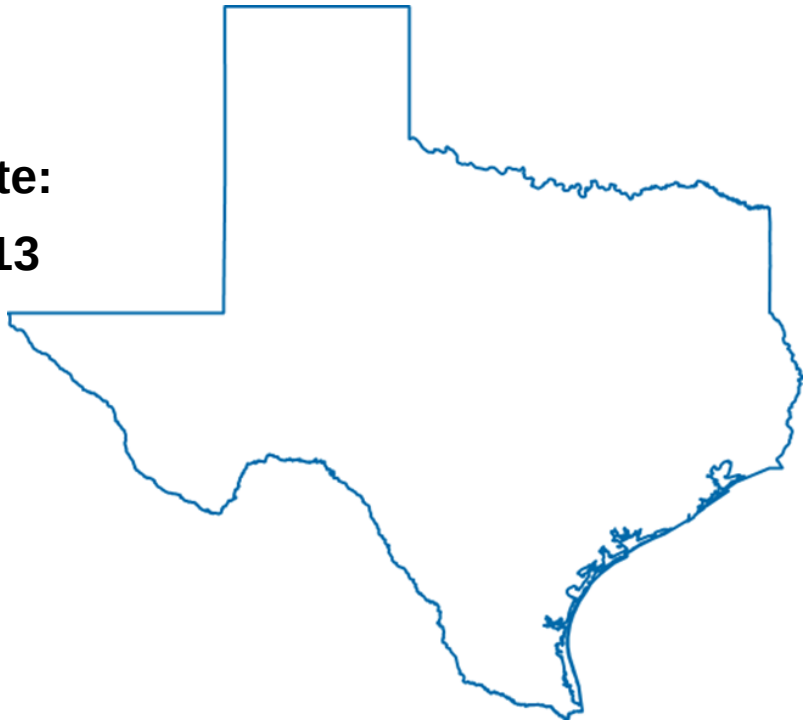
Public Utility Commission of Texas

Texas Technical Reference Manual

Version 1.0

Volume 2: Residential Measures

Guide for PY2014 Implementation



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utilities, their consultants and EESPs such as Frontier Associates, ICF, ClearRESULT and Nexant[1]. Portions of the Technical Reference Manual are copyrighted 2001-2013 by the Electric Utility Marketing Managers of Texas (EUMMOT), while other portions are copyrighted 2001-2013 by Frontier Associates.Certain technical content was added by the EM&V team to provide further explanation and direction as well as consistent structure and level of information.

TRM Technical Support

Technical support and questions can be emailed to: TexasTRM@tetratech.com

[1] Source materials are cited throughout the TRM. For version 1.0, there are some missing citations, which the EM&V team is working to have completed by TRM version 2.1.

1 INTRODUCTION

This volume of the TRM contains the deemed savings for residential measures that have been approved for use in Texas by the Public Utility Commission of Texas (PUCT). This volume includes instructions regarding various savings calculators and reference sources of the information. TRM 1.0 serves as a centralized source of deemed savings values; where appropriate, Measurement & Verification (M&V) methods by measure category are noted for informational purposes only regarding the basis of projected and claimed savings.

Table 1-1 provides an overview of the residential measures contained within this TRM 1.0 Volume 2 and the types of deemed savings estimates available for each one. There are five types of deemed savings estimates identified:

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

Table 1-1: Residential Deemed Savings by Measure Category

Measure Category	Measure Description	Point Estimates	Deemed Savings Tables	Savings Algorithm	Calculator	M&V
Lighting	Compact Fluorescent Lamps	--	X	X	--	--
HVAC	Central AC	--	X	--	--	--
	Duct Efficiency Improvement	--	--	X	X	X
	Ground Source Heat Pump	--	X	--	--	--
	Central Heat Pump	--	X	--	--	--
	Split System and Single-Package Heat Pumps between 65,000 BTU/hr and 240,000 BTU/hr	--	X	--	--	--
	Split System and Single-Package Air Conditioners between 65,000 BTU/H and 240,000 BTU/H	--	X	--	--	--
	Window AC	--	X	X	--	--
Building Envelope	Air Infiltration	--	X	X	--	X
	Ceiling Insulation	--	X	--	--	--
	Wall Insulation	--	X	--	--	--
	Floor Insulation	--	X	--	--	--
	ENERGY STAR® Windows	--	X	--	--	--
	Solar Screens	--	X	--	--	--
Domestic Water Heating	Faucet Aerators	--	--	X	--	--
	Low-Flow Showerheads	--	--	X	--	--
	Water Heater Jackets	--	--	X	--	--
	Water Heater Pipe Insulation	--	--	X	--	--
	Heat Pump Water Heater	--	X	--	--	--
	Water Heater Replacement–High Efficiency	--	X	X	--	--
	Water Heater Replacement–Solar Water Heating	--	X	X	--	--
Appliances	ENERGY STAR® Clothes Washer	X	--	--	--	--
	ENERGY STAR® Dishwasher	X	--	--	--	--
	ENERGY STAR® Refrigerator	X	--	--	--	--
	ENERGY STAR® Ceiling Fans	X	--	--	--	--
Whole-House	New Homes	--	--	X	X	X
Renewables	Solar Electric (Photovoltaic) Energy System	--	--	X	--	--
Load Management	Direct Load Control Switches Installed on Outdoor Compressor Units	X	--	--	--	--
	Direct Load Control Switches Installed on Swimming Pool Pump Motors	X	--	--	--	--

2 RESIDENTIAL MEASURES

2.1 RESIDENTIAL: LIGHTING

2.1.1 Compact Fluorescent Lamps Measure Overview

TRM Measure ID: R-LT-CF

Market Sector: Residential Hard-to-Reach

Measure Category: Lighting

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive and Direct Install

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

This measure involves the replacement of standard incandescent or halogen lamps with compact fluorescent lamps (CFLs). Deemed savings are calculated based on an average daily usage of 2.2 hours per day.

Eligibility Criteria

CFL incentives are only available to customers under the Hard-to-Reach Standard Offer template. Savings may also be awarded under low-income and hard-to-reach market transformation programs, as determined by each utility.

Baseline Condition

Standard incandescent or halogen lamps are the baseline. As Energy Independence and Security Act (EISA) of 2007 phases out the old standard allowed wattages of incandescent lamps, the new maximum wattages will become the baseline.

Table 2-1. EISA 2007 Revised Baselines

New Maximum Wattage	Old Standard Incandescent Wattage	Rated Lumens	Effective Date
29	40	310–749	1/1/2014
43	60	750 - 1049	1/1/2014
53	75	1050 - 1489	1/1/2013
72	100	1490 - 2600	1/1/2012

High-Efficiency Condition

In order to qualify for an incentive, the installed CFL must be an ENERGY STAR-approved CFL.

The ENERGY STAR® CFL specification includes:

- Starting time of approximately one second
- Efficiency level for lamps of 15 watts or more is 60 lumens/watt
- Efficiency level for lamps of less than 15 watts is 45 lumens/watt

The fixture wattage rating dictates the maximum CFL wattage installed. If there is no fixture wattage rating shown on the fixture, the fixture wattage shall be assumed to be 60 watts, or, after January 1, 2014, 43 watts. For example, when replacing an incandescent lamp in a fixture rated for 60W (or 43W after January 1, 2014), the maximum wattage CFL that may be installed is 16W.

“Hollywood-style” incandescent fixtures with four or more lamps may not be retrofitted with screw-in CFLs. These fixtures may be retrofitted with hard-wired fluorescent fixtures only. The addition of a disk device to a screw-in CFL to prevent its removal does not qualify it as a hard-wired fixture.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Wattage reduction is defined as the difference between the wattage of a standard incandescent lamp, as defined by EISA 2007, and the wattage of a comparable CFL. A comparable CFL wattage range was identified by lumen output, as defined by EISA 2007. Within this wattage range, a typical CFL wattage was established for each range based on market availability.

Energy savings are calculated based on an average daily usage of 2.2 hours per day,[2] resulting in an approximate annual usage of 803 hours. They are calculated as follows:

[2] Evaluation of 2008 Texas ‘Make Your Mark’ Statewide CFL Program Report. Frontier Associates. June 2009.

$$\Delta kWh = \frac{\left(Wattage_{Comparable\ Incandescent\ Light} - Wattage_{Measure\ CFL}\right)}{1000} \times 803 hours$$

Equation 1

Summer and winter demand savings are determined by applying a coincidence factor associated with each season. These coincidence factors were determined by analyzing hourly data[3] to determine the percentage of time that CFLs were on during peak hours, resulting in a summer coincidence factor of 0.08 and a winter coincidence factor of 0.11 (see Table 2-2 and Table 2-3). The demand savings are calculated as follows:

$$\Delta kW = \frac{\left(Wattage_{Comparable\ Incandescent\ Light} - Wattage_{Measure\ CFL}\right)}{1000} \times \text{Peak Demand Coincidence}$$

Equation 2

Table 2-2. CFL – Summer Percentage ON by Month and Hour

Hour	June	July	Aug	Sept	Average
13	0.066	0.066	0.068	0.070	*0.07*
14	0.070	0.070	0.071	0.072	*0.07*
15	0.071	0.071	0.072	0.074	*0.07*
16	0.067	0.068	0.070	0.073	*0.07*
17	0.063	0.064	0.068	0.074	*0.07*
18	0.074	0.075	0.079	0.086	*0.08*
19	0.090	0.091	0.096	0.104	*0.10*
			TOTAL AVERAGE		***0.08***

Table 2-3. CFL – Winter Percentage ON by Month and Hour

Hour	Dec	Jan	Feb	Average
6	0.073	0.073	0.072	*0.07*
7	0.077	0.077	0.076	*0.08*
8	0.081	0.081	0.078	*0.08*
9	0.08	0.079	0.077	*0.08*
18	0.1	0.099	0.094	*0.10*
19	0.12	0.119	0.114	*0.12*
20	0.156	0.154	0.147	*0.15*
21	0.188	0.187	0.182	*0.19*
		TOTAL AVERAGE		***0.11***

[3] DEER 2011 Update Documentation: "Support documents for the above summary of content, methods and parameters document." (updated May 16, 2012). http://www.deeresources.com/.

Deemed Energy and Demand Savings Tables

EISA 2007 put in place regulations to phase out standard incandescent bulbs. Starting in 2012, the manufacture of 100W incandescent bulbs is no longer permitted, with 75W bulbs following in 2013, and 60W and 40W bulbs in 2014 (see Table 2-4 through Table 2-6). Each year, the EISA lighting regulations reduce the baseline wattage for a given lumen range. Therefore, different savings tables are provided for the years of EISA implementation, with updates from the previous year's wattage struck out, as the following tables show.

Table 2-4. CFL Energy Savings for 2012

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Annual Energy Savings (kWh)
11	9-11	40	310–749	2.2	23.3
13	12-16	60	750–1049	2.2	37.7
20	17-21	75	1050–1489	2.2	44.2
23	22-27	72	1490–2600	2.2	39.3

Table 2-5. CFL Energy Savings for 2013

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Annual Energy Savings (kWh)
11	9-11	40	310–749	2.2	23.3
13	12-16	60	750–1049	2.2	37.7
20	17-21	53	1050–1489	2.2	26.5
23	22-27	72	1490–2600	2.2	39.3

Table 2-6. CFL Energy Savings for 2014

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Annual Energy Savings (kWh)
11	9-11	29	310–749	2.2	14.5
13	12-16	43	750–1049	2.2	24.1
20	17-21	53	1050–1489	2.2	26.5
23	22-27	72	1490–2600	2.2	39.3

Deemed Summer Demand Savings Tables

Table 2-7. CFL Summer Peak Demand Savings for 2012

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	40	310–749	2.2	0.002
13	12-16	60	750–1049	2.2	0.004
20	17-21	75	1050–1489	2.2	0.004
23	22-27	72	1490–2600	2.2	0.004

Table 2-8. CFL Summer Peak Demand Savings for 2013

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	40	310–749	2.2	0.002
13	12-16	60	750–1049	2.2	0.004
20	17-21	53	1050–1489	2.2	0.003
23	22-27	72	1490–2600	2.2	0.004

Table 2-9. CFL Summer Peak Demand Savings for 2014

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	29	310–749	2.2	0.001
13	12-16	43	750–1049	2.2	0.002
20	17-21	53	1050–1489	2.2	0.003
23	22-27	72	1490–2600	2.2	0.004

Deemed Winter Demand Savings Tables

Table 2-10. CFL Winter Peak Demand Savings for 2012

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	40	310–749	2.2	0.003
13	12-16	60	750–1049	2.2	0.005
20	17-21	75	1050–1489	2.2	0.006
23	22-27	72	1490–2600	2.2	0.005

Table 2-11. CFL Winter Peak Demand Savings for 2013

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	40	310–749	2.2	0.003
13	12-16	60	750–1049	2.2	0.005
20	17-21	53	1050–1489	2.2	0.004
23	22-27	72	1490–2600	2.2	0.005

Table 2-12. CFL Winter Peak Demand Savings for 2014

Measure CFL (Watt)	Measure CFL (Range of Watts)	Comparable Incandescent Light (Watt)	Lumen Output	Daily Usage (Hrs/Day)	Demand Savings (kW)
11	9-11	29	310–749	2.2	0.002
13	12-16	43	750–1049	2.2	0.003
20	17-21	53	1050–1489	2.2	0.004
23	22-27	72	1490–2600	2.2	0.005

Claimed Peak Demand Savings

For this measure, the winter period peak demand savings is highest, so it would be used as the claimed peak demand value. The summer and winter peak demand period values are calculated as the average of the maximum hourly value for each hour across the full summer or winter months.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of an indoor screw-in CFL is established at 5.3 years.

These values are consistent with the EULs reported in the 2008 California Database for Energy Efficiency Resources (DEER), under the assumption of an 8,000-hour manufacturer rated life.

Program Tracking Data & 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:

- Number of CFLs installed
- Wattage of each installed CFL

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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.
- Docket No. 39899. 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, Southwestern Electric Power Company, Texas-New Mexico Power Company, and Southwestern Public Service Company to Revise Existing Commission-Approved Deemed Savings for CFLs in Residential Hard-to-Reach Programs. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- Energy Independence and Security Act of 2007
- ENERGY STAR® specifications for CFL lamps

Document Revision History

Table 2-13. Residential Compact Fluorescent Lamp Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2 RESIDENTIAL: HEATING, VENTILATION, AND AIR CONDITIONING

2.2.1 Duct Efficiency Improvement Measure Overview

TRM Measure ID: R-HV-DE

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

Savings Methodology: Engineering Algorithms and Estimates and Calculator

Measure Description

This measure involves sealing leaks in supply and return ducts of the HVAC distribution systems of homes or converted residences with either central air conditioning or a ducted heating system.

Eligibility Criteria

All residential customers with refrigerated air cooling are eligible for this measure.

Duct leakage should be assessed following BPI standards through testing. In some limited cases, where testing is not possible or unsafe (e.g. due to potential presence of asbestos), visual assessment may be satisfactory. The duct leakage testing should not be conducted in homes where either evidence of asbestos or mold is present or suspected due to the age of the home.[4]

Duct Sealing is a residential retrofit measure.

[4] The Building Performance Institute, Inc. (BPI) Standard Reference: Building Performance Institute Technical Standards for the Building Analyst Professional, v2/28/05mda, Page 1 of 17, states:
"Health and Safety:
Where the presence of asbestos, lead, mold and/or other potentially hazardous material is known or suspected, **all relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety**. Blower door depressurization tests may not be performed in homes *where there is a risk of asbestos becoming airborne and being drawn into the dwelling."*

Table 2-14. Duct Sealing – Applicability

Application Type	Applicable	Notes
Retrofit	Y	Leakage-to-outside testing is required
New Construction	N	

Baseline Condition

The savings calculation methods for this measure are valid up to a maximum pre-installation leakage rate of 35 percent of total fan flow.[5] Data from nearly 28,000 single-family and mobile home duct blaster tests conducted for duct efficiency improvements in Texas between 2003 and 2006 show that more than 70 percent of all pre-retrofit leakage rates fall below 38 percent total leakage.[6]

Engineering calculations show that the interior temperature in those settings that exceed 38 percent total leakage would be above the thermally acceptable comfort levels published by ASHRAE in its 2009 Fundamentals publication. Homeowners would likely take steps to remedy the situation independent of the program long before their duct system reached these leakage levels, and certainly before the rated useful life of the duct leakage measure. The proposed pre-installation leakage limits will help ensure that the deemed savings are an accurate reflection of the program's impacts, and that the program focuses its efforts on scenarios where leakage conditions are likely to persist if unaddressed for several years.

High-Efficiency Condition

Materials used should be long-lasting materials, such as mastics, UL 181A or UL 181B approved foil tape, or aerosol-based sealants. Fabric-based duct tape is not allowed.

The selected methodology for estimating duct sealing energy savings requires duct leakage testing using either a duct pressurization device (e.g., Duct Blaster™), or a combination duct pressurization and blower door.

Duct Leakage Testing

Measurements to determine pre-installation and post-installation leakage rates must be performed in accordance with utility-approved procedures. For this measure, leakage-to-outside must be directly measured. The Project Sponsor should use the Combination Duct Blaster™ (or equivalent) and Blower Door method. Other tests—such as the blower door subtraction method—may be accepted at the utility's discretion. Prior to beginning any installations, the Project Sponsor must submit the intended method(s) and may be required to provide the utility with evidence of competency, such as Home Energy Rating System (HERS) or North American Technician Excellence (NATE) certification. Leakage rates must be measured and reported at the average air distribution system operating pressure (25 Pa).[7]

[5] $Total\ Fan\ Flow = Cooling\ Capacity\ (tons) \times 400$

[6] Based on data collected by Frontier Associates, LLC for investor-owned utilities in Texas.

[7] See RESNET Technical Committee, Proposed Amendment: Chapter 8 RESNET Standards, 800 RESNET Standard for Performance Testing and Work Scope: Enclosure and Air Distribution Leakage Testing; Section 803.2 and Table 803.1.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Cooling Energy Savings (Electric)

$$kWh_{savings,C} = \frac{(DL_{pre} - DL_{post}) \times EFLH_C \times (h_{out}\rho_{out} - h_{in}\rho_{in}) \times 60}{1,000 \times SEER}$$

Equation 3

Where:

DL_{pre} = *Pre-improvement duct leakage at 25 Pa (cu. ft./min)*

DL_{post} = *Post-improvement duct leakage at 25 Pa (cu. ft./min)*

$EFLH_C$ = *Equivalent full load cooling hours*[8]

h = *Outdoor/Indoor seasonal specific enthalpy (Btu/lb)*[9]

ρ_{out} = *Density of outdoor air (lb/sq. ft.)*[10]

Table 2-15. Equivalent Full Load Cooling Hours

Weather Zone	$EFLH_C$
Zone 1: Amarillo, TX	1,142
Zone 2: Dallas-Ft. Worth, TX	1,926
Zone 3: Houston, TX	2,209
Zone 4: Corpus Christi, TX	2,958
Zone 5: El Paso, TX	1,524

Table 2-16. Seasonal Specific Enthalpy (Btu/lb)

Weather Zone	h_{out}	h_{in}
Zone 1: Amarillo, TX	32	28
Zone 2: Dallas-Ft. Worth, TX	36	29
Zone 3: Houston, TX	37	30
Zone 4: Corpus Christi, TX	39	31
Zone 5: El Paso, TX	29	26

[8] ENERGY STAR Central A/C Savings Calculator http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CA .
[9] ANSI/ASHRAE Standard 152-2004, Table 6.3b.
[10] ASHRAE Fundamentals 2009, Chapter 1: Psychometrics, Equation 11, Equation 41, Table 2.

Table 2-17. Density of Outdoor Air (lb/sq. ft.)

Weather Zone	Temp. (°F)[11]	ρ_{out}
Zone 1: Amarillo, TX	95	0.0740
Zone 2: Dallas-Ft. Worth, TX	99	0.0738
Zone 3: Houston, TX	94	0.0741
Zone 4: Corpus Christi, TX	94	0.0741
Zone 5: El Paso, TX	98	0.0738

ρ_{in} = *Density of conditioned air at 75°F(lb/sq. ft.) = 0.0756 (default)*[12]

60 = *Constant to convert from minutes to hours*

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

SEER = *Seasonal Energy Efficiency Ratio of existing system (Btu/W·hr) = 13 (default)*[13]

Heating Energy Savings (Heat Pump)

$$kWh_{savings,H} = \frac{(DL_{pre} - DL_{post}) \times 60 \times 0.77 \times HDD \times 24 \times 0.018}{1,000 \times HSPF}$$

Equation 4

Where:

DL_{pre} = *Pre-improvement duct leakage at 25 Pa (sq. ft./min)*

DL_{post} = *Post-improvement duct leakage at 25 Pa (sq. ft./min)*

60 = *Constant to convert from minutes to hours*

0.77 = *Factor to correlate design load hours to EFLH under actual working conditions (to account for the fact that people do not always operate their heating system when the outside temperature is less than 65°F)*[14]

HDD = *Heating degree days ()*[15]

Table 2-18. Heating Degree Days

Weather Zone	HDD
Zone 1: Amarillo, TX	4,318
Zone 2: Dallas-Ft. Worth, TX	2,370
Zone 3: Houston, TX	1,525
Zone 4: Corpus Christi, TX	950
Zone 5: El Paso, TX	2,543

[11] Manual J, Volume 7, Table 1.
[12] ASHRAE Fundamentals 2009, Chapter 1: Psychometrics, Equation 11, Equation 41, Table 2.
[13] DOE minimum allowed SEER for new air conditioners after January 23, 2006: 13.0 SEER.
[14] Manual J, Volume 7: Appendix A-4.
[15] National Climatic Data Center: http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmhdd.html.

24	=	*Constant to convert from days to hours*
0.018	=	*Volumetric heat capacity of air (Btu/sq. ft.°F)*
1,000	=	*Constant to convert from W to kW*
HSPF	=	*Heating Seasonal Performance Factor of existing system (Btu/W·hr) = 7.7 (default)16*

Heating Energy Savings (Electric Resistance)

$$\boldsymbol{kWh_{savings,H} = \frac{(DL_{pre} - DL_{post}) \times 60 \times 0.77 \times HDD \times 24 \times 0.018}{3,412}}$$

Equation 5

Where:

$\mathrm{DL_{pre}}$	=	*Pre-improvement duct leakage at 25 Pa (sq. ft./min)*
$\mathrm{DL_{post}}$	=	*Post-improvement duct leakage at 25 Pa (sq. ft./min)*
60	=	*Constant to convert from minutes to hours*
0.77	=	*Factor to correlate design load hours to EFLH under actual working conditions (to account for the fact that people do not always operate their heating system when the outside temperature is less than 65°F)17*
HDD	=	*Heating degree days ()18*
24	=	*Constant to convert from days to hours*
0.018	=	*Volumetric heat capacity of air (Btu/sq. ft.°F)*
3,412	=	*Constant to convert from Btu to kWh*

[16] DOE minimum allowed HSPF for new air conditioners after January 23, 2006: 7.7 HSPF.
[17] Manual J, Volume 7: Appendix A-4.
[18] National Climatic Data Center: http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmhdd.html.

Cooling Demand Savings (Electric)

$$kW_{savings,C} = \frac{kWh_{savings,C}}{EFLH_C} \times 1.163 \times CF$$

Equation 6

Where:

$kWh_{savings,C}$	=	*Calculated kWh savings for cooling*
$EFLH_C$	=	*Equivalent full load cooling hours19 ()*
1.163	=	*Constant to convert efficiency from SEER to EER20*
CF	=	*Coincidence factor = 0.8721*

Heating Demand Savings (Electric Resistance and Heat Pump)

$$kW_{savings,H} = \frac{kWh_{savings,H}}{0.77 \times HDD \times 24} \times CF$$

Equation 7

Where:

$kWh_{savings,H}$	=	*Calculated kWh savings for heating*
0.77	=	*Factor to correlate design load hours to EFLH under actual working conditions (to account for the fact that people do not always operate their heating system when the outside temperature is less than 65°F)22*
HDD	=	*Heating degree days ()23*
24	=	*Constant to convert from days to hours*
CF	=	*Coincidence factor = 0.83 (heat pumps, default)24 = 1.00 (electric resistance, default)25*

[19] ENERGY STAR Central A/C Savings Calculator http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CA.

[20] Department of Energy: Building America House Simulation Protocols, p.7 (revised October 2010). Approximation: EER = -0.02 x $SEER_2$ + 1.12 x SEER.

[21] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential air conditioners be sized at 115% of the maximum cooling requirement of the house. Assuming that the house's maximum cooling occurs during the hours 4 to 5 PM, the guideline leads to a coincidence factor for residential HVAC measures of 1.0/1.15 = 0.87.

[22] Manual J, Volume 7: Appendix A-4.

[23] National Climatic Data Center: http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmhdd.html.

[24] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115% of the maximum cooling requirement of the house (for cooling dominated climates). Based on AHRI data for 1.5 to 5 ton HVAC systems, the average ratio of rated heating capacity to cooling

Deemed Energy and Demand Savings Tables

This section is not applicable.

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand savings would be the higher value between summer or winter peak demand savings.

Additional Calculators and Tools

There is a calculator to estimate the energy and demand savings associated with this measure using the algorithms described in the previous subsection.

Measure Life and Lifetime Savings

The estimated useful life (EUL) for a duct sealing measure is 18.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[26]

Program Tracking Data & 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
- Heating type (gas, resistance heat, heat pump)
- Pre-improvement duct leakage at 25 Pa (sq. ft./min)
- Post-improvement duct leakage at 25 Pa (sq. ft./min)

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capacity is 0.96. Assuming that the house's maximum cooling occurs during the hours 4 to 5 PM, and adjusting for the average ratio of heating to cooling capacity, the guideline leads to a coincidence factor for residential heat pumps of 0.96/1.15 = 0.83.

[25] Standard assumption.

[26] 2008 California Database for Energy Efficiency Resources (DEER).

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.
- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-19. Duct Efficiency Improvement Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2.2 Central Air Conditioner Measure Overview

TRM Measure ID: R-HV-AC

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

Residential retrofit of an existing central air conditioning system with a new central air conditioning system in an existing building or the installation of a new central air conditioning system in a new residential construction. A new central air conditioning system includes an entire packaged unit, or a split system consisting of an indoor unit with a matching remote condensing unit. Maximum cooling capacity per unit is 65,000 Btu/hour.

Eligibility Criteria

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

Baseline Condition

In new construction, the baseline is assumed to be a new central air conditioning system with an AHRI-listed Seasonal Energy Efficiency Ratio (SEER) rating of 13.0. For retrofit installations, the baseline is assumed to be 12.44. This value incorporates an adjustment to the baseline SEER value to reflect the percentage of current non-program replacements that do not include the installation of an AHRI-matched condensing unit and evaporator coil.

High-Efficiency Condition

Air conditioning equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards.

Manufacturer data sheets on installed air conditioning equipment or AHRI reference numbers must be provided.

The central air conditioning equipment must meet the following standard:

- Minimum AHRI-listed SEER rating of 14.00
- Minimum AHRI-listed Energy Efficiency Rating (EER) of 11.5

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

In reviewing data on the relationship between efficiency and outdoor air temperature, the Frontier research team concluded that actual unit performance data, if it could be obtained from the major manufacturers, should be used to develop performance curves for units in each of the following SEER ranges:

- 13.0 – 13.9
- 14.0 – 14.9
- 15.0 – 15.9
- 16.0 – 16.9
- 17.0 – 17.9
- 18 and above

Performance data for residential heat pumps and air conditioners was requested from each of the four largest manufacturers, Carrier, Goodman/Amana, Lennox, and American Standard/Trane. Collectively these manufacturers account for a 71% national market share. Each of the manufacturers provided performance data, allowing the research team to develop performance curves for each size and SEER range. For some individual units in certain higher SEER ranges, performance data was interpolated from other sizes in that same SEER range. This was necessary because the manufacturers do not produce units in all SEER ranges and capacities. For example, some higher-SEER units may not be available in 1.5, 2.5, 3.5 or 5-ton sizes.

The availability of this data allowed the research team to directly assess the performance of typical units currently being installed in Texas residences. By using actual performance data in conjunction with hourly weather conditions in each of the four weather zones, the research team avoided the need to weather-adjust SEER and EER values, and provided a potentially more accurate estimate of annual cooling energy use. This approach also allowed the research team to incorporate the cyclic degradation factor into the seasonal energy use calculation.

For the air conditioner deemed savings, unit performance data was selected for units in each of the seven sizes and six SEER ranges, for a total of forty-two product types. For each of the product types in the 13 and 14 SEER ranges, data was available from at least three manufacturers. One manufacturer supplied product data for selected condenser/coil combinations in each product line. The others provided data on all their residential products. In selecting an appropriate condenser/coil combination, the research team generally used the following criteria:

1. SEER value at or near low end of the SEER range, e.g., 14.00

2. All units had to have a minimum 11.5 EER
3. The specific condenser/coil combination that was tested by the manufacturer
4. Highest sales volume combination

In some cases, the research team selected a condenser/coil combination that didn't meet the above criteria, typically if required to find a sufficient number of units with a particular SEER value to produce a robust analysis. Selecting units with SEER values at or near the low end of the SEER range addresses the concern raised by the auditors about using the mid-point of the SEER range rather, than the median SEER value of all units within this range.

The performance data is not reported in a consistent manner by all manufacturers. For example, some manufacturers don't report performance data for 65 degree ambient. In these cases, performance data was extrapolated.

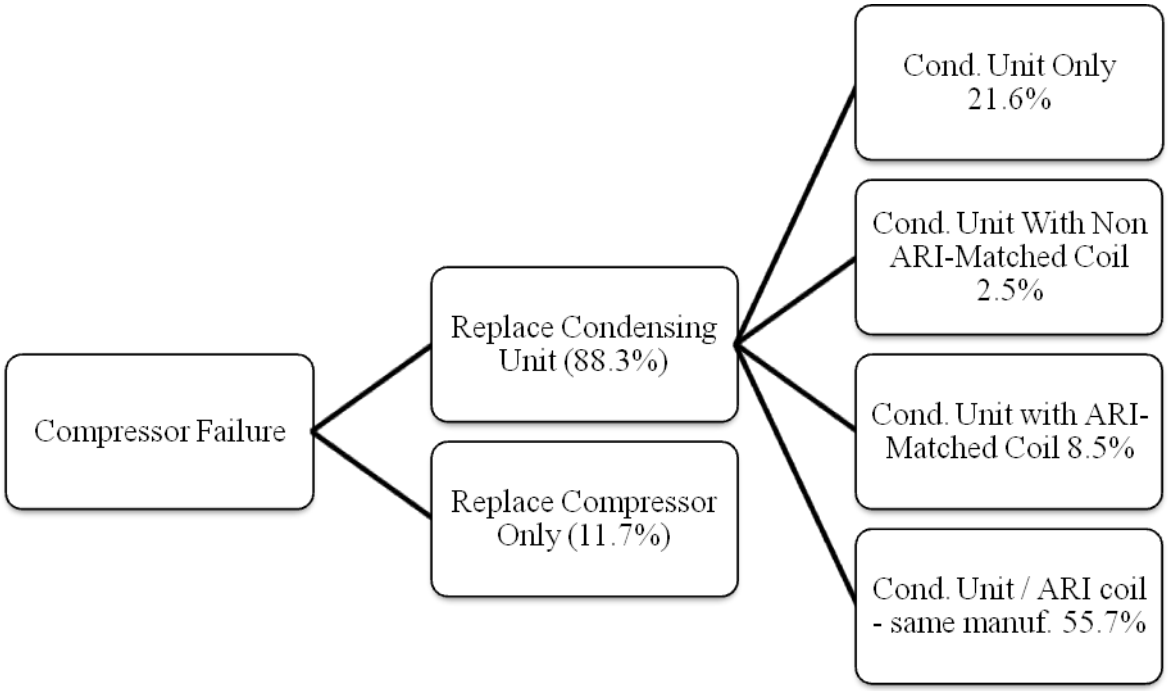
The data from each manufacturer was weighted based on national market share information. Weighted average performance curves were thus developed for each of the forty-two product types.

