{SetPoint}$	=	*Average shower temperature = 101°F* [272]
T_{Supply}	=	*Average supply water temperature (see Table 250)*
SPH	=	*Average number of showerheads per household = 1.74 showerheads*[273]

[270] Occupants per home for Texas from US Census Bureau, "Persons per household, 2009-2013". August 2020.https://www.census.gov/quickfacts/TX..

[271] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum. Showerhead and Faucet Aerator Meter Study". Prepared for Michigan Evaluation Working Group.

[272] Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study". Prepared for Michigan Evaluation Working Group

[273] 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.[274]

ConversionFactor = *3,412 Btu/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.

$$Demand\ Savings\ (per\ showerhead) = \frac{\rho \times C_P \times (GPM_{Base} - GPM_{Low}) \times N \times t \times (T_{ShowerAvg} - T_{SupplySeasonal})}{SPH \times RE \times Conversion\ Factor} \times CF$$

Equation 66

Where:

$T_{SupplySeasonal}$ = *Seasonal supply water temperature (see Table 250)*

CF = *Peak coincidence factorsavings (see Table* 251*)*

[274] 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.

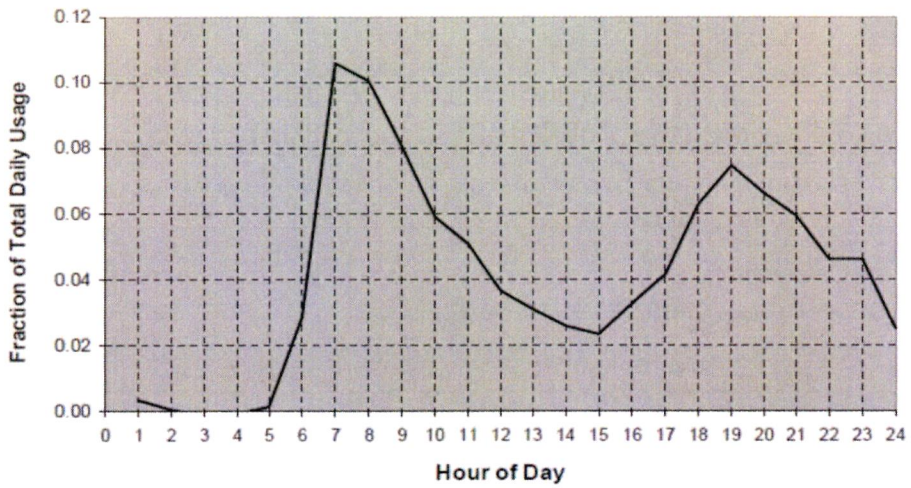
Table 250. Low-Flow Showerheads—Water Mains Temperatures

Climate zone	Water mains temperature (°F)[275]		
		$T_{SupplySeasonal}$	
	$T_{SupplyAverage}$	Summer	Winter
Climate zone 1: Panhandle	62.9	73.8	53.7
Climate zone 2: North	71.8	84.0	60.6
Climate zone 3: South	74.7	84.5	65.5
Climate zone 4: Valley	77.2	86.1	68.5
Climate zone 5: West	70.4	81.5	60.4

Table 251. Low-Flow Showerheads—Peak Coincidence Factors

Climate zones	Summer	Winter
Climate zone 1: Panhandle	0.039	0.073
Climate zone 2: North	0.035	0.075
Climate zone 3: South	0.038	0.080
Climate zone 4: Valley	0.038	0.068
Climate zone 5: West	0.028	0.069

Figure 9. Shower, Bath, and Sink Hot Water Use Profile[276]



Source: Building America Performance Analysis Procedures for Existing Homes.

[275] Based on typical meteorological year (TMY) dataset for TMY3, available through the National Solar Radiation Database (NSRDB) Data Viewer. https://nsrdb.nrel.gov/data-sets/archives.html. Accessed August 2020.

[276] 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.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a low-flow showerhead is established at 10 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[277]

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)

[277] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com/.

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

Not applicable.

Document Revision History

Table 252. Residential 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.

2.4.3 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.

Table 253. Water Heater Pipe Insulation—Baseline Standard

Baseline
Un-insulated hot water 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.

