New Mexico Technical Resource Manual for the Calculation of Energy Efficiency Savings

Prepared for the New Mexico Public Regulation Commission

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TABLES

ACKNOWLEDGEMENTS

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1 INTRODUCTION

The intent of this Technical Reference Manual (TRM) is to provide a transparent and consistent basis for calculating energy (kWh or therms) and demand (kW) savings generated by the State of New Mexico's energy efficiency programs. In addition, estimated measure lives and measure costs are provided to assist with calculations of measure cost-effectiveness. The TRM is developed based on input from the following four investor-owned utilities:

- Southwestern Public Service Company (SPS)
- El Paso Electric (EPE)
- Public Service Company of New Mexico (PNM)
- New Mexico Gas Company (NMGC)

Measure savings were derived from existing work. Information was taken from the following data sources, listed in order of importance:

- Workpapers of the New Mexico investor-owned utilities
- Evaluations of the New Mexico utilities' programs conducted by the statewide evaluator
- California's Database for Energy Efficiency Resources (DEER)
- TRMs from other states
- The US Department of Energy (DOE)
- ENERGY STAR®
- Other sources cited throughout the document

Section 2 provides a discussion of parameters that are common to all measures, including both climate zones and building types. The remaining sections of the TRM are organized by measure. The following information is provided for each of the measures included in the TRM:

- Measure overview
- Savings methodology summary
- Gross energy savings estimation (kWh or therms)

- Gross coincident peak demand savings estimation (kW)
- Non-energy benefits
- Measure life (years)
- Incremental cost ($)

Default values are provided for various parameters throughout the TRM. These defaults will be used when project-specific information cannot be gathered (e.g., upstream programs and retrofits of very old equipment). However, site-specific inputs should be used whenever possible to maximize the accuracy of savings estimates. During program evaluations, any available site-specific data will be used to calculate savings.

Utilities may choose to perform custom calculations instead of the methods presented in the TRM. This is acceptable as long as the custom calculations are performed according to industry-accepted modeling systems and practices and use site-specific data whenever possible. Custom calculations will be reviewed during program evaluations and compared to TRM calculations to determine the most accurate estimate of savings. Peak demand savings are defined as the reduction in average kilowatts (kW) during the period of 3:00-6:00 PM on the hottest summer weekdays, specifically in June and July, Monday through Friday.

Additional parameters needed to determine net measure savings, such as installation rates and net-to-gross ratios (NTGRs), are not provided in this TRM. These parameters are to be determined through program evaluations.

2 COMMON PARAMETERS

2.1 CLIMATE ZONES

For the purposes of this TRM, New Mexico is divided into four climate zones. Heating and cooling degree days and other weather parameters for the four zones are based on the representative cities shown in Table 1. Degree days were taken from the National Oceanic and Atmospheric Administration (NOAA) 30-year averages for the four cities (at the location designated by "Station Name" in Table 1.

Table 1: New Mexico Climate Zones

Representative City	Station Name	Heating Degree-days (65 °F base)	Cooling Degree-days (65 °F base)
Albuquerque	Albuquerque International Airport	4,180	1,322
Las Cruces	New Mexico State University	2,816	1,899
Roswell	Roswell Industrial Air Park	3,289	1,790
Santa Fe	Santa Fe Co Municipal Airport	5,417	645

Roswell has greater humidity, resulting in higher air-conditioning demand, while Las Cruces has a higher value for cooling degree days (CDD) than Roswell. For hours with a dry-bulb temperature greater than 75 °F, the average relative humidity in Roswell is 29%, while Las Cruces's is 23%, according to TMY3 data.

Distribution of New Mexico locations into the four climate zones is based on the map published by the International Energy Conservation Code (IECC),[1] with the following exceptions:

- Roswell is the representative city of a climate zone separate from Albuquerque – the IECC has Roswell in the Albuquerque climate zone
- In some cases, counties are assigned to climate zones based on demographics more than geography. For example, Sandoval County is assigned to the

[1] https://codes.iccsafe.org/content/IECC2021P1/chapter-3-ce-general-requirements

Albuquerque climate zone rather than the Santa Fe zone because most of the county's population lives near Albuquerque.

Table 2 shows the assignment of county to weather zone.

Table 2: Weather Zones by County

County	Weather Zone City
Bernalillo	Albuquerque
Catron	Santa Fe
Chaves	Roswell
Cibola	Albuquerque
Colfax	Santa Fe
Curry	Roswell
De Baca	Albuquerque
Doña Ana	Las Cruces
Eddy	Roswell
Grant	Albuquerque
Guadalupe	Albuquerque
Harding	Santa Fe
Hidalgo	Las Cruces
Lea	Roswell
Lincoln	Albuquerque
Los Alamos	Santa Fe
Luna	Las Cruces

County	Weather Zone City
McKinley	Santa Fe
Mora	Santa Fe
Otero	Las Cruces
Quay	Albuquerque
Rio Arriba	Santa Fe
Roosevelt	Roswell
San Juan	Santa Fe
San Miguel	Santa Fe
Sandoval	Albuquerque
Santa Fe	Santa Fe
Sierra	Las Cruces
Socorro	Albuquerque
Taos	Santa Fe
Torrance	Santa Fe
Union	Albuquerque
Valencia	Albuquerque

2.2 BUILDING TYPES

Residential measures are either applicable to all residences or, in some cases, to one of the following building types:

- Single-family
- Multi-family
- Manufactured home

Commercial measures are often broken out by building type. The selection of building types shown in Table 3 is based on the DEER categories. Utilities may use additional building types, with the proviso that the source for additional building types is well-documented. Utilities may also wish to combine DEER building types. Table 3 shows the building types and their saturations, which can be used to derive weighted average values when combining building types.

Measures reported within the multi-family segment overlap between the residential and commercial segments. For example, in-unit measures would likely be considered residential, while common area and exterior measures would likely be regarded as commercial. Multi-family projects should use measures from the residential and commercial portions of this TRM, as appropriate.

Table 3: DEER 2008 Building Types

Building Type	Abbreviation	Prevalence
Commercial	Com	100.00%
Assembly	Asm	6.10%
Education - Primary School	EPr	2.60%
Education - Secondary School	Ese	2.50%
Education - Community College	ECC	2.30%
Education - University	EUn	2.30%
Education - Relocatable Classroom	ERC	2.50%
Grocery	Gro	4.20%
Health/Medical - Hospital	Hsp	2.20%
Health/Medical - Nursing Home	Nrs	2.20%
Lodging - Hotel	Htl	2.20%
Lodging - Motel	Mtl	2.20%
Manufacturing - Bio/Tech	MBT	5.90%
Manufacturing - Light Industrial	MLI	5.90%
Office - Large	OfL	17.00%
Office - Small	OfS	5.10%
Restaurant - Sit-Down	RSD	1.40%
Restaurant - Fast-Food	RFF	1.40%
Retail - 3-Story Large	Rt3	5.50%
Retail - Single-Story Large	RtL	5.30%
Retail - Small	RtS	5.30%
Storage - Conditioned	SCn	7.40%
Storage - Unconditioned	SUn	7.40%
Storage - Refrigerated Warehouse	WRf	0.80%

2.3 EARLY RETIREMENT

The equations and default parameters throughout the TRM are based on a time of sale or replace on burnout scenario. In these cases, the prevailing energy code is used to set the baseline efficiency. However, real-world scenarios can include early retirement cases, which includes the replacement of functional equipment prior to the end of its useful life.

Starting in 2021, the TRM provides the allowance (but not requirement) of early retirement replacements for HVAC, appliances, and domestic hot water equipment. During an early retirement scenario, program administrators are allowed to use the in-situ baseline for the remaining useful life (RUL) of the pre-existing equipment and then transition to a code-required baseline for the balance of the useful life of the installed equipment. The equipment's RUL will equal one-third of the expected useful life (EUL) of the installed equipment.

For example, residential furnaces (Measure 4.10) have an EUL of 15 years. Under an early retirement scenario, the savings relative to the in-situ baseline are claimed for the first 5 years (5 = 1/3 * 15), and the savings relative to the code-required equipment are claimed for the remaining 10 years.

The burden of proof to claim a particular project as early retirement falls to the program administrator. The evaluator is also responsible for validating that early retirement scenarios are applied appropriately for the various programs. If sufficient data to substantiate early retirement claims is unavailable, the standard efficiency presented in the TRM should be used. To be eligible for early retirement savings, the program administrator should:

1. Provide detailed project-level documentation to substantiate the input parameters, such as efficiency, used in an early retirement calculation for large individual projects, such as large commercial or industrial equipment. This could include operational data or calculations, equipment specifications, or measured data.
2. For smaller projects, provide validation from customers or trade allies that the existing equipment was in proper working condition, and there must be a reasonable estimate of the equipment’s efficiency. Large scale application of a typical in-situ efficiency assumption, for example with a midstream hot water

heater program, will be reviewed on a case-by-case basis between the program administrator and their evaluator.

3. Track savings for early retirement projects separately within program administrator tracking systems to allow for careful evaluation of early retirement savings if warranted by evaluators. Tracking systems must contain the remaining useful life, expected useful life, first-year savings relative to the in-situ baseline, and later savings relative to the code baseline.
4. Ensure that the maximum allowable remaining useful life for any measure is one-third of the installed equipment expected useful life.

The code or standard practice baseline used for the adjusted savings should be equal to the code requirements outlined in the current version of the TRM. Incremental costs for early retirement measures are the full measure replacement costs.

3 COMMERCIAL MEASURES

3.1 LOW-FLOW FAUCET AERATOR

This measure saves water heating energy by reducing the consumption of hot water.

3.1.1 MEASURE OVERVIEW

Sector	Commercial
End use	Water heating
Fuel	Electricity and Natural Gas
Measure category	Low-flow faucet aerators
Delivery mechanism	Direct Install
Baseline description	Federal standard (2.2 GPM), or the average of existing conditions if higher than 2.2 GPM
Efficient case description	Low Flow Faucet Aerator with one of the following nominal flow rates 1) 0.5 gpm 2) 1.0 gpm In one of the following facility types 1) Prison 2) Hospital, Nursing Home 3) Dormitory 4) Hospitality 5) Commercial 6) Middle or High School 7) Elementary School

3.1.2 SAVINGS

The measure applies only to the facility types specified in Table 4, Table 5, and Table 6 which provides the deemed savings values per aerator installed based on the climate zone. For kit-based programs and programs for which the water heating fuel is unknown, multiply the savings listed in the tables below with the type of water-heating system fuel type percentage and the in-service rates (ISR) provided in the variable definitions in Section 3.1.3. The savings listed in Table 4, Table 5, and Table 6 do NOT include the Fuel% or ISR parameters.