Using the unit performance data compiled as outlined above, the kW demand and Btuh capacity of the units was calculated at each temperature point between 65 and 115 degrees ambient. An oversize factor of 115% was assumed, as was a cyclic degradation factor 0.25 (ASHRAE default value). Separate calculation models were developed for single-speed and two-speed units. For peak demand, the average peak hour kW value corresponding to the 99% design temperature for the representative cities in each of the four weather zones was calculated. For the units in the 14.5 SEER category, data was interpolated from the 14 SEER and 15 SEER units. This separate category was developed for central air conditioners and heat pumps so utilities running programs that require ENERGY STAR® qualified units can accurately determine savings once the ENERGY STAR® specification goes to 14.5 SEER in 2009.

To determine annual cooling energy consumption, hourly weather data for each of the four weather zones was used. The performance of the unit at the midpoint of each temperature bin (e.g. 77.5 degrees for the 75-80 degree bin) was determined. Using manufacturer values for input kW and capacity, coupled with cooling load, and number of hours in each of the temperature bins, we produced the seasonal performance of each of the forty-two product types. Comparison with the performance of the baseline unit in each size range provided estimates of peak demand reduction and annual cooling energy savings.

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

Figure 2-1. Unit Replacement Percentages upon Compressor Failure



Source: Docket No. 36780

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

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

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

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

In new construction, there is no possibility of a partial system (e.g. condensing unit-only) changeout, so the 12.44 baseline would not be appropriate. Therefore, the baseline for new construction installations is set at the federal government's minimum efficiency standard of 13 SEER.

Climate Zone. These deemed savings values were developed using data from a study of performance at different ambient temperatures across a range of HVAC manufacturers. To calculate energy savings, performance data were weighted by the number of hours at each

temperature point; to calculate demand savings performance data at the ASHRAE design temperature was used, as in Project No. 27647.[27]

Deemed Energy and Demand Savings Tables

Table 2-20 through Table 2-29 present the energy savings (kWh) associated with central air conditioners installed in both new homes (13.0 SEER baseline) and retrofit homes (12.44 SEER baseline) for the five Texas climate zones.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-20. Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	218	301	384	456	615	657
2.0	291	401	512	608	820	875
2.5	364	502	639	760	1,025	1,094
3.0	437	602	767	913	1,230	1,313
3.5	510	702	895	1,065	1,434	1,532
4.0	582	803	1,023	1,217	1,639	1,751
5.0	728	1,003	1,279	1,521	2,049	2,188

Table 2-21. Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	323	405	488	560	719	761
2.0	430	540	650	747	959	1,014
2.5	538	675	813	934	1,198	1,268
3.0	645	810	976	1,121	1,438	1,521
3.5	753	945	1,138	1,308	1,677	1,775
4.0	860	1,081	1,301	1,494	1,917	2,029
5.0	1,075	1,351	1,626	1,868	2,396	2,536

[27] Energy Efficiency Program Implementation Docket, P.U.C. SUBST R. §25.181 (n) Energy Implementation Project, Project No. 27647.

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-22. Energy Savings (kWh) for 13 SEER New Construction Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	319	441	562	667	910	968
2.0	426	587	749	889	1,214	1,291
2.5	532	734	936	1,111	1,517	1,613
3.0	639	881	1,124	1,334	1,821	1,936
3.5	745	1,028	1,311	1,556	2,124	2,259
4.0	852	1,175	1,498	1,778	2,427	2,581
5.0	1,065	1,469	1,873	2,223	3,034	3,227

Table 2-23. Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	472	594	715	820	1,063	1,121
2.0	630	791	953	1,093	1,418	1,495
2.5	787	989	1,191	1,366	1,772	1,868
3.0	945	1,187	1,430	1,640	2,126	2,242
3.5	1,102	1,385	1,668	1,913	2,481	2,616
4.0	1,259	1,583	1,906	2,186	2,835	2,989
5.0	1,574	1,978	2,383	2,733	3,544	3,736

Climate Zone 3: South Region, Houston Weather Data

Table 2-24. Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	361	506	650	758	1,042	1,118
2.0	481	674	867	1,011	1,389	1,490
2.5	601	843	1,084	1,264	1,737	1,863
3.0	722	1,011	1,301	1,517	2,084	2,235
3.5	842	1,180	1,518	1,770	2,431	2,608
4.0	962	1,348	1,734	2,023	2,778	2,980
5.0	1,203	1,685	2,168	2,528	3,473	3,725

Table 2-25. Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	522	667	811	919	1,203	1,278
2.0	696	889	1,082	1,226	1,604	1,705
2.5	870	1,111	1,352	1,532	2,005	2,131
3.0	1,043	1,333	1,623	1,839	2,406	2,557
3.5	1,217	1,555	1,893	2,145	2,807	2,983
4.0	1,391	1,777	2,163	2,452	3,208	3,409
5.0	1,739	2,222	2,704	3,065	4,009	4,261

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-26. Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	426	596	766	896	1,234	1,321
2.0	568	795	1,021	1,195	1,645	1,761
2.5	710	993	1,277	1,494	2,056	2,202
3.0	852	1,192	1,532	1,793	2,468	2,642
3.5	994	1,391	1,787	2,092	2,879	3,082
4.0	1,136	1,589	2,043	2,390	3,290	3,522
5.0	1,420	1,987	2,553	2,988	4,113	4,403

Table 2-27. Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	618	788	958	1,089	1,426	1,513
2.0	824	1,051	1,277	1,451	1,901	2,017
2.5	1,030	1,313	1,597	1,814	2,377	2,522
3.0	1,236	1,576	1,916	2,177	2,852	3,026
3.5	1,442	1,839	2,236	2,540	3,327	3,530
4.0	1,648	2,102	2,555	2,903	3,803	4,035
5.0	2,060	2,627	3,194	3,628	4,753	5,043

Climate Zone 5: West Region El Paso Weather Data

Table 2-28. Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 5

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	268	373	477	559	769	820
2.0	357	497	636	745	1,025	1,094
2.5	447	621	795	931	1,281	1,367
3.0	536	745	954	1,118	1,538	1,641
3.5	625	869	1,114	1,304	1,794	1,914
4.0	714	994	1,273	1,490	2,050	2,187
5.0	893	1,242	1,591	1,863	2,563	2,734

Table 2-29. Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 5

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	391	495	600	682	891	943
2.0	521	660	800	909	1,189	1,257
2.5	651	826	1,000	1,136	1,486	1,572
3.0	781	991	1,200	1,363	1,783	1,886
3.5	912	1,156	1,400	1,590	2,080	2,200
4.0	1,042	1,321	1,600	1,818	2,377	2,515
5.0	1,302	1,651	2,000	2,272	2,972	3,143

Deemed Summer Demand Savings Tables

Table 2-30 through Table 2-39 present the summer demand savings (kW) associated with central air conditioners installed in both new homes (13.0 SEER baseline) and retrofit homes (12.44 SEER baseline) for the five Texas climate zones.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-30. Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.13	0.15	0.18	0.23	0.30	0.31
2.0	0.17	0.21	0.24	0.31	0.41	0.42
2.5	0.21	0.26	0.30	0.39	0.51	0.52
3.0	0.25	0.31	0.36	0.46	0.61	0.63
3.5	0.30	0.36	0.42	0.54	0.71	0.73
4.0	0.34	0.41	0.48	0.62	0.81	0.83
5.0	0.42	0.51	0.60	0.77	1.01	1.04

Table 2-31. Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.22	0.25	0.30	0.37	0.38
2.0	0.26	0.29	0.33	0.40	0.49	0.51
2.5	0.32	0.37	0.41	0.50	0.62	0.63
3.0	0.38	0.44	0.49	0.60	0.74	0.76
3.5	0.45	0.51	0.58	0.70	0.86	0.88
4.0	0.51	0.59	0.66	0.79	0.99	1.01
5.0	0.64	0.73	0.82	0.99	1.23	1.26

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-32. Demand Savings (kW) for 13 SEER New Construction Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.12	0.14	0.17	0.23	0.28	0.28
2.0	0.16	0.19	0.22	0.30	0.37	0.37
2.5	0.20	0.24	0.28	0.38	0.46	0.47
3.0	0.24	0.28	0.33	0.45	0.55	0.56
3.5	0.28	0.33	0.39	0.53	0.64	0.65
4.0	0.32	0.38	0.44	0.60	0.73	0.75
5.0	0.39	0.47	0.55	0.75	0.92	0.93

Table 2-33. Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.21	0.24	0.30	0.34	0.35
2.0	0.25	0.28	0.31	0.39	0.46	0.47
2.5	0.31	0.35	0.39	0.49	0.57	0.58
3.0	0.38	0.42	0.47	0.59	0.69	0.70
3.5	0.44	0.49	0.55	0.69	0.80	0.82
4.0	0.50	0.56	0.63	0.79	0.92	0.93
5.0	0.63	0.70	0.78	0.98	1.15	1.17

Climate Zone 3: South Region, Houston Weather Data

Table 2-34. Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.13	0.15	0.17	0.23	0.29	0.30
2.0	0.17	0.20	0.23	0.30	0.39	0.41
2.5	0.21	0.25	0.29	0.38	0.49	0.51
3.0	0.25	0.30	0.35	0.46	0.58	0.61
3.5	0.30	0.35	0.41	0.53	0.68	0.71
4.0	0.34	0.40	0.46	0.61	0.78	0.81
5.0	0.42	0.50	0.58	0.76	0.97	1.02

Table 2-35. Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.22	0.24	0.29	0.36	0.37
2.0	0.26	0.29	0.32	0.39	0.48	0.50
2.5	0.32	0.36	0.40	0.49	0.60	0.62
3.0	0.39	0.44	0.48	0.59	0.72	0.74
3.5	0.45	0.51	0.56	0.69	0.84	0.87
4.0	0.52	0.58	0.64	0.79	0.96	0.99
5.0	0.65	0.73	0.80	0.98	1.20	1.24

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-36. Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.13	0.15	0.18	0.23	0.30	0.31
2.0	0.17	0.20	0.24	0.31	0.40	0.41
2.5	0.21	0.25	0.30	0.38	0.50	0.52
3.0	0.25	0.30	0.36	0.46	0.60	0.62
3.5	0.30	0.36	0.42	0.54	0.70	0.72
4.0	0.34	0.41	0.47	0.61	0.80	0.82
5.0	0.42	0.51	0.59	0.77	1.00	1.03

Table 2-37. Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.22	0.24	0.30	0.37	0.38
2.0	0.26	0.29	0.33	0.40	0.49	0.50
2.5	0.32	0.36	0.41	0.49	0.61	0.63
3.0	0.39	0.44	0.49	0.59	0.73	0.75
3.5	0.45	0.51	0.57	0.69	0.85	0.88
4.0	0.52	0.58	0.65	0.79	0.97	1.00
5.0	0.64	0.73	0.82	0.99	1.22	1.25

Climate Zone 5: West Region El Paso Weather Data

Table 2-38. Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 5

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.12	0.14	0.17	0.23	0.28	0.28
2.0	0.16	0.19	0.22	0.30	0.37	0.37
2.5	0.20	0.24	0.28	0.38	0.46	0.47
3.0	0.24	0.28	0.33	0.45	0.55	0.56
3.5	0.28	0.33	0.39	0.53	0.64	0.65
4.0	0.32	0.38	0.44	0.60	0.73	0.75
5.0	0.39	0.47	0.55	0.75	0.92	0.93

Table 2-39. Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 5

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.21	0.24	0.30	0.34	0.35
2.0	0.25	0.28	0.31	0.39	0.46	0.47
2.5	0.31	0.35	0.39	0.49	0.57	0.58
3.0	0.38	0.42	0.47	0.59	0.69	0.70
3.5	0.44	0.49	0.55	0.69	0.80	0.82
4.0	0.50	0.56	0.63	0.79	0.92	0.93
5.0	0.63	0.70	0.78	0.98	1.15	1.17

Deemed Winter Demand Savings Tables

Deemed winter demand savings are not applicable to this measure since this measure is a cooling measure only.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a packaged air conditioning unit is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[28]

Program Tracking Data & 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:

- Size in tons of the installed unit
- Seasonal Energy Efficiency Ratio (SEER) of the installed unit
- Climate zone of the site

[28] 2008 California Database for Energy Efficiency Resources (DEER).

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 36780. Petition of Electric Utility Marketing Managers of Texas to Revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems. 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

- ASHRAE 90.1-1999 (Residential Buildings)
- ACCA Manual J Residential Load Calculation (8th Edition)[29]

Document Revision History

Table 2-40. Residential Central Air Conditioner Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

Central Air Conditioner for Low Income and Hard-to-Reach Market Transformation

TRM Measure ID: R-HV-AC

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Direct Install

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

[29] https://www.acca.org/store/product.php?pid=172.

Measure Description

Low income or hard-to-reach market transformation program retrofit of an existing central air conditioning system with a new central air conditioning system in an existing building. A new central air conditioning system includes an entire packaged unit, or a split system consisting of an indoor unit with a matching remote condensing unit. Maximum cooling capacity per unit is 65,000 Btu/hour.

Eligibility Criteria

Replacement units must have a cooling capacity of less than 65,000 Btu/hour (5.4 tons) to be eligible for these deemed savings. The unit to be replaced must be functioning at the time of removal; only early replacements are eligible for these deemed savings.

Baseline Condition

AHRIFor retrofit installations, the baseline is assumed to be 12.44. This value incorporates an adjustment to the baseline SEER value to reflect the percentage of current non-program replacements that do not include the installation of an AHRI-matched condensing unit and evaporator coil.

High-Efficiency Condition

Air conditioning equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards.

Manufacturer data sheets on installed air conditioning equipment or AHRI reference numbers must be provided.

The central air conditioning equipment must meet the following standard:

- Minimum AHRI-listed SEER rating of 14.00
- Minimum AHRI-listed EER of 11.5

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

In order to calculate the energy (kWh) savings associated with the installation of a new central air conditioning system in a home through a low-income or hard-to-reach market transformation program, the savings must be weighted by the age of the unit to be replaced.

The following equations may be used to calculate the deemed energy savings awarded to a newly-installed central air conditioner:

$$\textbf{Annual kWh Savings} = \left(\frac{\textbf{AC Age}}{\textbf{AC Age} + \textbf{Remaining Service Life}}\right) \times \textbf{Annual kWh Savings}_{\textbf{Replace on Burnout}} + \left(\frac{\textbf{Remaining Service Life}}{\textbf{AC Age} + \textbf{Remaining Service Life}}\right) \times \textbf{Annual kWh Savings}_{\textbf{Retrofit}}$$

Equation 8

Remaining service life is dependent upon the age of the replaced central air conditioner. The remaining service life can be found in Table 2-41.

Table 2-41. Remaining Service Life of Replaced Unit

Age of Replaced Unit	Remaining Service Life
1	18
2	17
3	16
4	15
5	14
6	13
7	12
8	11.5
9	10.5
10	9
11	8.5
12	8
13	7.5
14	7
15	5.5
16	5
17	4.5
18	3.5
19	3
20	2.5
21	1.5
22	1.5
23	1
24	0
25	0

Age of Replaced Unit	Remaining Service Life
26	0
27	0
28	0
29	0
30	0

The deemed demand savings awarded for the installation of a new central air conditioning unit are provided in the lookup tables below.

Deemed Energy and Demand Savings Tables

Table 2-42 through Table 2-49 present the energy savings (kWh) associated with central air conditioners installed in retrofit homes for climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-42. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	322.5748	912.5757
2	430.0997	1,216.768
2.5	537.6246	1,520.96
3	645.1495	1,825.151
3.5	752.6745	2,129.344
4	860.1994	2,433.535
5	1,075.249	3,041.919

Table 2-43. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	560.4301	1,150.431
2	747.2401	1,533.908
2.5	934.0501	1,917.385
3	1,120.86	2,300.862
3.5	1,307.67	2,684.339
4	1,494.48	3,067.816
5	1868.1	3,834.77

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-44. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	472.3031	1,338.589
2	629.7375	1,784.786
2.5	787.1719	2,230.982
3	944.6063	2,677.179
3.5	1,102.041	3,123.375
4	1,259.475	3,569.572
5	1,574.344	4,461.965

Table 2-45. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	819.8243	1,686.111
2	1,093.099	2,248.147
2.5	1,366.374	2,810.184
3	1,639.649	3,372.221
3.5	1,912.923	3,934.258
4	2,186.198	4,496.295
5	2,732.748	5,620.369

Climate Zone 3: South Region, Houston Weather Data

Table 2-46. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	521.738	1,433.267
2	695.6506	1,911.022
2.5	869.5633	2,388.778
3	1,043.476	2,866.533
3.5	1,217.389	3,344.289
4	1,391.301	3,822.044
5	1,739.127	4,777.556

Table 2-47. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	919.4246	1,830.953
2	1,225.9	2,441.271
2.5	1,532.374	3,051.589

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
3	1,838.849	3,661.907
3.5	2,145.324	4,272.225
4	2,451.799	4,882.542
5	3,064.749	6,103.178

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-48. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	618.061	1,706.19
2	824.0814	2,274.92
2.5	1,030.102	2,843.65
3	1,236.122	3,412.38
3.5	1,442.142	3,981.11
4	1,648.163	4,549.84
5	2,060.203	5,687.3

Table 2-49. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Retrofit}}$
1.5	1,088.516	2,176.645
2	1,451.354	2,902.193
2.5	1,814.193	3,627.741
3	2,177.032	4,353.29
3.5	2,539.87	5,078.838
4	2,902.709	5,804.386
5	3,628.386	7,255.483

Deemed Summer Demand Savings Tables

Table 2-50 through Table 2-57 present the summer demand savings (kW) associated with central air conditioners installed in retrofit homes for climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-50. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.192396033
2	0.256528044
2.5	0.320660055

Tons	Summer Demand Savings (kW)
3	0.384792066
3.5	0.448924077
4	0.513056088
5	0.64132011

Table 2-51. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.298093936
2	0.397458581
2.5	0.496823227
3	0.596187872
3.5	0.695552517
4	0.794917163
5	0.993646453

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-52. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.187630017
2	0.250173356
2.5	0.312716695
3	0.375260034
3.5	0.437803373
4	0.500346712
5	0.62543339

Table 2-53. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.295274386
2	0.393699181
2.5	0.492123976
3	0.590548771
3.5	0.688973567
4	0.787398362
5	0.984247952

Climate Zone 3: South Region, Houston Weather Data

Table 2-54. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.193870661
2	0.258494215
2.5	0.323117769
3	0.387741323
3.5	0.452364877
4	0.51698843
5	0.646235538

Table 2-55. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.294935393
2	0.393247191
2.5	0.491558989
3	0.589870786
3.5	0.688182584
4	0.786494382
5	0.983117977

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-56. Lookup Savings for an Installed Air Conditioner with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.193144218
2	0.257525624
2.5	0.32190703
3	0.386288436
3.5	0.450669843
4	0.515051249
5	0.643814061

Table 2-57. Lookup Savings for an Installed Air Conditioner with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.296255807
2	0.395007742
2.5	0.493759678
3	0.592511613
3.5	0.691263549
4	0.790015484
5	0.987519355

Deemed Winter Demand Savings Tables

Deemed winter demand savings are not applicable to this measure since this measure is a cooling measure only.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a packaged air conditioning unit is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[30]

Program Tracking Data & 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:

- Size in tons of the installed unit
- Seasonal Energy Efficiency Ratio (SEER) of the installed unit
- Climate zone of the site
- Age of replaced unit

[30] 2008 California Database for Energy Efficiency Resources (DEER)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Correspondence with Frontier, CenterPoint, AEP Texas North Company

Relevant Standards and Reference Sources

- ASHRAE 90.1-1999 (Residential Buildings)
- ACCA Manual J Residential Load Calculation (8th Edition)[31]

Document Revision History

Table 2-58. Low Income Weatherization or Hard-to-Reach Market Transformation Program Central Air Conditioner Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

[31] https://www.acca.org/store/product.php?pid=172.

2.2.3 Ground Source Heat Pump Measure Overview

TRM Measure ID: R-HV-GH

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

The following tables present the proposed deemed savings values for ground source heat pumps for each of the four climate zones. The deemed savings are dependent upon the energy efficiency rating (EER) of the equipment, and are presented as kWh and kW savings per ton installed. Deemed savings values are calculated based on replacement of an existing 13.0 SEER air source heat pump with minimum 8.0 HSPF. These values represent all demand and energy savings that may be assigned to a ground source heat pump.

Eligibility Criteria

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

Baseline Condition

Only ground source heat pumps that replace an existing air source heat pump, ground source heat pump system, or other combination of electric heating and cooling systems are eligible for these deemed savings. Deemed savings values are calculated based on replacement of an existing 13.0 SEER air source heat pump with minimum 8.0 HSPF.

High-Efficiency Condition

The ground source heat pump must meet a minimum ENERGY STAR® criteria of 14.0 EER (ISO/AHRI 13256-1) in order to be eligible for these deemed savings.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be further addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Table 2-59 through Table 2-62 show the energy savings (kWh) of the home installing a new ground source heat pump both with and without desuperheaters per climate zones 1, 2, 3 and 4.

Table 2-59. Ground Source Heat Pump Energy Savings for Climate Zone 1 – Panhandle Region

Ground Source Heat Pumps – Climate Zone 1	
Climate Zone 1 – with Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	1,083
High (17 EER and above)	1,309
Climate Zone 1 – without Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	469
High (17 EER and above)	699

Table 2-60. Ground Source Heat Pump Energy Savings for Climate Zone 2 – North Region

Ground Source Heat Pumps – Climate Zone 2	
Climate Zone 2 – with Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	1,064
High (17 EER and above)	1,230
Climate Zone 2 – without Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	269
High (17 EER and above)	443

Table 2-61. Ground Source Heat Pump Energy Savings for Climate Zone 3 – South Region

Ground Source Heat Pumps – Climate Zone 3	
Climate Zone 3 – with Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	1,030
High (17 EER and above)	1,114
Climate Zone 3 – without Desuperheaters	
GSHP Efficiency	**Energy savings [kWh/ton]**
Low (less than 17 EER)	218
High (17 EER and above)	322

Table 2-62. Ground Source Heat Pump Energy Savings for Climate Zone 4 – Valley Region

Ground Source Heat Pumps – Climate Zone 4	
Climate Zone 4 – with Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	1,015
High (17 EER and above)	1,164
Climate Zone 4 – without Desuperheaters	
GSHP Efficiency	**Energy Savings [kWh/ton]**
Low (less than 17 EER)	194
High (17 EER and above)	291

Deemed Summer Demand Savings Tables

Table 2-63 through Table 2-66 show the summer demand savings (kW) of the home installing a new ground source heat pump both with and without desuperheaters per climate zones 1, 2, 3 and 4.

Table 2-63. Ground Source Heat Pump Summer Peak Demand Savings for Climate Zone 1 – Panhandle Region

Ground Source Heat Pumps – Climate Zone 1	
Climate Zone 1 – with Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.46
High (17 EER and above)	0.51
Climate Zone 1 – without Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.01
High (17 EER and above)	0.08

Table 2-64. Ground Source Heat Pump Summer Peak Demand Savings for Climate Zone 2 – North Region

Ground Source Heat Pumps – Climate Zone 2	
Climate Zone 2 – with Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.50
High (17 EER and above)	0.57
Climate Zone 2 – without Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.05
High (17 EER and above)	0.21

Table 2-65. Ground Source Heat Pump Summer Peak Demand Savings for Climate Zone 3 – South Region

Ground Source Heat Pumps – Climate Zone 3	
Climate Zone 3 – with Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.52
High (17 EER and above)	0.50
Climate Zone 3 – without Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.06
High (17 EER and above)	0.15

Table 2-66. Ground Source Heat Pump Summer Peak Demand Savings for Climate Zone 3 – Valley Region

Ground Source Heat Pumps – Climate Zone 4	
Climate Zone 4 – with Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.49
High (17 EER and above)	0.53
Climate Zone 4 – without Desuperheaters	
GSHP Efficiency	**Demand Savings [kW/ton]**
Low (less than 17 EER)	0.08
High (17 EER and above)	0.12

Deemed Winter Demand Savings Tables

This section is not available.

Claimed Peak Demand Savings

For this measure, the summer peak demand savings would be used for the claimed peak demand savings.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a high-efficiency heat pump unit is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[32]

Program Tracking Data & 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:

- Size in tons
- Energy Efficiency Ratio (EER) of the unit installed
- Climate zone of the site

[32] 2008 California Database for Energy Efficiency Resources (DEER).

- Whether a desuperheater was also installed or present

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

Relevant Standards and Reference Sources

- ISO/AHRI 13256-1
- The applicable version of ENERGY STAR®'s specifications and requirements addressing residential ground source heat pumps.

Document Revision History

Table 2-67. Ground Source Heat Pump Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2.4 Central Heat Pump Measure Overview

TRM Measure ID: R-HV-HP

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

This measure involves the installation of a new residential central heat pump. Note that separate savings methodologies are applied to the replacement of an existing electric resistance furnace with a new split or packaged residential heat pump system.

All measure installation standards and baseline data from the central air conditioner measure shall apply to the heat pump measure.

Eligibility Criteria

Replacement units with capacity ≥ 65,000 Btu/hour (5.4 tons) are ineligible for these deemed savings.

Replacement of Electric Resistance Furnace

These deemed savings are for heat pumps replacing electric resistance furnaces installed as a retrofit measure in existing homes.

Table 2-68. Central Heat Pump – Applicability of Electric Resistance Furnace Replacement

Application Type	Applicable	Notes
Retrofit	Y	Early retirement only
New Construction	N	

Baseline Condition

Replacement of Electric Resistance Furnace

Baseline is an electric resistance furnace. By the nature of the technology, all electric resistance furnaces have the same efficiency with HSPF = 3.41

New Home or Retrofit, No Replacement of Electric Resistance Furnace

In new construction, the baseline is assumed to be a new heat pump system with an AHRI-listed SEER rating of 13.0 and an HSPF of 7.7. For retrofit installations, the baseline is assumed to be 12.44 SEER and 7.7 HSPF. This value incorporates an adjustment to the baseline SEER value (cooling only) to reflect the percentage of current non-program replacements that do not include the installation of an AHRI-matched condensing unit and evaporator coil.

High-Efficiency Condition

Equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards.

Manufacturer data sheets on installed air conditioning equipment or AHRI equivalent combined compressor and coil HSPF must be provided to the utility in the Implementation Report.

Replacement of Electric Resistance Furnace

The efficient condition/minimum required efficiency for completing this measure is an air source heat pump exceeding federal minimum standards.

Table 2-69. Central Heat Pump – Baseline and Efficiency Standard

Baseline	Efficiency Standard
Electric resistance furnace	Heat pump with SEER 14/HSPF 7.8

New Home or Retrofit, No Replacement of Electric Resistance Furnace

Heat pumps shall have a minimum SEER of 14.00 and an HSPF of 8.2.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

In reviewing data on the relationship between efficiency and outdoor air temperature, the Frontier research team concluded that actual unit performance data, if it could be obtained from the major

manufacturers, should be used to develop performance curves for units in each of the following SEER ranges:

- 13.0 – 13.9
- 14.0 – 14.9
- 15.0 – 15.9
- 16.0 – 16.9
- 17.0 – 17.9
- 18 and above

Performance data for residential heat pumps and air conditioners was requested from each of the four largest manufacturers, Carrier, Goodman/Amana, Lennox, and American Standard/Trane. Collectively these manufacturers account for a 71% national market share. Each of the manufacturers provided performance data, allowing the research team to develop performance curves for each size and SEER range. For some individual units in certain higher SEER ranges, performance data was interpolated from other sizes in that same SEER range. This was necessary because the manufacturers do not produce units in all SEER ranges and capacities. For example, some higher-SEER units may not be available in 1.5, 2.5, 3.5 or 5-ton sizes.

The availability of this data allowed the research team to directly assess the performance of typical units currently being installed in Texas residences. By using actual performance data in conjunction with hourly weather conditions in each of the four weather zones, the research team avoided the need to weather-adjust SEER and EER values, and provided a potentially more accurate estimate of annual cooling energy use. This approach also allowed the research team to incorporate the cyclic degradation factor into the seasonal energy use calculation.

For the air conditioner deemed savings, unit performance data was selected for units in each of the seven sizes and six SEER ranges, for a total of forty-two product types. For each of the product types in the 13 and 14 SEER ranges, data was available from at least three manufacturers. One manufacturer supplied product data for selected condenser/coil combinations in each product line. The others provided data on all their residential products. In selecting an appropriate condenser/coil combination, the research team generally used the following criteria:

1. SEER value at or near low end of the SEER range, e.g., 14.00
2. All units had to have a minimum 11.5 EER
3. The specific condenser/coil combination that was tested by the manufacturer
4. Highest sales volume combination

In some cases, the research team selected a condenser/coil combination that didn't meet the above criteria, typically if required to find a sufficient number of units with a particular SEER value to produce a robust analysis. Selecting units with SEER values at or near the low end of the SEER range addresses the concern raised by the auditors about using the mid-point of the SEER range rather, than the median SEER value of all units within this range.

The performance data is not reported in a consistent manner by all manufacturers. For example, some manufacturers don't report performance data for 65 degree ambient. In these cases, performance data was extrapolated.

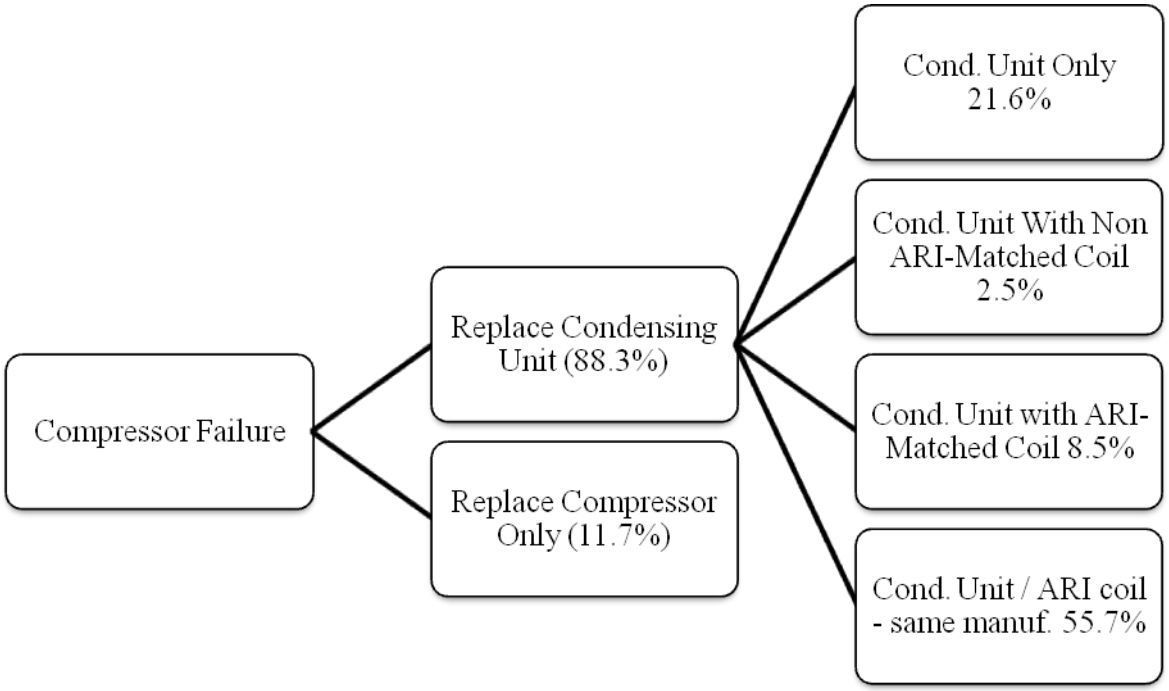
The data from each manufacturer was weighted based on national market share information. Weighted average performance curves were thus developed for each of the forty-two product types.