Table 254. Water Heater Pipe Insulation—Efficiency Standard

Efficiency standard
Minimum insulation of R-3

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:

$$\text{kWh}_{Savings} = \left(U_{pre} - U_{post}\right) \times A \times \left(T_{pipe} - T_{ambient\ annual}\right) \times \left(\frac{1}{RE}\right) \times \frac{Hours_{Total}}{conversion\ factor}$$

Equation 67

Where:

U_{pre}[278] = $\frac{1}{2.03} = 0.49\ {}^{Btu}/_{hr \cdot sq.ft.\cdot °F}$

U_{post} = $\frac{1}{2.03+R_{Insulation}}\ {}^{Btu}/_{hr \cdot sq.ft.\cdot °F}$

$\text{R}_{\text{Insulation}}$ = *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:*

[278] 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.

Table 255. Estimated Pipe Surface Area

Pipe diameter (inches)	Pipe surface area (square feet)[279]
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}*(°F)* = *120°F*[280]

$T_{ambientannual}$ *(°F)* = *Ambient annual temperature (see Table 256)*

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.*[281]

$Hours_{Total}$ = *8,760 hr. per year*

Conversion factor = *3,412 Btu per kWh*

Demand Savings Algorithms

$$kW = (U_{pre} - U_{post}) \times A \times (T_{Pipe} - T_{ambient\ seasonal}) \times \left(\frac{1}{RE}\right) \times \frac{CF}{conversion\ factor}$$

Equation 68

Where:

$T_{ambientseasonal}$*(°F)* = *Ambient seasonal temperature (see Table 256)*

CF= *Coincident peak demand factor, 1*[282]

---

[279] 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

[280] 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.

[281] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://www.ahrinet.org.

[282] Coincidence factor of 1 assumes that a constant tank and near tank piping temperature is maintained across all hours of the year.

Table 256. Ambient Temperatures per Climate Zone

Climate zone		Ambient temperature (°F)					
		Water heater location: unconditioned space[283]			Water heater location: Conditioned Space[284]		
		Annual	Peak seasonal		Annual	Peak seasonal	
			Summer	Winter		Summer	Winter
1	Panhandle	65.5	106	32	71.8	73.9	69.6
2	North	73.1	108.1	42			
3	South	76.3	108.2	46			
4	Valley	78.4	103	55			
5	West	71.8	108	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.

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.

[283] 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).

[284] Average ambient temperatures for conditioned space were taken from the U.S. 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.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of water heater pipe insulation installed for an electric water heater is established at 13 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[285]

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
- 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)

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

Not applicable.

[285] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com.

Document Revision History

Table 257. Residential Water Heater 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.

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:

$$kWh_{Saving} = (U_{pre} - U_{post}) \times A \times (T_{tank} - T_{ambient\ annual}) \times \left(\frac{1}{RE}\right) \times \frac{Hours_{Total}}{conversion\ factor}$$

Equation 69

Where:

U_{pre} = *1/ (5) Btu/hr sq.ft. °F*[286]

U_{post} = *1/ (5+$R_{Insulation}$) 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 258.*

Table 258. Estimated Tank Area[287]

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}*(°F)* = *Average temperature of the tank, default use 120°F* [288]

$T_{ambientannual}$ *(°F)* = *Ambient annual temperature (see Table 259)*

---

[286] Baseline storage tank assembly is assumed to have thermal performance of R5.

[287] 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.

[288] 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.*[289]

$\text{Hours}_{\text{Total}}$ = *8,760 hours per year*

Conversion factor = *3,412 Btu per kWh*

Demand Savings Algorithms

$$Tank\ Insulation\ Demand\ Savings\ (kW) = (U_{pre} - U_{post}) \times A \times (T_{Tank} - T_{ambient\ seasonal}) \times \frac{1}{RE} \times \frac{\text{CF}}{conversion\ factor}$$

Equation 70

Where:

$\text{T}_{\text{ambientseasonal}}$*(°F)* = *Ambient seasonal temperature (see Table 259)*

CF = *Peak coincidence factor*[290] *= 1*

Table 259. Ambient Temperatures per Climate Zone

		Ambient temperature (°F)					
		Water heater location: unconditioned space[291]			Water heater location: conditioned space[292]		
			Peak seasonal			Peak seasonal	
	Climate zone	Annual	Summer	Winter	Annual	Summer	Winter
1	Panhandle	65.5	106	32	71.8	73.9	69.6
2	North	73.1	108.1	42			
3	South	76.3	108.2	46			
4	Valley	78.4	103	55			
5	West	71.8	108	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.

[289] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at http://www.ahrinet.org.

[290] Coincidence factor of 1 assumes that a constant tank temperature is maintained across all hours of the year.

[291] 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).