For facilities with gas-fired water heaters, energy savings (in therms) from this measure are listed in Table 4.

Table 4: Commercial Low-flow Faucet Aerator Gas Savings (therms)

	Albuquerque		Las Cruces		Roswell		Santa Fe	
Facility Type	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm
Prison	48.8	34.5	36.1	25.4	37.4	26.4	58.7	41.5
Hospital, Nursing Home	4.9	3.4	3.6	2.5	3.7	2.6	5.9	4.1
Dormitory	36.7	25.9	27.1	19.1	28.1	19.8	44.1	31.1
Hospitality	4.9	3.4	3.6	2.5	3.7	2.6	5.9	4.1
Commercial	34.9	24.7	25.8	18.2	26.7	18.9	42.0	29.6
Middle or High School	18.4	11.3	13.6	8.4	14.1	8.7	22.1	13.6
Elementary School	8.3	5.1	6.1	3.8	6.3	3.9	10.0	6.1

Electric savings for facilities with electric water heaters are shown in Table 5.

Table 5: Commercial Low-flow Faucet Aerator Electric Savings (kWh)

	Albuquerque		Las Cruces		Roswell		Santa Fe	
Facility Type	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm
Prison	1,169	825	863	609	895	632	1,405	992
Hospital, Nursing Home	117	82	86	61	89	63	141	99
Dormitory	877	619	647	457	672	474	1,055	745
Hospitality	117	82	86	61	89	63	141	99
Commercial	836	590	617	435	640	452	1,005	709
Middle or High School	441	271	325	200	338	208	530	326
Elementary School	198	122	146	90	152	93	238	147

Electric demand savings are shown in Table 6.

Table 6: Commercial Low-flow Faucet Aerator Electric Demand Savings (kW)

	Albuquerque		Las Cruces		Roswell		Santa Fe	
Facility Type	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm	0.5 gpm	1.0 gpm
Prison	0.1409	0.0994	0.1040	0.0734	0.1079	0.0762	0.1694	0.1196
Hospital, Nursing Home	0.0922	0.0651	0.0681	0.04800	0.0706	0.0498	0.1109	0.0783
Dormitory	0.1409	0.0994	0.1040	0.0734	0.1079	0.0762	0.1694	0.1196
Hospitality	0.0038	0.0027	0.0028	0.0020	0.0029	0.0021	0.0046	0.0033
Commercial	0.0820	0.0579	0.0605	0.0427	0.0628	0.0443	0.0985	0.0696
Middle or High School	0.1410	0.0868	0.1041	0.0641	0.1080	0.0665	0.1696	0.1043
Elementary School	0.0470	0.0289	0.0347	0.0214	0.0360	0.0222	0.0565	0.0348

3.1.3 ENERGY SAVINGS ESTIMATION

Savings are derived using the following formula.[2]

$$Svgs = \frac{(FlowPre - FlowPost) \times 60 \times (TempUsage - TempCold) \times HoursxHeatCapacity \times Density \times Const \times Fuel\% \times ISR}{EffDHW}$$

Where:

Svgs	= *Annual energy savings, in therms*
FlowPre	= *Baseline flow rate, depends on facility type, see Table 7, gpm*
FlowPost	= *Measure flow rate, either 0.5 or 1.0 gpm*
60	= *Minutes to hours conversion*
$Temp_{Usage}$	= *Temperature of water coming out of faucet, 87.8 °F*[3]
$Temp_{Cold}$	= *Temperature of inlet water, see Table 8*
Hours	= *Operating Hours, see Table 7*
Days	= *Days per year faucet is used, depends on facility type, see Table 7*
HeatCapacity	= *Heat capacity of water, 1 Btu per pound per °F*
Density	= *Density of water, 8.33 pounds per gallon*
Const	= *Constant. Gas: 1 therm/100,000 Btus. Electric: 0.00029307107 kWh/Btu*
EffDHW	= *Thermal efficiency of water heater, 0.80 for gas, or 98% for electric*
Fuel%	= *Percentage split between gas, electric and propane water heating. When water heating fuel is known, use 100%. For kit-based and other program types for which the water heating fuel is not known, use territory-specific percentages.*[4] *If territory-specific values are not known, use default values of 50% gas and 50% electricity.*
ISR	= *In-service rate, representing the proportion of distributed showerheads which are actually installed. For direct-install and downstream programs, use 0.95. For kit-based programs, use a territory-specific value; 0.5 for efficiency kits and 0.91 for leave behind kits. If a territory-specific value is not known, use a default value of 0.95.*[5]

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[2] ADM Associates, Evaluation of 2011 DSM Portfolio, New Mexico Gas Company, 2016, citing CLEAResult Workpaper, “Low Flow Aerators – 0.5[1.0] gpm” https://nmgco.com/userfiles/files/MeasurementVerificationReport.pdf

[3] According to Cadmus report “Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study”, the average usage temperature for faucets is 87.8 °F.

[4] US Energy Information Administration. https://www.eia.gov/consumption/commercial/data/2012/bc/cfm/b31.php The percentages shown are based on the West Mountain region in the table.

[5] Illinois Technical Reference Manual V12, measure 4.3.2

Values for facility-dependent parameters including flow and hours are shown in Table 7.

Table 7: Commercial Low-flow Faucet Aerator Facility-dependent Parameters

Facility Type	Baseline Flow Rate (gpm)	Annual Operating Hours
Prison	2.2	182.5
Hospital, Nursing Home	2.2	18.25
Dormitory	2.2	137
Hospitality	2.2	18.25
Commercial	2.2	130.5
Middle or High School	1.8	90
Elementary School	1.8	40.5

Table 8 provides inputs for inlet water temperature based on climate zone.

Table 8: Inlet Water Temperature [6]

Climate Zone	Temperature Cold (°F)
Albuquerque	62.6
Las Cruces	69.2
Roswell	68.5
Santa Fe	57.5

Parameter values are based on the following sources shown in Table 9.[7]

Table 9: Commercial Low-flow Faucet Aerator Parameter Sources

Baseline Flow Rate	The maximum flow rate federal standard for lavatories and aerators was set in the Federal Energy Policy Act of 1992 and codified at 2.2 gpm at 60 psi in 10 CFR 430.32.
Baseline Flow Rate	For schools, field data from school installs in Santa Fe and Albuquerque showed an average initial flow rate of 1.8 gpm.
Measure Flow Rate	Product search shows many products available that cost-effectively ($2 per aerator) meet 1.0 gpm specification. ConservationWarehouse.com
Temperature Usage	According to Cadmus report "Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study," the average usage temperature for faucets is 87.8 °F.
Days per Year	365 for facilities that operate year-round; 365 x (5/7) = 261 for commercial facilities open weekdays; 180 for schools open weekdays except summer; 365 x (9/12) = 274 for dormitories with few occupants in the summer
Minutes per Day	Three minutes per day is assumed for private lavatories used in hotel guest rooms, hospital patient rooms, and nursing homes; Connecticut UI and CLP Program Savings Documentation, September 25, 2009 uses assumption of 3 faucets per household and 1

[6] Average annual cold water temperatures for each city were calculated using Equation 4 in the Department of Energy's "Building America Performance Analysis Procedures for Existing Homes". (https://www.nrel.gov/docs/fy06osti/38238.pdf). Ambient temperatures were taken from TMY3 data for each city.

[7] Ibid

	minute per faucet; Thirty minutes per day faucet use for commercial lavatories from Federal Energy Management Program Energy Cost Calculator for Faucets and Showerheads (reference also used in the Massachusetts TRM), default for aerators in commercial applications. For schools, an initial assumption was made that a faucet runs for 30 minutes per day based on the initial assumption that there are 20 students in each faucet in a school. Field data acquired in fourteen elementary schools in Santa Fe and Albuquerque has shown that, on average, there is one faucet for every 9 students in an elementary school, partially due to additional faucets in classrooms. Minutes per faucet reflect that data (applying a 9/20 ratio to 30 minutes). Limited data for middle and high schools (two middle schools and one high school) shows 22 students per aerator, consistent with the initial assumption of 30 minutes per faucet.
Thermal Efficiency of Water Heater	Minimum federal standard (69 CFR 203, 10-21-2004) for a new commercial gas water heater (gas storage water heater 100 gallon or larger capacity)

3.1.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following formula:

$$Svgs = (\Delta kWh / Hours) * CF$$

Where:

Svgs = *Annual demand savings, in kW*

ΔkWh = *Calculated value for electric energy savings*

Hours = *Operating Hours, see Table 7*

See CF = *Coincidence factor for electric load reduction, see Table 10*

Table 10: Commercial Low-flow Faucet Aerator Coincidence Factor[8]

City	Coincidence Factors
Prison	0.0220
Hospital, Nursing Home	0.0144
Dormitory	0.0220
Hospitality	0.0006
Commercial	0.0128
Middle or High School	0.0288
Elementary School	0.0096

[8] Values taken from measure 4.3.2 in Illinois Technical Reference Manual version 12.0.

3.1.5 NON-ENERGY BENEFITS

Deemed water savings are shown in Table 11 by facility type and flow per installed aerator. Local water and wastewater rates need to be applied to these values to monetize savings.

Table 11: Commercial Low-flow Faucet Aerator Water Savings (gallons)

Facility Type	Water Savings (gal) for a 0.5 gpm unit	Water Savings (gal) for a 1.0 gpm unit
Prison	18,615	13,140
Hospital, Nursing Home	1,862	1,314
Dormitory	13,974	9,864
Hospitality	1,862	1,314
Commercial	13,311	9,396
Middle or High School	7,020	4,320
Elementary School	3,159	1,944

3.1.6 MEASURE LIFE

The lifetime for this measure is 10 years.[9]

3.2 PRE-RINSE SPRAY VALVES

3.2.1 MEASURE OVERVIEW

Sector	Commercial
End use	Water heating
Fuel	Electricity and Natural Gas
Measure category	Low-flow pre-rinse spray valves
Delivery mechanism	Direct Install (retrofit)
Baseline description	Either federal standards or average existing conditions
Efficient case description	1.25 gpm

9 DEER 2014 EUL Table

3.2.2 SAVINGS

The measure applies only to certain facility types, as shown in Table 12, which provides deemed savings values per installed unit.