Using the unit performance data compiled as outlined above, the kW demand and Btuh capacity of the units was calculated at each temperature point between 65 and 115 degrees ambient. An oversize factor of 115% was assumed, as was a cyclic degradation factor 0.25 (ASHRAE default value). Separate calculation models were developed for single-speed and two-speed units. For peak demand, the average peak hour kW value corresponding to the 99% design temperature for the representative cities in each of the four weather zones was calculated. For the units in the 14.5 SEER category, data was interpolated from the 14 SEER and 15 SEER units. This separate category was developed for central air conditioners and heat pumps so utilities running programs that require ENERGY STAR® qualified units can accurately determine savings once the ENERGY STAR® specification goes to 14.5 SEER in 2009.

To determine annual cooling energy consumption, hourly weather data for each of the four weather zones was used. The performance of the unit at the midpoint of each temperature bin (e.g. 77.5 degrees for the 75-80 degree bin) was determined. Using manufacturer values for input kW and capacity, coupled with cooling load, and number of hours in each of the temperature bins, we produced the seasonal performance of each of the forty-two product types. Comparison with the performance of the baseline unit in each size range provided estimates of peak demand reduction and annual cooling energy savings.

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

Figure 2-2. Unit Replacement Percentages upon Compressor Failure



Source: Docket No. 36780

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

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

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

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

In new construction, there is no possibility of a partial system (e.g. condensing unit-only) changeout, so the 12.44 baseline would not be appropriate. Therefore, the baseline for new construction installations is set at the federal government's minimum efficiency standard of 13 SEER.

Replacement of Electric Resistance Furnace

Heating energy and winter demand deemed savings were estimated using heat pump performance curves developed by the National Renewable Energy Laboratory for a prototypical unit. Performance curves derate the capacity and efficiency of the heat pumps operating in heating mode according to outside air temperature. Unit loading was estimated as a function of outdoor air temperature, and hours of heating mode operation under different loadings were estimated using typical meteorological year data for each weather zone. Finally, predicted HVAC operation was limited to meeting 77 percent of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions, taking into account that heating systems are not always operated even when outdoor conditions indicate they should.

Winter demand savings are estimated according to expected unit performance under design conditions. For all weather zones, it is assumed that typical HVAC systems are sized to 115 percent of their design cooling load (oversized by 15 percent). Heating mode capacity was related to rated cooling capacity using the rated capacity in cooling and heating mode of the residential market heat pump products of four major manufacturers according to data exported from AHRI. Data were exported from the AHRI directory and the average ratio for each equipment size (1 ton, 1.5 ton, 2 ton, etc.) of heating capacity to cooling capacity was multiplied by the rated (cooling side) capacity to estimate the heat pump capacity. Loading, capacity, and performance were thus estimated as a function of outdoor air temperature. Heat pump system output was then compared to its loading under design conditions. To the extent the load could not be met by the heat pump alone, the remainder of the load was assumed to be met with backup electric resistance heat.

New Home or Retrofit, No Replacement of Electric Resistance Furnace

Details and derivations of savings methodology will be addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Replacement of Electric Resistance Furnace

Table 2-70 through Table 2-74 present the energy savings (kWh) per heating load type associated with a central heat pump replacing an electric resistance furnace for all the five Texas climate zones.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-70. Heat Pump (Heat kWh Only), Climate Zone 1

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	5,181	5,277	5,362	5,447	5,532	5,609	5,680
2	6,857	6,982	7,094	7,206	7,315	7,417	7,510
2.5	8,550	8,707	8,847	8,986	9,122	9,249	9,365
3	10,291	10,480	10,648	10,817	10,982	11,135	11,275
3.5	12,114	12,337	12,537	12,736	12,931	13,113	13,279
4	13,773	14,026	14,252	14,478	14,707	14,912	15,101
4.5	15,701	15,992	16,252	16,512	16,752	16,989	17,205
5	17,152	17,466	17,747	18,027	18,303	18,558	18,791

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-71. Heat Pump (Heat kWh Only), Climate Zone 2

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2,962	3,015	3,062	3,109	3,238	3,279	3,317
2	3,942	4,011	4,074	4,136	4,305	4,360	4,410
2.5	4,923	5,010	5,088	5,165	5,377	5,444	5,507
3	5,913	6,018	6,112	6,205	6,460	6,542	6,617
3.5	6,916	7,039	7,149	7,260	7,558	7,654	7,743
4	7,892	8,033	8,158	8,283	8,626	8,735	8,836
4.5	8,912	9,072	9,216	9,359	9,739	9,864	9,979
5	9,855	10,030	10,186	10,342	10,767	10,902	11,028

Climate Zone 3: South Region, Houston Weather Data

Table 2-72. Heat Pump (Heat kWh Only), Climate Zone 3

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1,865	1,897	1,927	1,956	2,069	2,093	2,117
2	2,487	2,531	2,570	2,609	2,758	2,791	2,822
2.5	3,109	3,163	3,212	3,261	3,447	3,488	3,526
3	3,731	3,796	3,855	3,914	4,137	4,187	4,233
3.5	4,350	4,427	4,496	4,565	4,826	4,884	4,939
4	4,973	5,061	5,139	5,218	5,517	5,583	5,645
4.5	5,591	5,690	5,779	5,868	6,203	6,278	6,349
5	6,218	6,327	6,425	6,523	6,895	6,978	7,054

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-73. Heat Pump (Heat kWh Only), Climate Zone 4

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1,141	1,162	1,180	1,198	1,293	1,307	1,321
2	1,524	1,551	1,576	1,600	1,726	1,745	1,764
2.5	1,906	1,940	1,970	2,000	2,158	2,182	2,205
3	2,286	2,327	2,363	2,399	2,589	2,618	2,645
3.5	2,662	2,710	2,752	2,794	3,015	3,049	3,081
4	3,046	3,100	3,148	3,197	3,449	3,488	3,525
4.5	3,417	3,478	3,533	3,588	3,871	3,915	3,957
5	3,810	3,878	3,938	3,999	4,314	4,363	4,408

Climate Zone 5: West Region El Paso Weather Data

Table 2-74. Heat Pump (Heat kWh Only), Climate Zone 5

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	3,104	3,159	3,207	3,256	3,430	3,471	3,510
2	4,137	4,210	4,275	4,339	4,569	4,624	4,675
2.5	5,170	5,260	5,341	5,422	5,709	5,778	5,842
3	6,206	6,315	6,412	6,509	6,855	6,937	7,014
3.5	7,243	7,371	7,485	7,599	8,003	8,101	8,191
4	8,276	8,421	8,551	8,682	9,145	9,255	9,358
4.5	9,316	9,482	9,630	9,778	10,294	10,421	10,538
5	10,344	10,525	10,687	10,849	11,425	11,562	11,690

New Home or Retrofit, No Replacement of Electric Resistance Furnace

Table 2-75 through Table 2-86 present the energy savings (kWh) for both heating and cooling load types associated with a central heat pump replacing an HVAC system type other than electric resistance furnace for climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Heat Pump (Cooling Only – See Separate Heating Tables), Climate Zone 1

Table 2-75. Heat Pump Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	204	293	383	500	541	650
2.0	273	391	510	667	722	867
2.5	341	489	638	834	902	1,084
3.0	409	587	765	1,001	1,083	1,301
3.5	477	685	893	1,167	1,263	1,518
4.0	545	783	1,020	1,334	1,444	1,734
5.0	682	978	1,275	1,668	1,805	2,168

Table 2-76. Heat Pump Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	306	396	485	602	643	752
2.0	409	527	646	803	858	1,003
2.5	511	659	808	1,004	1,072	1,254
3.0	613	791	969	1,205	1,287	1,505
3.5	715	923	1,131	1,405	1,501	1,756
4.0	817	1,055	1,292	1,606	1,716	2,006
5.0	1,022	1,318	1,615	2,008	2,145	2,508

Heat Pump (Heat kWh Only), Climate Zone 1

Table 2-77. Heat Pump Energy Savings (kWh), Heating Only – Zone 1

Size (tons)	HSPF Range				
	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	269	365	460	554	648
2.0	358	486	613	739	864
2.5	448	608	767	924	1,080
3.0	537	730	920	1,109	1,295
3.5	627	851	1,073	1,293	1,511
4.0	717	973	1,226	1,478	1,727
4.5	806	1,094	1,380	1,663	1,943
5.0	896	1,216	1,533	1,848	2,159

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Heat Pump (Cooling Only – See Separate Heating Tables), Climate Zone 2

Table 2-78. Heat Pump Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	307	432	558	763	809	956
2.0	409	577	744	1,017	1,079	1,275
2.5	511	721	931	1,271	1,349	1,594
3.0	613	865	1,117	1,526	1,619	1,912
3.5	716	1,009	1,303	1,780	1,889	2,231
4.0	818	1,153	1,489	2,034	2,159	2,550
5.0	1,022	1,442	1,861	2,543	2,698	3,187

Table 2-79. Heat Pump Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	457	583	708	913	960	1,106
2.0	609	777	945	1,217	1,279	1,475
2.5	761	971	1,181	1,521	1,599	1,844
3.0	913	1,165	1,417	1,826	1,919	2,212
3.5	1,066	1,359	1,653	2,130	2,239	2,581
4.0	1,218	1,553	1,889	2,434	2,559	2,950
5.0	1,522	1,942	2,361	3,043	3,198	3,687

Heat Pump (Heat kWh Only), Climate Zone 2

Table 2-80. Heat Pump Energy Savings (kWh), Heating Only – Zone 2

Size (tons)	HSPF Range				
	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	120	162	204	245	286
2.0	160	216	272	327	381
2.5	200	270	340	409	476
3.0	239	324	408	490	572
3.5	279	378	476	572	667
4.0	319	432	544	654	762
4.5	359	486	612	735	857
5.0	399	540	680	817	953

Climate Zone 3: South Region, Houston Weather Data

Heat Pump (Cooling Only – See Separate Heating Tables), Climate Zone 3

Table 2-81. Heat Pump Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	337	488	638	875	931	1,099
2.0	450	650	850	1,166	1,241	1,466
2.5	562	813	1,063	1,458	1,551	1,832
3.0	675	975	1,275	1,749	1,861	2,199
3.5	787	1,138	1,488	2,041	2,171	2,565
4.0	900	1,300	1,700	2,332	2,481	2,931
5.0	1,125	1,625	2,125	2,915	3,102	3,664

Table 2-82. Heat Pump Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	495	645	795	1,032	1,088	1,257
2.0	660	860	1,060	1,376	1,451	1,676
2.5	825	1,075	1,325	1,720	1,813	2,095
3.0	990	1,290	1,590	2,064	2,176	2,513
3.5	1,155	1,505	1,855	2,408	2,539	2,932
4.0	1,320	1,720	2,120	2,752	2,901	3,351
5.0	1,650	2,150	2,650	3,440	3,627	4,189

Heat Pump (Heat kWh Only), Climate Zone 3

Table 2-83. Heat Pump Energy Savings (kWh), Heating Only – Zone 3

Size (tons)	HSPF Range				
	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	69	93	117	141	164
2.0	92	124	156	187	218
2.5	115	155	195	234	273
3.0	138	186	234	281	327
3.5	161	217	273	328	382
4.0	184	248	312	375	436
4.5	207	279	351	422	491
5.0	230	310	390	468	546

Climate Zone 4: Valley Region Corpus Christi Weather Data

Heat Pump (Cooling Only – See Separate Heating Tables), Climate Zone 4

Table 2-84. Heat Pump Energy Savings (kWh) for 13.0 SEER New Construction Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	399	575	752	1,031	1,099	1,299
2.0	532	767	1,002	1,375	1,465	1,731
2.5	665	959	1,253	1,718	1,831	2,164
3.0	798	1,151	1,503	2,062	2,197	2,597
3.5	931	1,342	1,754	2,406	2,564	3,030
4.0	1,064	1,534	2,004	2,749	2,930	3,463
5.0	1,330	1,918	2,505	3,437	3,662	4,329

Table 2-85. Heat Pump Energy Savings (kWh) for 12.44 SEER Retrofit Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	587	763	940	1,219	1,287	1,487
2.0	783	1,018	1,253	1,625	1,716	1,982
2.5	978	1,272	1,566	2,032	2,144	2,478
3.0	1,174	1,527	1,879	2,438	2,573	2,973
3.5	1,370	1,781	2,192	2,844	3,002	3,469
4.0	1,565	2,035	2,505	3,251	3,431	3,964
5.0	1,957	2,544	3,132	4,063	4,289	4,955

Heat Pump (Heating kWh Only), Climate Zone 4

Table 2-86. Heat Pump Energy Savings (kWh), Heating Only – Zone 4

Size (tons)	HSPF Range				
	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	53	71	89	107	125
2.0	70	95	119	143	166
2.5	88	118	149	178	208
3.0	105	142	178	214	249
3.5	123	166	208	250	291
4.0	140	189	238	286	332
4.5	158	213	268	321	374
5.0	175	237	297	357	416

Deemed Summer Demand Savings Tables

Replacement of Electric Resistance Furnace

This section is not applicable.

New Home or Retrofit, No Replacement of Electric Resistance Furnace

Table 2-87 through Table 2-94 present the summer demand savings (kW) associated with a central heat pump replacing an HVAC system type other than electric resistance furnace for both new construction and retrofit homes per climate zone 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-87. Heat Pump Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.12	0.16	0.20	0.20	0.23	0.32
2.0	0.16	0.22	0.27	0.27	0.31	0.42
2.5	0.21	0.27	0.33	0.34	0.39	0.53
3.0	0.25	0.32	0.40	0.41	0.46	0.63
3.5	0.29	0.38	0.47	0.48	0.54	0.74
4.0	0.33	0.43	0.53	0.54	0.62	0.85
5.0	0.41	0.54	0.66	0.68	0.77	1.06

Table 2-88. Heat Pump Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 1

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.23	0.26	0.27	0.30	0.38
2.0	0.25	0.30	0.35	0.36	0.40	0.51
2.5	0.31	0.38	0.44	0.45	0.49	0.64
3.0	0.38	0.45	0.53	0.54	0.59	0.76
3.5	0.44	0.53	0.62	0.63	0.69	0.89
4.0	0.50	0.60	0.70	0.72	0.79	1.02
5.0	0.63	0.75	0.88	0.90	0.99	1.27

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-89. Heat Pump Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.13	0.16	0.19	0.20	0.20	0.28
2.0	0.17	0.21	0.25	0.26	0.27	0.38
2.5	0.21	0.26	0.31	0.33	0.34	0.47
3.0	0.25	0.31	0.38	0.39	0.41	0.57
3.5	0.29	0.37	0.44	0.46	0.48	0.66
4.0	0.33	0.42	0.50	0.52	0.54	0.75
5.0	0.42	0.52	0.63	0.65	0.68	0.94

Table 2-90. Heat Pump Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 2

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.23	0.26	0.26	0.27	0.35
2.0	0.26	0.30	0.34	0.35	0.36	0.47
2.5	0.32	0.38	0.43	0.44	0.45	0.59
3.0	0.39	0.45	0.51	0.53	0.55	0.70
3.5	0.45	0.53	0.60	0.62	0.64	0.82
4.0	0.52	0.60	0.68	0.71	0.73	0.94
5.0	0.65	0.75	0.86	0.88	0.91	1.17

Climate Zone 3: South Region, Houston Weather Data

Table 2-91. Heat Pump Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.12	0.16	0.19	0.20	0.22	0.30
2.0	0.17	0.21	0.26	0.27	0.29	0.40
2.5	0.21	0.27	0.32	0.33	0.37	0.51
3.0	0.25	0.32	0.39	0.40	0.44	0.61
3.5	0.29	0.37	0.45	0.47	0.51	0.71
4.0	0.33	0.42	0.52	0.53	0.59	0.81
5.0	0.41	0.53	0.65	0.67	0.73	1.01

Table 2-92. Heat Pump Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 3

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.23	0.26	0.27	0.29	0.37
2.0	0.25	0.30	0.35	0.36	0.38	0.49
2.5	0.32	0.38	0.43	0.44	0.48	0.62
3.0	0.38	0.45	0.52	0.53	0.57	0.74
3.5	0.45	0.53	0.61	0.62	0.67	0.86
4.0	0.51	0.60	0.70	0.71	0.76	0.99
5.0	0.64	0.75	0.87	0.89	0.96	1.23

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-93. Heat Pump Demand Savings (kW) for 13.0 SEER New Construction Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.12	0.16	0.20	0.20	0.23	0.31
2.0	0.17	0.21	0.26	0.27	0.30	0.41
2.5	0.21	0.27	0.33	0.34	0.38	0.52
3.0	0.25	0.32	0.39	0.40	0.45	0.62
3.5	0.29	0.37	0.46	0.47	0.53	0.72
4.0	0.33	0.43	0.53	0.54	0.60	0.83
5.0	0.41	0.53	0.66	0.67	0.76	1.04

Table 2-94. Heat Pump Demand Savings (kW) for 12.44 SEER Retrofit Baseline – Zone 4

Size (tons)	SEER Range					
	14.0–14.4	14.5–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18+
1.5	0.19	0.23	0.26	0.27	0.29	0.38
2.0	0.25	0.30	0.35	0.36	0.39	0.50
2.5	0.32	0.38	0.44	0.45	0.49	0.63
3.0	0.38	0.45	0.53	0.54	0.58	0.75
3.5	0.44	0.53	0.61	0.62	0.68	0.88
4.0	0.51	0.60	0.70	0.71	0.78	1.00
5.0	0.63	0.75	0.88	0.89	0.97	1.25

Deemed Winter Demand Savings Tables

Replacement of Electric Resistance Furnace

Table 2-95 through Table 2-98 present the winter demand savings (kW) per heating load type associated with a central heat pump replacing an electric resistance furnace for all five climate zones.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-95. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 1

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1.4	1.44	1.48	1.52	1.34	1.38	1.41
2	1.79	1.84	1.89	1.94	1.71	1.76	1.8
2.5	2.21	2.28	2.34	2.4	2.11	2.17	2.23
3	2.69	2.77	2.84	2.92	2.57	2.65	2.71
3.5	3.3	3.4	3.49	3.57	3.16	3.25	3.33
4	3.66	3.77	3.87	3.97	3.51	3.6	3.69
4.5	4.43	4.56	4.68	4.8	4.25	4.36	4.47
5	4.48	4.61	4.74	4.86	4.29	4.41	4.52

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-96. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 2

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.26	2.31	2.34	2.38	2.25	2.29	2.32
2	2.93	2.98	3.03	3.08	2.91	2.96	3
2.5	3.63	3.7	3.76	3.83	3.61	3.67	3.73
3	4.4	4.49	4.56	4.64	4.37	4.45	4.51
3.5	5.32	5.42	5.51	5.6	5.29	5.38	5.46
4	5.96	6.07	6.17	6.27	5.92	6.02	6.11
4.5	7.05	7.19	7.31	7.43	7.01	7.13	7.23
5	7.34	7.48	7.6	7.72	7.29	7.41	7.52

Climate Zone 3: South Region, Houston Weather Data

Table 2-97. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 3

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.53	2.57	2.61	2.65	2.56	2.6	2.64
2	3.27	3.33	3.38	3.43	3.31	3.36	3.41
2.5	4.06	4.13	4.19	4.26	4.11	4.18	4.23
3	4.92	5.01	5.08	5.16	4.98	5.06	5.13
3.5	5.95	6.05	6.14	6.23	6.02	6.11	6.2
4	6.66	6.77	6.88	6.98	6.75	6.85	6.94
4.5	7.88	8.02	8.14	8.26	7.98	8.11	8.21
5	8.2	8.34	8.47	8.6	8.31	8.43	8.54

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-98. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 4

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.09	2.13	2.16	2.19	2.17	2.21	2.23
2	2.8	2.84	2.89	2.93	2.91	2.95	2.99
2.5	3.5	3.56	3.61	3.66	3.64	3.69	3.74
3	4.19	4.26	4.33	4.39	4.36	4.42	4.48
3.5	4.87	4.96	5.03	5.11	5.07	5.14	5.21
4	5.58	5.68	5.76	5.85	5.81	5.89	5.97
4.5	6.24	6.35	6.45	6.54	6.5	6.59	6.68
5	6.99	7.11	7.21	7.32	7.27	7.37	7.47

Climate Zone 5: West Region El Paso Weather Data

Table 2-99. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 5

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.39	2.44	2.48	2.52	2.40	2.44	2.48
2	3.10	3.15	3.20	3.25	3.11	3.16	3.20
2.5	3.84	3.91	3.98	4.04	3.86	3.92	398
3	4.66	4.74	4.82	4.89	4.68	4.75	4.82
3.5	5.63	5.73	5.82	5.91	5.65	5.74	5.82
4	6.30	6.42	6.52	6.62	6.33	6.43	6.52
4.5	7.46	7.60	7.72	7.84	7.49	7.61	7.72
5	7.76	7.90	8.03	8.16	7.79	7.92	8.03

New Home or Retrofit, No Replacement of Electric Resistance Furnace

Winter demand savings are not available for heat pumps replacing an HVAC system type other than an electric resistance furnace. This will be addressed in a future version of the TRM.

Claimed Peak Demand Savings

For this measure, if the heat pump is replacing an electric resistance furnace the higher value of the winter and summer peak demand savings would be used as the claimed peak demand savings. Otherwise, the summer peak demand savings would be used.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a high-efficiency heat pump unit is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).

Program Tracking Data & 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:

- Size in tons of the installed unit
- Seasonal Energy Efficiency Ratio (SEER) of the unit installed
- Heating Seasonal Performance Factor (HSPF) of the unit installed
- Climate zone of the site
- Type of unit replaced (e.g., electric resistance furnace, air source heat pump)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 36780. Petition of Electric Utility Marketing Managers of Texas to Revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems. Public Utility Commission of Texas.
- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- ASHRAE 90.1-1999 (Residential Buildings)

- ACCA Manual J Residential Load Calculation (8th Edition)[33]

Document Revision History

Table 2-100. Central Heat Pump Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

Central Heat Pumps for Low Income and Hard-to-Reach Market Transformation Programs

TRM Measure ID: R-HV-HP

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Direct Install

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

This measure involves the installation of a new residential central heat pump. All measure installation standards and baseline data from the central air conditioner measure shall apply to the heat pump measure.

Eligibility Criteria

Replacement units with capacity ≥ 65,000 Btu/hour (5.4 tons) are ineligible for these deemed savings. The unit to be replaced must be functioning at the time of removal; only early replacements are eligible for these deemed savings.

[33] https://www.acca.org/store/product.php?pid=172.

Replacement of Electric Resistance Furnace

These deemed savings are for heat pumps replacing electric resistance furnaces installed as an early replacement measure in existing homes.

Table 2-101. Central Heat Pump – Applicability of Electric Resistance Furnace Replacement

Application Type	Applicable	Notes
Retrofit	Y	Early retirement only
New Construction	N	

Baseline Condition

Replacement of Electric Resistance Furnace

Baseline is an electric resistance furnace. By the nature of the technology, all electric resistance furnaces have the same efficiency.

No Replacement of Electric Resistance Furnace

For early replacement installations, the baseline is assumed to be 12.44 SEER and 7.7 HSPF. This value incorporates an adjustment to the baseline SEER value (cooling only) to reflect the percentage of current non-program replacements that do not include the installation of an AHRI-matched condensing unit and evaporator coil.

High-Efficiency Condition

Equipment shall be properly sized to dwelling based on ASHRAE or ACCA Manual J standards.

Manufacturer data sheets on installed air conditioning equipment or AHRI equivalent combined compressor and coil HSPF must be provided to the utility in the Implementation Report.

Replacement of Electric Resistance Furnace

The efficient condition/minimum required efficiency for completing this measure is an air source heat pump exceeding federal minimum standards.

Table 2-102. Central Heat Pump – Baseline and Efficiency Standard

Baseline	Efficiency Standard
Electric resistance furnace	Heat pump with SEER 14/HSPF 7.8

No Replacement of Electric Resistance Furnace

Heat pumps shall have a minimum SEER of 14.00 and an HSPF of 8.2.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Replacement of Electric Resistance Furnace

Heating energy and winter demand deemed savings were developed using heat pump performance curves developed by the National Renewable Energy Laboratory for a prototypical unit. Performance curves derate the capacity and efficiency of the heat pumps operating in heating mode according to outside air temperature. Unit loading was estimated as a function of outdoor air temperature, and hours of heating mode operation under different loadings were estimated using typical meteorological year data for each weather zone. Finally, predicted HVAC operation was limited to meeting 77 percent of load, using a factor applied in Manual J to correlate design load hours to equivalent full load hours under actual operating conditions, taking into account that heating systems are not always operated even when outdoor conditions indicate they should.

Winter demand savings are estimated according to expected unit performance under design conditions. For all weather zones, it is assumed that typical HVAC systems are sized to 115 percent of their design cooling load (oversized by 15 percent). Heating mode capacity was related to rated cooling capacity using the rated capacity in cooling and heating mode of the residential market heat pump products of four major manufacturers according to data exported from AHRI. Data were exported from the AHRI directory and the average ratio for each equipment size (1 ton, 1.5 ton, 2 ton, etc.) of heating capacity to cooling capacity was multiplied by the rated (cooling side) capacity to estimate the heat pump capacity. Loading, capacity, and performance were thus estimated as a function of outdoor air temperature. Heat pump system output was then compared to its loading under design conditions. To the extent the load could not be met by the heat pump alone, the remainder of the load was assumed to be met with backup electric resistance heat.

No Replacement of Electric Resistance Furnace

Heating energy savings values are based on an existing heat pump with a baseline HSPF of 7.8, and can be found in Table 2-77, Table 2-80, Table 2-83, and Table 2-86.

Cooling Energy Savings

In order to calculate the cooling energy (kWh) savings associated with the installation of a new central heat pump system in a home through a low-income or hard-to-reach market transformation program, the savings must be weighted by the age of the unit to be replaced.

The following equations may be used to calculate the deemed energy savings awarded to a newly-installed central heat pump:

$$\boldsymbol{Annual\ kWh\ Savings} = \left(\frac{\boldsymbol{HP\ Age}}{\boldsymbol{HP\ Age + Remaining\ Service\ Life}}\right) \times \boldsymbol{Annual\ Cooling\ kWh\ Savings_{Replace\ on\ Burnout}} + \left(\frac{\boldsymbol{Remaining\ Service\ Life}}{\boldsymbol{HP\ Age + Remaining\ Service\ Life}}\right) \times \boldsymbol{Annual\ Cooling\ kWh\ Savings_{Early\ Replacement}}$$

Equation 9

Values for replace-on-burnout and early retirement cooling kWh savings can be found in Table 2-109 through Table 2-116.

Remaining service life is dependent upon the age of the replaced heat pump. The remaining service life can be found in Table 2-103.

Table 2-103. Remaining Service Life of Replaced Unit

Age of Replaced Unit	Remaining Service Life
1	18
2	17
3	16
4	15
5	14
6	13
7	12
8	11.5
9	10.5
10	9
11	8.5
12	8
13	7.5
14	7
15	5.5
16	5
17	4.5
18	3.5
19	3
20	2.5
21	1.5
22	1.5
23	1
24	0
25	0
26	0
27	0
28	0
29	0
30	0

The deemed demand savings awarded for the installation of a new central heat pump unit are provided in the lookup tables below.

Deemed Energy and Demand Savings Tables

Replacement of Electric Resistance Furnace

Table 2-104 through Table 2-108 present the energy savings (kWh) per heating load type associated with a central heat pump replacing an electric resistance furnace for all the five Texas climate zones.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-104. Heat Pump (Heat kWh Only), Climate Zone 1

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	5,181	5,277	5,362	5,447	5,532	5,609	5,680
2	6,857	6,982	7,094	7,206	7,315	7,417	7,510
2.5	8,550	8,707	8,847	8,986	9,122	9,249	9,365
3	10,291	10,480	10,648	10,817	10,982	11,135	11,275
3.5	12,114	12,337	12,537	12,736	12,931	13,113	13,279
4	13,773	14,026	14,252	14,478	14,707	14,912	15,101
4.5	15,701	15,992	16,252	16,512	16,752	16,989	17,205
5	17,152	17,466	17,747	18,027	18,303	18,558	18,791

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-105. Heat Pump (Heat kWh Only), Climate Zone 2

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2,962	3,015	3,062	3,109	3,238	3,279	3,317
2	3,942	4,011	4,074	4,136	4,305	4,360	4,410
2.5	4,923	5,010	5,088	5,165	5,377	5,444	5,507
3	5,913	6,018	6,112	6,205	6,460	6,542	6,617
3.5	6,916	7,039	7,149	7,260	7,558	7,654	7,743
4	7,892	8,033	8,158	8,283	8,626	8,735	8,836
4.5	8,912	9,072	9,216	9,359	9,739	9,864	9,979
5	9,855	10,030	10,186	10,342	10,767	10,902	11,028

Climate Zone 3: South Region, Houston Weather Data

Table 2-106. Heat Pump (Heat kWh Only), Climate Zone 3

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1,865	1,897	1,927	1,956	2,069	2,093	2,117
2	2,487	2,531	2,570	2,609	2,758	2,791	2,822
2.5	3,109	3,163	3,212	3,261	3,447	3,488	3,526
3	3,731	3,796	3,855	3,914	4,137	4,187	4,233
3.5	4,350	4,427	4,496	4,565	4,826	4,884	4,939
4	4,973	5,061	5,139	5,218	5,517	5,583	5,645
4.5	5,591	5,690	5,779	5,868	6,203	6,278	6,349
5	6,218	6,327	6,425	6,523	6,895	6,978	7,054

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-107. Heat Pump (Heat kWh Only), Climate Zone 4

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1,141	1,162	1,180	1,198	1,293	1,307	1,321
2	1,524	1,551	1,576	1,600	1,726	1,745	1,764
2.5	1,906	1,940	1,970	2,000	2,158	2,182	2,205
3	2,286	2,327	2,363	2,399	2,589	2,618	2,645
3.5	2,662	2,710	2,752	2,794	3,015	3,049	3,081
4	3,046	3,100	3,148	3,197	3,449	3,488	3,525
4.5	3,417	3,478	3,533	3,588	3,871	3,915	3,957
5	3,810	3,878	3,938	3,999	4,314	4,363	4,408

Climate Zone 5: West Region El Paso Weather Data

Table 2-108. Heat Pump (Heat kWh Only), Climate Zone 5

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	3,104	3,159	3,207	3,256	3,430	3,471	3,510
2	4,137	4,210	4,275	4,339	4,569	4,624	4,675
2.5	5,170	5,260	5,341	5,422	5,709	5,778	5,842
3	6,206	6,315	6,412	6,509	6,855	6,937	7,014
3.5	7,243	7,371	7,485	7,599	8,003	8,101	8,191
4	8,276	8,421	8,551	8,682	9,145	9,255	9,358
4.5	9,316	9,482	9,630	9,778	10,294	10,421	10,538
5	10,344	10,525	10,687	10,849	11,425	11,562	11,690

No Replacement of Electric Resistance Furnace

Heating energy savings values are based on an existing heat pump with a baseline HSPF of 7.8, and can be found in Table 2-77, Table 2-80, Table 2-83, and Table 2-86.