[292] Average ambient temperatures for conditioned space were taken from the U.S. 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) for storage water heater tank insulation is established at 7 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[293]

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
- 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

[293] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com.

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

Not applicable.

Document Revision History

Table 260. Residential Water Heater 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.

2.4.5 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.[294]

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.

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.

[294] 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.

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 261).[295]

Table 261. Federal Standard for Residential Electric Storage Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR)[296,297]	Uniform energy factor (UEF)[298]
≥ 20 gal and ≤ 55 gal	Very Small Usage	0 ≤ FHR < 18	0.8808 − (0.0008 × V_r)
	Low Usage	18 ≤ FHR < 51	0.9254 − (0.0003 × V_r)
	Medium Usage	51 ≤ FHR < 75	0.9307 − (0.0002 × V_r)
	High Usage	75 ≤ FHR	0.9349 − (0.0001 × V_r)
> 55 gal and ≤ 120 gal	Very Small Usage	0 ≤ FHR < 18	1.9236 − (0.0011 × V_r)
	Low Usage	18 ≤ FHR < 51	2.0440 − (0.0011 × V_r)
	Medium Usage	51 ≤ FHR < 75	2.1171 − (0.0011 × V_r)
	High Usage	75 ≤ FHR	2.2418 − (0.0011 × 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.

High-Efficiency Condition

For water heater replacement and fuel substitution, the new unit must meet the following federal minimum energy factor shown in Table 262. Water heaters must be installed in accordance with local code requirements.

---

[295] 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. Accessed August 2020

[296] "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.

[297] Assume FHR equal to that of installed water heater.

[298] Vr is the Rated Storage Volume (in gallons), as determined pursuant to 10 CFR 429.17.

Table 262. Water Heater Replacement—Efficiency Standards[299]

DHW type	Rated storage volume	Draw pattern	FHR	UEF[300]
Electric Tankless	< 2 gal	Very Small Usage	0 ≤ FHR < 18	0.91
		Low Usage	18 ≤ FHR < 51	0.91
		Medium Usage	51 ≤ FHR < 75	0.91
		High Usage	75 ≤ FHR	0.92
Gas Tankless	< 2 gal and > 50,000 Btuh	Very Small Usage	0 ≤ FHR < 18	0.80
		Low Usage	18 ≤ FHR < 51	0.81
		Medium Usage	51 ≤ FHR < 75	0.81
		High Usage	75 ≤ FHR	0.81
Gas Storage	≥ 20 gal and ≤ 55 gal	Very Small Usage	0 ≤ FHR < 18	0.3456 – (0.0020 x V_r)
		Low Usage	18 ≤ FHR < 51	0.5982 – (0.0019 x V_r)
		Medium Usage	51 ≤ FHR < 75	0.6483 – (0.0017 x V_r)
		High Usage	75 ≤ FHR	0.6920 – (0.0013 x V_r)
	> 55 gal and ≤ 100 gal	Very Small Usage	0 ≤ FHR < 18	0.6470 – (0.0006 x V_r)
		Low Usage	18 ≤ FHR < 51	0.7689 – (0.0005 x V_r)
		Medium Usage	51 ≤ FHR < 75	0.7897 – (0.0004 x V_r)
		High Usage	75 ≤ FHR	0.8072 – (0.0003 x 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.

[299] 10 CFR Part 430.32 Energy and water conservation standards. Available online: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32. Accessed August 2020.

[300] Vr is the Rated Storage Volume (in gallons), as determined pursuant to 10 CFR 429.17.

Electric Tankless Water Heater

Energy Savings Algorithm

$$kWh_{savings} = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{3{,}412}$$

Equation 71

Where:

ρ = *Water density (= 8.33 lbs/gallons)*

C_p = *Specific heat of water (= 1 Btu/lb· °F)*

GPY = *Estimated annual hot water use in gallons/year, specified by number of bedrooms in the home (see Table 263)*

Table 263. Water Heater Consumption (Gal/Year)[301]

Climate zone		Number of bedrooms			
		1	2	3	4
1	Panhandle	15,476	20,171	24,866	29,561
2	North	14,778	19,244	23,710	28,177
3	South	14,492	18,864	23,236	27,608
4	Valley	14,213	18,494	22,775	27,056
5	West	14,905	19,412	23,920	28,427

$T_{SetPoint}$ = *Water heater setpoint (= 120°F)*[302]

$T_{Supply,ann}$ = *Annual average mains temperature from Table 264*

UEF_{pre} = *Baseline uniform energy factor (calculate per* Table 262*)*[303]

UEF_{post} = *Uniform energy factor of new water heater (must exceed values from Table 262)*

3,412 = *Constant to convert from Btu to kWh*

---

[301] Building America Research Benchmark Definition. December 2009, p 13. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.