Table 12: Commercial Low-flow Pre-rinse Spray Valve Savings (therms or kWh per year)

Facility Type	Annual Gas Savings (therms)	Annual Electric Savings (kWh)
Restaurant	175	4,178
Fast Food	36	858
Prison	482	11,525
Hospital	482	11,525
Nursing Home	482	11,525
University Dining Hall	362	8,651
School	119	2,842

3.2.3 ENERGY SAVINGS ESTIMATION

Savings are derived from the following formula.[10]

$$Svgs = \frac{((FlowPre \times UsagePre) - (FlowPost \times UsagePost)) \times DeltaT \times Days \times Const}{EffDHW}$$

Where:

Svgs	*= Annual energy savings, in therms or kWh*
FlowPre	*= Baseline flow rate, 2.25 gpm*
UsagePre	*= Baseline usage duration, depends on facility type, see Table 13, Hours*
FlowPost	*= Measure flow rate, 1.25 gpm*
UsagePost	*= Measure usage duration, depends on facility type, see Table 13, Hours*
DeltaT	*= Temperature difference between hot and cold water, see Table 13, °F*
Days	*= Days per year faucet is used, depends on facility type, see Table 13*
Const	*= Constant. Gas: 8.33 therms/100,000 gallons per °F. Electric: 8.33 Btu/gallon per °F/0.000293071 kWh/Btu for electric*
EffDHW	*= Thermal efficiency of water heater, 0.80 for gas, 98% for electric*

Values for facility-dependent parameters are shown in Table 13.

[10] ADM Associates, Evaluation of 2011 DSM Portfolio, New Mexico Gas Company, 2016, citing CLEAResult Workpaper, “Low Flow Pre-Rinse Spray Valve”. https://nmgco.com/userfiles/files/MeasurementVerificationReport.pdf

Table 13: Commercial Low-flow Pre-rinse Spray Valve Facility-dependent Parameters

Facility Type	Baseline Usage (Hours)	Measure Usage (Hours)	Delta T (°F)	Days per Year
Restaurant	1.27	1.343	65	365
Fast Food	0.54	0.73	52	365
Prison	3.5	3.7	65	365
Hospital	3.5	3.7	65	365
Nursing Home	3.5	3.7	65	365
Dormitory	3.5	3.7	65	274
School	1.75	1.85	65	180

Parameter values are based on the sources listed in Table 14.[11]

Table 14: Commercial Low-flow Pre-rinse Valve Parameter Sources

Average Baseline Flow Rate of Sprayer	Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-4, p. 23
Average Post Measure Flow Rate of Spray Head	Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-5, p. 23
Baseline Water Usage Duration	Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-6, p. 24
	City of Calgary Pre-Rinse Spray Valve Pilot Study, Veritec Consulting Inc., 2005, Table 1, p.7
	CEE Guidance for Pre-Rinse Spray Valves gives 3.0 to 4.0 hours per day operation for institutional applications, averaging at 3.5 hours (210 minutes) per day; apply restaurant ratio of post to pre-retrofit usage (80.6/76.2) to calculate post-retrofit usage of 222 minutes per day
	Assuming that institutions (i.e., prisons, hospitals, nursing homes) are serving three meals a day, prorate schools by 1.5 to 3 (assuming schools serve breakfast to half of the students and lunch to all), yielding 105 minutes per day pre-retrofit, apply restaurant ratio of post to pre- retrofit usage (80.6/76.2) to calculate post-retrofit usage of 111minutes per day.
Post Measure Water Usage Duration	Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-5, p. 23
	CEE Commercial Kitchen Initiative Program Guidance on Pre-Rinse Spray Valves, p. 3
	CEE Guidance for Pre-Rinse Spray Valves gives 3.0 to 4.0 hours per day operation for institutional applications, averaging at 3.5 hours (210 minutes) per day; apply restaurant ratio of post to pre-retrofit usage (80.6/76.2) to calculate post-retrofit usage of 222 minutes per day.

[11] Ibid

	Assuming that institutions (i.e., prisons, hospitals, nursing homes) are serving three meals a day, prorate schools by 1.5 to 3 (assuming schools serve breakfast to half of the students and lunch to all), yielding 105 minutes per day pre-retrofit, apply restaurant ratio of post to pre- retrofit usage (80.6/76.2) to calculate post-retrofit usage of 111minutes per day.
Facility Operating Days per Year	365 for facilities that operate year round; 180 for schools open weekdays except summer, 365 x (9/12) = 274 for dormitories with few occupants in the summer
Average Temperature Differential Between Hot and Cold Water	Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-5, p. 23
	CEE Commercial Kitchen Initiative Program Guidance on Pre-Rinse Spray Valves, p. 3
	Applying temperature differential for restaurants to institutions and schools
Efficiency Of Gas Water Heater	Minimum federal standard (69 CFR 203, 10-21-2004) for a new commercial gas water heater (gas storage water heater 100 gallon or larger capacity).

3.2.4 DEMAND SAVINGS ESTIMATION

There are no demand savings associated with this measure.

3.2.5 NON-ENERGY BENEFITS

Deemed water savings are shown in Table 15 by facility type. Local water and wastewater rates need to be applied to these values to monetize savings.

Table 15: Commercial Low-flow Pre-rinse Valve Water Savings (gallons)

Facility Type	Annual savings (gallons
Restaurant	25,806
Fast Food	6,625
Prison	71,175
Hospital	71,175
Nursing Home	71,175
Dormitory	53,430
School	17,550

3.2.6 MEASURE LIFE

The effective life for this measure is 5 years.[12]

[12] Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, p. 30 https://www.calmac.org/publications/EM&V_report_-_CUWCC_Phase_2_PRSV_Distribution_Program_(2-21-07_FINAL).pdf

3.3 LIGHTING – RETROFIT

This measure category applies to lighting fixtures or lamp upgrades within existing facilities that are not part of a major remodel, which requires the newly installed lighting to meet building energy codes. In general, lighting is considered an early replacement measure where the baseline is equal to pre-existing conditions. An exception is when incandescent lamps are replaced; the baseline in this case is equal to minimum federal standards. The lighting retrofit measure category applies to reductions in lighting wattage. Savings associated with lighting controls are calculated separately.

3.3.1 MEASURE OVERVIEW

Sector	Commercial
End use	Lighting
Fuel	Electricity
Measure category	Lighting - retrofit
Delivery mechanism	Rebate
Baseline description	Either federal standards, existing conditions, or the average of existing conditions
Efficient case description	Fixtures or lamps with lower wattage than the baseline

3.3.2 SAVINGS

Energy Savings can only be attributed to qualified technologies. High-performance and reduced-watt T8 linear fluorescent lamps must be qualified by the Consortium for Energy Efficiency (CEE). Their respective ballasts need to be qualified by National Electrical Manufacturers Association (NEMA). LED lamps and fixtures must be qualified and listed by at least one of the following organizations: DesignLights Consortium (DLC), ENERGY STAR®, or DOE LED Lighting Facts. If all the organizations discontinue fixture qualifications, the TRM must be revised. At the utilities' discretion, LED products not listed on a qualified products list (QPL) may receive approval if results of independent lab testing show the products comply with the Minimum Efficacy (lm/W) and L70 requirements listed in the most current version of the DLC Technical Requirements. In addition, when a product is non-qualified, such as in the case of a product for which a qualification category has not been established, then a custom approach may be used. If a utility chooses to approve a non-qualified LED, it must clearly demonstrate how any non-qualified aspects of the product have been accounted for (e.g., applying a shorter measure life).

Allowable methods of deriving savings are described in the following sections.

3.3.3 ENERGY SAVINGS ESTIMATION

Lighting energy savings (kWh) are derived with the following formula.

$$Svgs = \frac{(kW_{PRE} - kW_{POST})}{1000} \times Quantity \times OperatingHours \times HVAC_{Energy_{Factor}}$$

Where:

Svgs	=	*Annual energy savings, in kWh*
kW_{PRE}	=	*Wattage of the baseline lamp*
kW_{POST}	=	*Wattage of the installed lamp*
OperatingHours	=	*Annual hours the lamp is on, see Table 16 and Table 17.*
HVAC_Energy_Factor	=	*Adjustment to lighting savings to account for the decreased cooling load, see Table 18.*
Quantity	=	*Number of units installed*

The parameters in this equation can be derived with three general methods:

1. Prescriptive
2. Partial-prescriptive
3. Custom

The prescriptive methodology specifies measure descriptions, with baseline and efficient-case wattages embedded in the measure. An example is the replacement of an 8 ft. T-12 magnetic ballast fixtures with 8 ft. T-8 electronic ballast fixtures. Pre- and post-wattages are pre-determined as part of the measure definition. Also, part of the measure definition is annual operating hours, which vary by building type.

The partial-prescriptive methodology allows selection of pre- and post-fixtures or lamps from a wattage table. Certain restrictions apply (e.g., T-12 lamps are not allowed in the post case), but the general requirement is simply that the selections save energy. Operating hours can either be based on building type as shown in Section 3.3.3.2 or be derived from a site-specific schedules.

The custom method allows wattages to be based on product cut sheets and hours to be based on site-specific schedules.

The HVAC Energy Factor is pre-determined in all cases according to building type as shown in Table 18.

3.3.3.1 Wattage Sources

Utilities have flexibility in the sources for the wattage table, but the following restrictions apply.

- Source tables must be published by established and well-known sources and be provided or freely available.
- Sources for the table must be clearly shown.
- Incandescent baseline lamp wattages must be equivalent to federal standards for the year the measure is implemented.
- T-12 lamps and magnetic ballasts are permitted as retrofit baselines for the foreseeable future.
- Replacement ballasts must be electronic.

The following are recommended sources for the wattage table. These tables have been publicly reviewed and approved by state regulatory commissions. The most current version of these tables for the year the measure is implemented shall be used.