Table 2-109 through Table 2-116 present the cooling energy savings (kWh) associated with a central heat pump replacing a central HVAC system for climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-109. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	306	884
2	409	1,179
2.5	511	1,474
3	613	1,769
3.5	715	2,063
4	817	2,358
5	1,022	2,948

Table 2-110. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	602	1,178
2	803	1,571
2.5	1,004	1,964
3	1,205	2,356
3.5	1,405	2,749
4	1,606	3,142
5	2,008	3,927

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-111. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	457	1,307
2	609	1,742
2.5	761	2,178
3	913	2,613
3.5	1,066	3,049
4	1,218	3,485
5	1,522	4,356

Table 2-112. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	913	1,757
2	1,217	2,342
2.5	1,521	2,928
3	1,826	3,513
3.5	2,130	4,099
4	2,434	4,684
5	3,043	5,856

Climate Zone 3: South Region, Houston Weather Data

Table 2-113. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	495	1,387
2	660	1,849
2.5	825	2,311
3	990	2,773
3.5	1,155	3,236
4	1,320	3,698
5	1,650	4,622

Table 2-114. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	1,032	1,916
2	1,376	2,554
2.5	1,720	3,193
3	2,064	3,831
3.5	2,408	4,470
4	2,752	5,108
5	3,440	6,385

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-115. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	587	1,652
2	783	2,202
2.5	978	2,753
3	1,174	3,304
3.5	1,370	3,854
4	1,565	4,405
5	1,957	5,506

Table 2-116. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Annual kWh Savings$_{\text{Replace on Burnout}}$	Annual kWh Savings$_{\text{Early Replacement}}$
1.5	1,219	2,274
2	1,625	3,032
2.5	2,032	3,790
3	2,438	4,548
3.5	2,844	5,306
4	3,251	6,065
5	4,063	7,581

Deemed Summer Demand Savings Tables

Replacement of Electric Resistance Furnace

This section is not applicable.

No Replacement of Electric Resistance Furnace

Table 2-117 through Table 2-124 present the summer demand savings (kW) associated with a central heat pump replacing an HVAC system type other than electric resistance furnace per climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-117. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.188138608
2	0.250851477
2.5	0.313564346
3	0.376277216
3.5	0.438990085
4	0.501702954
5	0.627128693

Table 2-118. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.269898115
2	0.359864153
2.5	0.449830192
3	0.53979623
3.5	0.629762269
4	0.719728307
5	0.899660384

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-119. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.194004693
2	0.258672924
2.5	0.323341155
3	0.388009386
3.5	0.452677617
4	0.517345848
5	0.64668231

Table 2-120. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.267856268
2	0.357141691
2.5	0.446427114
3	0.535712536
3.5	0.624997959
4	0.714283382
5	0.892854227

Climate Zone 3: South Region, Houston Weather Data

Table 2-121. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.19078205
2	0.254376067
2.5	0.317970084
3	0.3815641
3.5	0.445158117
4	0.508752134
5	0.635940167

Table 2-122. Lookup Savings for an Installed Heat Pump with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.26792977
2	0.357239694
2.5	0.446549617
3	0.53585954
3.5	0.625169464
4	0.714479387
5	0.893099234

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-123. Lookup Savings for an Installed Heat Pump with SEER ≥ 14 and < 16

Tons	Summer Demand Savings (kW)
1.5	0.189455491
2	0.252607322
2.5	0.315759152
3	0.378910983
3.5	0.442062813
4	0.505214644
5	0.631518305

Table 2-124. Lookup savings for an installed heat pump with SEER ≥ 16

Tons	Summer Demand Savings (kW)
1.5	0.268953314
2	0.358604419
2.5	0.448255524
3	0.537906629
3.5	0.627557733
4	0.717208838
5	0.896511048

Deemed Winter Demand Savings Tables

Replacement of Electric Resistance Furnace

Table 2-125 through Table 2-128 present the winter demand savings (kW) associated with a central heat pump replacing an electric resistance furnace for climate zones 1, 2, 3 and 4.

Climate Zone 1: Panhandle Region, Amarillo Weather Data

Table 2-125. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 1

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	1.4	1.44	1.48	1.52	1.34	1.38	1.41
2	1.79	1.84	1.89	1.94	1.71	1.76	1.8
2.5	2.21	2.28	2.34	2.4	2.11	2.17	2.23
3	2.69	2.77	2.84	2.92	2.57	2.65	2.71
3.5	3.3	3.4	3.49	3.57	3.16	3.25	3.33
4	3.66	3.77	3.87	3.97	3.51	3.6	3.69
4.5	4.43	4.56	4.68	4.8	4.25	4.36	4.47
5	4.48	4.61	4.74	4.86	4.29	4.41	4.52

Climate Zone 2: North Region, Dallas / Ft. Worth Weather Data

Table 2-126. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 2

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.26	2.31	2.34	2.38	2.25	2.29	2.32
2	2.93	2.98	3.03	3.08	2.91	2.96	3
2.5	3.63	3.7	3.76	3.83	3.61	3.67	3.73
3	4.4	4.49	4.56	4.64	4.37	4.45	4.51
3.5	5.32	5.42	5.51	5.6	5.29	5.38	5.46
4	5.96	6.07	6.17	6.27	5.92	6.02	6.11
4.5	7.05	7.19	7.31	7.43	7.01	7.13	7.23
5	7.34	7.48	7.6	7.72	7.29	7.41	7.52

Climate Zone 3: South Region, Houston Weather Data

Table 2-127. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 3

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.53	2.57	2.61	2.65	2.56	2.6	2.64
2	3.27	3.33	3.38	3.43	3.31	3.36	3.41
2.5	4.06	4.13	4.19	4.26	4.11	4.18	4.23
3	4.92	5.01	5.08	5.16	4.98	5.06	5.13
3.5	5.95	6.05	6.14	6.23	6.02	6.11	6.2
4	6.66	6.77	6.88	6.98	6.75	6.85	6.94
4.5	7.88	8.02	8.14	8.26	7.98	8.11	8.21
5	8.2	8.34	8.47	8.6	8.31	8.43	8.54

Climate Zone 4: Valley Region Corpus Christi Weather Data

Table 2-128. Heat Pump – Demand Savings (Heating kW Only), Climate Zone 4

Size (tons)	HSPF Range						
	7.8–7.9	8.0–8.1	8.2–8.3	8.4–8.5	8.6–8.7	8.8–8.9	9.0–9.1
1.5	2.09	2.13	2.16	2.19	2.17	2.21	2.23
2	2.8	2.84	2.89	2.93	2.91	2.95	2.99
2.5	3.5	3.56	3.61	3.66	3.64	3.69	3.74
3	4.19	4.26	4.33	4.39	4.36	4.42	4.48
3.5	4.87	4.96	5.03	5.11	5.07	5.14	5.21
4	5.58	5.68	5.76	5.85	5.81	5.89	5.97
4.5	6.24	6.35	6.45	6.54	6.5	6.59	6.68
5	6.99	7.11	7.21	7.32	7.27	7.37	7.47

No Replacement of Electric Resistance Furnace

This section is not applicable.

Claimed Peak Demand Savings

For this measure, if the heat pump is replacing an electric-resistance furnace, winter peak demand savings would be used as the claimed peak demand savings. Otherwise, summer peak demand savings would be used.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a high-efficiency heat pump unit is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).

Program Tracking Data & 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:

- Size in tons of the installed unit
- Seasonal Energy Efficiency Ratio (SEER) of the unit installed
- Heating Seasonal Performance Factor (HSPF) of the unit installed
- Climate zone of the site
- Age of replaced unit

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

- ASHRAE 90.1-1999 (Residential Buildings)
- ACCA Manual J Residential Load Calculation (8th Edition)

Document Revision History

Table 2-129. Low Income Weatherization or Hard-to-Reach Market Transformation Program Central Heat Pump Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2.5 Split System and Single-Package Heat Pumps between 65,000 Btu/hr and 240,000 Btu/hr Measure Overview

TRM Measure ID: R-HV-PS

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

The following deemed savings values are applicable to replacements of split or single-package heat pump systems. Only installations which replace an existing split system or single-package heat pump system or other electric heating system are eligible to receive this annual heating savings component of the deemed energy savings.

Eligibility Criteria

Only installations which replace an existing split system or single package heat pump system or other electric heating system are eligible to receive this annual heating savings component of the deemed energy savings.

Baseline Condition

Baseline is assumed to be a new rooftop package or split system heat pump system. For units with cooling capacities between 65,000 Btu/hr and 135,000 Btu/hr, the baseline is a coefficient of performance (COP) of 3.0 (current ASHRAE 90.1 standard). For units with cooling capacities between 135,000 Btu/hr and 240,000 Btu/hr, the baseline is a coefficient of performance (COP) of 2.9 (current ASHRAE 90.1 standard).

High-Efficiency Condition

For units with cooling capacities between 65,000 Btu/hr and 135,000 Btu/hr, there are two efficiency levels for which deemed energy savings have been calculated:

- 3.2 is ASHRAE 90.1-1999 / CEE Tier 1 Standard.
- 3.4 is ASHRAE 90.1-1999 / CEE Tier 2 Standard.

For units with cooling capacities between 135,000 Btu/hr and 240,000 Btu/hr, the two efficiency levels for which deemed energy savings have been calculated are as follows:

- 3.1 is ASHRAE 90.1-1999 / CEE Tier 1 Standard.
- 3.3 is ASHRAE 90.1-1999 / CEE Tier 2 Standard.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Engineering calculations were used to measure the demand and energy impacts of energy-efficient models versus baseline efficiency models. Typical Meteorological Year (TMY) hourly weather data for representative cities in each of the four climate zones (Amarillo, Dallas, Houston, and Corpus Christi) was used, along with performance curve data from representative models to determine heat pump capacity and kWh, as well as backup heat kWh for each temperature "bin." Total annual heating kWh for these representative systems were then compared with the baseline system to determine heating season energy savings.

For this measure, additional cooling savings and the proposed deemed kW savings are based on the heat pump's EER, and are the same values as for a split system or single-package air conditioning system of the same capacity and EER.

Deemed Energy and Demand Savings Tables

Annual Heating Savings

Table 2-130 and Table 2-131 present the energy savings (kWh) per heating load type associated with this measure for climate zones 1, 2, 3 and 4.

Table 2-130. Split System and Single-Package
65,000-135,000 Btu/hr Heat Pump Energy Savings – Heating

Units greater than 65,000 Btu/hr and less than 135,000 Btu/h				
COP	Zone 1	Zone 2	Zone 3	Zone 4
	kWh per Ton	kWh per Ton	kWh per Ton	kWh per Ton
3.2	342	121	53	38
3.4	674	232	101	72

Ton = cooling ton

Table 2-131. Split System and Single-Package
135,000-240,000 Btu/hr Heat Pump Energy Savings – Heating

Units greater than 135,000 Btu/hr and less than 240,000 Btu/h				
COP	Zone 1	Zone 2	Zone 3	Zone 4
	kWh per Ton	kWh per Ton	kWh per Ton	kWh per Ton
3.1	372	79	30	20
3.3	730	132	58	39

Ton = cooling ton

Annual Cooling Savings

Table 2-132 and Table 2-133 present the energy savings (kWh) per cooling load type associated with this measure for climate zones 1, 2, 3 and 4.

Table 2-132. Split System and Single-Package
65,000-135,000 Btu/hr Heat Pump Energy Savings – Cooling

Units greater than 65,000 Btu/hr and less than 135,000 Btu/h			
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
kWh per EER-Ton	**kWh per EER-Ton**	**kWh per EER-Ton**	**kWh per EER-Ton**
202	309	392	440

Table 2-133. Split System and Single-Package
135,000-240,000 Btu/hr Heat Pump Energy Savings – Cooling

Units greater than 135,000 Btu/hr and less than 240,000 Btu/h			
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
kWh per EER-Ton	**kWh per EER-Ton**	**kWh per EER-Ton**	**kWh per EER-Ton**
151	242	284	324

Deemed Summer Demand Savings Tables

For this measure, the deemed kW savings are based on the heat pump's EER, and are the same values as for a split system or single-package air conditioning system of the same capacity and EER.

Table 2-134 and Table 2-135 present the summer demand savings (kW) associated with this measure for climate zones 1, 2, 3 and 4.

Table 2-134. Split System and Single-Package
65,000-135,000 Btu/hr Heat Pump Summer Peak Demand Savings

Units Greater than 65,000 Btu/hr and Less than 135,000 Btu/h			
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
kW per EER-Ton	**kW per EER-Ton**	**kW per EER-Ton**	**kW per EER-Ton**
0.10	0.10	0.11	0.11

Table 2-135. Split System and Single-Package
135,000-240,000 Btu/hr Heat Pump Summer Peak Demand Savings

Units Greater than 135,000 Btu/hr and Less than 240,000 Btu/h			
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
kW per EER-Ton	**kW per EER-Ton**	**kW per EER-Ton**	**kW per EER-Ton**
0.12	0.12	0.12	0.12

Deemed Winter Demand Savings Tables

This section is not available and will be addressed in the future versions of TRM.

Claimed Peak Demand Savings

The summer peak demand savings would be used as the Claimed peak demand savings.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a high efficiency heat pump is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[34]

Program Tracking Data & 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:

- Coefficient of Performance (COP) of the installed unit
- Cooling capacity in Btu per hour of the installed unit
- Energy Efficiency Ratio (EER) of the installed unit
- Tonnage of the installed unit
- Climate zone of the site

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- ASHRAE 90.1-1999 (Residential Buildings)

[34] 2008 California Database for Energy Efficiency Resources (DEER).

- ASHRAE 90.1-1999 / Consortium for Energy Efficiency Tier 1 Standard
- ASHRAE 90.1-1999 / Consortium for Energy Efficiency Tier 2 Standard

Document Revision History

Table 2-136. Split System and Single-Package Heat Pumps between 65,000 Btu/hr and 240,000 Btu/hr Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2.6 Split System and Single-Package Air Conditioners between 65,000 Btu/hr and 240,000 Btu/hr Measure Overview

TRM Measure ID: R-HV-SA

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

The following deemed savings values may be used to calculate an incentive for replacing an existing central air conditioner with a premium efficiency central air conditioner through a standard offer program.

Eligibility Criteria

The deemed savings apply only to a central air conditioner replaced with a higher efficiency central air conditioner.

Baseline Condition

Baseline is assumed to be a new central air conditioning system with an EER of 8.9 for units up to 135,000 Btu/hr, and 8.5 for units between 135,000 Btu/hr and 240,000 Btu/hr.

High-Efficiency Condition

Minimum standard for units up to 135,000 Btu/hr is 10.0 EER and 9.5 EER for units between 135,000 Btu/hr and 240,000 Btu/hr.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Engineering calculations were used to measure the demand and energy impacts of energy-efficient models versus baseline efficiency models, using performance data from currently-available units. Comparisons were made for each temperature bin, and annual performance calculations were made using bin weather data from representative cities (Amarillo, Dallas, Houston, and Corpus Christi) in each of the four climate zones.

Deemed Savings Example

New unit is a 10-ton package rooftop unit with an EER of 10.5 installed in Zone 2. Baseline EER is 8.9 for units less than 135,000 Btu/hr.

From the table below, select deemed savings values of 0.10 kW/ton and 309 kWh/ton.

$$\boldsymbol{kW\ savings} = \mathbf{0.10} \times (\boldsymbol{Unit\ EER} - \boldsymbol{Baseline\ EER}) \times \boldsymbol{tons}$$

$$\boldsymbol{kW\ savings} = \mathbf{0.10} \times (\mathbf{10.5} - \mathbf{8.9}) \times \mathbf{10} = \mathbf{1.6}\ \boldsymbol{kW}$$

Equation 10

$$\boldsymbol{kWh\ savings} = \mathbf{309} \times (\boldsymbol{Unit\ EER} - \boldsymbol{Baseline\ EER}) \times \boldsymbol{tons}$$

$$\boldsymbol{kWh\ savings} = \mathbf{309} \times (\mathbf{10.5} - \mathbf{8.9}) \times \mathbf{10} = \mathbf{4{,}944}\ \boldsymbol{kWh}$$

Equation 11

Deemed Energy and Demand Savings Tables

Table 2-137 and Table 2-138 present the energy savings (kWh) associated with this measure for climate zones 1, 2, 3 and 4.

Table 2-137. Split System and Single-Package 65,000-135,000 Btu/hr Air Conditioner Energy Savings

Units greater than 65,000 Btu/hr and less than 135,000 Btu/h			
Zone 1	Zone 2	Zone 3	Zone 4
kWh per EER-Ton	kWh per EER-Ton	kWh per EER-Ton	kWh per EER-Ton
202	309	392	440

Table 2-138. Split System and Single-Package 135,000-240,000 Btu/hr Air Conditioner Energy Savings

Units greater than 135,000 Btu/hr and less than 240,000 Btu/h			
Zone 1	Zone 2	Zone 3	Zone 4
kWh per EER-Ton	kWh per EER-Ton	kWh per EER-Ton	kWh per EER-Ton
151	242	284	324

Deemed Summer Demand Savings Tables

Table 2-139 and Table 2-140 present the summer demand savings (kW) associated with this measure for climate zones 1, 2, 3 and 4.

Table 2-139. Split System and Single-Package
65,000-135,000 Btu/hr Air Conditioner Summer Peak Demand Savings

Units greater than 65,000 Btu/hr and less than 135,000 Btu/h			
Zone 1	Zone 2	Zone 3	Zone 4
kW per EER-Ton	kW per EER-Ton	kW per EER-Ton	kW per EER-Ton
0.10	0.10	0.11	0.11

Table 2-140. Split System and Single-Package
135,000-240,000 Btu/hr Air Conditioner Summer Peak Demand Savings

Units greater than 135,000 Btu/hr and less than 240,000 Btu/h			
Zone 1	Zone 2	Zone 3	Zone 4
kW per EER-Ton	kW per EER-Ton	kW per EER-Ton	kW per EER-Ton
0.12	0.12	0.12	0.12

Deemed Winter Demand Savings Tables

Winter demand savings is not applicable to this measure. Since this measure is a cooling measure only.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the Claimed peak demand savings value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a high efficiency air conditioner (packaged or split system) is 15.0 years.

This value is consistent with the EUL reported in the 2008 California Database for Energy Efficiency Resources (DEER).[35]

[35] 2008 California Database for Energy Efficiency Resources (DEER).

Program Tracking Data & 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:

- Cooling capacity of the installed unit in Btu per hour
- Energy Efficiency Ratio (EER) of the unit installed
- Tonnage of the installed unit
- Climate zone of the site

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-141. Split System and Single-Package Air Conditioners between 65,000 Btu/hr and 240,000 Btu/hr Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.2.7 Window Air Conditioner Measure Overview

TRM Measure ID: R-HV-WA

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

The following deemed savings values are applicable in calculating an incentive for a room air conditioner replaced with a higher efficiency room air conditioner in a dwelling occupied by a residential energy consumer.

Eligibility Criteria

The deemed savings apply only to a window air conditioner replaced with a higher efficiency window air conditioner.

Baseline Condition

Baseline is assumed to be a new air conditioning unit with an EER rating that meets current NAECA standard. Current NAECA EER standard varies from 8.5 to 9.8 depending on the type and capacity of unit. Minimum cooling capacity is 5,000 Btu/hour, and the maximum is 25,000 Btu/hour.

High-Efficiency Condition

Units meeting current ENERGY STAR® specification qualify for incentive. This specification is 10 percent above the new NAECA standard for all categories.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables. Engineering calculations were used to measure the demand and energy impacts of energy-efficient models versus baseline efficiency models. Annual

operating hours for each of the four climate zones were derived from ASHRAE summer cooling load hour data. Window unit operating hours were assumed to be equal to central air conditioner operating hours.

Deemed Energy and Demand Savings Tables

Table 2-142 through Table 2-145 present the energy savings (kWh) associated with window air conditioners per climate zones 1, 2, 3 and 4.

Table 2-142. Window Air Conditioner Energy Savings (kWh) – Climate Zone 1: Panhandle Region

Window Air Conditioners – Energy Savings, Climate Zone 1					
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	kWh Savings	15% Above Standard (EER)	kWh Savings
Less than 6,000	9.7	10.7	51	11.2	73
6,000–7,999	9.7	10.7	54	11.2	78
8,000–13,999	9.8	10.8	104	11.3	149
14,000–19,999	9.7	10.7	140	11.2	201
20,000 and above	8.5	9.4	240	9.8	345

Table 2-143. Window Air Conditioner Energy Savings (kWh) – Climate Zone 2: North Region

Window Air Conditioners – Energy Savings, Climate Zone 2					
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	kWh Savings	15% Above Standard (EER)	kWh Savings
Less than 6,000	9.7	10.7	68	11.2	97
6,000–7,999	9.7	10.7	73	11.2	104
8,000–13,999	9.8	10.8	139	11.3	199
14,000–19,999	9.7	10.7	187	11.2	269
20,000 and above	8.5	9.4	320	9.8	460

Table 2-144. Window Air Conditioner Energy Savings (kWh) – Climate Zone 3: South Region

Window Air Conditioners – Energy Savings, Climate Zone 3					
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	kWh Savings	15% Above Standard (EER)	kWh Savings
Less than 6,000	9.7	10.7	93	11.2	134
6,000–7,999	9.7	10.7	100	11.2	143
8,000–13,999	9.8	10.8	191	11.3	274
14,000–19,999	9.7	10.7	257	11.2	369
20,000 and above	8.5	9.4	440	9.8	632

Table 2-145. Window Air Conditioner Energy Savings (kWh) – Climate Zone 4: Valley Region

Window Air Conditioners – Energy Savings, Climate Zone 4					
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	kWh Savings	15% Above Standard (EER)	kWh Savings
Less than 6,000	9.7	10.7	98	11.2	140
6,000–7,999	9.7	10.7	104	11.2	150
8,000–13,999	9.8	10.8	200	11.3	287
14,000–19,999	9.7	10.7	269	11.2	386
20,000 and above	8.5	9.4	460	9.8	661

Deemed Summer Demand Savings Tables

Table 2-146 presents the summer demand savings (kW) associated with window air conditioners.

Table 2-146. Window Air Conditioner Summer Peak Demand Savings (kW) – All Climate Zones

Window Air Conditioners – Demand Savings, All Climate Zones					
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	kW Savings	15% Above Standard (EER)	kW Savings
Less than 6,000	9.7	10.7	0.054	11.2	0.078
6,000–7,999	9.7	10.7	0.058	11.2	0.083
8,000–13,999	9.8	10.8	0.111	11.3	0.160
14,000–19,999	9.7	10.7	0.150	11.2	0.215
20,000 and above	8.5	9.4	0.257	9.8	0.368

Deemed Winter Demand Savings Tables

Deemed winter demand savings are not applicable to this measure since this measure is a cooling measure only.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the Claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a window air conditioning unit is 13.0 years.

This value is consistent with the EUL reported in the Department of Energy (DOE) Technical Support Document for Energy Conservation Standards for Room Air Conditioners.[36]

Program Tracking Data & 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:

- Cooling capacity of the installed unit in Btu per hour
- Energy Efficiency Ratio (EER) of the unit installed
- Climate zone of the site

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for window air conditioners.
- National Appliance Energy Conservation Act (NAECA)

Document Revision History

Table 2-147. Window Air Conditioner Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

Window Air Conditioner for Low Income and Hard-to-Reach Market Transformation

TRM Measure ID: R-HV-WA

Market Sector: Residential

Measure Category: HVAC

[36] DOE Technical Support Document for Energy Conservation Standards for Room Air Conditioners.

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type: Direct Install

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

The following deemed savings values are applicable in calculating an incentive for a room air conditioner replaced with a higher efficiency room air conditioner in a dwelling occupied by a residential energy consumer who qualifies for the low-income or hard-to-reach market transformation program offered by their utility.

Eligibility Criteria

The deemed savings apply only to a window air conditioner replaced with a higher efficiency window air conditioner. The unit to be replaced must be functioning at the time of removal; only early replacements are eligible for these deemed savings.

Baseline Condition

Baseline is assumed to be a new air conditioning unit with an EER rating that meets current NAECA standard. Current NAECA EER standard varies from 8.5 to 9.8 depending on the type and capacity of unit. Minimum cooling capacity is 5,000 Btu/hour, and the maximum is 25,000 Btu/hour.

High-Efficiency Condition

Units meeting current ENERGY STAR® specification qualify for incentive. This specification is 10 percent above the new NAECA standard for all categories.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be further addressed in a future version of the TRM.

In order to calculate the summer peak demand (kW) and energy (kWh) savings associated with the installation of a new window air conditioner in a home through a low-income or hard-to-reach market transformation program, the savings must be weighted by the age of the unit to be replaced.

The following equations may be used to calculate the deemed energy and summer peak demand savings awarded to a newly-installed window air conditioner. Note that the annual operating hours of window AC units is assumed to be 1,716 hours.

$$\begin{aligned}&\textbf{Annual kWh Savings}\\&=\left(\frac{\textbf{Window AC Age}}{\textbf{Window AC Age}+\textbf{Remaining Service Life}}\right)\\&\times\textbf{Annual kWh Savings}_{\textbf{Replace on Burnout}}\\&+\left(\frac{\textbf{Remaining Service Life}}{\textbf{Window AC Age}+\textbf{Remaining Service Life}}\right)\\&\times\textbf{Annual kWh Savings}_{\textbf{Early Replacement}}\end{aligned}$$

Equation 12

$$\begin{aligned}&\textbf{Annual kWh Savings}_{\textbf{Early Replacement}}\\&=\frac{\textbf{Window AC Size}\left[\frac{\textbf{BTU}}{\textbf{h}}\right]}{\mathbf{1000}}\times\mathbf{1716}\,\textbf{annual operating hours}\\&\times\left(\frac{\mathbf{1}}{\textbf{Federal Standard}_{\textbf{Early Replacement}}}-\frac{\mathbf{1}}{\mathbf{10\%}\,\textbf{Above Standard}_{\textbf{Early Replacement}}}\right)\end{aligned}$$

Equation 13

$$\begin{aligned}&\textbf{Annual kWh Savings}_{\textbf{Replace on Burnout}}\\&=\frac{\textbf{Window AC Size}\left[\frac{\textbf{BTU}}{\textbf{h}}\right]}{\mathbf{1000}}\times\mathbf{1716}\,\textbf{annual operating hours}\\&\times\left(\frac{\mathbf{1}}{\textbf{Federal Standard}_{\textbf{Replace on Burnout}}}-\frac{\mathbf{1}}{\mathbf{10\%}\,\textbf{Above Standard}_{\textbf{Replace on Burnout}}}\right)\end{aligned}$$

Equation 14

$$\begin{aligned}&\textbf{Annual kW Savings}\\&=\left(\frac{\textbf{Window AC Age}}{\textbf{Window AC Age}+\textbf{Remaining Service Life}}\right)\\&\times\frac{\textbf{Annual kWh Savings}_{\textbf{Replace on Burnout}}}{\mathbf{1716}\,\textbf{annual operating hours}}\\&+\left(\frac{\textbf{Remaining Service Life}}{\textbf{Window AC Age}+\textbf{Remaining Service Life}}\right)\\&\times\frac{\textbf{Annual kWh Savings}_{\textbf{Early Replacement}}}{\mathbf{1716}\,\textbf{annual operating hours}}\end{aligned}$$

Equation 15

Federal standards for a unit replaced on burnout can be found in Table 2-148. Remaining service life is equal to the unit lifetime, 13 years, minus the age of the window air conditioner replaced:

$$Remaining\ Service\ Life = Lifetime - Window\ AC\ Age, Lifetime = 13\ years$$

Equation 16

Deemed Energy and Demand Savings Tables

Table 2-148 presents the federal standards for window air conditioner efficiency, as used to calculate energy and demand savings in through Equation 16.

Table 2-148. Window Air Conditioner Standards – All Climate Zones

Window Air Conditioners – Standards for Energy and Demand Savings, All Climate Zones				
	Replace on Burnout		Early Replacement	
Size (Btu/hr)	Federal Standard (EER)	10% Above Standard (EER)	Federal Standard (EER)	10% Above Standard (EER)
5,000	9.7	10.7	8.5	10.7
10,000	9.7	10.7	9	10.7
12,000	9.8	10.8	9	10.8
18,000	9.7	10.7	8.8	10.7
24,000	8.5	9.4	8.2	9.4

Deemed Summer Demand Savings Tables

See Table 2-148 for the federal standards used to calculate window air conditioner demand savings.

Deemed Winter Demand Savings Tables

Deemed winter demand savings are not applicable to this measure since this measure is a cooling measure only.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a window air conditioning unit is 13.0 years.

This value is consistent with the EUL reported in the DOE Technical Support Document for Energy Conservation Standards for Room Air Conditioners.[37]

Program Tracking Data & 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:

- Cooling capacity of the installed unit in Btu per hour
- Energy Efficiency Ratio (EER) of the unit installed
- Installation status (retrofit, replacement on burnout)
- Age of the replaced unit

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for window air conditioners.
- National Appliance Energy Conservation Act (NAECA)

Document Revision History

Table 2-149. Low Income Weatherization or Hard-to-Reach Market Transformation Program Window Air Conditioner Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

[37] DOE Technical Support Document for Energy Conservation Standards for Room Air Conditioners.

2.3 RESIDENTIAL: BUILDING ENVELOPE

2.3.1 Air Infiltration Measure Overview

TRM Measure ID: R-BE-AI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

Savings Methodology: Engineering Algorithm and Estimates

Measure Description

This measure reduces air infiltration into the residence, using pre- and post-treatment blower door air pressure readings to confirm air leakage reduction. Homes treated for air infiltration reduction must have electric air conditioning to qualify for these deemed savings values.

Eligibility Criteria

There is an upper limit of 4.00 CFM_{50} per square foot of house floor area for the pre-retrofit infiltration rate on eligible projects. This cap may not apply to homes implementing the measure under utilities' low-income or hard-to-reach market transformation programs.

Baseline Condition

For residential dwellings, the winter/summer air change per hour (ACH) differential was derived from ESPRE model weather data for the Panhandle (Amarillo weather), North (Dallas weather), South (Houston weather), and Valley (Corpus Christi weather) climate zones. Electric air conditioning was assumed for all homes, with gas, electric or heat pump heating.

Table 2-150. Baseline Seasonal ACH by Climate Zone

Air Infiltration Values (ACH)		
Region	**Winter ACH**	**Summer ACH**
Climate Zone 1: Panhandle	1.25	0.96
Climate Zone 2: North	0.94	0.49
Climate Zone 3: South	0.86	0.54
Climate Zone 4: Valley	0.95	0.94
Climate Zone 5: West	0.94	0.49

High-Efficiency Condition

To qualify for an incentive, a minimum air leakage reduction of 10 percent of the pre-installation reading is required. Utilities may require competency testing of personnel who will perform the blower door tests.