[302] 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.

[303] 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 264. Water Mains Temperature[304]

Climate zone		Water mains temperature (°F)		
			$T_{supply,seasonal}$	
		$T_{supply,annual}$	Summer	Winter
1	Panhandle	62.9	73.8	53.7
2	North	71.8	84.0	60.6
3	South	74.7	84.5	65.5
4	Valley	77.2	86.1	68.5
5	West	70.4	81.5	60.4

Demand Savings Algorithm

$$kW_{savings,summer} = CF_{Summer} \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,summer}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{365 \times 3{,}412}$$

Equation 72

$$kW_{savings,winter} = CF_{Winter} \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,winter}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{UEF_{post}}\right)}{365 \times 3{,}412}$$

Equation 73

Where:

CF = *Coincident peak demand factor, see Table 265.*

$T_{Supply,sum}$ = *Summer average water mains temperature (see Table 264)*

$T_{Supply,win}$ = *Winter average water mains temperature (see Table 264)*

[304] Based on TMY3 dataset. TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. https://nsrdb.nrel.gov/data-sets/archives.html. Accessed August 2020.

Table 265. Coincident Peak Demand Factors[305]

Climate zone	Summer CF	Winter CF
1	0.042	0.067
2	0.039	0.068
3	0.041	0.070
4	0.041	0.065
5	0.036	0.067

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.

Energy Savings Algorithm for Units Less than 55 Gallons

$$kWh_{savings} = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}}\right)}{3{,}412}$$

Equation 74

Demand Savings Algorithm for Units Less than 55 Gallons

$$SummerkW_{savings} = CF_{Summer} \times \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,summer}) \times \left(\frac{1}{UEF_{pre}}\right)}{365 \times 3{,}412}$$

Equation 75

$$WinterkW_{savings} = CF_{Winter} \times \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,winter}) \times \left(\frac{1}{UEF_{pre}}\right)}{365 \times 3{,}412}$$

Equation 76

[305] 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. Accessed August 2020.

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.

$$kWh_{savings} = \frac{[8.33 \times 1 \times 19{,}244 \times (120 - 71.8) \times (\frac{1}{0.9227} - \frac{1}{0.99})]}{3{,}412} = 167\,kWh$$

$$kW_{savings,summer} = 0.042 \times \frac{[8.33 \times 1 \times 19{,}244 \times (120 - 84) \times (\frac{1}{0.9227} - \frac{1}{0.99})]}{365 \times 3{,}412} = 0.01\,kW$$

$$kW_{savings,winter} = 0.068 \times \frac{[8.33 \times 1 \times 19{,}244 \times (120 - 60.6) \times (\frac{1}{0.9227} - \frac{1}{0.99})]}{365 \times 3{,}412} = 0.04\,kW$$

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.

$$kWh_{savings} = \frac{[8.33 \times 1 \times 14{,}905 \times (120 - 70.4) \times (\frac{1}{0.9247})]}{3{,}412} = 1{,}952\,kWh$$

$$kW_{savings,summer} = 0.036 \times \frac{[8.33 \times 1 \times 14{,}905 \times (120 - 81.5) \times (\frac{1}{0.9247})]}{365 \times 3{,}412} = 0.15\,kW$$

$$kW_{savings,winter} = 0.067 \times \frac{[8.33 \times 1 \times 14{,}905 \times (120 - 60.4) \times (\frac{1}{0.9247})]}{365 \times 3{,}412} = 0.43\,kW$$

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 average EULs for installed equipment are: 20 years for a tankless water heater (gas or electric) and 11 years for a high-efficiency gas water heater.

These values are consistent with the EULs reported in the 2014 California DEER.[306]

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
- Volume of the replacement water heater (gallons, zero if tankless)
- Volume of the existing water heater (gallons)
- First hour rating of replacement water heater (gal/hr)
- Uniform energy factor of the replacement water heater
- Number of bedrooms
- 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

Not applicable.

[306] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com/.

Document Revision History

Table 266. Residential Water Heater Installations 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.
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.