- California DEER
- New York Device Codes and Rated Lighting System Wattage Table
- Massachusetts Device Codes and Rated Lighting System Wattage Table - Retrofit
- Pennsylvania TRM Appendix C Lighting Inventory Tool
- State of Illinois Energy Efficiency Technical Reference Manual

Using the custom methodology, efficient fixture wattages can be specified by manufacturer's cut sheets, which are submitted with the application.

3.3.3.2 Operating Hours

Prescriptive hours are derived from DEER 2014 by facility type. Table 16 shows the building's weighted average DEER 2014 commercial lighting operating hours. Additional building types are allowed, with the constraint that the operating hours must be sourced from a published reference. As an alternative to using the building weighted-average operating hours, hours can be assigned on an area-type basis, as shown in Table 17. If using the area-type method, an additional category of "Safety," or "Always on" can be assigned to any of the building types for lights which operate 8,760 hours per year. Either method should be used for all hours assigned to a given facility. When sufficient information exists, using hours on an area-type basis is preferred to using building weighted average hours. A new Building Type "exterior" was added to the existing list of building type list which operates 4,192 hours per year.

Site-specific custom hours may be used if they are estimated using metering or other documented site-specific information (e.g., published hours, customer interviews). Custom operating hours must be derived from a user-entered schedule rather than a single entry for annual hours. The schedule must include entries for weekdays, Saturdays, Sundays, and holidays, and must note whether there is seasonal variation in the schedule.

Table 16: DEER 2014 Commercial Lighting Hours of Use – Building Weighted Average

Lighting Hours of Use	Indoor	Indoor	Outdoor[13]	Saturation
Building Type	**Other**	**Screw-In Bulb**	**All**	
Assembly	2,611	2,300	4,192	6.1%
Education - Primary School	2,140	2,240	4,192	2.6%
Education - Secondary School	2,280	2,330	4,192	2.5%
Education - Community College	2,420	2,420	4,192	2.3%
Education - University	2,350	2,370	4,192	2.3%
Education - Relocatable Classroom	2,480	2,600	4,192	2.5%
Grocery	4,910	3,890	4192	4.2%
Health/Medical - Hospital	5,260	4,200	4,192	2.2%
Health/Medical - Nursing Home	4,160	3,570	4,192	2.2%
Lodging - Hotel	1,950	1,670	4,192	2.2%
Lodging - Motel	1,550	1,370	4,192	2.2%
Manufacturing - Bio/Tech	3,530	3,090	4,192	5.9%
Manufacturing - Light Industrial	3,220	2,580	4,192	5.9%
Office - Large	2,640	3,000	4,192	17.0%
Office - Small	2,590	2,980	4,192	5.1%

[13] Outdoor lighting hours of use is based on the darkness hours provided in the U.S. Naval Observatory (https://aa.usno.navy.mil/data/Dur_OneYear). Also, according to EPE's 2017 metering of streetlights, exterior lights controlled by a photocell turn on approximately 10 minutes after sunset and turn off approximately 10 minutes before sunrise. The above outdoor lighting hours is the average value for Albuquerque, Roswell, Las Cruces and Santa Fe.

Lighting Hours of Use	Indoor	Indoor	Outdoor[13]	Saturation
Building Type	**Other**	**Screw-In Bulb**	**All**	
Restaurant - Sit-Down	4,830	4,830	4,192	1.4%
Restaurant - Fast-Food	4,840	4,810	4,192	1.4%
Retail - 3-Story Large	3,380	3,710	4,192	5.5%
Retail - Single-Story Large	4,270	4,350	4,192	5.3%
Retail - Small	3,380	4,010	4,192	5.3%
Storage - Conditioned	3,420	2,760	4,192	7.4%
Storage - Unconditioned	3,420	2,760	4,192	7.4%
Storage - Refrigerated Warehouse	4,770	4,730	4,192	0.8%
Commercial - general[14]	3,175	3,050	4,192	100%

Table 17: DEER Equivalent Full Load Hours for Screw-in Bulbs and Non-screw-in Fixtures – Area-Type

Building Type	Space Use	Other	Screw-In Bulbs
Assembly	**Whole Building**		
Assembly	Auditorium	2,601	2,304
Assembly	Office (General)	3,395	2,351
Education - Primary School	**Whole Building**		
Education - Primary School	Classroom/Lecture	2,415	2,484
Education - Primary School	Exercising Centers and Gymnasium	2,025	2,273
Education - Primary School	Dining Area	1,330	1,429
Education - Primary School	Kitchen and Food Preparation	1,648	1,724
Education - Secondary School	**Whole Building**		
Education - Secondary School	Classroom/Lecture	2,400	2,443
Education - Secondary School	Office (General)	2,280	2,297
Education - Secondary School	Exercising Centers and Gymnasium	2,322	2,372
Education - Secondary School	Computer Room (Instructional/PC Lab)	2,097	2,363
Education - Secondary School	Dining Area	2,321	2,336
Education - Secondary School	Kitchen and Food Preparation	1,146	1,269
Education – Relocatable Classroom	Whole Building	2,480	2,600
Education - Community College	**Whole Building**		
Education - Community College	Classroom/Lecture	2,705	2,777

[14] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” lighting hours).

Building Type	Space Use	Other	Screw-In Bulbs
Education - Community College	Office (General)	2,878	2,723
Education - Community College	Computer Room (Instructional/PC Lab)	2,396	2,788
Education - Community College	Comm/Ind Work (General, Low Bay)	3,369	2,906
Education - Community College	Dining Area	2,824	2,778
Education - Community College	Kitchen and Food Preparation	3,237	2,759
Education - University	**Whole Building**		
Education - University	Classroom/Lecture	2,419	2,623
Education - University	Office (General)	2,753	2,550
Education - University	Computer Room (Instructional/PC Lab)	2,275	2,733
Education - University	Comm/Ind Work (General, Low Bay)	2,973	2,677
Education - University	Dining Area	2,842	2,620
Education - University	Kitchen and Food Preparation	2,947	2,726
Education - University	Hotel/Motel Guest Room (incl. toilets)	1,147	1,155
Education - University	Corridor	2,851	2,670
Grocery	**Whole Building**		
Grocery	Retail Sales, Grocery	4,988	3,956
Grocery	Office (General)	4,548	3,517
Grocery	Comm/Ind Work (Loading Dock)	4,988	3,956
Grocery	Refrigerated (Food Preparation)	4,402	3,517
Grocery	Refrigerated (Walk-in Freezer)	4,402	3,517
Grocery	Refrigerated (Walk-in Cooler)	4,402	3,517
Health/Medical - Hospital	**Whole Building**		
Health/Medical - Hospital	Office (General)	5,250	4,333
Health/Medical - Hospital	Dining Area	6,312	4,586
Health/Medical - Hospital	Kitchen and Food Preparation	6,312	4,586
Health/Medical - Hospital	Laboratory, Medical	4,587	3,544
Health/Medical - Hospital	Medical and Clinical Care	5,595	4,436
Health/Medical - Nursing Home	**Whole Building**		
Health/Medical - Nursing Home	Hotel/Motel Guest Room (incl. toilets)	4,269	3,526
Health/Medical - Nursing Home	Office (General)	3,640	3,465
Health/Medical - Nursing Home	Corridor	7,708	4,705
Health/Medical - Nursing Home	Dining Area	3,729	3,519
Health/Medical - Nursing Home	Kitchen and Food Preparation	3,729	3,519
Lodging - Hotel	**Whole Building**		
Lodging - Hotel	Hotel/Motel Guest Room (incl. toilets)	793	804
Lodging - Hotel	Corridor	7,828	5,949
Lodging - Hotel	Dining Area	3,460	3,127
Lodging - Hotel	Kitchen and Food Preparation	4,492	3,663

Building Type	Space Use	Other	Screw-In Bulbs
Lodging - Hotel	Bar, Cocktail Lounge	3,793	3,295
Lodging - Hotel	Lobby (Hotel)	7,828	5,949
Lodging - Hotel	Laundry	4,124	3,608
Lodging - Hotel	Office (General)	3,293	3,024
Lodging - Motel	**Whole Building**		
Lodging - Motel	Hotel/Motel Guest Room (incl. toilets)	702	679
Lodging - Motel	Office (General)	5,450	5,516
Lodging - Motel	Laundry	4,381	4,236
Lodging - Motel	Corridor	6,954	5,516
Manufacturing - Bio/Tech	**Whole Building**		
Manufacturing - Bio/Tech	Laboratory, Medical	2,834	2,306
Manufacturing - Bio/Tech	Office (General)	2,865	2,306
Manufacturing - Bio/Tech	Corridor	6,252	6,185
Manufacturing - Bio/Tech	Computer Room (Mainframe/Server)	2,737	2,306
Manufacturing - Bio/Tech	Dining Area	2,737	2,513
Manufacturing - Bio/Tech	Kitchen and Food Preparation	2,737	2,342
Manufacturing - Bio/Tech	Conference Room	3,303	2,362
Manufacturing - Light Industrial	**Whole Building**		
Manufacturing - Light Industrial	Comm/Ind Work (General, High Bay)	3,156	2,574
Manufacturing - Light Industrial	Storage (Unconditioned)	3,473	2,606
Office - Large	**Whole Building**		
Office - Large	Office (Open Plan)	2,630	2,951
Office - Large	Office (Executive/Private)	2,630	2,951
Office - Large	Corridor	2,630	3,675
Office - Large	Lobby (Office Reception/Waiting)	2,681	3,675
Office - Large	Conference Room	2,681	1,568
Office - Large	Copy Room (photocopying equipment)	2,681	3,675
Office - Large	Restrooms	2,681	3,675
Office - Large	Mechanical/Electrical Room	2,681	1,568
Office - Small	**Whole Building**		
Office - Small	Office (Executive/Private)	2,590	2,965
Office - Small	Corridor	2,590	3,249
Office - Small	Lobby (Office Reception/Waiting)	2,590	3,826
Office - Small	Conference Room	2,590	1,505
Office - Small	Copy Room (photocopying equipment)	2,590	3,826
Office - Small	Restrooms	2,590	3,826
Office - Small	Mechanical/Electrical Room	2,590	1,505
Restaurant - Sit-Down	**Whole Building**		