Blower door air pressure measurements will also be used to ensure that air infiltration in a residence shall not be less than the standards set forth in the following table:

Table 2-151. Minimum Final Ventilation Rate*

	Number of Stories		
Shielding	**Single Story**	**Two Story**	**3 or More Stories**
Well shielded	1.18	0.95	0.83
Normal	0.99	0.79	0.69
Exposed	0.89	0.71	0.62

* Measured in cubic feet per minute at 50 Pascal per square foot of conditioned area.

Well shielded is defined as urban areas with high buildings or sheltered areas, and building surrounded by trees, bermed earth, or higher terrain.

Normal is defined as buildings in a residential neighborhood or subdivision setting, with yard space between buildings. 80 percent to 90 percent of houses fall in this category.

Exposed is defined as buildings in an open setting with few buildings or trees around and buildings on top of a hill or ocean front, exposed to winds.

As an example, the minimum post-installation air exchange rate for an 1800 square foot, one-story home with normal shielding is 1782 CFM_{50} (1800 x 0.99). In order to qualify for the air infiltration control deemed savings, there must be a minimum 10 percent reduction between the pre- and post-installation ventilation rate. Therefore, the pre-installation ventilation rate must be at least 1960 CFM_{50} (1782 x 110%) in order to be considered for air infiltration control measures.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

The following formula shall be used to calculate deemed savings for infiltration efficiency improvements. The formula applies to Residential and Hard-to-Reach single-family and

multifamily dwellings, and to all building heights and shielding factors. Only structures with electric refrigerated air conditioning systems are eligible.

$$\boldsymbol{Deemed\ Savings = CFM_{50} \times V}$$

Equation 17

Where:

CFM_{50} = *Air infiltration reduction in Cubic Feet per Minute at 50 Pascal*

V = *The corresponding value in the deemed savings tables*

Deemed Energy and Demand Savings Tables

The following formula shall be used to calculate deemed energy savings for infiltration efficiency improvements.

$$\boldsymbol{Deemed\ Energy\ Savings = CFM_{50} \times V}$$

Equation 18

Where:

$CFM50$ = *Air infiltration reduction in Cubic Feet per Minute at 50 Pascal*

V = *The corresponding value in Table 2-152. Energy Savings per CFM50 Reduction*

Table 2-152. Energy Savings per CFM_{50} Reduction

Region	kWh Impact per CFM_{50} Reduction		
	Gas Heat	Resistance Heat	Heat Pump Heat
Panhandle	0.1262	1.6673	0.7933
North	0.1929	1.0565	0.5046
South	0.2694	0.7945	0.4438
Valley	0.6268	0.9732	0.7368
El Paso	0.1212	0.8096	N/A

Deemed Summer Demand Savings Tables

The following formula shall be used to calculate deemed summer demand savings for air infiltration improvements.

$$Deemed\ Summer\ Demand\ Savings = CFM_{50} \times V$$

Equation 19

Where:

CFM50 = *Air infiltration reduction in Cubic Feet per Minute at 50 Pascal*

V = *The corresponding value in the Table 2-153. Peak Summer Demand Savings per CFM50 Reduction*

Table 2-153. Peak Summer Demand Savings per CFM_{50} Reduction

Region	Summer kW Impact per CFM_{50} Reduction
Panhandle	0.00024
North	0.00019
South	0.00026
Valley	0.00043
El Paso	0.000207

Deemed Winter Demand Savings Tables

The following formula shall be used to calculate deemed winter demand savings for air infiltration improvement:

$$Deemed\ Winter\ Demand\ Savings = CFM_{50} \times V$$

Equation 20

Where:

CFM50 = *Air infiltration reduction in Cubic Feet per Minute at 50 Pascal*

V = *The corresponding value in Table 2-154. Peak Winter Demand Savings per CFM50 Reduction*

Table 2-154. Peak Winter Demand Savings per CFM_{50} Reduction

Region	Winter kW Impact per CFM_{50} Reduction	
	Electric Resistance	Heat Pump
Panhandle	0.000842	0.000553
North	0.000616	0.000261
South	0.000486	0.000221
Valley	0.000528	0.000305
El Paso	0.000534	N/A

Claimed Peak Demand Savings

For this measure, the higher of the summer and winter period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

According to the DEER Final Report December 2008, the Estimated Useful Life is 11 years for air infiltration reduction.

Program Tracking Data & 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
- Pre-retrofit air infiltration in cubic feet per minute at 50 Pascal
- Post-retrofit air infiltration in cubic feet per minute at 50 Pascal
- Heating type (gas, resistance heat, heat pump)
- Square footage of the house
- Shielding level (well shielded, normal, exposed)
- Number of stories

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.
- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-155. Air Infiltration Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.3.2 Ceiling Insulation Measure Overview

TRM Measure ID: R-BE-CI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

Ceiling insulation savings are calculated per square foot of treated ceiling area above a conditioned space. Ceiling insulation must be added only to homes with electric air conditioning or HTR homes with evaporative cooling systems to qualify for these deemed savings values.

Eligibility Criteria

This measure applies to homes with electric air conditioning or HTR homes with evaporative cooling systems.

Baseline Condition

In existing construction, ceiling insulation levels vary greatly depending on the age of the home, type of insulation, and activity in the attic (such as using the attic for storage and HVAC equipment). Deemed savings tables are based on the current level of ceiling insulation in the home from R-0 to R-22. The current insulation level of each home will be determined and documented by the insulation installer. Degradation due to age and density of the existing insulation should be taken into account.

In the event that existing insulation is or has been removed, the existing R-value will be based upon the R-value of the existing insulation prior to removal.

High-Efficiency Condition

A ceiling insulation level of R-30 is recommended throughout Texas as prescribed by DOE. The combined R-values of the existing insulation and the insulation being added will total at least R-30. The R-value of the existing insulation can be no greater than R-22.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Present the energy savings (kWh) associated with ceiling insulation for the five Texas climate zones.

Table 2-156. Climate Zone 1: Panhandle Region –
Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.86	9.99	5.04
R-1 to R-4	0.52	6.43	3.14
R-5 to R-8	0.24	3.19	1.48
R-9 to R-14	0.11	1.67	0.76
R-15 to R-22	0.05	0.71	0.31

Table 2-157. Climate Zone 2: North Region –
Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	1.22	6.71	3.16
R-1 to R-4	0.79	4.32	2.07
R-5 to R-8	0.40	2.15	1.04
R-9 to R-14	0.21	1.13	0.54
R-15 to R-22	0.09	0.47	0.23

Table 2-158. Climate Zone 3: South Region –
Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	1.00	4.40	2.14
R-1 to R-4	0.64	2.81	1.40
R-5 to R-8	0.32	1.38	0.70
R-9 to R-14	0.17	0.72	0.36
R-15 to R-22	0.07	0.30	0.15

Table 2-159. Climate Zone 4: Valley Region –
Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	1.30	3.64	2.10
R-1 to R-4	0.85	2.33	1.39
R-5 to R-8	0.44	1.15	0.70
R-9 to R-14	0.23	0.60	0.37
R-15 to R-22	0.10	0.25	0.15

Table 2-160.Climate Zone 5: West Region –
Residential Ceiling Insulation Deemed Annual Energy Savings (kWh)

Ceiling Insulation Base R-value	Gas Heat (per sq. ft.)	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)*
R-0	2.59	5.66	N/A
R-1 to R-4	1.56	3.48	N/A
R-5 to R-8	1.12	2.28	N/A
R-9 to R-14	0.74	1.54	N/A
R-15 to R-22	0.51	1.10	N/A

* Savings for Heat Pump are not provided for El Paso due to the minimal prevalence of homes heated with heat pumps in this region.

Deemed Summer Demand Savings Tables

Present the summer demand savings (kW) associated with ceiling insulation for the five Texas climate zones.

Table 2-161. Climate Zone 1: Panhandle Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.000973	0.000973
R-1 to R-4	0.000608	0.000622
R-5 to R-8	0.000297	0.000311
R-9 to R-14	0.000153	0.000153
R-15 to R-22	0.000068	0.000074

Table 2-162. Climate Zone 2: North Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.001027	0.001027
R-1 to R-4	0.000622	0.000662
R-5 to R-8	0.000297	0.000311
R-9 to R-14	0.000153	0.000162
R-15 to R-22	0.000074	0.000074

Table 2-163. Climate Zone 3: South Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.000973	0.000973
R-1 to R-4	0.000608	0.000622
R-5 to R-8	0.000297	0.000297
R-9 to R-14	0.000153	0.000153
R-15 to R-22	0.000074	0.000074

**Table 2-164. Climate Zone 4: Valley Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)**

Ceiling Insulation Base R-value	Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.001027	0.001027
R-1 to R-4	0.000622	0.000649
R-5 to R-8	0.000284	0.000297
R-9 to R-14	0.000135	0.000153
R-15 to R-22	0.000068	0.000074

**Table 2-165. Climate Zone 5: West Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)**

Ceiling Insulation Base R-value	Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)*
R-0	0.002053	N/A
R-1 to R-4	0.001200	N/A
R-5 to R-8	0.000860	N/A
R-9 to R-14	0.000531	N/A
R-15 to R-22	0.000275	N/A

* Savings for Heat Pump are not provided for El Paso due to the minimal prevalence of homes heated with heat pumps in this region.

Deemed Winter Demand Savings Tables

Present the winter demand savings associate with ceiling insulation for the five Texas climate zones.

**Table 2-166. Climate Zone 1: Panhandle Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)**

Ceiling Insulation Base R-value	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.003988	0.001239
R-1 to R-4	0.002468	0.000672
R-5 to R-8	0.001062	0.000300
R-9 to R-14	0.000584	0.000249
R-15 to R-22	0.000268	0.000125

Table 2-167. Climate Zone 2: North Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.002992	0.001053
R-1 to R-4	0.001869	0.000661
R-5 to R-8	0.000796	0.000272
R-9 to R-14	0.000459	0.000150
R-15 to R-22	0.000208	0.000089

Table 2-168. Climate Zone 3: South Region -
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.002192	0.000766
R-1 to R-4	0.001355	0.000492
R-5 to R-8	0.000565	0.000195
R-9 to R-14	0.000329	0.000118
R-15 to R-22	0.000151	0.000067

Table 2-169. Climate Zone 4: Valley Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
R-0	0.001802	0.000748
R-1 to R-4	0.001120	0.000488
R-5 to R-8	0.000483	0.000196
R-9 to R-14	0.000275	0.000114
R-15 to R-22	0.000123	0.000059

Table 2-170. Climate Zone 5: West Region –
Residential Ceiling Insulation Deemed Demand Savings (kW)

Ceiling Insulation Base R-value	Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)*
R-0	0.002348	N/A
R-1 to R-4	0.001410	N/A
R-5 to R-8	0.000775	N/A
R-9 to R-14	0.000571	N/A
R-15 to R-22	0.000458	N/A

* Savings for Heat Pump are not provided for El Paso due to the minimal prevalence of homes heated with heat pumps in this region.

Claimed Peak Demand Savings

For this measure, the higher of the summer and winter period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007),[38] the Estimated Useful Life is 25 years for ceiling insulation.

Program Tracking Data & 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:

- The climate zone
- Base R-value of original insulation
- R-value of installed insulation
- Heating type (gas, electric, heat pump) Square footage of ceiling insulation installed above a conditioned space

[38] GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007). http://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.
- Docket No. 41722. Petition of AEP Texas Central Company, AEP Texas North Company, CenterPoint Energy Houston Electric, LLC, El Paso Electric Company, Entergy Texas, Inc., Oncor Electric Delivery Company LLC, Sharyland Utilities, L.P., Southwestern Electric Power Company, Southwestern Public Service Company, and Texas-New Mexico Power Company to Approve Revisions to Residential Deemed Savings to Incorporate Winter Peak Demand Impacts and Update Certain Existing Deemed Savings Values. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-171. Ceiling Insulation Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.3.3 Wall Insulation Measure Overview

TRM Measure ID: R-BE-WI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type: Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

Wall insulation savings are per square foot of treated wall area (gross wall area less window and door area), and are based on R-0 increased to R-13. Wall insulation must be added only to homes with electric air conditioning or HTR homes with evaporative cooling systems to qualify for these deemed savings values.

Eligibility Criteria

This measure applies to homes with electric air conditioning or HTR homes with evaporative cooling systems.

Baseline Condition

The baseline is considered to be a house with no wall insulation in the 4 inches wall cavity.

High-Efficiency Condition

The standard throughout Texas for adding wall insulation to an existing wall cavity is R-13, as prescribed by United States Department of Energy (DOE) and Texas Department of Housing & Community Affairs (TDHCA) programs. To qualify for the incentive, there must be no existing wall insulation.

Under the Hard-To-Reach template, wall insulation reduces the ventilation rate in the home and therefore a post-installation blower door test must be conducted. Results must comply with the Minimum Final Ventilation Rate table found in the Air Infiltration section of this document.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be further addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Present the deemed energy savings values for five Texas climate zones.

Table 2-172. Climate Zone 1: Panhandle Region – Residential Wall Insulation Deemed Annual Energy Savings (kWh)

Electric A/C,Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.33586	11.014	6.496

Table 2-173. Climate Zone 2: North Region – Residential Wall Insulation Deemed Annual Energy Savings (kWh)

Electric A/C, Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.45875	7.043	2.990

Table 2-174. Climate Zone 3: South Region – Residential Wall Insulation Deemed Annual Energy Savings (kWh)

Electric A/C, Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.24242	4.529	1.726

Table 2-175. Climate Zone 4: Valley Region – Residential Wall Insulation Deemed Annual Energy Savings (kWh)

Electric A/C, Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.28199	3.273	1.310

Table 2-176. Climate Zone 5: West Region – Residential Wall Insulation Deemed Annual Energy Savings (kWh)

Electric A/C, Gas Heat (per sq. ft.)	Electric A/C, Electric Heat (per sq. ft.)	Electric A/C, Heat Pump (per sq. ft.)
0.996655	4.214643	N/A

Deemed Summer Demand Savings Tables

Present the deemed summer demand savings tables for five Texas climate zones.

Table 2-177. Climate Zone 1: Panhandle Region – Residential Wall Insulation Deemed Demand Savings (kW)

Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
0.0005892	0.0005892

Table 2-178. Climate Zone 2: North Region – Residential Wall Insulation Deemed Demand Savings (kW)

Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
0.0007576	0.0008418

Table 2-179. Climate Zone 3: South Region – Residential Wall Insulation Deemed Demand Savings (kW)

Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
0.0006734	0.0006734

Table 2-180. Climate Zone 4: Valley Region – Residential Wall Insulation Deemed Demand Savings (kW)

Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
0.0007576	0.0007576

Table 2-181. Climate Zone 5: West Region – Residential Wall Insulation Deemed Demand Savings (kW)

Gas Heat & Electric Heat (per sq. ft.)	Heat Pump (per sq. ft.)
0.000695	N/A

Deemed Winter Demand Savings

Present the deemed winter demand savings for climate zone 5. Deemed winter demand savings for this measure are not currently available for the other climate zones.

Table 2-182. Deemed Winter Peak Demand Savings (kW) – Residential Wall Insulation

Climate Zone	Winter Peak Avg. kW Savings Electric Heat (per sq. ft.)
Zone 1	N/A
Zone 2	N/A
Zone 3	N/A
Zone 4	N/A
Zone 5	0. 001218

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the Claimed peak demand value for climate zone 1 to 4. The winter period peak demand savings would be used as the claimed peak demand value for climate zone 5 only for households with gas heating system type or electric heat other than heat pump.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007), the Estimated Useful Life is 25 years for wall insulation.

Program Tracking Data & 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
- Heating type (gas, electric, heat pump)
- Cooling type
- Square footage of treated wall area (gross wall area less window and door area)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

- 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

This section is not applicable.

Document Revision History

Table 2-183. Wall Insulation Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.3.4 Floor Insulation Measure Overview

TRM Measure ID: R-BE-FI

Market Sector: Residential

Measure Category: Building Envelope

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Implementation Type: Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

Floor insulation savings are per square foot of treated floor area above a non-conditioned space. Floor insulation must be added only to existing homes with electric air conditioning or HTR homes with evaporative cooling systems to qualify for these deemed savings values.

Eligibility Criteria

This measure applies to homes with electric air conditioning or HTR homes with evaporative cooling systems.

Baseline Condition

The baseline is considered to be a house with pier and beam construction and no floor insulation against the floor of conditioned area.

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 & Community Affairs (TDHCA) programs. To qualify for the incentive, there must be no existing floor insulation. 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 remains 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 inches clearance from bottom of the insulation to the ground is required by Occupational Safety and Health Association (OSHA).

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Building load simulation software that calculates hourly load data was used to create savings for a series of models. The software used was ESPRE 2.1 (EPRI Simplified Program for Residential Energy). The base model of the prototype home was a model that was calibrated to residential load data by Planergy, Inc. The load data used for calibration was the South Texas End-Use Study, 1990 by Central Power and Light.

Building shell measures are sensitive to weather, and Texas is somewhat unique because there is a great difference in weather patterns between Amarillo in the northern panhandle and Corpus Christi in south Texas. A series of models were created to determine the difference in weather data throughout the eight weather regions in Texas as defined in the Model Energy Code. In an effort to simplify deemed savings values, available TMY weather data from ten different regions was analyzed. Based on the results, the different weather regions were collapsed down to the following four regions.

- Climate Zone 1: Panhandle Region (Amarillo weather data)
- Climate Zone 2: North Region (Dallas weather data)
- Climate Zone 3: South Region (Houston weather data)
- Climate Zone 4: Valley Region (Corpus Christi weather data)
- Savings values for Climate Zone 5 (West Region) were appended at a later date.

Table 2-184. Residential Floor Insulation – Prototypical Home Characteristics

Shell Characteristic	Value	Source
Conditioned Area (site-built)	1,850 square feet	South Texas End Use Study, Central Power and Light, 1990, Table 3-1 average sq. ft. conditioned area – 1854 sq. ft.; Entergy 1984 Baseline Study, average sq. ft. single family home 1834 sq. ft.; baseline data from SPS and AEP utilities efficiency programs is similar for existing homes (sq. ft. within 7% of 1850 sq. ft.)
Conditioned Area (manufactured home)	1,504 square feet	Average square footage of homes sold since 1983 (1.045 million) from The Manufactured Housing Industry in Texas, 1999 Report. Information in report received from the Texas Department of Housing Community Affairs and Texas Manufactured Housing Association member manufacturers and retailers. Percent of sales of new & used manufactured homes to total sales of new & used single family homes for metropolitan statistical areas is 34.3%.
Foundation	Pier and Beam	Entergy 1984 Baseline Study single family homes 56% slab foundation, 44% pier & beam; pier & beam foundation varies 1-

Shell Characteristic	Value	Source
		4% in energy and demand from slab foundation model. Skirting around perimeter is assumed insulated and vented. Ground under home is assumed to be bare, without any type of moisture barrier.
Base Floor Insulation	R-2.36	ESPRE default based on hardwood floor without carpet or other 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 an R-15 loose-fill insulation for manufactured housing and other non-site-built homes.
Ceiling Insulation	R-19	Average insulation level in an existing home used in model; SPS Baseline data for 1998 IRP, residential AC replacement programs average ceiling insulation level for existing homes R-20.51 of 1,010 homes in efficiency programs
Wall Insulation	R-10.26	ESPRE default based on wood frame, 4" wall stud, sheathing, siding or brick, R-11 insulation with ½" gypsum, SPS Baseline data for 1998 IRP average wall insulation R-10.94
Window Area	10.2% of floor area (~13-15% of wall area)	Average window area per wall used during calibration of model; window area equal for each wall orientation
Air Infiltration	1.1 and 0.9 ACH (winter, summer)	Average air changes per hour of air infiltration for existing homes used during calibration of model
Window U-value	0.72	WTU Baseline Survey, 1996 and WTU's Residential MARS database; U-0.72 represents a mix of single and double pane windows in existing homes
Thermostat Settings	70 winter; 78 summer	Average thermostat settings used during calibration of model
Orientation	Square house	To average effect of orientation of building due to a wide variety of building configurations and orientations; walls are equal area and face north/south/east/west
Duct Losses	25% overall loss (thermal and air leakage)	Average duct losses for existing homes used during calibration of model
Air Conditioning	10.0 SEER	SPS Baseline data for 1998 IRP, residential AC replacement programs average SEER 10.2 of 1,010 replaced units, NAECA standard is 10.0
Gas Heating	78 AFUE	Annual Fuel Utilization Efficiency - base gas furnace efficiency
Electric Resistance Heat	COP 1.0	Coefficient of Performance for central electric resistance heating systems
Heat Pump	10.0 SEER and 7.2 HSPF	SPS Baseline data for 1998 IRP, residential AC replacement programs average SEER 10.2 of 1,010 replaced units. Average HSPF based on Carrier Product Data 1999, 10.0 SEER

Deemed Energy and Demand Savings Tables

Present the energy savings (kWh) for all five Texas climate zones.

Table 2-185. Climate Zone 1: Panhandle Region –
Residential Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	No Savings[39]	No Savings
Electric Heat	5.00054	4.98271
Heat Pump	2.59838	2.51197

Table 2-186. Climate Zone 2: North Region –
Residential Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.06486	0.03457
Electric Heat	2.93189	2.90027
Heat Pump	1.11730	1.09707

Table 2-187. Climate Zone 3: South Region –
Residential Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	No Savings	No Savings
Electric Heat	1.70757	1.65891
Heat Pump	0.58324	0.55718

Table 2-188. Climate Zone 4: Valley Region –
Residential Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.02378	No Savings
Electric Heat	1.16649	1.12832
Heat Pump	0.42757	0.40359

[39] No savings: Some models showed a slight increase in total annual electricity use for adding floor insulation with gas heating. The cooler, bare ground underneath the house acts as a heat sink and draws heat from the house when no insulation is present. With the addition of floor insulation, cooling consumption increased slightly due to the insulation blocking the advantage of the bare ground.

Table 2-189. Climate Zone 5: West Region –
Residential Floor Insulation Deemed Annual Energy Savings (kWh)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.313416	0.810602
Electric Heat	3.878664	2.594086
Heat Pump	N/A	N/A

Deemed Summer Demand Savings Tables

Present the deemed summer demand savings (kW) for four Texas climate zones (1, 2, 3 and 4).

Table 2-190. Climate Zone 1: Panhandle Region –
Residential Floor Insulation Deemed Summer Demand Savings (kW)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.000216	0.000199
Electric Heat	0.000216	0.000199
Heat Pump	0.000216	0.000266

Table 2-191. Climate Zone 2: North Region –
Residential Floor Insulation Deemed Summer Demand Savings (kW)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.000270	0.000266
Electric Heat	0.000270	0.000266
Heat Pump	0.000270	0.000266

Table 2-192. Climate Zone 3: South Region –
Residential Floor Insulation Deemed Summer Demand Savings (kW)

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.000216	0.000266
Electric Heat	0.000216	0.000266
Heat Pump	0.000216	0.000266

**Table 2-193. Climate Zone 4: Valley Region –
Residential Floor Insulation Deemed Summer Demand Savings (kW)**

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.000270	0.000266
Electric Heat	0.000270	0.000266
Heat Pump	0.000270	0.000266

**Table 2-194. Climate Zone 5: West Region –
Residential Floor Insulation Deemed Summer Demand Savings (kW)**

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0.000505	0.000003
Electric Heat	0.000505	0.000003
Heat Pump	N/A	N/A

Deemed Winter Demand Savings Tables

presents the deemed winter demand savings for climate zone 5. Deemed winter demand savings for this measure are not currently available for the other climate zones.

**Table 2-195. Climate Zone 5: West Region –
Residential Floor Insulation Deemed Winter Demand Savings (kW)**

Electric A/C and Heating Type	Site Built Home (per sq. ft.)	Manufactured Home (per sq. ft.)
Gas Heat	0	0
Electric Heat	0.001577	0.001278
Heat Pump	N/A	N/A

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value for climate zones 1-4 and homes in climate zone 5 with gas heating. Homes with electric heating in climate zone 5 would use the winter peak demand savings as the claimed peak demand value.

Additional Calculators and Tools

This section is 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 & 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

- Heating type (gas, electric, heat pump)
- Home type (site built or manufactured)
- Square footage of installed insulation

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 41070. Petition of El Paso Electric Company to Approve Revisions to Residential and Commercial Deemed Savings Based on Climate Data Specific to El Paso, Texas. Public Utility Commission of Texas.
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-196. Floor Insulation Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.3.5 ENERGY STAR® Windows Measure Overview

TRM Measure ID: R-BE-EW

Market Sector: Residential

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Measure Category: Building Envelope

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

ENERGY STAR® windows savings are calculated on per square foot of window basis, inclusive of frame and sash. Windows must be installed only in homes with electric air conditioning or hard-to-reach homes with evaporative cooling systems to qualify for these deemed savings values.

Eligibility Criteria

This measure applies to homes with electric air conditioning or hard-to-reach homes with evaporative cooling systems.

Baseline

The baseline is a double-glazed (i.e., double-pane), clear window with an aluminum frame, with a U-factor of 0.87, a solar heat gain coefficient (SHGC) of 0.66, and air infiltration of 1 CFM/sq.ft.

High-Efficiency Condition

For a window to qualify for these deemed savings, it must meet the relevant ENERGY STAR® criteria anywhere in the state. Table 2-197 lists the ENERGY STAR® specifications for windows as of January 2010. 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 2-197. ENERGY STAR® Windows Specifications, January 2010

U.S. Region, ENERGY STAR®	U-Factor Btu/(h·ft^2·°F)	Solar Heat Gain Coefficient (SHGC)
North-Central	≤ 0.32	≤ 0.40
South-Central	≤ 0.35	≤ 0.30
Southern	≤ 0.60	≤ 0.27

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

To develop the recommended deemed savings values, we relied on information contained in the NFRC 900 database.[40] To develop deemed savings estimates from the NFRC 900 database, the following steps were taken:

- The difference in energy consumption and electrical demand between a home with base case and change case[41] windows was calculated from the database for the prototypes in Brownsville (Valley Region), San Antonio (South Region), Fort Worth (North Region) and Oklahoma City (a proxy for the Panhandle region).
- The heating fuel energy use reported in the NFRC 900 database was converted into electricity requirements and natural gas requirements, depending upon three alternative assumptions regarding the type of HVAC equipment present in the home (heat pumps, electric resistance heating, or natural gas heating).
- The "per-home" estimates were divided by the total assumed window area (231 ft.^{2}) to derive "per-square foot of window" estimates.

Deemed Energy and Demand Savings Tables

Table 2-198 through Table 2-201 present the energy savings (kWh) for four Texas climate zones (1, 2, 3 and 4).

[40] The National Fenestration Rating Council has developed a database of the annual energy impacts for various types of windows installed in a typical new, single family, single story residence in various U.S. cities. This database, called NFRC 900, contains results for four Texas cities: Brownsville, El Paso, Fort Worth and San Antonio. Here we will assume the results for Oklahoma City will serve as a reasonable proxy for the energy savings and demand reduction achievable in the Texas Panhandle. The NFRC 900 database was developed by LBNL.

[41] The change case window assumed in the NFRC 900 database exceeds the minimum requirements (U-factor = .30, SHGC = .29, Cfm/ft2 = .15), and is more representative of higher-end windows, such as those manufactured by Andersen, Pella, or Marvin.

Table 2-198. Climate Zone 1: Panhandle Region – Residential ENERGY STAR® Windows Deemed Annual Energy Savings (kWh)

Heating Type	kWh Savings (per sq. ft.)
Installed in home with non-electric heating	2.68
Installed in home with electric resistance heating	9.50
Installed in home with heat pump	6.85

Table 2-199. Climate Zone 2: North Region – Residential ENERGY STAR® Windows Deemed Annual Energy Savings (kWh)

Heating Type	kWh Savings (per sq. ft.)
Installed in home with non-electric heating	3.46
Installed in home with electric resistance heating	6.88
Installed in home with heat pump	5.27

Table 2-200. Climate Zone 3: South Region – Residential ENERGY STAR® Windows Deemed Annual Energy Savings (kWh)

Heating Type	kWh Savings (per sq. ft.)
Installed in home with non-electric heating	3.81
Installed in home with electric resistance heating	6.48
Installed in home with heat pump	5.26

Table 2-201. Climate Zone 4: Valley Region – Residential ENERGY STAR® Windows Deemed Annual Energy Savings (kWh)

Heating Type	kWh Savings (per sq. ft.)
Installed in home with non-electric heating	4.72
Installed in home with electric resistance heating	6.06
Installed in home with heat pump	5.35

Deemed Summer Demand Savings Tables

Present the summer demand savings tables for four Texas climate zones (1, 2, 3 and 4).

Table 2-202. Climate Zone 1: Panhandle Region – Residential ENERGY STAR® Windows Deemed Demand Savings (kW)

Heating Type	kW Savings (per sq. ft.)
Installed in home with non-electric heating	0.0033
Installed in home with electric resistance heating	0.0033
Installed in home with heat pump	0.0033

Table 2-203. Climate Zone 2: North Region – Residential ENERGY STAR® Windows Deemed Demand Savings (kW)

Heating Type	kW Savings (per sq. ft.)
Installed in home with non-electric heating	0.0028
Installed in home with electric resistance heating	0.0028
Installed in home with heat pump	0.0028

Table 2-204. Climate Zone 3: South Region – Residential ENERGY STAR® Windows Deemed Demand Savings (kW)

Heating Type	kW Savings (per sq. ft.)
Installed in home with non-electric heating	0.0024
Installed in home with electric resistance heating	0.0024
Installed in home with heat pump	0.0024

Table 2-205. Climate Zone 4: Valley Region – Residential ENERGY STAR® Windows Deemed Demand Savings (kW)

Heating Type	kW Savings (per sq. ft.)
Installed in home with non-electric heating	0.0027
Installed in home with electric resistance heating	0.0027
Installed in home with heat pump	0.0027

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is 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.

Program Tracking Data & 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:

- The climate zone
- Heating type (non-electric, electric resistance, heat pump)
- Area of ENERGY STAR® windows installed

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 22241, Item 48. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-206. ENERGY STAR® Windows Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.3.6 Solar Screens Measure Overview

TRM Measure ID: R-BE-SC

Market Sector: Residential

Measure Category: Building Envelope

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup Tables)

Savings Methodology: Engineering Estimates

Measure Description

This measure is for households with electric air conditioning or evaporative cooling. Solar screen must be installed on windows facing predominately east or west and receive significant direct sun exposure. Solar screens that block at least 65 percent of the solar heat gain qualify for deemed savings. Deemed savings are per square foot of window or door opening.

Eligibility Criteria

This measure is for households with electric air conditioning or evaporative cooling.

Baseline Condition

The baseline is a single pane, clear glass, unshaded, east or west facing window with a solar heat gain coefficient of 0.75. Baseline window area is assumed to be 10.2 percent of the floor area.

High-Efficiency Condition

To qualify for solar screen deemed savings, windows must be facing predominately east or west and receive significant direct sun exposure. Solar screen material must reduce solar heat gain by at least 65 percent. Solar screens are not recommended for homes with electric heat.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be further addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Table 2-207 presents the deemed energy savings value per square foot of solar screen installed.

Table 2-207. Deemed Energy (kWh) Savings per Square Foot of Solar Screen

Weather Zone	Electric AC, Gas Heat (per sq. ft.)	Electric AC, Electric Heat (per sq. ft.)	Electric AC, Heat Pump (per sq. ft.)
1	4.22938	0.45208	1.91859
2	5.18338	2.08937	3.54039
3	5.82998	3.78803	4.72758
4	7.03837	6.23033	6.65677
5	7.967266	-0.856480	N/A

Deemed Summer Demand Savings Tables

Table 2-208 presents the deemed summer peak demand savings value per square foot of solar screen installed.