2.4.6 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

The residential heat pump water heater (HPWH) measure involves the installation of an integrated or "drop-in" ENERGY STAR® HPWH. Deemed savings values are presented on a per unit basis. Deemed savings variables include storage tank volume, first-hour rating, and HPWH installation location (in conditioned or unconditioned space). In addition, this measure accounts for the interactive air conditioning energy savings and heating penalty associated with the HPWH when installed inside conditioned space.[307]

These deemed savings are calculated using the amended federal standards for electric consumer water heaters effective April 16, 2015.

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.

These deemed savings are for heat pump water heaters installed as a replace-on-burnout measure or as an early retirement measure in existing homes. However, savings are calculated under the assumption of replace-on-burnout. New construction homes are also eligible to claim savings under this measure.

Baseline Condition

This baseline applies to replace-on-burnout, early retirement, and new construction.

[307] Interaction with space heating equipment only affects deemed savings for units below 55 gallons. 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 are essentially the same for base and change case systems, so they cancel each other out.

The baseline condition is an electric storage water heater (EWH) with baseline efficiency (UEF: uniform energy factor) determined by tank size and draw pattern – a proxy for first hour rating – based on the amended federal energy efficiency standards for residential water heaters with tank sizes 20–120 gallons, as published in 10 CFR Part 430.32 of the Federal Register:[308]

Table 267. Federal Standard for Residential Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR) [309]	Uniform energy factor[310]
≥ 20 gal and ≤ 55 gal	Very Small Usage	0 ≤ FHR < 18	0.8808 − (0.0008 × V_r)
	Low Usage	18 ≤ FHR < 51	0.9254 − (0.0003 × V_r)
	Medium Usage	51 ≤ FHR < 75	0.9307 − (0.0002 × V_r)
	High Usage	75 ≤ FHR	0.9349 − (0.0001 × V_r)
> 55 gal and ≤ 120 gal	Very Small Usage	0 ≤ FHR < 18	1.9236 − (0.0011 × V_r)
	Low Usage	18 ≤ FHR < 51	2.0440 − (0.0011 × V_r)
	Medium Usage	51 ≤ FHR < 75	2.1171 − (0.0011 × V_r)
	High Usage	75 ≤ FHR	2.2418 − (0.0011 × V_r)

Because 98% of all certified ENERGY STAR® water heaters are in the medium and high usage categories, the *very small usage* and *low usage* draw pattern categories are not included in this measure. Discarding these draw patterns and applying average tank volumes within four strata of storage tank sizes, the application of this equation provides the following baseline efficiency levels for residential electric storage water heaters.

Table 268. Heat Pump Water Heaters—Minimum Required Uniform Energy Factors

Usage rate	Tank size (gallons)			
	45	65	75	82
Medium Usage	0.922	2.046	2.035	N/A
High Usage	N/A	2.170	2.159	2.152

The 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. For smaller systems, the baseline technology remains an electric storage water heater with electric resistance as the primary heat source.

---

[308] 10 CFR Part 430.32 Energy and water conservation standards and their effective dates. Online. Available: www.ecfr.gov/cgi-bin/text-idx?SID=80dfa785ea350ebeee184bb0ae03e7f0&mc=true&node=se10.3.430_132&rgn=div8. Accessed August 2020.

[309] "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.

[310] Vr is the Rated Storage Volume (in gallons), as determined pursuant to 10 CFR 429.17.

High-Efficiency Condition

The efficient condition is a heat pump water heater certified by ENERGY STAR® with uniform energy factor (UEF) greater than 2.3.[311] A complete list of certified ENERGY STAR® heat pump water heaters can be accessed via the ENERGY STAR® program website.[312]

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.[313]

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Deemed savings are estimated using a model that applies a similar algorithm to that used in the Water Heater Installations measure, based on gallons per year, temperature difference, and efficiency (UEF). The average uniform energy factor (UEF) of ENERGY STAR® certified systems with UEF > 2.3 by storage tank size strata and first-hour rating/usage draw pattern according to the list of certified products available in August 2018.[314] Consumption in gallons per year us estimated using data from Building America Performance Analysis Procedures for Existing Homes.[315] Temperature data are based on TMY3 dataset.[316]

---

[311] ENERGY STAR® Requirements (as of April 2015): HPWH must have nominal input of 75,000 BTU/h or less, 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. Unit must have "integrated" or "drop-in" configuration. EF ≥ 2.0 for units ≤ 55 gal, EF ≥ 2.20 for units > 55 gal, first-hour rating (FHR) ≥ 50 gallons/hour, Warranty ≥ 6 years on sealed systems, Safety UL 174 and UL 1995. . See: https://www.energystar.gov/products/water_heaters/residential_water_heaters_key_product_criteria.