Building Type	Space Use	Other	Screw-In Bulbs
Restaurant - Sit-Down	Dining Area	4,851	4,851
Restaurant - Sit-Down	Lobby (Main Entry and Assembly)	4,851	4,851
Restaurant - Sit-Down	Kitchen and Food Preparation	4,819	4,819
Restaurant - Sit-Down	Restrooms	4,620	4,620
Restaurant - Fast-Food	**Whole Building**		
Restaurant - Fast-Food	Dining Area	4,855	4,825
Restaurant - Fast-Food	Lobby (Main Entry and Assembly)	4,855	4,825
Restaurant - Fast-Food	Kitchen and Food Preparation	4,817	4,787
Restaurant - Fast-Food	Restrooms	4,682	4,653
Retail - 3-Story Large	**Whole Building**		
Retail - 3-Story Large	Retail Sales and Wholesale Showroom	3,554	3,997
Retail - 3-Story Large	Storage (Conditioned)	2,708	2,564
Retail - 3-Story Large	Office (General)	2,602	2,564
Retail - Single-Story Large	**Whole Building**		
Retail - Single-Story Large	Retail Sales and Wholesale Showroom	5,545	5,147
Retail - Single-Story Large	Storage (Conditioned)	3,409	3,004
Retail - Single-Story Large	Office (General)	3,379	3,122
Retail - Single-Story Large	Auto Repair Workshop	4,269	4,588
Retail - Single-Story Large	Kitchen and Food Preparation	4,193	4,503
Retail - Small	**Whole Building**		
Retail - Small	Retail Sales and Wholesale Showroom	3,510	4,325
Retail - Small	Storage (Conditioned)	2,860	2,748
Storage - Conditioned	**Whole Building**		
Storage - Conditioned	Storage (Conditioned)	3,420	2,760
Storage - Conditioned	Office (General)	3,420	2,760
Storage - Unconditioned	**Whole Building**		
Storage - Unconditioned	Storage (Unconditioned)	3,420	2,760
Storage - Unconditioned	Office (General)	3,420	2,760
Warehouse – Refrigerated	**Whole Building**		
Warehouse – Refrigerated	Refrigerated (Frozen Storage)	4,791	4,767
Warehouse – Refrigerated	Refrigerated (Cooled Storage)	4,791	4,767
Warehouse – Refrigerated	Comm/Ind Work (Loading Dock)	4,791	4,767
Warehouse – Refrigerated	Office (General)	3,502	2,690

3.3.3.3 HVAC Energy Factor

This parameter accounts for the reduced cooling load due to the reduction in internal lighting waste heat from the replacement of pre-existing equipment. Values for each building type are shown in Table 18[15]. Albuquerque values were adjusted for other climate zones using a ratio of commercial cooling hours for the respective climate zones (see Commercial High Efficiency Packaged Air Conditioning measure).

Table 18: Statewide Table of HVAC Interactive Energy Factors

Building Type	Albuquerque	Santa Fe	Roswell	Las Cruces
College/University	1.169	1.101	1.198	1.181
Grocery	1.082	1.049	1.096	1.088
Heavy Industry	1.024	1.014	1.028	1.026
Hotel/Motel	1.372	1.222	1.437	1.399
Light Industry	1.024	1.014	1.028	1.026
Medical	1.285	1.170	1.334	1.306
Office	1.216	1.129	1.254	1.232
Restaurant	1.207	1.124	1.243	1.223
Retail/Service	1.196	1.117	1.230	1.210
K-12 School	1.295	1.176	1.346	1.316
Warehouse	1.048	1.029	1.057	1.052
Dwelling Unit	1.372	1.222	1.437	1.399
Miscellaneous	1.191	1.114	1.224	1.205
Garage	1.000	1.000	1.000	1.000
Exterior	1.000	1.000	1.000	1.000

3.3.3.4 Refrigerated Space HVAC Factors

When lighting is upgraded inside refrigerated spaces, the reduced load on the refrigeration system applies for all lighting hours, not just when the outside temperature is high. HVAC energy and demand factors are shown in Table 19 for lighting in refrigerated spaces.[16]

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[15] Values were derived by KEMA for PNM using simulations with Albuquerque weather. (Public Service Company of New Mexico Commercial and Industrial Incentive Program Work Papers, 2018.)

16 EPE regulatory filing, based on a number of secondary sources.

Table 19: Lighting Energy and Demand Factors for Refrigerated Spaces

Refrigerated Space Type	Energy Factor	Demand Factor
Freezer	1.3	1.3
Cooler	1.25	1.25

3.3.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure between 3:00 to 6:00 pm on the hottest summer weekdays. Demand savings are derived from the following equation.

$$Svgs = (kW_{PRE} - kW_{POST}) \times HVAC_{Demand_{Factor}} \times Coincident_{Factor}$$

Where:

Svgs	= *Demand savings, in kW*
kWPRE	= *Wattage of the baseline lamp (divided by 1,000)*
kWPOST	= *Wattage of the installed lamp (divided by 1,000)*
Coincident_Factor	= *Adjusts the gross kW savings to account for overlap with the peak period, see Table 20.*
HVAC_Demand_Factor	= *Adjustment to lighting savings to account for the decreased cooling load, see Table 20.*

The HVAC Demand Factor parameter accounts for the reduced cooling load due to the reduction in internal lighting waste heat. Values derived for Albuquerque are a good estimate for statewide values. Single statewide values for each building type are shown in Table 20[17], which also shows the Coincident Factor, which accounts for the overlap between the kW reduction and the peak period.

[17] Values Were Derived by KEMA for PNM Using Simulations with Albuquerque Weather. (Public Service Company of New Mexico Commercial and Industrial Incentive Program Work Papers, 2018.)

Table 20: Statewide Table of HVAC Interactive Demand Factors and Coincidence Factors

Building Type	Coincident Factor	HVAC Demand Factor
College/University	0.76	1.326
Grocery	0.69	1.337
Heavy Industry	0.85	1.054
Hotel/Motel	0.86	1.237
Light Industry	0.92	1.054
Medical	0.75	1.344
Office	0.70	1.374
Restaurant	0.81	1.313
Retail/Service	0.83	1.283
K-12 School	0.64	1.311
Warehouse	0.70	1.093
Dwelling Unit	0.095	1.237
Miscellaneous	0.72	1.247
Garage	1	1.000
Exterior	0	1.000

3.3.5 NON-ENERGY BENEFITS

Well-designed lighting retrofits generally result in higher quality lighting.

3.3.6 MEASURE LIFE

The measure life for commercial lighting depends on the type of lighting installed and the building type impacted. Values are shown in Table 21[18].

[18] DEER 2014 EUL Table

Table 21: Statewide Table of Lighting Measure Life (years)

Enduse	Measure	Effective Useful Life
Indoor Lighting	CFL Fixtures	12
Indoor Lighting	CFL Lamps	EUL varies by building type
Indoor Lighting	Exit Lighting	16
Indoor Lighting	Linear Fluorescents	EUL varies by building type
Indoor Lighting	Linear Fluorescent - Fixtures	16
Indoor Lighting	LEDs (including LED tubes)	EUL varies by building type
Outdoor Lighting	HID Lighting - High Pressure Sodium	15
Outdoor Lighting	HID Lighting - Metal Halide	15
Outdoor Lighting	HID Lighting (T-5)	15
Outdoor Lighting	CFL Lamps	2.44
Outdoor Lighting	LEDs	16
Indoor Lighting	HID Lighting - High Pressure Sodium	EUL varies by building type
Indoor Lighting	HID Lighting - Metal Halide	EUL varies by building type
Indoor Lighting	HID Lighting (T-5)	EUL varies by building type

Values which vary by building type are shown in Table 22.

Table 22: Lighting Measure Life (years) by Building Type

Building Type	CFL	Screw-In LED Bulbs[19]	Other LED[20]	Other
Assembly	4.37	21.7	19.1	15
Education - Primary School	4.17	22.3	23.4	15
Education - Secondary School	4.02	21.5	21.9	15
Education - Community College	4.38	20.7	20.7	15
Education - University	4.08	21.1	21.3	15
Education - Relocatable Classroom	3.76	19.2	20.2	15

[19] Screw-In LED Bulb measure life determined by dividing 50,000 rated LED hours by the Screw-In Bulb annual operating hours listed in Table 16

[20] Screw-In LED Bulb measure life determined by dividing 50,000 rated LED hours by the Other annual operating hours listed in Table 16

Building Type	CFL	Screw-In LED Bulbs[21]	Other LED[22]	Other
Grocery	2.58	12.9	10.2	14.33
Health/Medical - Hospital	2.45	11.9	9.5	14.34
Health/Medical - Nursing Home	2.8	14	12	15
Lodging - Hotel	6.02	29.9	25.6	15
Lodging - Motel	6.57	36.5	32.3	15
Manufacturing - Bio/Tech	2.86	16.2	14.2	15
Manufacturing - Light Industrial	3.82	19.4	15.5	15
Office - Large	3.17	16.7	18.9	15
Office - Small	3.25	16.8	19.3	15
Restaurant - Sit-Down	2.08	10.4	10.4	14.54
Restaurant - Fast-Food	2.07	10.4	10.3	14.48
Retail - 3-Story Large	2.7	13.5	14.8	15
Retail - Single-Story Large	2.62	11.5	11.7	15
Retail - Small	2.69	12.5	14.8	15
Storage - Conditioned	3.6	18.1	14.6	15
Storage - Unconditioned	3.6	18.1	14.6	15
Storage - Refrigerated Warehouse	2.09	10.6	10.5	14.59
Commercial - general	3.24	21.7	19.1	15

3.4 LIGHTING – NEW CONSTRUCTION

This measure category applies to the installation of lighting fixtures or lamps within new facilities, or part of a major remodel for an existing facility where newly installed lighting is required to meet building energy Codes.

[21] Screw-In LED Bulb measure life determined by dividing 50,000 rated LED hours by the Screw-In Bulb annual operating hours listed in Table 16

[22] Screw-In LED Bulb measure life determined by dividing 50,000 rated LED hours by the Other annual operating hours listed in Table 16

3.4.1 MEASURE OVERVIEW

Sector	Commercial
End use	Lighting
Fuel	Electricity
Measure category	Lighting - new
Delivery mechanism	Rebate
Baseline description	Code: IECC 2021
Efficient case description	Fixtures or lamps with lower wattage than the baseline

3.4.2 SAVINGS

This measure applies to reductions in lighting wattage; savings due to lighting controls are calculated separately after lighting wattage savings are determined. The baseline is equal to code-minimum requirements. Allowable methods of deriving savings are described below.