Table 2-208. Deemed Summer Peak Demand Savings per Square Foot of Solar Screen

Weather Zone	Summer Peak Avg. kW Savings (per sq. ft.)
1	0.000954
2	0.002438
3	0.001590
4	0.002756
5	0.003412

Deemed Winter Demand Savings Tables

Table 2-209 presents the deemed winter peak demand savings value per square foot of solar screen installed for climate zone 5. Deemed winter demand savings for this measure are not currently available for the other climate zones.

Table 2-209. Deemed Winter Peak Demand Savings per Square Foot of Solar Screen

Weather Zone	Winter Peak Avg. kW Savings (per sq. ft.)
1	N/A
2	N/A
3	N/A
4	N/A
5	-0.004275

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the Claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

According to the DEER Final Report December 2008, the Estimated Useful Life is 10 years for solar screens.

Program Tracking Data & 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
- Heating type (gas, electric, heat pump)
- Square footage of windows or door openings treated

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-210. Solar Screens Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

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 Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

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-only installation of kitchen and bathroom faucet aerators. In order to be awarded these deemed savings, the fuel type of the water heater must be electricity.

Table 2-211. Faucet Aerators – Applicability

Application Type	Applicable
Retrofit	Y
New Construction	N

Baseline Condition

The 2.2 gpm baseline faucet flow rate is based on the Energy Policy Act of 1992 (EPAct 92). 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 gallons per minute (gpm).[42]

Table 2-212. Faucet Aerators – Baseline and Efficiency Standard

Baseline	Efficiency Standard
2.2 gpm minimum	1.5 gpm maximum

High-Efficiency Condition

Aerators that have been defaced so as 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

Estimated Hot Water Usage Reduction

Baseline and efficiency-standard water usages per capita were derived from an analysis of metered studies of residential water efficiency retrofit projects conducted for Seattle, WA; the East Bay Municipal Utility District (CA); and Tampa, FL.[43,44,45] See Table 2-213. Estimated Aerator Hot Water Usage Reduction for derivation of water usage values.

To determine water consumption, the following formula was used:

$$\boldsymbol{Faucet\ use\ (gallons) per\ person\ per\ day} \times \boldsymbol{Occupants\ per\ home} \times \frac{\boldsymbol{365 \frac{days}{year}}}{\boldsymbol{Faucets\ per\ home}}$$

Equation 21

[42] http://www.epa.gov/watersense/partners/faucets_final.html.
[43] Seattle Home Water Conservation Study: "The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes." December 2000. http://allianceforwaterefficiency.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=856.
[44] Residential Indoor Water Conservation Study: "Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District Service Area." July 2003. http://www.ebmud.com/sites/default/files/pdfs/residential_indoor_wc_study_0.pdf.
[45] Tampa Water Department Residential Water Conservation Study: "The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes." January 8, 2004. www.cuwcc.org/WorkArea/downloadasset.aspx?id=12162.

Applying the formula to the values used for Texas from Table 2-213 returns the following values for baseline and post water consumption.

$$\boldsymbol{Baseline}: \mathbf{9.7 \times 2.79 \times {}^{365}/_{3.93} = 2,513}$$

Equation 22

$$\boldsymbol{Post\ (1.5\ gpm)}: \mathbf{8.2 \times 2.79 \times {}^{365}/_{3.93} = 2,125}$$

Equation 23

$$Post\ (1.0\ gpm): 7.2 \times 2.79 \times {}^{365}/_{3.93} = 1{,}866$$

Equation 24

Gallons of hot water saved per year can be found by subtracting the post consumption in gallons per year per aerator from the baseline consumption, and then multiplying the result by the percent hot water.

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.5\ gpm): (2{,}513 - 2{,}125) \times 0.669 = 260$$

Equation 25

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.0\ gpm): (2{,}513 - 1{,}866) \times 0.669 = 433$$

Equation 26

Table 2-213. Estimated Aerator Hot Water Usage Reduction

	Seattle	Tampa	East Bay	Average	Value used for Texas
Faucet use gallons/person/day (baseline)	9.2	9.4	10.5	9.7	9.7
Faucet use gallons/person/day (1.5 gpm)	8.0	6.2	10.5	8.2	8.2
Faucet use gallons/person/day (1.0 gpm)*					7.2
Occupants per home**	2.54	2.92	2.56	2.67	2.79
Faucets per home***					3.93
Gallons/year/faucet (baseline)					2,513
Gallons/year /faucet (1.5 gpm)					2,125
Gallons/year /faucet (1.0 gpm)					1,866
Percent hot water	76.1%	not listed	57.6%	66.9%	66.9%
DHW gallons saved/year/faucet for 1.5 gpm					260
DHW gallons saved/year/faucet for 1.0 gpm					433

Notes:

*This value is a linear extrapolation of gallons per person per day from the baseline (2.2 gpm) and the 1.5 gpm case.

** Occupants per home for Texas from US Census Bureau, Texas, “Persons per household, 2007-2011.” Accessed January 2013 http://quickfacts.census.gov/qfd/states/48000.html.

*** Faucets per home assumed to be equal to one plus the number of half bathrooms and full bathrooms per home, taken from 2009 RECS, Table HC2.10.

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:

$$Energy\ Savings = \frac{\rho \times C_P \times V \times (T_{SetPoint} - T_{SupplyAverage}) \times \left(\frac{1}{RE}\right)}{Conversion\ Factor}$$

Equation 27

Where:

ρ	=	*Water density, 8.33 lbs./gallon*
C_P	=	*Specific heat of water, 1 Btu/lb°F*
V	=	*Gallons of hot water saved per year per faucet. See Table 2-213. Estimated Aerator Hot Water Usage Reduction*
$T_{SetPoint}$	=	*Water heater set point (default value 120°F)*[46]
$T_{SupplyAverage}$	=	*Average supply water temperature (Water Main Temperature from Table 2-214. Water Mains Temperature)*
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.*[47]
ConversionFactor	=	*3,412 Btu/kWh*

Demand Savings Algorithms

Demand savings will be calculated using the following formula:

$$Demand\ Savings = \frac{\rho \times C_P \times V \times (T_{SetPoint} - T_{SupplySeasonal}) \times \left(\frac{1}{RE}\right)}{Conversion\ Factor} \times Ratio_{annual\ kWh}^{Peak_{seasonal}kW}$$

Equation 28

Where:

$T_{SupplySeasonal}$	=	*see Table 2-214. Water Mains Temperature*
Ratio of peak seasonal kW /annual kWh savings		
	=	*see Table 2-215. Water Fixture Peak Demand Ratios*

[46] Note that the temperature of the water at faucet is likely to be lower, due to thermal losses in the water pipe system within the home, and tempering of the water temperature by the user.

[47] 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 2-214. Water Mains Temperature

Weather Zone		Water Mains Temperature °F*		
		T Supply Average	T Supply Seasonal	
			Summer	Winter
1	Amarillo	62.9	73.8	53.7
2	Dallas	71.8	84.0	60.6
3	Houston	74.7	84.5	65.5
4	Corpus Christi	77.2	86.1	68.5
5	El Paso	70.4	81.5	60.4

* Based on typical meteorological year (TMY) dataset for TMY3: http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/.

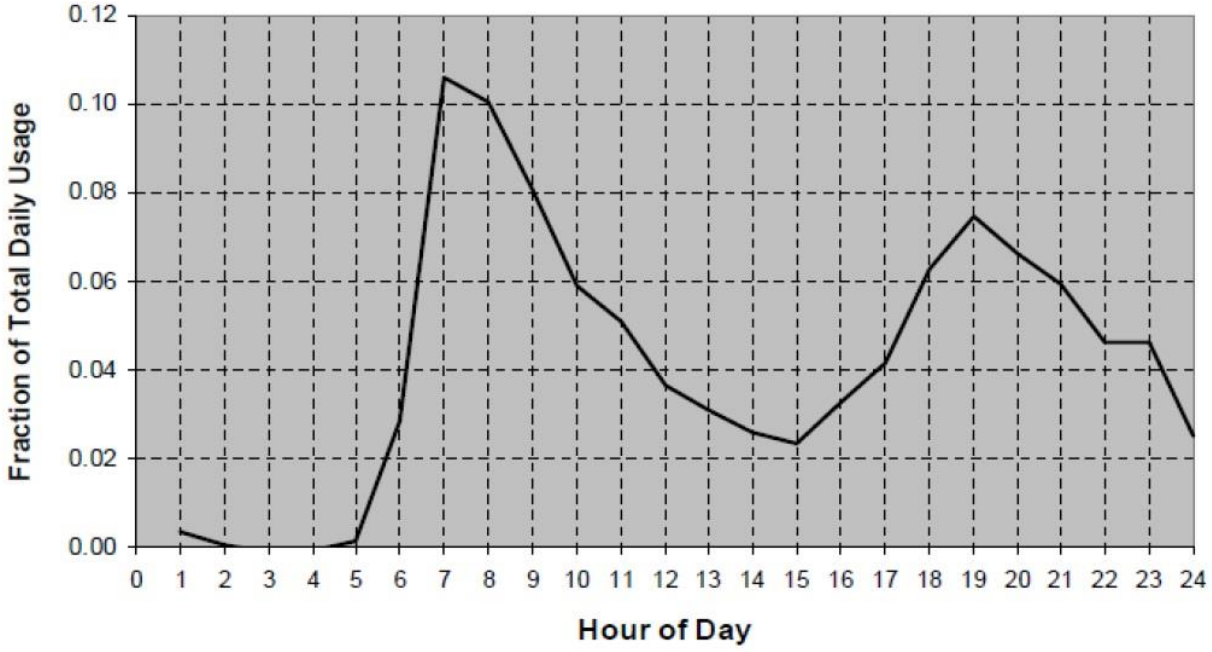
Table 2-215. Water Fixture Peak Demand Ratios

Peak Demand Ratios*	
Summer	Winter
0.000110	0.000274

* US Department of Energy's "Building America Performance Analysis Procedures for Existing Homes" combined domestic hot water use profile (http://www.nrel.gov/docs/fy06osti/38238.pdf).

The fixture peak demand ratios were derived by taking the fraction hot water use during the peak hour (summer: 5PM, winter: 8AM) to the total daily usage from the Building America Performance Analysis Procedures for Existing Homes, and dividing it by the number of days per year (365). The fraction of hot water use during the winter peak hour to total daily water usage is 0.1: $0.1/365 = 0.000274$. The summer peak hour to total daily water usage is 0.04: $0.04/365 = 0.000110$.

Figure 2-3. Shower, Bath, and Sink Hot Water Use Profile



Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand will be the higher of the calculated summer and winter peak demand.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average lifetime for this measure is 10 years (DEER 2008).

Program Tracking Data & 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 weather zone
- Recovery Efficiency (RE) or COP, if available
- Flow rate in gallons per minute (gpm) of faucet installed
- Water heater type (e.g., heat pump, electric resistance)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-216. Faucet Aerators Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.2 Low-Flow Showerheads Measure Overview

TRM Measure ID: R-WH-SH

Market Sector: Residential

Measure Category: Water Heating

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

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 2.0, 1.7, or 1.5 gallons 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 measure in existing homes. In order to be awarded these deemed savings, the fuel type of the water heater must be electricity.

Table 2-217. Low-Flow Showerheads – Applicability

Application Type	Applicable
Retrofit	Y
New Construction	N

Baseline Condition

The US Environmental Protection Agency (EPA) WaterSense Program has implemented efficiency standards for showerheads requiring a maximum flow rate of 2.0 gpm.[48]

[48] http://www1.eere.energy.gov/femp/program/waterefficiency_bmp7.html.

Table 2-218. Low-Flow Showerhead – Baseline and Efficiency Standards

Existing Showerhead Baseline Flow Rate	New Showerhead Flow Rate*
2.5 gpm minimum	1.5 gpm, 1.75 gpm or 2.0 gpm maximum

* 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 the meeting the baseline requirements above, existing showerheads that have been defaced so as 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

Estimated Hot Water Usage Reduction

Baseline and efficiency-standard water usages per capita were derived from an analysis of metered studies of residential water efficiency retrofit projects conducted for Seattle, WA; the East Bay Municipal Utility District (CA); and Tampa, FL.[49,50,51] See for derivation of water usage values.

To determine water consumption, the following formula was used:

$$Gallons\ per\ shower \times Showers\ per\ person\ per\ day \times 365\ \frac{days}{year} \times \frac{Occupants\ per\ home}{Showerheads\ per\ home}$$

Equation 29

Applying the formula to the values used for Texas from returns the following values for baseline and post water consumption.

$$Baseline\ (2.5\ gpm)\text{: } 20.7 \times 0.69 \times 365 \times \left({}^{2.79}/_{1.68}\right) = 8{,}658$$

[49] Seattle Home Water Conservation Study: "The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes." December 2000. http://allianceforwaterefficiency.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=856.

[50] Residential Indoor Water Conservation Study: "Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District Service Area." July 2003. http://www.ebmud.com/sites/default/files/pdfs/residential_indoor_wc_study_0.pdf.

[51] Tampa Water Department Residential Water Conservation Study: "The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes." January 8, 2004. www.cuwcc.org/WorkArea/downloadasset.aspx?id=12162.

$$Baseline\ (2.0\ gpm): 16.5 \times 0.72 \times 365 \times \left({}^{2.79}/_{1.68}\right) = 7{,}201$$

$$Baseline\ (1.5\ gpm): 12.4 \times 0.72 \times 365 \times \left({}^{2.79}/_{1.68}\right) = 5{,}412$$

Equation 30

Although the referenced studies do not provide data on 1.75 gpm showerheads, the consumption values for 2.5, 2.0, and 1.5 gpm roughly follow a linear pattern. Taking a simple average of the consumption for 2.0 and 1.5 gpm showerheads returns a value for a 1.75 gpm showerhead:

$$Post\ (1.75\ gpm): (7{,}201 + 5{,}412)/2 = 6{,}306$$

Equation 31

Gallons of hot water saved per year can be found by subtracting the post consumption in gallons per year per showerhead from the baseline consumption, and then multiplying the result by the percent hot water.

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (2.0\ gpm): (8{,}658 - 7{,}201) \times 0.737 = 1{,}074$$

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.75\ gpm): (8{,}658 - 6{,}306) \times 0.737 = 1{,}733$$

$$Gallons\ of\ hot\ water\ saved\ per\ year\ (1.5\ gpm): (8{,}658 - 5{,}412) \times 0.737 = 2{,}392$$

Equation 32

Table 2-219. Estimated Showerhead Hot Water Usage Reduction

	Seattle	Tampa	East Bay	Average	Value used for Texas
Gallons/shower @ 2.5 gpm (baseline)	19.8	20	22.3	20.7	20.7
Gallons/shower @ 2.0 gpm	15.8	16	17.8	16.5	16.5
Gallons/shower @ 1.5 gpm	11.9	12	13.4	12.4	12.4
Showers/person/day (baseline)	0.51	0.92	0.65	0.69	0.69
Showers/person/day (post)	0.59	0.82	0.74	0.72	0.72
Occupants per home*	2.54	2.92	2.56	2.67	2.79
Showerheads per home**					1.68
Gallons/year/showerhead @ 2.5 gpm (baseline)					8,658
Gallons/year /showerhead @ 2.0 gpm					7,201
Gallons/year /showerhead @ 1.75 gpm					6,306
Gallons/year /showerhead @ 1.5 gpm					5,412

	Seattle	Tampa	East Bay	Average	Value used for Texas
Percent hot water	75.50%	not listed	71.90%	73.70%	73.70%
2.0 gpm showerhead DHW gallons saved /year					**1,074**
1.75 gpm showerhead DHW gallons saved /year					**1,733**
1.5 gpm showerhead DHW gallons saved /year					**2,392**

Notes:
* Occupants per home for Texas from US Census Bureau, Texas, "Persons per household, 2007-2011." Accessed January 2013 http://quickfacts.census.gov/qfd/states/48000.html.
** Showerheads per home assumed to be equal to the number of full bathrooms per home, taken from 2009 RECS, Table HC2.10.

Energy Savings Algorithms

Energy savings for this measure are calculated as follows:

$$Energy\ Savings = \frac{\rho \times C_P \times V \times (T_{SetPoint} - T_{Supply}) \times \left(\frac{1}{RE}\right)}{Conversion\ Factor}$$

Equation 33

Where:

ρ = *Water density, 8.33 lbs./gallon*

C_P = *Specific heat of water, 1 Btu/lb•°F*

V = *Gallons of hot water saved per year per showerhead. See*

$T_{SetPoint}$ = *Water heater set point: 120°F*[52]

T_{Supply} = *Average supply water temperature based on climate zone, see .*

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.*[53]

ConversionFactor = *3,412 Btu/kWh*

[52] Hot water consumption accounts for thermal losses delivering hot water to the showerhead, and tempering to typical shower temperature.
[53] 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.

Demand Savings Algorithms

Demand savings will be calculated using the following formula:

$$Demand\ Savings = \frac{\rho \times C_P \times V \times (T_{SetPoint} - T_{SupplySeasonal}) \times \left(\frac{1}{RE}\right)}{Conversion\ Factor} \times Ratio_{annual\ kWh}^{Peak_{seasonal}kW}$$

Equation 34

Where:

$T_{SupplySeasonal}$ = *see*

Ratio of peak_seasonal kW /annual kWh savings

= *see*

Table 2-220. Water Mains Temperature

Weather Zone		Water Mains Temperature (°F)*		
		T Supply Average	T Supply Seasonal	
			Summer	Winter
1	Amarillo	62.9	73.8	53.7
2	Dallas	71.8	84.0	60.6
3	Houston	74.7	84.5	65.5
4	Corpus Christi	77.2	86.1	68.5
5	El Paso	70.4	81.5	60.4

* Based on typical meteorological year (TMY) dataset for TMY3: http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/.

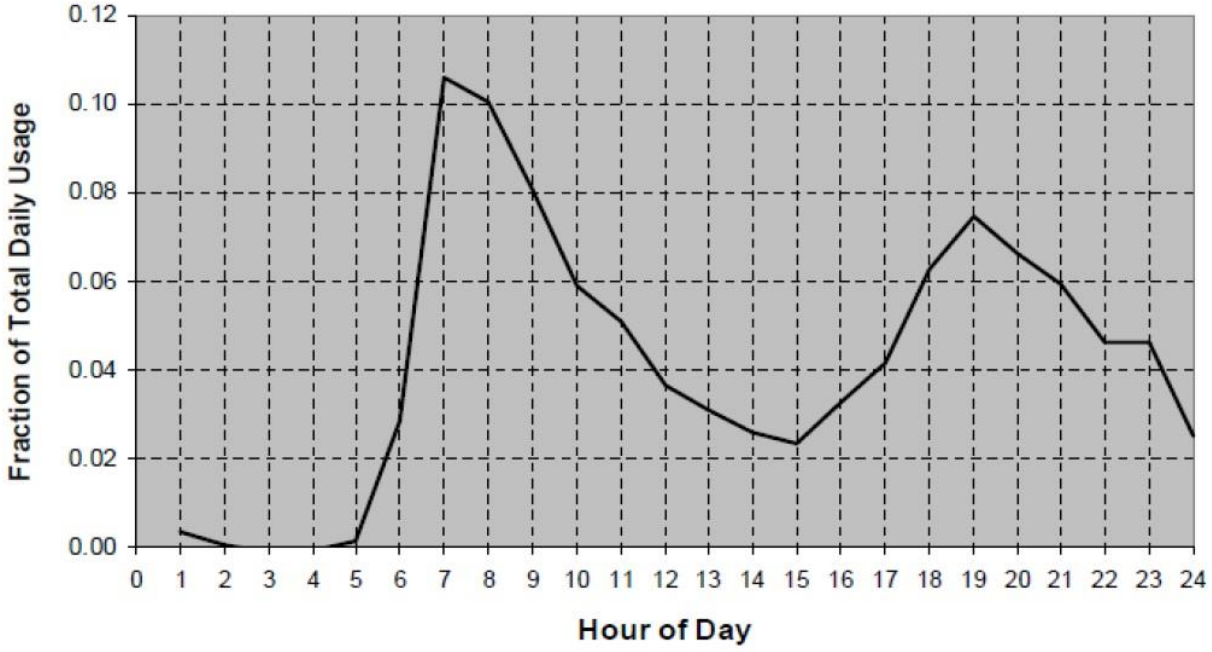
Table 2-221. Water Fixture Peak Demand Ratios

Peak Demand Ratios*	
Summer	Winter
0.000110	0.000274

* US Department of Energy's "Building America Performance Analysis Procedures for Existing Homes" combined domestic hot water use profile (http://www.nrel.gov/docs/fy06osti/38238.pdf).

The fixture peak demand ratios were derived by taking the fraction hot water use during the peak hour (summer: 5pm, winter: 8am) to the total daily usage from the Building America Performance Analysis Procedures for Existing Homes, and dividing it by the number of days per year (365). The fraction of hot water use during the winter peak hour to total daily water usage is 0.1: $0.1/365 = 0.000274$. The summer peak hour to total daily water usage is 0.04: $0.04/365 = 0.000110$.

Figure 2-4. Shower, Bath, and Sink Hot Water Use Profile



Source: Building America Performance Analysis Procedures for Existing Homes

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand will be the higher of the calculated summer and winter peak demand.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average life of this measure is 10 years (DEER 2008).

Program Tracking Data & 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 weather zone
- Recovery Efficiency (RE) or COP, if available
- Flow rate in gallons per minute (gpm) of showerhead installed
- Water heater type (e.g., heat pump, electric resistance)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-222. Low-Flow Showerheads Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.3 Water Heater Pipe Insulation Measure Overview

TRM Measure ID: R-WH-PI

Market Sector: Residential

Measure Category: Water Heating

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values Calculations

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

This measure requires the installation of pipe insulation on un-insulated 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. In order to be awarded these deemed savings, the fuel type of the water heater must be electricity.

Table 2-223. Water Heater Pipe Insulation – Applicability

Application Type	Applicable	Notes
Retrofit	Y	Savings cannot be claimed in conjunction with the installation of a new water heater
New Construction	N	

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 2-224. 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) 2009 section N1103.3: Mechanical system piping insulation requires R-3 insulation.

Table 2-225. 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:

$$Energy\ per\ year\ savings = \left(U_{pre} - U_{post}\right) \times A \times \left(T_{pipe} - T_{ambient\ annual}\right) \times \left(\frac{1}{RE}\right) \times \frac{Hours_{Total}}{conversion\ factor}$$

Equation 35

Where:

U_{pre}[54] = $\frac{1}{2.03} = 0.49\ {}^{Btu}/_{hr \cdot sq.ft. \cdot °F}$

U_{post} = $\frac{1}{2.03 + R_{Insulation}}$

$R_{Insulation}$ = *R-value of installed insulation*

A = *Pipe surface area insulated in square feet* (πDL) *with L (length) and D (pipe diameter) in feet. The maximum length allowable for insulation is 6 feet. If the pipe area is unknown, use the following table:*

[54] 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 2-226. Estimated Pipe Surface Area

Pipe Diameter (inches)	Pipe Surface Area (square feet)[55]
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*[56]

$T_{ambientannual}$ *(°F)* = *See Table 2-227. Ambient Temperatures per Climate Zone*

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.*[57]

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

Conversion factor = *3,412 Btu per kWh*

Demand Savings Algorithms

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

Equation 36

Where:

$T_{ambientseasonal}(°F)$ = *See*

[55] 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.

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

[56] 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.

[57] 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 2-227. Ambient Temperatures per Climate Zone

Climate Zone		Ambient Temperature (°F)					
		Water Heater Location: Unconditioned Space*			Water Heater Location: Conditioned Space**		
		Annual	Peak Seasonal		Annual	Peak Seasonal	
			Summer	Winter		Summer	Winter
1	Amarillo	65.5	106	32	72.7	75.1	69.3
2	Dallas	73.1	108.1	42			
3	Houston	76.3	108.2	46			
4	Corpus Christi	78.4	103	55			
5	El Paso	71.8	108	41.1			

* Average ambient temperatures 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 & Cooling System Location Temperatures (Garage).
** Weighted average reported thermostat set points from RECS. Times associated with these set points are assumed to be the same as those assumed by ENERGY STAR: http://www.energystar.gov/index.cfm?c=thermostats.pr_thermostats_guidelines.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand will be the higher of the calculated summer and winter peak demand.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average Estimated Useful Life for this measure is 13 years, which is equivalent to the lifetime of a residential water heater (Docket No. 36779).

Program Tracking Data & 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
- 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

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-228. Water Heater Pipe Insulation Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.4 Water Heater Tank Insulation Measure Overview

TRM Measure ID: R-WH-WJ

Market Sector: Residential

Measure Category: Water Heating

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

This measure requires the installation of tank insulation on un-insulated 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. In order to be awarded these deemed savings, the fuel type of the water heater must be electricity.

Table 2-229. Water Heater Tank Insulation – Applicability

Application Type	Applicable
Retrofit	Y
New Construction	N

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. Manufacturer's instructions on the water heater jacket and the water heater itself should be followed. Thermostat and heating element access panels must be left uncovered.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy Savings Algorithms

Hot water tank insulation energy savings are calculated using the following formula:

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

Equation 37

Where:

U_{pre} = *1/(5) Btu/hr sq.ft. °F*

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

$R_{Insulation}$ = *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 2-230. Estimated Tank Area

Volume (gal)	A (sf.)*
30	17.45
40	21.81
50	22.63
60	26.94
80	30.36
120	38.73

* Tank area was obtained from a survey of electric water heater manufacturer data. Dimensions for each tank size were collected and averaged to determine a typical square footage of each size water heater. Accessed April 2013: http://www.hotwater.com/water-heaters/residential/conventional/electric/promax/standard/ Accessed April 2013: http://www.whirlpoolwaterheaters.com/products/electric-water-heaters/es40r92-45d/.

$T_{tank}(°F)$ = *Average temperature of the tank, default use 120°F*[58]

$T_{ambientannual}$ *(°F)* = *See*

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.*[59]

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

Conversion factor = *3,412 Btu per kWh*

Energy Savings Algorithms

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

Equation 38

Where:

$T_{ambientseasonal}(°F)$ = *See*

Table 2-231. Ambient Temperatures per Climate Zone

Climate Zone		Ambient Temperature (°F)					
		Water Heater Location: Unconditioned Space			Water Heater Location: Conditioned Space		
		Annual	Peak Seasonal		Annual	Peak Seasonal	
			Summer	Winter		Summer	Winter
1	Amarillo	65.5	106	32	72.7	75.1	69.3
2	Dallas	73.1	108.1	42			
3	Houston	76.3	108.2	46			
4	Corpus Christi	78.4	103	55			
5	El Paso	71.8	108	41.1			

* Average ambient temperatures 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 & Cooling System Location Temperatures (Garage).
** Weighted average reported thermostat set points from RECS. Times associated with these set points are assumed to be the same as those assumed by ENERGY STAR: http://www.energystar.gov/index.cfm?c=thermostats.pr_thermostats_guidelines.

[58] 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.
[59] 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.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand savings would be the higher value between the summer and winter peak demand savings.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average measure life for storage water heater tank insulation is 7 years (DEER 2008).

Program Tracking Data & 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 weather 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.

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-232. Water Heater Tank Insulation Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.5 Water Heater Replacement – High Efficiency and Fuel Substitution Measure Overview

TRM Measure ID: R-WH-WH

Market Sector: Residential

Measure Category: Water Heating

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Calculations

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

This measure involves the replacement of an existing electric resistance storage water heater with a new electric resistance or gas fueled water heater.

Eligibility Criteria

Heat pump water heaters are not eligible for this measure (see separate heat pump water heater measure). Both storage and tankless (instantaneous) water heaters are eligible for this measure, as long as they meet all other requirements.

These deemed savings are water heater replacements installed as a retrofit measure in existing homes.

Table 2-233. Water Heater Replacement – Applicability

Application Type	Applicable
Retrofit	Y
New Construction	N

Baseline Condition

Baseline is assumed to be an electric resistance storage water heater meeting the Department of Energy (DOE) energy efficiency standard (10 CFR Part 430) for Energy Factor (EF), set out below.

Table 2-234. Water Heater Replacement – Baseline

Baseline
Electric resistance storage water heater with EF = 0.97–0.00132 * tank volume (gallons)

High-Efficiency Condition

The efficiency standard for a high efficiency electric unit is 0.04 EF points above the baseline. For fuel substitution the unit must meet the federal minimum EF for a gas water heater. Water heaters must be installed in accordance with local code requirements.

Table 2-235. Water Heater Replacement – Efficiency Standards

Efficiency Standard
Electric resistance water heater with EF = 1.01–0.00132 * tank volume (gallons) Gas water heater with EF = 0.67–0.0019 * tank volume (gallons)

Table 2-236. Water Heater Energy Factors for Common Tank Volumes (not exhaustive)

Fuel Type	Tank Volume (Gallons)			
	30	40	50	80
Baseline (Electric Resistance)	0.93	0.92	0.90	0.86
Efficiency Standard – Electric Resistance	0.97	0.96	0.94	0.90
Efficiency Standard – Natural Gas	0.61	0.59	0.58	0.52

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

All deemed savings values are calculated using the following standard algorithms for water heating:

Energy Savings Algorithm – High Efficiency Electric Water Heater Replacements

$$kWh_{savings} = \frac{\rho \times C_p \times GPY \times (T_{SetPoint} - T_{Supply,ann}) \times (\frac{1}{EF_{pre}} - \frac{1}{EF_{post}})}{3412 Btu/kWh}$$

Equation 39

Where:

ρ = *Water density, 8.33 lbs/gallons*

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

GPY = *Estimated annual hot water use (gal/year), specified in Table 2-237.*

Table 2-237. Water Heater Consumption (gal/year)*

Climate Zone		Number of Bedrooms			
		1	2	3	4
1	Amarillo	15,476	20,171	24,866	29,561
2	Dallas	14,778	19,244	23,710	28,177
3	Houston	14,492	18.864	23,236	27,608
4	Corpus Christi	14,213	18,494	22,775	27,056
5	El Paso	14,905	19,412	23,920	28,427

* Building America Research Benchmark Definition, December 2009 (http://www.nrel.gov/docs/fy10osti/47246.pdf).

$T_{SetPoint}$ = *Water heater set point = 120°F*

$T_{Supply,ann}$ = *Annual average mains temperature from Table 2-238*

EF_{pre} = *Baseline value from Table 2-236, or calculated per Table 2-234*

EF_{post} = *Energy Factor of new water heater*

Conversion Factor = *3,412 Btu/kWh*

Table 2-238. Water Mains Temperature

Climate Zone		Water Mains Temperature °F		
		T Supply Average	T Supply Seasonal	
			Summer	Winter
1	Amarillo	62.9	73.8	53.7
2	Dallas	71.8	84.0	60.6
3	Houston	74.7	84.5	65.5
4	Corpus Christi	77.2	86.1	68.5
5	El Paso	70.4	81.5	60.4

Based on typical meteorological year (TMY) dataset for TMY3: http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/.