[312] ENERGY STAR Certified Water Heaters. Online. Available: https://www.energystar.gov/productfinder/product/certified-water-heaters/?scrollTo=721.5999755859375&search_text=&fuel_filter=Electric&type_filter=Heat+Pump&brand_name_isopen=&input_rate_thousand_btu_per_hour_isopen=&markets_filter=United+States&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=uniform_energy_factor_uef&sort_direction=asc&currentZipCode=1871&page_number=0&lastpage=0

[313] Heat Pump Water Heaters. Department of Energy, May 2012. Online. Available: http://energy.gov/energysaver/articles/heat-pump-water-heaters. Accessed: August 2020..

[314] As of August 2020, the ENERGY STAR® products list includes 205 residential heat pump water heaters with UEF >2.3.

[315] 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. Accessed August 2020.

[316] TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. https://nsrdb.nrel.gov/data-sets/archives.html. Accessed August 2020.

Deemed Energy Savings Tables

Deemed savings are developed for heat pump water heaters in four size ranges: less than or equal to 55 gallons, 56-69 gallons, 70-79 gallons, and 80 gallons or more. These sizes correspond to the four basic sizes of HPWHs commercially available at the time these deemed savings were developed, according to a review of manufacturer data provided on the ENERGY STAR® and AHRI websites. Table 269 presents the deemed energy savings tables for medium usage HPWHs for the five Texas climate zones. This table assumes a replace-on-burnout scenario but may be used for early retirement and new construction projects.

Table 269. Medium Usage Residential HPWH Deemed Annual Energy Savings (kWh)

Climate zone		HPWH tank size range (gallons)	Conditioned space			Unconditioned space
			Gas heat	Electric resistance	Heat pump	
1	Panhandle	<55	2,244	1,450	1,899	2,102
		55-69	592	592	592	616
		70-79	600	600	600	623
2	North	<55	1,985	1424	1,741	1,825
		55-69	496	496	496	500
		70-79	502	502	502	506
3	South	<55	1,897	1342	1,656	1,729
		55-69	465	465	465	457
		70-79	470	470	470	462
4	Valley	<55	1,840	1,510	1,696	1,649
		55-69	434	434	434	425
		70-79	439	439	439	430
5	West	<55	2,001	1,440	1,758	1,865
		55-69	511	511	511	515
		70-79	517	517	517	521

Table 270 presents the deemed energy savings tables for high usage HPWHs for the five Texas climate zones.

Table 270. High Usage Residential HPWH Deemed Annual Energy Savings (kWh)

Climate zone		HPWH tank size range (gallons)	Conditioned space			Unconditioned space
			Gas heat	Electric resistance	Heat pump	
1	Panhandle	55-69	652	652	652	677
		70-79	769	769	769	799
		80+	478	478	478	497
2	North	55-69	546	546	546	550
		70-79	644	644	644	649
		80+	401	401	401	404
3	South	55-69	511	511	511	502
		70-79	603	603	603	593
		80+	375	375	375	369
4	Valley	55-69	477	477	477	467
		70-79	563	563	563	551
		80+	351	351	351	343
5	West	55-69	562	562	562	566
		70-79	663	663	663	668
		80+	412	412	412	416

Deemed Summer Demand Savings Tables

Table 271 presents the deemed summer demand savings for medium usage heat pump water heaters across the five Texas climate zones.

Table 271. Medium Usage Residential HPWH Deemed Summer Demand Savings (kW)

Climate zone		HPWH tank size range (gallons)	Conditioned space	Unconditioned space
1	Panhandle	<55	0.31	0.27
		55-69	0.07	0.06
		70-79	0.07	0.06
2	North	<55	0.24	0.20
		55-69	0.05	0.04
		70-79	0.05	0.04
3	South	<55	0.24	0.20
		55-69	0.05	0.04
		70-79	0.05	0.04
4	Valley	<55	0.23	0.19
		55-69	0.05	0.04
		70-79	0.05	0.04
5	West	<55	0.26	0.22
		55-69	0.05	0.05
		70-79	0.06	0.05

Table 272 presents the deemed summer demand savings for medium usage heat pump water heaters across the five Texas climate zones.