3.4.3 ENERGY SAVINGS ESTIMATION

Savings can be calculated using the Lighting Power Density (LPD) method or a fixture-by-fixture method.

With the LPD method, either the Building Area Method as defined in IECC 2021, or the Space-by-Space Method as defined in ASHRAE 90.1 2016 can be used to calculate the Interior Lighting Power Density. Savings for each space are determined using the following equation.

$$Svgs = (LPD_{CODE} \times SquareFeet - (\Sigma\ Watts/1000)) \times OperatingHours \times HVAC_{Energy_{Factor}}$$

Where:

Svgs	= *Annual energy savings, in kWh*
LPD_{CODE}	= *Code Lighting Power Density, W/ft²*, see *Table 23*
SquareFeet	= *Square footage of the building or space area with the given LPD*
Watts	= *Sum of fixture wattage*
OperatingHours	= *Annual hours the lamp is on, see note below*
$HVAC_{EnergyFactor}$	= *Adjustment to lighting savings to account for the decreased cooling load, see note below*

Operating Hours, kWPOST, and HVAC Energy Factor are determined as described in the "Lighting – Retrofit" section. LPDCODE values by building type are shown in Table 23.

Table 23: Baseline LPD by Building Type

Building Area Type	Lighting Power Density (W/ft^2)
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: Bar Lounge/Leisure	0.8
Dining: Cafeteria/Fast Food	0.76
Dining: Family	0.71
Dormitory	0.53
Exercise Center	0.72
Gymnasium	0.76
Fire station	0.56
Health Care Clinic	0.81
Hospital	0.96
Hotel/Motel	0.56
Library	0.83
Manufacturing facility	0.82
Motion Picture Theater	0.44
Multifamily	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing Arts Theater	0.84
Police Station	0.66
Post Office	0.65
Religious Building	0.67
Retail	0.84
School/University	0.72
Sports Arena	0.76
Town Hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

Allowable LPDs by space-type are shown in Table 24.[23]

Table 24: Baseline Interior LPD by Space Type

Common Space Types	LPD (watts/ft^2)	Building Type Specific Space Types	LPD (watts/ft^2)
Atrium		**Automotive (See Vehicular maintenance area)**	
Less than 40 feet in height	0.48	Convention Center—exhibit space	0.61
Greater than 40 feet in height	0.60	Dormitory—living quarters	0.50
Audience seating area		Facility for the visually impaired	
In an auditorium	0.61	In a chapel (and not used primarily by the staff	0.70
In a convention center	0.82	In a recreation room (and not used primarily by the staff)	1.77
In a gymnasium	0.23	Fire Station—sleeping quarters	0.23
In a motion picture theater	0.27	Gymnasium/fitness center	
In a penitentiary	0.67	In an exercise area	0.90
In a performing arts theater	1.16	In a playing area	0.85
In a religious building	0.72	Healthcare facility	
In a sports arena	0.33	In an exam/treatment room	1.40
Otherwise	0.33	In an imaging room	0.94
Banking activity area	0.61	In a medical supply room	0.62
Classroom/lecture hall/training room		In a nursery	0.92
In a penitentiary	0.89	In a nurse's station	1.17
Otherwise	0.71	In an operating room	2.26
Computer room, Data Center	0.94	In a patient room	0.68
Conference/meeting/multipurpose room	0.97	In a physical therapy room	0.91
Copy/print room	0.31	In a recovery room	1.25
Corridor		Library	
In a facility for the visually impaired (and not used primarily by the staff)	0.71	In a reading area	0.96
In a hospital	0.71	In the stacks	1.18
In a manufacturing facility	0.29	Manufacturing facility	
Otherwise	0.41	In a detailed manufacturing area	0.80
Courtroom	1.20	In an equipment room	0.76
Dining area		In an extra-high-bay area (greater than 50' floor-to-ceiling height)	1.42
In bar/lounge or leisure dining	0.86	In a high-bay area (25-50' floor-to-ceiling height)	1.24
In cafeteria or fast food dining	0.40	In a low-bay area (less than 25' floor-to-ceiling height)	0.86
In a facility for the visually impaired (and not used primarily by the staff)	1.27	Museum	
In family dining	0.60	In a general exhibition area	0.31
In a penitentiary	0.42	In a restoration room	1.10
Otherwise	0.43	Performing arts theater—dressing room	0.41
Electrical/mechanical room	0.43	Post office—sorting area	0.76
Emergency vehicle garage	0.52	Religious buildings	

[23] IECC2021

Common Space Types	LPD (watts/ft^2)	Building Type Specific Space Types	LPD (watts/ft^2)
Food preparation area	1.09	In a fellowship hall	0.54
Guestroom	0.41	In a worship/pulpit/choir area	0.85
Laboratory		Retail facilities	
In or as a classroom	1.11	In a dressing/fitting room	0.51
Otherwise	1.33	In a mall concourse	0.82
Laundry/washing area	0.53	Sports arena—playing area	
Loading dock, interior	0.88	For a Class I facility	2.94
Lobby		For a Class II facility	2.01
For an elevator	0.65	For a Class III facility	1.30
In a facility for the visually impaired (and not used primarily by the staff)	1.69	For a Class IV facility	0.86
In a hotel	0.51	Transportation facility	
In a motion picture theater	0.23	In a baggage/carousel area	0.39
In a performing arts theater	1.25	In an airport concourse	0.25
Otherwise	0.84	At a terminal ticket counter	0.51
Locker room	0.52	Warehouse—storage area	
Lounge/breakroom		For medium to bulky, palletized items	0.33
In a healthcare facility	0.42	For smaller, hand-carried items	0.69
Otherwise	0.59	Warehouse	
Office		Fine Material Storage	1.4
Enclosed	0.74	Medium/Bulky Material Storage	0.9
Open plan	0.61	Parking Garage—Garage Area	0.2
Parking area, interior	0.15	Transportation	
Pharmacy area	1.66	Airport—Concourse	0.6
Restroom		Air/Train/Bus—Baggage Area	1
In a facility for the visually impaired (and not used primarily by the staff)	1.26	Terminal—Ticket Counter	1.5
Otherwise	0.63		
Sales area	1.05		
Seating area, general	0.23		
Stairwell	0.49		
Storage room <50 ft^2	0.97		
Storage room ≥50 ft^2 ≤1000 ft^2	0.46		
Storage room	0.38		
Vehicular maintenance area	0.60		
Workshop	1.26		

Exterior LPD are shown in Table 25.

Table 25: Baseline Exterior LPD[24]

		Zone 1	Zone 2	Zone 3	Zone 4
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.03W/ft^2	0.04 W/ft^2	0.06 W/ft^2	0.08 W/ft^2
	Building Grounds				
	Walkways and ramps less than 10 feet wide	0.5 W/linear foot	0.5 W/linear foot	0.6 W/linear foot	0.7 W/linear foot
	Walkways and ramps10 feet wide or greater, plaza areas special feature areas	0.10 W/ft^2	0.10 W/ft^2	0.11 W/ft^2	0.14 W/ft^2
	Dining areas	0.65 W/ft^2	0.65 W/ft^2	0.75 W/ft^2	0.95 W/ft^2
	Stairways	0.6 W/ft^2	0.7 W/ft^2	0.7 W/ft^2	0.7 W/ft^2
	Pedestrian Tunnels	0.12 W/ft^2	0.12 W/ft^2	0.14 W/ft^2	0.21 W/ft^2
	Landscaping	0.03 W/ft^2	0.04 W/ft^2	0.04 W/ft^2	0.04 W/ft^2
	Building Entrances and Exits				
	Pedestrian and Vehicular entrances and exits	14 W/linear foot of door width	14 W/linear foot of door width	21 W/linear foot of door width	21 W/linear foot of door width
	Entry canopies	0.20 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
	Loading Docks	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
	Sales Canopies				
	Free standing and attached	0.4 W/ft^2	0.4 W/ft^2	0.6 W/ft^2	0.7 W/ft^2
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.20 W/ft^2	0.20 W/ft^2	0.35 W/ft^2	0.50 W/ft^2
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot
	Outdoor Sales				
Non tradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
	Automated teller machines (ATM) and night depositories	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location
	Uncovered entrances and gatehouse inspection stations at guarded facilities	0.50 W/ft^2 of area	0.50 W/ft^2 of area	0.50 W/ft^2 of area	0.50 W/ft^2 of area
	Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.35 W/ft^2 of area	0.35 W/ft^2 of area	0.35 W/ft^2 of area	0.35 W/ft^2 of area
	Drive-up windows/doors	200W per drive-through	200W per drive-through	200W per drive-through	200W per drive-through
	Parking near 24-hour retail entrances	400W per main entry	400W per main entry	400W per main entry	400W per main entry

The fixture-by-fixture method follows a similar approach as outlined in lighting – retrofit section and requires the assignment of a baseline fixture to each installed fixture. If all fixtures within a space are new, then all the fixtures must be included within a calculation, with the exception of those exempted by IECC. Calculations for these scenarios must show that the baseline meets code LPD requirements.

Linear fluorescent baseline fixtures shall be defined as standard T8 lighting with electronic ballast. In high-bay applications, the baseline shall be defined as pulse-start metal halide lighting. Screw-in baseline lamps must meet EISA efficacy requirements.

3.4.4 DEMAND SAVINGS ESTIMATION

Using the LPD method, peak demand savings are determined with the following equation:

$$Svgs = (LPD_{CODE} \times SquareFeet - (\Sigma\, Watts/1000)) \times HVAC_{Demand_{Factor}} \times Coincident_{Factor}$$

Where:

Svgs	= *Peak demand savings, in kW*
LPD_{CODE}	= *Code Lighting Power Density, W/ft^2, see note below*
SquareFeet	= *Square footage of the building area with the given LPD*
Watts	= *Sum of fixture wattage*
$Coincident_{Factor}$	= *Adjusts the gross kW savings to account for overlap with the peak period, see below*
$HVAC_{DemandFactor}$	= *Adjustment to lighting savings to account for the decreased cooling load, see below*

HVAC Demand Factor, Coincident Factor, and kW_{POST} are determined as described in the "Lighting – Retrofit" section. LPD_{CODE} is determined as described above, by building type or by space type.