Energy Savings Algorithm – Gas Water Heater (Fuel Substitution)

$$kWh_{savings} = \frac{\rho \times C_p \times GPY \times (T_{SetPoint} - T_{Supply,ann}) \times (\frac{1}{EF_{pre}} - \frac{1}{2.46 \times EF_{post}})}{3412Btu/kWh}$$

Equation 40

Where:

2.46 = *Site to source conversion to convert therms into kWh equivalent based on the ERCOT fuel mix-weighted average heat rate60*

Demand Savings Algorithm – High Efficiency Electric Water Heater Replacement:

$$SummerkW_{savings} = 1/24 \times \frac{\rho \times C_p \times GPD \times (T_{SetPoint} - T_{Supply,sum}) \times \left(\frac{1}{EF_{pre}} - \frac{1}{EF_{post}}\right)}{3412Btu/kWh}$$

Equation 41

$$WinterkW_{savings} = 1/24 \times \frac{\rho \times C_p \times GPD \times (T_{SetPoint} - T_{Supply,win}) \times \left(\frac{1}{EF_{pre}} - \frac{1}{EF_{post}}\right)}{3412Btu/kWh}$$

Equation 42

Where:

1/24 = *Conversion from daily energy use to hourly. Because electric-electric replacement savings are driven entirely by reduction in storage losses, storage losses are assumed to be evenly spread throughout the day, rather than consumption driven.*

GPD = *Estimated daily hot water use (gallons) = 18.0 x number bedrooms (18.0 = 6567/365)*

$T_{Supply,sum}$ = *Summer average water mains temperature from Table 2-238*

$T_{Supply,win}$ = *Winter average water mains temperature from Table 2-238*

[60] ERCOT's fuel mix in 2012 was 44.6% natural gas, 33.8% coal, 11.8% nuclear, 9.2% wind, and 0.6% hydro/other (http://www.ercot.com/news/press_releases/show/26382). Per DOE the average heat rate is 8,185 Btu/kWh for natural gas, 10,415 for coal, and 10,452 for nuclear. (http://www.eia.gov/electricity/annual/pdf/table5.3.pdf). For wind, hydro, and other a heat rate of 0 is assumed, i.e., that electricity is produced without the marginal use of source fuel. The result is an average heat rate of 8,404 Btu/kWh, or 2.46 source Btu per generated Btu.

Demand Savings Algorithm – Gas Water Heater (Fuel Substitution)

$$SummerkW_{savings} = Ratio_{daily\ gal}^{Sum\ peak\ gal} \times \frac{\rho \times C_p \times GPD \times (T_{SetPoint} - T_{Supply,sum}) \times \left(\frac{1}{EF_{pre}}\right)}{3412Btu/kWh}$$

Equation 43

$$WinterkW_{savings} = Ratio_{daily\ gal}^{Win\ peak\ gal} \times \frac{\rho \times C_p \times GPD \times (T_{SetPoint} - T_{Supply,sum}) \times \left(\frac{1}{EF_{pre}}\right)}{3412Btu/kWh}$$

Equation 44

Where:

$\text{Ratio}_{\text{dailygal}}^{\text{Sumpeakgal}}$ = *Ratio of hot water use during the typical summer peak hour (4-5pm) to daily hot water use = 0.0436. Because savings are consumption drive for electric-gas replacement, the portion of water consumption is used rather than assuming savings are evenly distributed throughout the day.*

$\text{Ratio}_{\text{dailygal}}^{\text{Winpeakgal}}$ = *Ratio of average hot water use during the winter peak hour (8am) to daily hot water use = 0.0794*

Examples

Example 1. An old 40 gallon electric water heater in a two bedroom home in Dallas is replaced with a new, high efficiency electric water heater with an EF of 0.96

$$kWh\ savings = \frac{\left[8.33 \times 1 \times 6567 \times 2 \times (120 - 71.8) \times \left(\frac{1}{0.92} - \frac{1}{0.96}\right)\right]}{3412} = 70.0\ \text{kWh}$$

$$Summer\ kW\ savings = \frac{1}{24} \times \frac{\left[8.33 \times 1 \times 18 \times 2 \times (120 - 84) \times \left(\frac{1}{0.92} - \frac{1}{0.96}\right)\right]}{3412} = 0.006\ \text{kW}$$

$$Winter\ kW\ savings = \frac{1}{24} \times \frac{\left[8.33 \times 1 \times 18 \times 2 \times (120 - 60.6) \times \left(\frac{1}{0.92} - \frac{1}{0.96}\right)\right]}{3412} = 0.010\ \text{kW}$$

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 an EF of 0.65

$$kWh\ savings = \frac{\left[8.33 \times 1 \times 6567 \times 1 \times (120 - 70.4) \times \left(\frac{1}{0.93} - \frac{1}{2.46 \times 0.65}\right)\right]}{3412} = 357.7\ \text{kWh}$$

$$Summer\ kW\ savings = 0.0436 \times \frac{\left[8.33 \times 1 \times 18 \times 1 \times (120 - 81.5) \times \left(\frac{1}{0.93}\right)\right]}{3412} = 0.079\ \text{kW}$$

$$Winter\ kW\ savings = 0.0794 \times \frac{\left[8.33 \times 1 \times 18 \times 1 \times (120 - 60.4) \times \left(\frac{1}{0.93}\right)\right]}{3412} = 0.224\ \text{kW}$$

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the claimed peak demand savings would be the higher value of summer and winter peak demand savings.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average Estimated Useful Life for this measure is 13.0 years for a high efficiency electric water heater (Docket No. 36779), or 11.0 years for a high efficiency gas water heater.

Program Tracking Data & 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 weather zone
- Volume of the replacement water heater in gallons
- Volume of the existing water heater in gallons
- Energy factor (EF) of the existing water heater
- EF of the replacement water heater
- Number of bedrooms

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

- 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

This section is not applicable.

Document Revision History

Table 2-239. Water Heater Replacement – High Efficiency and Fuel Substitution Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.6 Heat Pump Water Heater Measure Overview

TRM Measure ID: R-WH-HW

Market Sector: Residential

Measure Category: Water Heating

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric and gas

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values (Lookup 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" HPWH in lieu of standard electric storage water heaters (EWH). Deemed savings values are presented on a per-unit basis. Deemed savings variables include storage tank volume 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.

Eligibility Criteria

This measure applies to residential, electric, storage-type water heaters with storage capacities between 40 and 80 gallons, with maximum energy input of 4.5 kilowatts. Units with maximum energy input over 4.5 kW are ineligible, as are heat pump add-ons to existing storage water heaters. The measure does not apply to the replacement of gas water heaters.

These deemed savings are for Heat Pump Water Heaters installed as a retrofit measure in existing homes.

Table 2-240. Heat Pump Water Heaters – Applicability

Application Type	Applicable	Notes
Retrofit	Y	For replacement of electric storage water heater
New Construction	N	

Baseline Condition

The baseline condition is an electric storage water heater. The baseline efficiency is based on the Department of Energy (DOE) energy efficiency standard for residential water heaters with tank sizes 20 – 120 gallons, as published in 10 CFR Part 430 of the Federal Register:[61]

$$Energy\ Factor_{Base} = 0.97 - 0.00132 \times Rated\ Storage\ Volume\ (gallons)$$

Equation 45

Application of this equation provides the following baseline efficiency for electric storage water heaters.

Table 2-241. Heat Pump Water Heaters –
Minimum Required Energy Factors for Post-2004 Water Heaters

Tank Size (Gallons)			
40	**50**	**60**	**80**
0.92	0.90	0.89	0.86

High-Efficiency Condition

The efficient condition (i.e., equipment eligible to receive an incentive through a program) is a heat pump water heater that meets ENERGY STAR® qualifications.[62] Deemed savings are estimated using an energy factor (EF) of 2.2. This EF is the average efficiency of ENERGY STAR HPWHs as of June 2011.[63]

Heat pump water heaters depend on adequate ventilation for proper functioning, including adequate space for both inlet and outlet air flow, and should be installed in spaces in which 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.[64]

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Four basic variables specify the appropriate deemed demand and energy savings values for a given project:

[61] *10 CFR Part 430. Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule*. Online. Available: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/htgp_finalrule_fedreg.pdf. Accessed July 2011.

[62] ENERGY STAR Requirements (as of Jan-2011) - HPWH must have a maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water. Unit must have "integrated" or "drop-in" configuration. EF>= 2.0, first-hour rating (FHR) >= 50 gallons/hour, Warranty >= 6 years on sealed systems, Safety UL 174 & UL 1995.

[63] As of January 2013, thirty-three residential heat pump water heaters are rated by AHRI, with energy factors ranging from 2.0 to 2.4.

[64] Heat Pump Water Heaters. Department of Energy, May 2012. Online. Available: http://energy.gov/energysaver/articles/heat-pump-water-heaters. Accessed: February 22, 2013.

- The climate zone
- The HPWH tank size
- The HPWH installed location (Conditioned vs. Unconditioned Space)
- For HPWH installations in conditioned space, the building heating type (electric resistance, air-source heat pump, or gas furnace)

Deemed savings are specified for the four tank sizes of heat pump water heaters that dominate the list of AHRI-certified units: 40-gallon, 50-gallon, 60-gallon, and 80-gallon tanks. These sizes correspond to the four basic sizes of HPWHs commercially available at the time these deemed savings were developed.

Deemed Energy and Demand Savings Tables

Deemed savings are developed for heat pump water heaters in four size ranges: 40-49 gallon, 50-59 gallons, 60-79 gallons, and 80 or more gallon sizes. These sizes correspond to the four basic sizes of HPWHs commercially available at the time these deemed savings were developed, according to review of manufacturer data provided on the Energy Star and AHRI websites. through present the deemed saving tables for five Texas climate zones.

Table 2-242. Climate Zone 1: Amarillo, TX –
Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,704	1,967	2,395	2,997
	Heat Pump	1,364	1,620	2,038	2,627
	Elec. Resistance	920	1,168	1,572	2,144
Unconditioned Space	N/A	1,541	1,795	2,209	2,793

Table 2-243. Climate Zone 2: Dallas, TX –
Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,454	1,667	2,015	2,502
	Heat Pump	1,215	1,424	1,765	2,243
	Elec. Resistance	903	1,107	1,439	1,907
Unconditioned Space	N/A	1,282	1,493	1,835	2,316

Table 2-244. Climate Zone 3: Houston, TX –
Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,377	1,573	1,893	2,341
	Heat Pump	1,141	1,333	1,647	2,088
	Elec. Resistance	833	1,021	1,327	1,758
Unconditioned Space	N/A	1,202	1,398	1,718	2,167

Table 2-245. Climate Zone 4: Corpus Christi, TX –
Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,327	1,510	1,810	2,229
	Heat Pump	1,186	1,368	1,664	2,079
	Elec. Resistance	1,004	1,183	1,474	1,883
Unconditioned Space	N/A	1,128	1,312	1,611	2,031

Table 2-246. Climate Zone 5: El Paso, TX –
Residential HPWH Deemed Annual Energy Savings (kWh)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	1,472	1,692	2,051	2,554
	Heat Pump	1,232	1,449	1,801	2,296
	Elec. Resistance	921	1,131	1,474	1,959
Unconditioned Space	N/A	1,325	1,543	1,897	2,395

Deemed Summer Demand Savings Tables

Tables 2-274 through Table 2-278 present the deemed summer demand savings for heat pump water heaters across the five Texas climate zones.

Table 2-247. Climate Zone 1: Amarillo, TX –
Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	All	0.25	0.28	0.34	0.41
Unconditioned Space	N/A	0.21	0.24	0.29	0.37

Table 2-248. Climate Zone 2: Dallas, TX –
Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	All	0.19	0.21	0.25	0.30
Unconditioned Space	N/A	0.15	0.18	0.22	0.27

Table 2-249. Climate Zone 3: Houston, TX –
Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	All	0.19	0.21	0.25	0.30
Unconditioned Space	N/A	0.15	0.17	0.21	0.26

Table 2-250. Climate Zone 4: Corpus Christi, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	All	0.18	0.20	0.23	0.28
Unconditioned Space	N/A	0.14	0.16	0.20	0.25

Table 2-251. Climate Zone 5: El Paso, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	All	0.20	0.23	0.27	0.33
Unconditioned Space	N/A	0.16	0.19	0.23	0.29

Deemed Winter Demand Savings Tables

Tables 2-279 through Table 2-283 present the deemed winter demand savings for heat pump water heaters across the five Texas climate zones.

Table 2-252. Climate Zone 1: Amarillo, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	0.42	0.49	0.60	0.76
	Heat Pump	0.29	0.36	0.47	0.62
	Elec. Resistance	0.00	0.19	0.29	0.43
Unconditioned Space	N/A	0.38	0.44	0.55	0.70

Table 2-253. Climate Zone 2: Dallas, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	0.37	0.43	0.53	0.67
	Heat Pump	0.24	0.30	0.40	0.53
	Elec. Resistance	0.00	0.13	0.22	0.35
Unconditioned Space	N/A	0.34	0.40	0.49	0.62

Table 2-254. Climate Zone 3: Houston, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	0.33	0.38	0.47	0.60
	Heat Pump	0.20	0.26	0.34	0.46
	Elec. Resistance	0.00	0.09	0.17	0.29
Unconditioned Space	N/A	0.31	0.37	0.45	0.57

Table 2-255. Climate Zone 4: Corpus Christi, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	0.31	0.36	0.44	0.56
	Heat Pump	0.18	0.23	0.31	0.42
	Elec. Resistance	0.00	0.07	0.14	0.25
Unconditioned Space	N/A	0.30	0.35	0.43	0.54

Table 2-256. Climate Zone 5: El Paso, TX – Residential HPWH Deemed Demand Savings (kW)

Water Heater Location	Heating Type	HPWH Tank Size Range, Gallons			
		40	50	60	80
Conditioned Space	Gas	0.37	0.43	0.53	0.67
	Heat Pump	0.24	0.30	0.40	0.53
	Elec. Resistance	0.00	0.13	0.22	0.35
Unconditioned Space	N/A	0.35	0.40	0.50	0.63

Claimed Peak Demand Savings

For this measure, the Claimed Peak Demand will be the higher of the calculated summer and winter peak demand. In almost all cases, the Claimed Peak Demand will be the winter peak demand; however, for an electric resistance furnace with the heat pump water heater in conditioned space, summer peak demand savings will be used.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The Estimated Useful Life for this measure is 13 years. This EUL is consistent with the judgment of the American Council for an Energy-Efficient Economy as listed on its website.[65]

Program Tracking Data & 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
- The approximate volume of the replacement heat pump water heater tank in gallons
- The baseline energy factor (EF)

[65] Water Heating. American Council for an Energy Efficient Economy. Online. Available: http://www.aceee.org/consumer/water-heating. Accessed: September 2011.

- The EF of the replacement water heater
- Water heater type (e.g., heat pump, electric resistance)
- The installed location (conditioned vs. unconditioned space)
- For heat pump water heater installations in conditioned space, the building heating type (electric resistance, air-source heat pump, or gas furnace) References, Efficiency Standards, and Revision History

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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

This section is not applicable.

Document Revision History

Table 2-257. Heat Pump Water Heater Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.4.7 Water Heater Replacement – Solar Water Heating Measure Overview

TRM Measure ID: R-WH-WS

Market Sector: Residential

Measure Category: Water Heating

Applicable Dwelling (Building) Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electric

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Value Calculations

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

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

This section is not applicable.

Baseline Condition

This section is not applicable.

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 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 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 [Table attached; based on data submitted to the Public Utility Commission of Texas by Frontier & Associates for "Water Heater Replacements - High Efficiency and Fuel Substitution".].

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/.)

Examples

A passive SunEarth CP-40 with a SEF of 1.4 would consume 2133 kWh (2987/1.4), saving 1323 kWh compared to a baseline 50 gallon water heater that consumes 3458 kWh (values based on Frontier data).

An active Heliodyne HP 410 G 80 with a SEF of 2.0 would consume 1494 kWh (2987/2), saving 1965 kWh compared to the baseline 50 gallon water heater.

Use SRCC OG-300 Test to obtain SEF

SRCC = Solar Rating and Certification Corporation

OG-300 = test standard for SWH systems

SEF = Solar Energy Factor

Calculate kWh Savings

$$kWh\ savings = standard\ load \times \left(1 - \frac{EF}{SEF}\right) = (3{,}458) \times \left(1 - \frac{0.864}{2}\right) = 1{,}965kWh$$

Deemed Energy and Demand Savings Tables

The following table presents the energy savings for solar water heaters based on tank size and final Solar Energy Factor (SEF).

Table 2-258. Solar Water Heating Energy Savings (kWh)

Water Heating Replacements – Solar Water Heating Energy Savings			
Approximate Volume (gal)	**80**	**50**	**30**
Baseline (DOE Standard) EF	**0.82**	**0.86**	**0.89**
SRCC OG-300 Solar Energy Factor	**Energy Savings (kWh)**		
1.0	637	471	368
1.1	909	743	640
1.2	1,135	969	866
1.3	1,326	1,160	1,057
1.4	1,490	1,324	1,221
1.5	1,633	1,467	1,364
1.6	1,757	1,591	1,488
1.7	1,867	1,701	1,598
1.8	1,965	1,799	1,696
1.9	2,052	1,886	1,783
2.0	2,131	1,965	1,862
2.1	2,202	2,036	1,933
2.2	2,266	2,100	1,997
2.3	2,325	2,159	2,056
2.4	2,379	2,213	2,110
2.5	2,429	2,263	2,160
2.6	2,475	2,309	2,206
2.7	2,518	2,352	2,249
2.8	2,557	2,391	2,288
2.9	2,594	2,428	2,325
3.0	2,628	2,462	2,359
3.1	2,660	2,494	2,391
3.2	2,691	2,525	2,422
3.3	2,719	2,553	2,450
3.4	2,745	2,579	2,476
3.5	2,771	2,605	2,502
3.6	2,794	2,628	2,525
3.7	2,817	2,651	2,548
3.8	2,838	2,672	2,569
3.9	2,858	2,692	2,589
4.0	2,877	2,711	2,608
4.1	2,895	2,729	2,626
4.2	2,913	2,747	2,644
4.3	2,929	2,763	2,660
4.4	2,945	2,779	2,676

Water Heating Replacements – Solar Water Heating Energy Savings			
Approximate Volume (gal)	**80**	**50**	**30**
Baseline (DOE Standard) EF	**0.82**	**0.86**	**0.89**
SRCC OG-300 Solar Energy Factor	**Energy Savings (kWh)**		
4.5	2,960	2,794	2,691
4.6	2,975	2,809	2,706
4.7	2,988	2,822	2,719
4.8	3,002	2,836	2,733
4.9	3,014	2,848	2,745
5.0	3,027	2,861	2,758

Source: Tim Merrigan, National Renewable Energy Laboratory (2001)

Deemed Summer Demand Savings Tables

The following table presents the energy savings for solar water heaters based on tank size and final Solar Energy Factor (SEF).

Table 2-259. Solar Water Heating Demand Savings (kW)

Solar Water Heating Demand Savings kW
0.42

Diversified value fully displaced during solar peak.

This value consistent with Univ. of Texas study (0.4)

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The average Estimated Useful Life for this measure is 15.0 years (Docket No. 36779).

Program Tracking Data & 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 approximate volume of the replacement water heater in gallons
- SRCC OG-300 Solar Energy Factor of the replacement unit

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- 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.
- Docket No. 22241, Item 62. Petition by Frontier Associates for Approval of Second Set of Deemed Savings Estimates. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-260. Water Heater Replacement – Solar Water Heating Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.5 RESIDENTIAL: APPLIANCES

2.5.1 ENERGY STAR® Ceiling Fans Measure Overview

TRM Measure ID: R-AP-FN

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, Replace-on-Burnout, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR® ceiling fan and light kit. Savings are awarded at a flat per unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

This section is not applicable.

Baseline Condition

The baseline is a conventional non-ENERGY STAR® labeled ceiling fan and light kit.

High-Efficiency Condition

Table 2-261 displays the ENERGY STAR® requirements for eligible ceiling fans as of April 2012. 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 2-261. ENERGY STAR® Specifications for Ceiling Fans

ENERGY STAR® Specifications for Ceiling Fans
1. Specification defines residential ceiling fan airflow efficiency on a performance basis: CFM* of airflow per watt of power consumed by the motor and controls. Efficiency is measured on each of 3 speeds.
2. At low speed, fans must have a minimum airflow of 1,250 CFM and an efficiency of 155 CFM/Watt
3. Qualifying ceiling fan models must come with a minimum 30-year motor warranty; one-year component(s) warranty; and 2-year light kits warranty.
4. At high speed, fans must have a minimum airflow of 5,000 CFM* and an efficiency of 75 CFM/Watt
5. Integral or attachable lighting, including separately sold ceiling fan light kits, must meet certain requirements of the RLF specification. See QPI form for specific requirements.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy savings were calculated using the ENERGY STAR® Ceiling Fan Savings Calculator found on the ENERGY STAR® website. Peak demand savings were calculated using separate coincidence factors for the lighting and the fan motor portion of the ceiling fan savings. For lighting a coincidence factor of 0.08 was applied (referenced from the CFL METERING STUDY FINAL REPORT, Prepared for: Pacific Gas & Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, 2005). For the fan motor a coincidence factor of 0.446 was applied (derived from the EnergyGauge software ceiling fan profiles).

Deemed Energy and Demand Savings Tables

Table 2-262. ENERGY STAR® Ceiling Fan Energy Savings

ENERGY STAR® Ceiling Fan
Energy Savings
(kWh)
141

Deemed Summer Demand Savings Tables

Table 2-263. ENERGY STAR® Ceiling Fan Summer Peak Demand Savings

ENERGY STAR® Ceiling Fan
Peak Savings
(kW)
0.011

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 10 years.

This EUL is consistent with Docket No. 38025 approved in 2010.[66]

Program Tracking Data & 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 number of installed ENERGY STAR® ceiling fan and light kits.

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 38025. Petition of Electric Utility Marketing Managers of Texas to Amend Deemed Savings for ENERGY STAR® Appliance Measures. Public Utility Commission of Texas. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

The applicable version of the ENERGY STAR® specifications and requirements for ceiling fans.

[66] Docket No. 38025. Petition of Electric Utility Marketing Managers of Texas to Amend Deemed Savings for ENERGY STAR® Appliance Measures. Public Utility Commission of Texas.

Document Revision History

Table 2-264. ENERGY STAR® Ceiling Fan Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.5.2 ENERGY STAR® Clothes Washer Measure Overview

TRM Measure ID: R-AP-CW

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, Replace-on-Burnout, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR® clothes washer. Savings are awarded at a flat per unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

This section is not applicable.

Baseline Condition

The baseline is the Department of Energy (DOE) minimum efficiency standard for clothes washers.

High-Efficiency Condition

The table below displays the ENERGY STAR® requirements for eligible clothes washers through 2011. 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 2-265. ENERGY STAR® Specifications for Clothes Washers

ENERGY STAR® Clothes Washer		
Criteria/Product Type	**Current Criteria (as of July 1, 2009)**	**Proposed Changes for January 1, 2011**
ENERGY STAR® top and front loading	MEF ≥ 1.8 WF≤ 7.5	MEF ≥ 2.0 WF≤ 6.0
Federal Standard top and front loading	MEF≥ 1.26	MEF ≥ 1.26 WF≤ 9.5

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Table 2-266. ENERGY STAR® Clothes Washer Energy Savings (kWh)

ENERGY STAR® Clothes Washer – Annual Energy Savings				
Type	**Modified Energy Factor, MEF (Cu.Ft. / kWh / cycle)**	**Annual Washer kWh**	**Annual Elec. DHW kWh**	**Annual Elec. Dryer kWh**
DOE 2007 Standard	1.26	52.1	310	509
2009 ENERGY STAR®	1.8	44.7	145	420
Savings		**7**	**165**	**89**

Deemed Summer Demand Savings Table

Table 2-267. ENERGY STAR® Clothes Washer Summer Peak Demand Savings

ENERGY STAR® Clothes Washer – Peak Demand Savings				
Type	**Modified Energy Factor, MEF (Cu.Ft. / kWh / cycle)**	**Annual Washer kW**	**Annual Elec. DHW kW**	**Annual Elec. Dryer kW**
DOE 2007 Standard	1.26	0.0071	0.0424	0.0697
2009 ENERGY STAR®	1.8	0.0061	0.0199	0.0575
Savings		**0.0010**	**0.0226**	**0.0122**

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of an ENERGY STAR® clothes washer is established at 11 years.

This value is consistent with the EUL reported in Appliance Magazine in 2007.

Program Tracking Data & 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:

- Number of units installed
- Fuel type of water heater

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for clothes washers.

Document Revision History

Table 2-268. ENERGY STAR® Clothes Washer Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.5.3 ENERGY STAR® Dishwasher Measure Overview

TRM Measure ID: R-AP-DW

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, Replace-on-Burnout, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR® dishwasher. Savings are awarded at a flat per unit rate, both for energy and demand savings. This measure will apply to existing homes and new construction.

Eligibility Criteria

This section is not applicable.

Baseline Condition

The baseline is the Department of Energy (DOE) minimum efficiency standard for dishwashers.

High-Efficiency Condition

The following table displays the ENERGY STAR® requirements for eligible dishwashers for January 2010 through January 2012. 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 2-269. ENERGY STAR® Specifications for Dishwashers

ENERGY STAR® Dishwasher			
Standard Sized Models			
Criteria/Product Type	**January 1, 2010**	**July 1, 2011**	**January 20, 2012**
ENERGY STAR®	≤ 324 kWh/year ≤ 5.8 gallons/cycle	≤ 307 kWh/year ≤ 5.0 gallons/cycle	≤ 295 kWh/year ≤ 4.25 gallons/cycle
Federal Standard	≤ 355 kWh/year ≤ 6.5 gallons/cycle		
Compact Sized Models			
Criteria/Product Type	**January 1, 2010**	**July 1, 2011**	**January 20, 2012**
ENERGY STAR®	≤ 234 kWh/year ≤ 4.0 gallons/cycle	≤ 222 kWh/year ≤ 3.5 gallons/cycle	≤ 222 kWh/year ≤ 3.5 gallons/cycle
Federal Standard	≤ 260 kWh/year ≤ 4.5 gallons/cycle		

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy savings were calculated using the ENERGY STAR® Dishwasher Savings Calculator found on the ENERGY STAR® website. Peak demand savings were calculated using the 2007 Build America Benchmark normalized energy use profiles for dishwashers. A coincidence factor of 0.04 was applied to determine the peak savings.

Deemed Energy and Demand Savings Tables

Table 2-270. ENERGY STAR® Dishwasher Energy Savings

ENERGY STAR® Dishwasher Savings	
kWh Savings	
With Electric Water Heating	**Without Electric Water Heating**
74	33

Deemed Summer Demand Savings Table

Table 2-271. ENERGY STAR® Dishwasher Summer Peak Demand Savings

ENERGY STAR® Dishwasher Savings	
Peak kW Savings	
With Electric Water Heating	**Without Electric Water Heating**
0.00801	0.00297

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 11 years. This value is consistent with the EUL reported in Appliance Magazine in 2007.

Program Tracking Data & 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:

- Number of units installed
- Fuel type of water heater

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 38025. Petition of Electric Utility Marketing Managers of Texas to Amend Deemed Savings for ENERGY STAR® Appliance Measures. Public Utility Commission of Texas. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for dishwashers.

Document Revision History

Table 2-272. ENERGY STAR® Dishwasher Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.5.4 ENERGY STAR® Refrigerator Measure Overview

TRM Measure ID: R-AP-RF

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement, Replace-on-Burnout, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates

Measure Description

This measure applies to all ENERGY STAR® refrigerators that meet the criteria for the ENERGY STAR® label specified below.

Eligibility Criteria

This section is not applicable.

Baseline Condition

The baseline is the Department of Energy (DOE) minimum efficiency standard for refrigerators.

High-Efficiency Condition

The table below displays the ENERGY STAR® requirements for eligible refrigerators, which went into effect April 28, 2008. 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 2-273. ENERGY STAR® Specifications for Refrigerators

ENERGY STAR® Refrigerator		
Product Type	**Volume**	**Criteria as of April 28, 2008**
Full Size Refrigerators	7.75 cubic feet or greater	At least 20% more energy efficient than the minimum federal government standard (NAECA)

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Details and derivations of savings methodology will be addressed in a future version of the TRM.

Deemed Energy and Demand Savings Tables

Table 2-274. ENERGY STAR® Refrigerator Energy Savings

ENERGY STAR® Refrigerator Savings		
Replace on Burnout/ New Construction kWh Savings	**Multifamily Retrofit kWh Savings**	**Single-Family Retrofit kWh Savings**
123	713	743

Deemed Summer Demand Savings Tables

Table 2-275. ENERGY STAR® Refrigerator Summer Peak Demand Savings

ENERGY STAR® Refrigerator Savings		
Replace on Burnout/ New Construction Peak kW Savings	**Multifamily Retrofit Peak kW Savings**	**Single-Family Retrofit Peak kW Savings**
0.017	0.097	0.101

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 14 years.

This value is consistent with the EUL reported in Appliance Magazine in 2007.

Program Tracking Data & 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 home type (single or multifamily) where the refrigerator was installed
- The decision/action type of the installation (retrofit or new construction)

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for refrigerators.

Document Revision History

Table 2-276. ENERGY STAR® Refrigerator Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

ENERGY STAR® Refrigerator for Low Income and Hard-to-Reach Market Transformation

TRM Measure ID: V1-R-LI-AP-530000

Market Sector: Residential

Measure Category: Appliances

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Early Replacement

Program Delivery Type(s): Direct Install

Deemed Savings Type: Deemed Savings Calculations

Savings Methodology: Engineering Algorithms and Estimates

Measure Description

This document presents the accepted deemed savings awarded for the installation of an ENERGY STAR® refrigerator through a low-income program, or a hard-to-reach market transformation program. Savings are awarded based on the age of the unit replaced, and the size of the installed unit. This measure will apply only to existing homes, both single and multifamily.

Eligibility Criteria

The unit to be replaced must be functioning at the time of removal; only early replacements are eligible for these deemed savings.

Baseline Condition

The baseline is the Department of Energy (DOE) minimum efficiency standard for refrigerators.

High-Efficiency Condition

The table below displays the ENERGY STAR® requirements for eligible refrigerators, which went into effect April 28, 2008.

Table 2-277. ENERGY STAR® Specifications for Refrigerators

ENERGY STAR® Refrigerator		
Product Type	**Volume**	**Criteria as of April 28, 2008**
Full Size Refrigerators	7.75 cubic feet or greater	At least 20% more energy efficient than the minimum federal government standard (NAECA)

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

In order to calculate the summer peak demand (kW) and energy (kWh) savings associated with the installation of a new ENERGY STAR® refrigerator in a home through a low-income or hard-to-reach market transformation program, the savings must be weighted by the age of the unit to be replaced.

The following equations may be used to calculate the deemed energy and summer peak demand savings awarded to a newly-installed ENERGY STAR® refrigerator:

$$Annual\ kWh\ Savings = \left(\frac{Refrigerator\ Age}{Refrigerator\ Age + Remaining\ Service\ Life}\right) \times Annual\ kWh\ Savings_{Replace\ on\ Burnout} + \left(\frac{Remaining\ Service\ Life}{Refrigerator\ Age + Remaining\ Service\ Life}\right) \times Annual\ kWh\ Savings_{Retrofit}$$

Equation 46

$$Annual\ kW\ Savings = \left(\frac{Refrigerator\ Age}{Refrigerator\ Age + Remaining\ Service\ Life}\right) \times Annual\ kW\ Savings_{Replace\ on\ Burnout} + \left(\frac{Remaining\ Service\ Life}{Refrigerator\ Age + Remaining\ Service\ Life}\right) \times Annual\ kW\ Savings_{Retrofit}$$

Equation 47

Retrofit savings and savings for a unit replaced on burnout can be found in Table 2-279 and Table 2-280. Remaining Service life is dependent upon the age of the refrigerator replaced. The remaining life can be found in Table 2-278.