Table 272. High Usage Residential HPWH Deemed Summer Demand Savings (kW)

Climate zone		HPWH tank size range (gallons)	Conditioned space	Unconditioned space
1	Panhandle	55-69	0.07	0.07
		70-79	0.09	0.08
		80+	0.05	0.05
2	North	55-69	0.05	0.05
		70-79	0.06	0.06
		80+	0.04	0.03
3	South	55-69	0.05	0.05
		70-79	0.06	0.06
		80+	0.04	0.04
4	Valley	55-69	0.05	0.05
		70-79	0.06	0.05
		80+	0.04	0.03
5	West	55-69	0.06	0.05
		70-79	0.07	0.06
		80+	0.04	0.04

Deemed Winter Demand Savings Tables

Table 273 presents the deemed winter demand savings for medium usage heat pump water heaters across the five Texas climate zones.

Table 273. Medium Usage Residential HPWH Deemed Winter Demand Savings (kW)

Climate zone		HPWH tank size range (gallons)	Conditioned space			Unconditioned space
			Gas heat	Electric resistance	Heat pump	
1	Panhandle	<55	0.57	0.00	0.44	0.54
		55-69	0.16	0.16	0.16	0.18
		70-79	0.16	0.16	0.16	0.18
2	North	<55	0.53	0.00	0.40	0.51
		55-69	0.15	0.15	0.15	0.16
		70-79	0.15	0.15	0.15	0.17
3	South	<55	0.48	0.00	0.36	0.47
		55-69	0.14	0.14	0.14	0.15
		70-79	0.14	0.14	0.14	0.15
4	Valley	<55	0.46	0.00	0.33	0.45
		55-69	0.13	0.13	0.13	0.14
		70-79	0.13	0.13	0.13	0.14
5	West	<55	0.52	0.00	0.39	0.51
		55-69	0.15	0.15	0.15	0.16
		70-79	0.15	0.15	0.15	0.16

Table 274 presents the deemed winter demand savings for high usage heat pump water heaters across the five Texas climate zones.

Table 274: High Usage Residential HPWH Deemed Winter Demand Savings (kW)

Climate zone		HPWH tank size range (gallons)	Conditioned space			Unconditioned space
			Gas heat	Electric resistance	Heat pump	
1	Panhandle	55-69	0.18	0.18	0.18	0.20
		70-79	0.21	0.21	0.21	0.23
		80+	0.13	0.13	0.13	0.15
2	North	55-69	0.17	0.17	0.17	0.18
		70-79	0.20	0.20	0.20	0.21
		80+	0.12	0.12	0.12	0.13
3	South	55-69	0.15	0.15	0.15	0.16
		70-79	0.18	0.18	0.18	0.19
		80+	0.11	0.11	0.11	0.12
4	Valley	55-69	0.14	0.14	0.14	0.15
		70-79	0.17	0.17	0.17	0.18
		80+	0.11	0.11	0.11	0.11
5	West	55-69	0.16	0.16	0.16	0.18
		70-79	0.19	0.19	0.19	0.21
		80+	0.12	0.12	0.12	0.13

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 for this measure is 13 years.[317]

[317] 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. Accessed August 2020.

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
- Approximate volume of the replacement heat pump water heater tank in gallons
- Replacement water heater UEF
- First-hour rating (FHR) of the replacement water heater
- Existing water heater type (heat pump, electric resistance)
- Installed location (conditioned, unconditioned space)
- For heat pump water heater installations in conditioned space, the building heating type (electric resistance, air-source heat pump, or gas furnace)
- 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

Not applicable.

Document Revision History

Table 275. Residential Heat Pump Water Heaters 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.

TRM version	Date	Description of change
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

2.4.7 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 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 279).[318] This baseline applies to replace-on-burnout, early retirement, and new construction applications.

[318] 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. Accessed August 2020.

Table 276. Federal Standard for Residential Electric Storage Water Heaters

Rated storage volume	Draw pattern	First hour rating (FHR)[319,320]	Uniform energy eactor (UEF)[321]
≥ 20 gal and ≤ 55 gal	Very Small Usage	0 ≤ FHR < 18	0.8808 − (0.0008 × V_r)
	Low Usage	18 ≤ FHR < 51	0.9254 − (0.0003 × V_r)
	Medium Usage	51 ≤ FHR < 75	0.9307 − (0.0002 × V_r)
	High Usage	75 ≤ FHR	0.9349 − (0.0001 × V_r)
> 55 gal and ≤ 120 gal	Very Small Usage	0 ≤ FHR < 18	1.9236 − (0.0011 × V_r)
	Low Usage	18 ≤ FHR < 51	2.0440 − (0.0011 × V_r)
	Medium Usage	51 ≤ FHR < 75	2.1171 − (0.0011 × V_r)
	High Usage	75 ≤ FHR	2.2418 − (0.0011 × V_r)

High-Efficiency Condition

Only solar water heaters meeting the SRCC OG-300 standard (based on tank size and final Solar Energy Factor-SEF) qualify for these deemed savings estimates.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Solar water heating savings values are on a per-unit basis. Deemed savings variables include tank volume and installed unit solar energy factor (SEF) as rated in the Solar Rating and Certification Corporation (SRCC) "Summary of SRCC Certified Solar Collector and Water Heating System Ratings." The Solar Energy Factor (SEF) 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 Energy Factor (EF) and listed in the Gas Appliance Manufacturers Association Directory of Certified Water Heating Products.