Using the fixture-by-fixture method, savings are determined as described in the "Lighting – Retrofit" section.

3.4.5 NON-ENERGY BENEFITS

Well-designed lighting systems generally result in higher quality lighting.

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[24] IECC 2021 Tables C405.5.2(2) and C405.5.2(3).

3.4.6 MEASURE LIFE

Measure life is determined as described in the “Lighting – Retrofit” section.

3.5 LIGHTING – CONTROLS

This measure category applies to the implementation of controls for retrofitted lighting fixtures or lamps, for pre-existing lighting fixtures or lamps, or for lighting fixtures or lamps installed within new facilities where building energy codes do not require controls. The baseline is equal to the lighting without controls.

3.5.1 MEASURE OVERVIEW

Sector	Commercial
End use	Lighting
Fuel	Electricity
Measure category	Lighting controls – new construction or retrofit
Delivery mechanism	Rebate
Baseline description	Lighting with either no controls, or manual controls
Efficient case description	Lighting controlled by occupancy sensor, interior lighting with daylighting controls, or exterior lighting with photocell controls

3.5.2 SAVINGS

Allowable methods of deriving savings are described below, which are derived from the prescriptive methods used by ADM Associates in its evaluations of the New Mexico utilities. The methodology used by the New Mexico utilities and other energy efficiency programs is also compared within this section.

3.5.3 ENERGY SAVINGS ESTIMATION

Savings are determined by the following equation.

$$Svgs = kW_{POST} \times Operating_{Hours} \times \ Controls\ Factor \times HVAC_{Energy_{Factor}}$$

Where:

$Svgs$ = *Annual energy savings, in kWh*

kW_{POST} = *Power draw of the controlled lamps*

$Operating_{Hours}$	= *Annual hours the lamp is on in the baseline, determined in a similar method to a standard lighting measure*
Controls Factor	= *% savings achieved by controls,* see *Table 26*
HVAC_Energy_Factor	= *Adjustment to lighting savings to account for the decreased cooling load, as for a standard lighting measure*

Table 26: Lighting Controls Factor per Technology[25]

Control Type	Definition	Relevant Technology	Controls Factor
Occupancy	Adjusting light levels according to the presence of occupants	Occupancy sensors, time clocks, energy management system	24%
Daylighting	Adjusting light levels automatically in response to the presence of natural light	Photosensors, time clocks	28%
Personal Tuning	Adjusting individual light levels by occupants according to their personal preferences; for example, to private offices, workstation-specific lighting in open-plan offices, and classrooms	Dimmers, wireless on-off switches, bi-level switches, computer-based controls, pre-set scene selection	31%
Institutional	(1) Adjustment of light levels through commissioning and technology to meet location specific needs or building policies; or (2) provision of switches or controls for areas or groups of occupants; examples of the former include high-end trim dimming (also known as ballast tuning or reduction of ballast factor), task tuning, and lumen maintenance	Dimmable ballasts, on-off or dimmer switches for non-personal lighting	36%
Multiple Approaches	Any combination of two or more of the above strategies	Any combination of two or more of the above strategies	38%

3.5.4 DEMAND SAVINGS ESTIMATION

Demand savings are derived from the following equation.

$$Svgs = kW_{POST} \times \text{Controls Factor} \times HVAC_{Demand_{Factor}} \times CoincidentFactor$$

Where:

Svgs	= *Demand savings, in kW*
kW_{POST}	= *Power draw of the controlled lamps*
HVAC_Demand_Factor	= *Adjustment to lighting savings to account for the decreased cooling load, as for a standard lighting measure, see Table 20*

[25] LBNL, A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings. http://eta-publications.lbl.gov/sites/default/files/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

CoincidentFactor = *Adjust the gross kW savings to account for overlap with the peak period, see Table 20.*

3.5.5 NON-ENERGY BENEFITS

Well-designed daylighting increases occupant comfort and productivity.

3.5.6 MEASURE LIFE

Measure life for lighting controls is 8 years.[26]

Table 27: Lighting Controls Measure Cost

Control Type	Measure Cost
Occupancy sensor, wall-mounted	$55
Occupancy sensor, ceiling-mounted	$125
Daylighting control	$65
Photocell	$60

3.6 HIGH EFFICIENCY PACKAGED/SPLIT AIR CONDITIONING/HEAT PUMP SYSTEM

This measure promotes the installation of high-efficiency unitary air-cooled air conditioning or heat pump equipment, including both single-package and split systems. This measure applies to the replacement of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building.

3.6.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity
Measure category	High Efficiency Packaged Air Conditioning/Heat Pump
Delivery mechanism	Rebate
Baseline description	IECC 2021 efficiency
Efficient case description	Efficiency must exceed IECC 2021

[26] DEER 2014 EUL Table.

3.6.2 SAVINGS

Savings are calculated on a building type basis according to system capacity and efficiency level as described below.

3.6.3 ENERGY SAVINGS ESTIMATION

Savings for units under 5.4 tons are determined with the following equations:

$$Svgs = Cooling\ Savings + Heating\ Savings$$ [30]

$$Cooling\ Savings = Cooling\ Capacity \times Cooling\ EFLH \times \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{Post}}\right)$$

$$Heating\ Savings = Heating\ Capacity \times Heating\ EFLH \times \left(\frac{1}{HSPF_{Base}} - \frac{1}{HSPF_{Post}}\right)$$

Savings for units between 5.4 tons and 20 tons are determined with the following equations:

$$Svgs = Cooling\ Savings + Heating\ Savings$$ [30]

$$Cooling\ Savings = Cooling\ Capacity \times Cooling\ EFLH \times \left(\frac{1}{IEER_{Base}} - \frac{1}{IEER_{Post}}\right)$$

$$Heating\ Savings = Heating\ Capacity \times Heating\ EFLH \times 0.293 \times \left(\frac{1}{COP_{Base}} - \frac{1}{COP_{Post}}\right)$$

Savings for units 20 tons and greater are determined with the following equations:

$$Svgs = Cooling\ Savings + Heating\ Savings$$

$$Cooling\ Savings = Cooling\ Capacity \times Cooling\ EFLH \times \left(\frac{1}{IPLV_{Base}} - \frac{1}{IPLV_{Post}}\right)$$

$$Heating\ Savings = Heating\ Capacity \times Heating\ EFLH \times 0.293 \times \left(\frac{1}{COP_{Base}} - \frac{1}{COP_{Post}}\right)$$

Where:

Svgs	= *Annual energy savings, in kWh*
Cooling Savings	= *Annual cooling energy savings, in kWh*
Heating Savings	= *Annual heating energy savings, in kWh*
Cooling Capacity	= *System cooling capacity, in kBtu/h*
Cooling EFLH	= *Effective full load cooling hours, see Table 30*
SEER	= *Seasonal Energy Efficiency Ratio, nominal rating of system in Btu/Wh, see Table 28 for baseline values*
IEER	= *Integrated Energy Efficiency Ratio, nominal rating of system in Btu/Wh, see Table 28*
for baseline values	
IPLV	= *Integrated Part Load Value, nominal rating of system in Btu/Wh, see Table 28 for baseline values*
Heating Capacity	= *System heating capacity, in kBtu/h*
Heating EFLH	= *Effective full load heating hours, see Table 31.*
HSPF	= *Heating Seasonal Performance Factor, nominal rating of system in Btu/Wh, see Table 28*
for baseline values.	
COP	= *Coefficient of Performance, nominal rating of packaged system in Btu/Btu, see Table 28*
for baseline values.	
0.293	= *Convert from kBtu to kWh*

Baseline efficiencies for packaged AC systems are shown in Table 28 and heat pumps systems are shown in Table 29.[27] Early retirement baselines are also eligible and should follow the guidance outlined in Section 2.3.

[27] IECC 2021 Table C403.3.2(1) and Table C403.3.2(2).

Table 28: Packaged AC System Baseline Efficiency Ratings

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency
Air Conditioners, Air cooled	< 65,000 Btu/h	Split system	13.0 SEER (before 1/1/2023) 13.4 SEER2 (after 1/1/2023)
		Single package	14.0 SEER (before 1/1/2023) 13.4 SEER2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.2 EER 12.9 IEER (before 1/1/2023) 14.8 IEER (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER 12.4 IEER (before 1/1/2023) 14.2 IEER (after 1/1/2023)
	≥240,000 Btu/h and <760,000 Btu/h	Split system and single package	10.0 EER 11.6 IEER (before 1/1/2023) 13.2 IEER (after 1/1/2023)
	≥760,000 Btu/h	Split system and single package	9.7 EER 11.2 IEER (before 1/1/2023) 12.5 IEER (after 1/1/2023)

Table 29: Heat Pump System Baseline Efficiency Ratings

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[a]
Heat Pumps, Air cooled (Cooling mode)	< 65,000 Btu/h	Split system	14.0 SEER (before 1/1/2023) 14.3 SEER2 (after 1/1/2023)
		Single package	14.0 SEER (before 1/1/2023) 13.4 SEER2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.0 EER 12.2 IEER (before 1/1/2023) 14.1 IEER (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	10.6 EER 11.6 IEER (before 1/1/2023) 13.5 IEER (after 1/1/2023)
	≥240,000 Btu/h	Split system and single package	9.5 EER 10.6 IEER (before 1/1/2023) 12.5 IEER (after 1/1/2023)
Heat Pumps, Air cooled (Heating mode)	< 65,000 Btu/h (cooling capacity)	Split system	8.2 HSPF (before 1/1/2023) 7.5 HSPF2 (after 1/1/2023)
		Single package	8.0 HSPF (before 1/1/2023) 6.7 HSPF2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	47-F db/43-F wb Outdoor air	3.3 COP (before 1/1/2023) 3.4 COP (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h (cooling capacity)	47-F db/43-F wb Outdoor air	3.2 COP (before 1/1/2023) 3.3 COP (after 1/1/2023)
	≥240,000 Btu/h	47-F db/43-F wb Outdoor air	3.2 COP

[a] Deduct 0.2 from the required EERs, SEERs and IEERs for units with a heating section other than electric resistance heat

Cooling EFLH values, derived from eQuest simulations of DEER building prototypes, are shown in Table 30.