Table 2-278. Remaining Service Life of Replaced Unit

Age of Replaced Unit	Remaining Service Life
1	18
2	17
3	16
4	15
5	14
6	13
7	12
8	11.5
9	10.5
10	9
11	8.5
12	8
13	7.5
14	7
15	5.5

Age of Replaced Unit	Remaining Service Life
16	5
17	4.5
18	3.5
19	3
20	2.5
21	1.5
22	1.5
23	1
24	0
25	0
26	0
27	0
28	0
29	0
30	0

Deemed Energy and Demand Savings Tables

Table 2-279. ENERGY STAR® Refrigerator Energy Savings

ENERGY STAR® Refrigerator Savings		
Replace on Burnout/ New Construction kWh Savings	**Multifamily Retrofit kWh Savings**	**Single-Family Retrofit kWh Savings**
123	713	743

Summer Demand Savings Table

Table 2-280. ENERGY STAR® Refrigerator Summer Peak Demand Savings

ENERGY STAR® Refrigerator Savings		
Replace on Burnout/ New Construction Peak kW Savings	**Multifamily Retrofit Peak kW Savings**	**Single-Family Retrofit Peak kW Savings**
0.017	0.097	0.101

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is established at 14 years.

This value is consistent with the EUL reported in Appliance Magazine in 2007.

Program Tracking Data & 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:

- Home type (single or multifamily) where the ENERGY STAR® refrigerator was installed
- Status of the installation (replacement on burnout, new construction, early replacement) must be recorded
- Size of the installed unit, in cubic feet

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual

Relevant Standards and Reference Sources

- The applicable version of the ENERGY STAR® specifications and requirements for refrigerators.

Document Revision History

Table 2-281. Low Income Weatherization or Hard-to-Reach Market Transformation Program ENERGY STAR® Refrigerator Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.6 RESIDENTIAL: WHOLE HOUSE

2.6.1 New Homes Measure Overview

TRM Measure ID: R-HS-NH

Market Sector: Residential

Measure Category: Whole-House

Applicable Building Types: Single-Family; Manufactured

Fuels Affected: Electricity and Gas

Decision/Action Type(s): New Construction

Program Delivery Type(s): Custom

Deemed Savings Type: For this measure, savings are not deemed and are estimated based on each house's specific characteristics and parameters.

Savings Methodology: EM&V and Whole-House Simulation Modeling

Measure Description

The New Homes program promotes a holistic approach to achieving energy efficient homes, including a combination of envelope and equipment-based improvements to reduce home energy use. The energy savings estimations process is designed to efficiently estimate electric energy and demand savings attributable to each participating home.

Eligibility Criteria

This measure does not apply to existing construction. Only new construction homes are eligible.

Baseline Condition[67]

For a list of baseline parameters and input values, see Table 2-282.

Table 2-282. New Home – Baseline Characteristics

Baseline Home Parameters and Characteristics	Baseline Specification / Value
House Envelope	
Unit Type	Single- Family Detached
Number of Stories Above Grade 1	Same as As-Built
Foundation Type	Same as As-Built

[67] Baseline parameters are subject to change when the relevant energy code gets updated.

Baseline Home Parameters and Characteristics	Baseline Specification / Value
Number of Bedrooms	Same as As-Built
Total Conditioned Floor Area	Same as As-Built
Total Conditioned Volume	Same as As-Built
Wall Height Per Floor	Same as As-Built
Window Distribution (N,S,E,W)	Same as As-Built
Percentage Window to Floor Area	Same as As-Built
Front Door Orientation	Same as As-Built
Aspect Ratio (Length / Width)	Use the same estimated average aspect ratio for both baseline and as-built. However, it is recommended to use actual aspect ratio when actual house footprint dimensions are available.
Roof Solar Absorptivity	Same as As-Built. When as-built data is not available, use 0.75.
Attic Insulation R-Value	See IECC 2009, Table 402.1.1
Cathedral Ceiling Insulation R-Value	R-19
Percentage Cathedral Ceilings	Same as As-Built
Wall Construction	2x4-16 inch on center spacing
Wall Framing Fraction	23%
Wall Insulation	See IECC 2009, Table 402.1.1
Wall Sheathing	Plywood
Wall Insulation Grade	3
Door R-Value	Same as As-Built.
Floor Insulation	See IECC 2009, Table 402.1.1
Rim Joist	Same as wall insulation
Window U Factor	See IECC 2009, Table 402.1.1
Window SHGC	See IECC 2009, Table 402.1.1
Air Infiltration	7 ACH50
Mechanical Ventilation	None
Slab Edge Insulation	See IECC 2009, Table 402.1.1
HVAC Equipment	
HVAC Equipment Type	Same as As-Built
Cooling Capacity	Same as As-Built
Heating Capacity	Same as As-Built
Cooling Efficiency (SEER)	13
Heating Efficiency (AFUE)	80
Heating Efficiency (HSPF) – Heat Pump	7.7 HSPF
Duct Location	100% Attic
Duct R-Value	R-6
Duct Leakage to Outside	8 CFM per 100 ft² of Conditioned Floor Area
Thermostat Type	Same as As-Built
Heating Setpoint	68 F
Cooling Setpoint	78 F

Baseline Home Parameters and Characteristics	Baseline Specification / Value
Water Heating System	
DHW Fuel Type	Same as As-Built
DHW Capacity (Gallons)	Same as As-Built for Storage. Assume a 50-gallon storage water heater when as-built water heater is instantaneous.
Energy Factor (EF)	See IECC 2009, Table 504.2
DHW Temperature	120 F
DHW Pipe Insulation	None
Low Flow Shower Heads	None

High-Efficiency Condition

The high-efficiency conditions are according to the as-built home's parameters and characteristics.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

House Simulation Modeling and Input Variables

Two house simulation models should be developed for each home utilizing an appropriate residential modeling package software. The first model simulates the baseline home's annual energy use and demand, while the second simulates the as-built home. The energy and demand savings are the difference in annual energy use between the as-built home and the baseline home.

Energy Savings Methodology

Energy savings are estimated utilizing whole-house simulation modeling based on on-site data collection.

Summer Demand Savings Methodology

Summer peak demand savings are estimated utilizing whole-house simulation modeling based on on-site data collection and load shape profiles for the specific climate zone.

Winter Demand Savings Methodology

Winter peak demand savings are estimated utilizing whole-house simulation modeling based on on-site data collection and load shape profiles for the specific climate zone.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

The applied method to estimate peak demand savings should be consistent with ERCOT definition.

Additional Calculators and Tools

Appropriate residential modeling package software should be used to simulate the baseline and as-built home's annual energy use and demand.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of a new home measure is established at 23.0 years.

Program Tracking Data & 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:

- House Envelope
    - Dwelling Unit Type
    - House Footprint Dimensions
    - Number of Stories Above Grade 1
    - Foundation Type
    - Number of Bedrooms
    - Total Conditioned Floor Area
    - Total Conditioned Volume
    - Wall Height Per Floor
    - Window Distribution (N,S,E,W)
    - Front Door Orientation
    - Aspect Ratio (Length / Width) – when available
    - Roof Solar Absorptivity – when available
    - Attic Insulation R-Value
    - Cathedral Ceiling Insulation R-Value
    - Percentage Cathedral Ceilings
    - Ceiling Insulation Grade

        - Wall Construction
        - Wall Framing Fraction
        - Wall Insulation (R-Value)
        - Wall Insulation Grade
        - Door Material (Wood, Metal, Vinyl, and whether Solid Core or Hallow) – when available
        - Rim Joist
        - Window U Factor
        - Window SHGC
        - Air Infiltration
        - Mechanical Ventilation
        - Slab Edge Insulation – only for houses located in IECC climate zone 4.
- HVAC Equipment
        - HVAC Equipment Type
        - Cooling Capacity
        - Heating Capacity
        - Cooling Efficiency (SEER)
        - Heating Efficiency (AFUE), and HSPF for heat pumps
        - Duct Location
        - Duct Insulation R-Value
        - Duct Leakage to Outside (CFA)
        - Heating Set-Point Temperature (°F)
        - Cooling Set-Point Temperature (°F)
        - Thermostat Type (Setback or No Setback)
- Water Heating System
        - Water Heating Systems
        - DHW Fuel Type
        - DHW Capacity (Gallons)
        - Energy Factor
        - DHW Set-Point Temperature
        - DHW Pipe Insulation
        - Number of Low Flow Shower Heads

References and Efficiency Standards

Petitions and Rulings

This section is not applicable.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-283. Water Heater Jacket Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.7 RESIDENTIAL: RENEWABLE ENERGY SYSTEMS

2.7.1 Solar Photovoltaic (PV) Measure Overview

TRM Measure ID: R-RN-PV

Market Sector: Residential

Measure Category: Renewables

Applicable Building Types: Single-family, duplex and triplex; Multifamily; Manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit, New Construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values and Calculation

Savings Methodology: Algorithms, Model-Calculator (PVWatts™)

Measure Description

This section summarizes the savings calculations of the Solar Photovoltaic Standard Offer, Market Transformation, and Pilot programs. The primary objective of these programs is to achieve cost-effective reduction in energy savings and peak demand savings. Participation in the Solar Photovoltaic program involves the installation of a solar photovoltaic system. There are two primary methods used to estimate savings. The deemed method uses deemed algorithms, and the M&V method uses a simulation tool: the National Renewable Energy Laboratory's (NREL) PVWatts™.

Eligibility Criteria

Only photovoltaic systems that result in net reductions of the customer's purchased energy and peak demand qualify for these deemed savings estimates.

The installation must also meet the following requirements in order to be eligible for these deemed savings values:

- The system shall be installed by a licensed electrical contractor or, in the case of a residential installation by the homeowner, with the approval of the electrical inspector in accordance with the National Electric Code (NEC 690, "Solar Photovoltaic Systems") or local building codes.
- If the system is utility interactive the inverter shall be listed by national testing laboratory (see, for example, UL 1741, "Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems") and meet the requirements of the Institute of Electrical

and Electronics Engineers (IEEE) Standard 929-2000 “Recommended Practice for Utility Interface of Photovoltaic (PV) Systems.”

- For Oncor, the array azimuth shall be within +/- 20 degrees of south; the tilt angle shall be between 0 (horizontal) and latitude + 15 degrees to use the deemed savings factors, otherwise the alternate method should be used.
- For AEP and EPE, The estimated annual electrical energy output of a solar electric system, as modeled by National Renewable Energy Laboratory’s (NREL) PVWatts™ and considering an appropriate factor for shading, must be at least 80% of the estimated annual energy output for an optimally-sited, un-shaded system of the same DC capacity.
- The estimated annual energy generation from the PV system shall not exceed the customer’s annual energy consumption.
- PUCT Docket No. 40885 allows for alternative means for estimating deemed savings for solar PV systems for non-standard installations, allowing residential customers around the state access to utility incentives for systems installed on roofs – or portions of roofs – that are not within 20 degrees of south, or for which the tilt angle must exceed 15 degrees from horizontal due to site specific considerations. The proposed alternative would also facilitate the installation of single-axis or two-axis tracking systems. For those solar PV installations that do not conform to the installation standards of the existing deemed savings, the deemed demand and energy savings should be established by modeling the performance of the system using PVWatts Version1.

Baseline Condition

PV system not currently installed (typical), or production capacity of an existing system is less than any utility requirements, so that additional panels can be added.

High-Efficiency Condition

PV systems must meet the eligibility criteria shown above to be eligible for incentives.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

The following formula calculates the energy savings for solar electric photovoltaic energy systems based on the rated watts DC_{STC}.

$$\boldsymbol{Deemed\ Energy\ Savings\ (kWh) = 1.60 \times Watts\ DC_{STC}\ installed}$$

Equation 48

Non-Standard Installation:

PUCT Docket No. 40885 allows for alternative means for estimating deemed savings for solar PV systems for non-standard installations, allowing commercial customers around the state access to utility incentives for systems installed on roofs – or portions of roofs – that are not within 20 degrees of south, or for which the tilt angle must exceed 15 degrees from horizontal due to site

specific considerations. The proposed alternative would also facilitate the installation of single-axis or two-axis tracking systems.

For those solar PV installations that do not conform to the installation standards of the existing deemed savings, the deemed demand and energy savings be established by modeling the performance of the system using PVWatts™ Version1.

Summer Demand Savings Methodology

The following formula calculates the demand savings for solar electric photovoltaic energy systems based on the rated watts DC_{STC}.

$$\boldsymbol{Deemed\ Demand\ Savings\ (kW) = 0.83 \times kW\ DC_{STC}\ installed}$$

Equation 49

Winter Demand Savings Methodology

This section is not applicable.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

This section is not applicable.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

Demand savings is currently calculated from the equation shown. There is no peak demand period associated with the calculation, but PV is clearly a summer peaking measure. It is worth noting that the peak output for a PV system peak typically occurs about 1 pm, which is much earlier than the typical utility system peak demand hour.

Additional Calculators and Tools

For non-standard installation PV systems, PVWatts™ should be used to model the performance of the system and to estimate energy and demand savings.

Measure Life and Lifetime Savings

The estimated useful life (EUL) of photovoltaic system is established at 30.0 years.

This value is consistent with the Frontier Associates' engineering estimate based on manufacturers' warranties.

Program Tracking Data & Evaluation Requirements

The following information will be required to be collected to determine the project eligibility.

- Project location (city)
- DC rating for the system
- Standard or Non-Standard System
- Savings approach type: Deemed algorithm or PVWatts™
- System Latitude
- System Tilt
- System Azimuth

References and Efficiency Standards

Petitions and Rulings

- 2013 Deemed Savings Manual
- Docket No. 40885. 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 Revise Deemed Savings Values for Commercial HVAC and Solar Photovoltaic Measures. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

- National Electric Code (NEC) 690, "Solar Photovoltaic Systems" or local building codes.
- Institute of Electrical and Electronics Engineers (IEEE) Standard 929-2000 "Recommended Practice for Utility Interface of Photovoltaic (PV) Systems." [68]

Document Revision History

Table 2-284. Residential Solar Electric (Photovoltaic) Energy Systems Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

[68] http://standards.ieee.org/findstds/standard/929-2000.html.

2.8 RESIDENTIAL: LOAD MANAGEMENT

2.8.1 Direct Load Control Switches Installed on Outdoor Compressor Units Measure Overview

TRM Measure ID: R-LM-OC

Market Sector: Residential

Measure Category: Load Management

Applicable Building Types: Single-family

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Standard Offer Program (SOP)

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates and M&V

Measure Description

These deemed savings values will provide a benchmark for estimating the annual summer peak demand savings associated with the curtailment of residential air conditioning energy usage during periods of high demand via direct load control switches installed on the outdoor compressor units of split unitary HVAC systems in detached single-family homes in CenterPoint Houston's service territory. The deemed savings values are on a per-home basis, predicated on basic considerations related to the design and implementation of a residential demand response program.

Eligibility Criteria

A direct load control switch must be installed on the electrical supply to all outdoor units (compressors) of the unitary split central air conditioning systems installed at a home. The home must be an occupied, single-family detached home that participates in a residential demand response program offered by CenterPoint Houston in which a direct load control switch is installed on the electrical supply to all outdoor units (compressors) of the unitary split central air conditioning systems installed at a home

Baseline Condition

This section is not applicable.

High-Efficiency Condition

This section is not applicable.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

CenterPoint Houston has been engaged in a multi-year research project evaluating the potential for a residential demand response program allowing residential customers in single-family, detached homes to provide summer peak demand savings by participating in load curtailment events with remotely-controllable, major electric energy end use equipment in their homes.

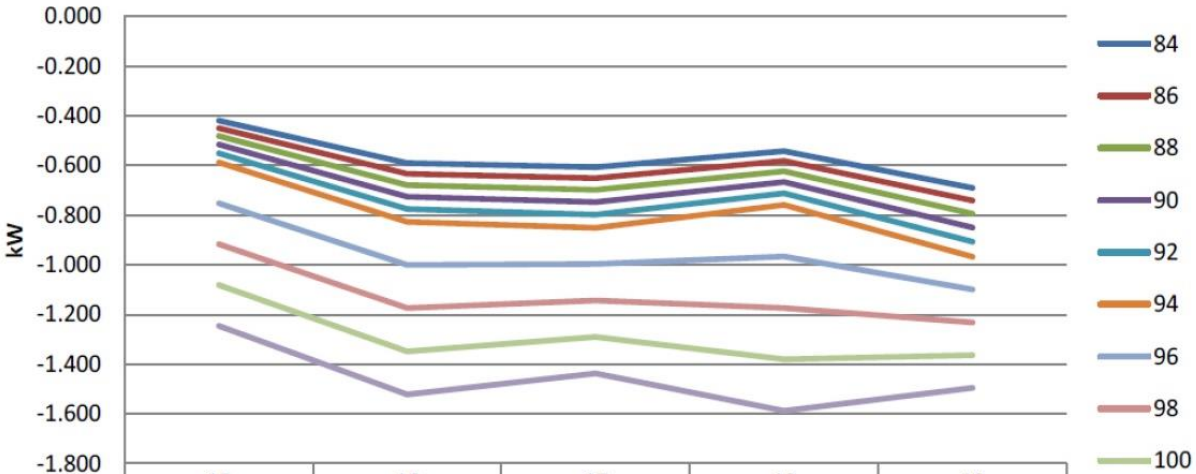
The 2011 pilot involved installation of 74 direct load control (DLC) switches on outdoor compressor units at the homes of test group participants in the CenterPoint Smart Partners program. Measurement and verification was performed using data from 30 homes (in which 35 switches were installed) randomly selected from among the participants.

The 2012 pilot involved installation of 1,379 DLC switches at 1,026 homes in the CenterPoint Houston service territory. A total of 314 customers were randomly selected for this M&V study. Submetering devices were installed on 458 air conditioner compressors and 18 pool pumps at these 314 premises. Participating homes were self-selected from among the customers of two Retail Electric Providers who agreed to participate in the program.

Load control events were called during the summers of 2011 and 2012. Events were two to four hours in duration (though only 3 and 4 hour events were included in the analysis presented herein), and began at either 2 p.m. or 3 p.m. (ending at either 6 p.m. or 7 p.m.; no three-hour events were begun at 2 p.m. to avoid “bounce back” in the peak hour, which frequently occurs between 5 p.m. and 6 p.m.). The general criterion for events was a daily high temperature above 94 degrees, but events were called with a range of temperatures occurring across the duration of events. Furthermore, operating conditions affecting residential demand for cooling vary across these hours (on average, occupancy is lower earlier in the afternoon and demand for cooling is further lowered for those homes employing afternoon setups via programmable thermostats until the evening program is engaged). As such, estimates of hourly load shed for HVAC compressors were developed by hour and by temperature.

Hourly compressor load shed estimates were developed by the implementing contractor using regression analysis on hourly loads estimated from on/off runtime monitoring of the controlled compressor units. They are reproduced in Figure 2-5, which shows load reduction between 2 p.m. and 7 p.m. (the values on the horizontal axis are the hour ending values, so 15 represents 15:00, or the hour from 2:00–3:00 p.m.). The load reduction in any single hour ranges from 0.42 kW at 84 degrees in the 2 p.m. hour to just under 1.6 kW at 102 degrees in the 6 p.m. hour.

Figure 2-5. Primary Load Reductions (kW/Household), DLC Switch on Residential HVAC Compressor Unit



	15	16	17	18	19
84	-0.419	-0.590	-0.607	-0.542	-0.691
86	-0.450	-0.633	-0.652	-0.582	-0.741
88	-0.482	-0.679	-0.698	-0.623	-0.794
90	-0.515	-0.726	-0.747	-0.666	-0.849
92	-0.551	-0.775	-0.798	-0.712	-0.907
94	-0.587	-0.827	-0.851	-0.759	-0.968
96	-0.752	-1.001	-0.997	-0.966	-1.100
98	-0.917	-1.175	-1.144	-1.174	-1.232
100	-1.082	-1.348	-1.290	-1.381	-1.364
102	-1.247	-1.522	-1.437	-1.588	-1.496

Development of the proposed deemed savings value based on this information takes into account two factors: (1) the expected design of the measure for which the proposed deemed savings value will be used, and (2) the weather conditions that can be expected in a summer peak demand period, when CenterPoint Houston will want to deploy the residential demand response to maximize capacity. Specifically, the proposed deemed savings values were developed based on the following assumptions about their intended use:

- Curtailment events will be four hours in duration, lasting either from 2 p.m. to 6 p.m. or 3 p.m. to 7 p.m., and will only be called on weekdays.
- Cycling will be accomplished by deploying a 50 percent cycling strategy (taken as a percentage of time) or an equivalent strategy.
- Participating customers will be asked to provide demand response services for up to 40 total hours per summer peak demand period (10 events, based on the above four hours per event).
- Curtailment events will be initiated on days when system demand is expected to be at its highest, which, in turn, will generally correlate with high temperatures.

Given these program considerations, an analysis of typical meteorological year data for CenterPoint Houston's service territory was undertaken, using Typical Meteorological Year (TMY3) data for Houston's Bush Intercontinental Airport. In a Typical Meteorological Year, there are twenty days with high temperatures of 96 degrees or above. Given that 2 of every 7 days are likely to be weekends, approximately 14 of these 20 days would be weekdays, on which events could be initiated. As such, it is reasonable to expect that the ten events called each summer peak demand season will occur on days for which conditions in these twenty peak days are representative. Using the average temperature in each hour between 2PM and 7 PM for those twenty days, typical load reductions for each hour can be constructed from the data provided in Figure 2-5.

Table 2-285. Typical Hourly Load Reductions, Compressor Units on Residential HVAC Systems

Hour	Temperature (^{0}F)	Typical Load Reduction (kW)
2 p.m.–3 p.m.	97.1	0.84
3 p.m.–4 p.m.	97.2	1.00
4 p.m.–5 p.m.	95.1	0.93
5 p.m.–6 p.m.	92.5	0.72
6 p.m.–7 p.m.	89.1	0.82
Average Hourly Load Reduction		**0.86**

Assuming an even distribution of events that run from 2 p.m. to 6 p.m. and events that run from 3 p.m. to 7 p.m., an average hourly load reduction of 0.86 kW per home is estimated.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

Occupied, single-family detached homes that participate in a residential demand response program offered by CenterPoint Houston in which a direct load control switch is installed on the electrical supply to all outdoor units (compressors) of the unitary split central air conditioning systems installed at a home are granted a deemed savings value of 0.86 kW per home per summer peak demand period.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The measure life for the residential demand response measure for which these deemed savings values are granted is one year.

Program Tracking Data & Evaluation Requirements

No primary inputs or contextual data must be specified or tracked by the program database to inform the evaluation and apply the savings properly, beyond evidence of participation.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41413. Petition of CenterPoint Energy Houston Electric, LLC to Establish Deemed Savings Values for Residential Demand Response with Direct Load Control Switches Installed on Outdoor Compressor Units. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-286. Residential Direct Load Control Switches Installed on Outdoor Compressor Units Revision History

Version	Date	Description of Change
1	11/25/2013	TRM V.1 origin

2.8.2 Direct Load Control Switches Installed on Swimming Pool Pump Motors Measure Overview

TRM Measure ID: R-LM-SP

Market Sector: Residential

Measure Category: Load Management

Applicable Building Types: Single-family

Fuels Affected: Electricity

Decision/Action Type(s): Retrofit

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Deemed Savings Values

Savings Methodology: Engineering Estimates and M&V

Measure Description

These deemed savings values will provide a benchmark for estimating the annual summer peak demand savings associated with the curtailment of swimming pool filtration system energy usage during periods of high demand via direct load control switches installed on the electrical supplies to pool pump motors in detached single-family homes in CenterPoint Houston's service territory. The deemed savings values are on a per-home basis, predicated on basic considerations related to the design and implementation of a residential demand response program.

Eligibility Criteria

Pool pump motors must be installed in an occupied, single-family detached home that participates in a residential demand response program offered by CenterPoint Houston in which a direct load control switch is installed on the electrical supply to the motor(s) driving the pump(s) of a swimming pool filtration system.

Baseline Condition

This section is not applicable.

High-Efficiency Condition

This section is not applicable.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

CenterPoint Houston has been engaged in a multi-year research project evaluating the potential for a residential demand response program allowing residential customers in single-family, detached homes to provide summer peak demand savings by participating in load curtailment events with remotely-controllable, major electric energy end use equipment in their homes.

The 2011 pilot involved installation of 74 direct load control (DLC) switches on outdoor compressor units at the homes of test group participants in the CenterPoint Smart Partners program. Measurement and verification was performed using data from 30 homes (in which 35 switches were installed) randomly selected from among the participants.

The 2012 pilot involved installation of 1,379 DLC switches at 1,026 homes in the CenterPoint Houston service territory. A total of 314 customers were randomly selected for this M&V study. Submetering devices were installed on 458 air conditioner compressors and 18 pool pumps at these 314 premises. Participating homes were self-selected from among the customers of two Retail Electric Providers who agreed to participate in the program.

Load control events were called during the summers of 2011 and 2012. Events were two to four hours in duration (though only 3 and 4 hour events were included in the analysis presented herein), and began at either 2 p.m. or 3 p.m. (ending at either 6 p.m. or 7 p.m.; no three-hour events were begun at 2 p.m. to avoid “bounce back” in the peak hour, which frequently occurs between 5 and 6 p.m.). The general criterion for events was a daily high temperature above 94 degrees, but events were called with a range of temperatures occurring across the duration of events. Furthermore, operating conditions affecting residential demand for cooling vary across these hours (on average, occupancy is lower earlier in the afternoon and demand for cooling is further lowered for those homes employing afternoon setups via programmable thermostats until the evening program is engaged). As such, estimates of hourly load shed for HVAC compressors were developed by hour and by temperature.

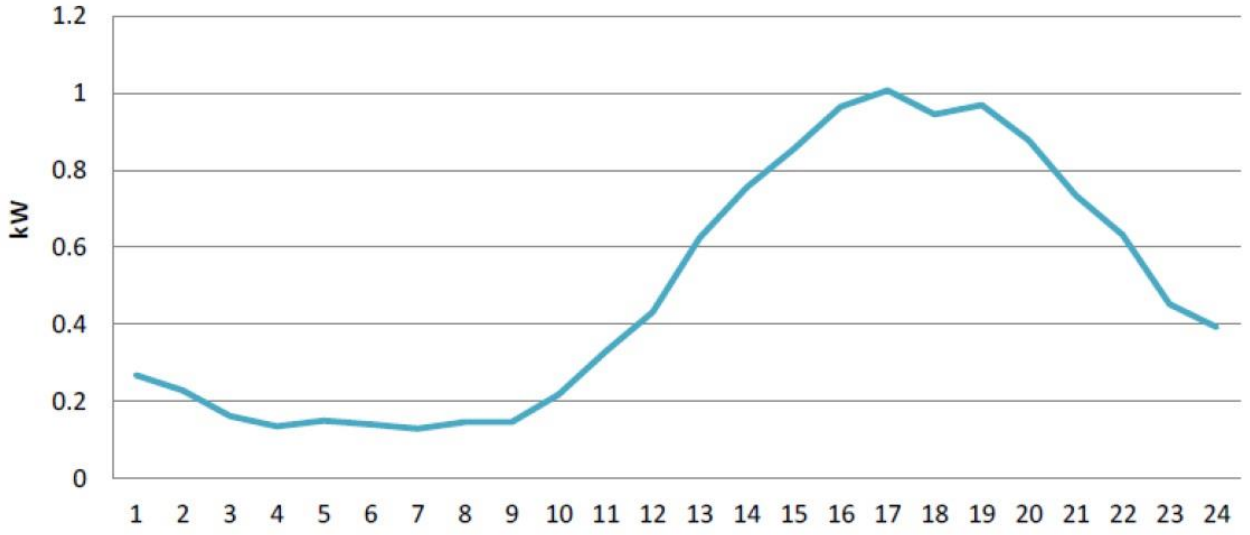
Development of the proposed deemed savings value based on this information takes into account two factors: (1) the expected design of the measure for which the proposed deemed savings value will be used, and (2) the weather conditions that can be expected in a summer peak demand period, when CenterPoint Houston will want to deploy the residential demand response to maximize capacity. Specifically, the proposed deemed savings values were developed based on the following assumptions about their intended use:

- Curtailment events will be four hours in duration, lasting either from 2 p.m. to 6 p.m. or 3 p.m. to 7 p.m., and will only be called on weekdays.
- Cycling will be accomplished by deploying a 100 percent cycling strategy (taken as a percentage of time) or an equivalent strategy.
- Participating customers will be asked to provide demand response services for up to 40 total hours per summer peak demand period (10 events, based on the above four hours per event).
- Curtailment events will be initiated on days when system demand is expected to be at its highest, which, in turn, will generally correlate with high temperatures.

Given these program considerations, an analysis of typical meteorological year data for CenterPoint Houston's service territory was undertaken, using Typical Meteorological Year (TMY3) data for Houston's Bush Intercontinental Airport. In a Typical Meteorological Year, there are twenty days with high temperatures of 96 degrees or above. Given that 2 of every 7 days are likely to be weekends, approximately 14 of these 20 days would be weekdays, on which events could be initiated. As such, it is reasonable to expect that the ten events called each summer peak demand season will occur on days for which conditions in these twenty peak days are representative.

The variables of interest in estimating pool pump demand savings are the typical energy draw of swimming pool pumps, and their aggregated load shape. Figure 2-6 presents the observed load shape from on-off monitoring and nameplate data collection for pool pumps observed in the 2012 pilot in Houston.

Figure 2-6. Average Hourly Pool Pump Demand



On average, the observed demand pattern is consistent with pumping systems that draw 1.5 kW for 8 hours per day; however, the curve provides relatively high coincidence, with average demand of 0.95 kW for the five hours between 2 p.m. and 7 p.m. during which the 4-hour events are likely to be called. As such, the proposed deemed demand savings for swimming pool pumps is 0.95 kW.

Deemed Energy and Demand Savings Tables

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

Deemed Summer Demand Savings Tables

Occupied, single-family detached homes that participate in a residential demand response program offered by CenterPoint Houston in which a direct load control switch is installed on the electrical supply to the motor(s) driving the pump(s) of a swimming pool filtration system are granted a deemed savings value of 0.95 kW per home per summer peak demand period.

Deemed Winter Demand Savings Tables

This section is not applicable.

Claimed Peak Demand Savings

For this measure, the summer period peak demand savings would be used as the claimed peak demand value.

Additional Calculators and Tools

This section is not applicable.

Measure Life and Lifetime Savings

The measure life for the residential demand response measure for which these deemed savings values are granted is one year.

Program Tracking Data & Evaluation Requirements

No primary inputs or contextual data must be specified or tracked by the program database to inform the evaluation and apply the savings properly, beyond evidence of participation.

References and Efficiency Standards

Petitions and Rulings

- Docket No. 41413. Petition of CenterPoint Energy Houston Electric, LLC to Establish Deemed Savings Values for Residential Demand Response with Direct Load Control Switches Installed on Outdoor Compressor Units. Public Utility Commission of Texas.

Relevant Standards and Reference Sources

This section is not applicable.

Document Revision History

Table 2-287. Residential Direct Load Control Switches Installed on Swimming Pool Pump Motors Revision History

	Date	Description of Change
1	11/25/2013	TRM V.1 origin