Both EF and SEF 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/.)

[319] "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. Accessed August 2020.
[320] Assume FHR equal to that of installed water heater.
[321] Vr is the Rated Storage Volume (in gallons), as determined pursuant to 10 CFR 429.17.

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

$$kWh_{savings} = \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,annual}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{SEF_{post}}\right)}{3{,}412}$$

Equation 77

Where:

ρ = *Water density (= 8.33 lbs/gallons)*

C_p = *Specific heat of water (= 1 Btu/lb· °F)*

GPY = *Estimated annual hot water use in gallons/year, specified by number of bedrooms in the home (see* Table 277*)*

Table 277. Water Heater Consumption (Gal/Year) [322]

Climate zone		Number of bedrooms			
		1	2	3	4
1	Panhandle	15,476	20,171	24,866	29,561
2	North	14,778	19,244	23,710	28,177
3	South	14,492	18,864	23,236	27,608
4	Valley	14,213	18,494	22,775	27,056
5	West	14,905	19,412	23,920	28,427

$T_{SetPoint}$ = *Water heater setpoint = 120°F*[323]

$T_{Supply,ann}$ = *Annual average mains temperature from* Table 278

EF_{pre} = *Baseline uniform energy factor (calculate per* Table 276*)*[324]

[322] Building America Research Benchmark Definition. December 2009, p 13. Available online: http://www.nrel.gov/docs/fy10osti/47246.pdf.

[323] 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.

[324] 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.

EF_{post} = *Solar energy factor of new water heater*

3,412 = *Constant to convert from Btu to kWh*

Table 278. Water Mains Temperature[325]

Climate zone		Water mains temperature (°F)		
		$T_{supply,annual}$	$T_{supply,seasonal}$	
			Summer	Winter
1	Panhandle	62.9	73.8	53.7
2	North	71.8	84.0	60.6
3	South	74.7	84.5	65.5
4	Valley	77.2	86.1	68.5
5	West	70.4	81.5	60.4

Demand Savings Algorithm

$$kW_{savings} = CF \times \frac{\rho \times C_p \times GPY \times (T_{setpoint} - T_{supply,seasonal}) \times \left(\frac{1}{UEF_{pre}} - \frac{1}{SEF_{post}}\right)}{365 \times 3{,}412}$$

Equation 78

Where:

$Ratio_{dailygal}^{Sumpeakgal}$ = *Coincident peak demand factor (see* Table 279*)*

$T_{Supply,sum}$ = *Summer/winter average water mains temperature (see* Table 278*)*

[325] Based on TMY3 dataset. TMY data is available through the National Solar Radiation Database (NSRDB) Data Viewer, https://maps.nrel.gov/nsrdb-viewer/. https://nsrdb.nrel.gov/data-sets/archives.html. Accessed August 2020.

Table 279. Coincident Peak Demand Factors[326]

Climate Zone	Summer CF	Winter CF
1	0.042	0.067
2	0.039	0.068
3	0.041	0.070
4	0.041	0.065
5	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) of a solar water heater is established at 15 years.

This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[327]

[326] 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. Accessed August 2020.

[327] 2014 California Database for Energy Efficiency Resources. http://www.deeresources.com

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 replacement water heater in gallons
- First hour rating of baseline water heater
- SRCC OG-300 Solar Energy Factor of the replacement 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

Not applicable.

Document Revision History

Table 280. Residential Solar Water Heaters 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.
v7.0	10/2019	TRM v7.0 update. No revision.
v8.0	10/2020	TRM v8.0 update. Updated algorithms and coincidence factors.

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, 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 consists of installing a temperature sensitive restrictor valve (TSRV)[328] 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. To use deemed savings, the fuel type of the water heater must be electricity or gas.

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.

[328] A temperature sensitive restrictor valve is any device that uses water temperature to regulate water flow in showers.