Table 30: Cooling EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	1,471	1,343	1,576	812
Education - Community College	1,085	1,290	1,360	629
Education - Primary School	436	508	554	289
Education - Relocatable Classroom	490	560	595	354
Education - Secondary School	450	479	555	213
Education - University	1,032	1,233	1,324	643
Grocery	824	961	1,038	391
Health/Medical – Hospital	1,189	1,181	1,387	604
Health/Medical - Nursing Home	984	958	1,206	481
Lodging - Hotel	1,521	1,679	1,797	974
Manufacturing - Bio/Tech	1,115	1,238	1,332	795
Manufacturing - Light Industrial	743	958	950	519
Office - Small	1,083	1,174	1,292	770
Restaurant - Fast-Food	1,271	1,267	1,377	754
Restaurant - Sit-Down	1,236	1,218	1,361	681
Retail - Single-Story Large	1,437	1,470	1,603	885
Retail - Small	1,296	1,361	1,438	847
Storage - Conditioned	492	698	697	336
Warehouse - Refrigerated	1,477	1,498	1,596	745
Other[28]	1,033	1,109	1,213	617

Heating EFLH values are shown in Table 31. Heating EFLH values are derived from the Texas TRM version 5, adjusting the Texas values based on heating degree-days comparisons between Amarillo, Albuquerque, and Santa Fe, and El Paso, Las Cruces, and

[28] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the "Office – Small" EFLH).

Roswell. Values that are blank in the Texas TRM were entered as NP (Not provided) in Table 31.

Table 31: Heating EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	NP	NP	NP	NP
Education - Community College	NP	NP	NP	NP
Education - Primary School	698	500	497	929
Education - Relocatable Classroom	733	528	525	975
Education - Secondary School	733	528	525	975
Education - University	NP	NP	NP	NP
Grocery	NP	NP	NP	NP
Health/Medical – Hospital	NP	NP	NP	NP
Health/Medical - Nursing Home	NP	NP	NP	NP
Lodging - Hotel	782	383	381	1,040
Manufacturing - Bio/Tech	339	179	178	450
Manufacturing - Light Industrial	339	179	178	450
Office - Small	339	179	178	450
Restaurant - Fast-Food	1,025	639	636	1,363
Restaurant - Sit-Down	1,119	751	747	1,488
Retail - Single-Story Large	903	470	468	1,202
Retail - Small	750	549	546	998
Storage - Conditioned	NP	NP	NP	NP
Warehouse - Refrigerated	NP	NP	NP	NP
Other[29]	339	179	178	450

[29] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the "Office – Small" EFLH)

3.6.4 DEMAND SAVINGS ESTIMATION

Peak demand savings are determined using the following equation:

$$PeakSvgs = Cooling\ Capacity \times \left(\frac{1}{EER_{Base}} - \frac{1}{EER_{Post}}\right) \times CF$$

Where:

CF = Coincidence Factor, see Table 32.

Other parameters are as defined above for energy savings.

For units only rated in SEER, SEER can be converted to EER using the formula:[30]

$$EER2 = -0.02 * SEER2^2 + 1.12 * SEER2$$

Coincidence factors are shown in Table 32. These values were derived from the Texas TRM version 5. The value for El Paso was used for Las Cruces, the value for Amarillo was used for Roswell, and the average of these two values was used for Albuquerque and Santa Fe.

Table 32: CF by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0.78	0.91	0.64	0.78
Education - Community College	0.78	0.87	0.69	0.78
Education - Primary School	0.78	0.91	0.64	0.78
Education - Relocatable Classroom	0.78	0.91	0.64	0.78
Education - Secondary School	0.78	0.87	0.69	0.78
Education - University	0.78	0.87	0.69	0.78
Grocery	0.74	0.80	0.68	0.74
Health/Medical – Hospital	0.77	0.81	0.72	0.77
Health/Medical - Nursing Home	0.78	0.88	0.68	0.78
Lodging - Hotel	0.61	0.63	0.58	0.61
Manufacturing - Bio/Tech	0.34	0.38	0.29	0.34
Manufacturing - Light Industrial	0.34	0.38	0.29	0.34

[30] Code specified SEER values converted to EER using EER = -0.02 x $SEER^2$ + 1.12 x SEER. Based on National Renewable Energy Laboratory (NREL) 2010, "Building America House Simulation Protocols." U.S. DOE. Revised October 2010 www.nrel.gov/docs/fy11osti/49246.pdf

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Office - Small	0.76	0.81	0.72	0.76
Restaurant - Fast-Food	0.75	0.76	0.73	0.75
Restaurant - Sit-Down	0.80	0.76	0.83	0.80
Retail - Single-Story Large	0.80	0.80	0.80	0.80
Retail - Small	0.79	0.83	0.75	0.79
Storage - Conditioned	0.55	0.75	0.34	0.55
Warehouse - Refrigerated	0.55	0.75	0.34	0.55
Other[31]	0.34	0.38	0.29	0.34

Example: A 14 SEER air conditioner with a capacity of 48 kBtu/h is installed in a primary educational institution in Albuquerque.

$$\text{Cooling savings} = 48\ \text{kBtu/h} \times 436\ \text{hours} \times (1/13 - 1/14) = 115\ \text{kWh}$$

$$SEER_{Baseline} = -0.02 \times (13)^2 + 1.12 \times 13 = 11.18$$

$$SEER_{Efficient} = -0.02 \times (14)^2 + 1.12 \times 14 = 11.76$$

$$\text{Demand Savings} = 48\ \text{kBtu/h} \times (1/11.18 - 1/11.76) \times 0.78 = 0.165\ \text{kW}$$

3.6.5 NON-ENERGY BENEFITS

Well-designed HVAC systems increase occupant comfort and productivity.

3.6.6 MEASURE LIFE

The measure life for a packaged AC system is 15 years, as shown in Table 33.[32]

[31] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the "Office – Small" CF)

[32] Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.

Table 33: Packaged AC Incremental Measure Cost

Measure	Minimum System (SEER 14)	Delta 1.0 SEER over 14/EER Improvement
65,000 Btuh or less	$113	$82
65,000 to 240,000 Btuh	$97	$48
240,000 to 760,000 Btuh	$247	$180
760,000 Btuh or more	$203	$181

3.7 LOW-FLOW SHOWERHEADS

This measure saves water heating energy by reducing the quantity of water heated.

3.7.1 MEASURE OVERVIEW

Sector	Commercial
End use	Water heating
Fuel	Electricity or Gas
Measure category	Low-flow showerheads
Delivery mechanism	Rebate/Direct Install/Mail-by-request
Baseline description	Federal standard 2.2 GPM or average existing conditions if higher than 2.2 GPM
Efficient case description	Showerhead with one of the following nominal flow rates 3) 2.0 gpm 4) 1.5 gpm In one of the following facility types 8) K-12 School 9) University dorm 10) Fitness center 11) Health in-patient shower 12) Employee shower (office or other) 13) Hospitality 14) Other commercial shower

3.7.2 SAVINGS

Deemed gas and electric annual energy savings, and deemed demand savings per installed unit are shown in Table 34, Table 35, and Table 36, respectively based on flow and climate zone. Savings shown do not include in-service-rates, which vary by delivery mechanism. For kit-based programs and programs for which the water heating fuel is unknown, multiply the savings listed below with the type of water-heating system fuel type percentage and the in-service rates provided in the next section. Note the savings listed in Table 34, Table 35, and Table 36

do not include the Fuel% or ISR parameters.

Table 34: Low-Flow Showerheads Gas Savings (therms)

	Albuquerque		Las Cruces		Roswell		Santa Fe	
	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm
K-12 School	5.75	3.29	4.76	2.72	4.87	2.78	6.53	3.73
Fitness center	159.17	90.95	131.73	75.28	134.78	77.02	180.49	103.14
Health patient shower	7.07	4.04	5.85	3.34	5.99	3.42	8.02	4.58
Employee shower	5.30	3.03	4.39	2.51	4.49	2.56	6.01	3.43
Hospitality	9.82	5.61	8.12	4.64	8.31	4.75	11.13	6.36
Other commercial shower	8.47	4.84	7.01	4.01	7.18	4.10	9.61	5.49

Table 35: Low-Flow Showerheads Electric Savings (kWh)

	Albuquerque		Las Cruces		Roswell		Santa Fe	
	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm	1.5 gpm	2.0 gpm
K-12 School	137.68	78.67	113.95	65.11	116.58	66.62	156.12	89.21
Fitness center	3,807.96	2,175.98	3,151.61	1,800.92	3,224.47	1,842.55	4,318.13	2,467.50
Health patient shower	169.20	96.69	140.04	80.02	143.28	81.87	191.87	109.64
Employee shower	126.77	72.44	104.92	59.95	107.34	61.34	143.75	82.14
Hospitality	234.86	134.21	194.38	111.08	198.88	113.64	266.33	152.19
Other commercial shower	202.74	115.85	167.79	95.88	171.67	98.10	229.90	131.37

Table 36: Low-Flow Showerheads Demand Savings (kW)

	1.5 gpm	2.0 gpm
Albuquerque	0.1116	0.0638
Las Cruces	0.0924	0.0528
Roswell	0.0945	0.0540
Santa Fe	0.1266	0.0723

3.7.3 ENERGY SAVINGS ESTIMATION

Savings are based on the methodology used by the Northwest Power and Conservation Council's Regional Technical Forum (RTF).[33] The basic equation for water heating energy used is:

$$Svgs = \frac{(FlowPre - FlowPost) \times (TempUsage - TempCold) \times 60 \times Hours \times HeatCapacity \times Density \times Const \times Fuel\% \times ISR}{Efficiency}$$

Where:

Svgs	= *Annual energy savings, therms or kWh*
FlowPre	= *Baseline flow rate, gpm, see Table 37*
FlowPost	= *Measure flow rate, gpm, see Table 37*
$Temp_{Usage}$	= *Temperature of water coming out of showerhead, see Table 37*
$Temp_{Cold}$	= *Temperature of inlet water, see table*
60	= *Minutes to hours conversion*
Hours	= *Operating Hours, Table 37*
HeatCapacity	= *Heat capacity of water, 1 Btu per pound per ˚F*
Density	= *Density of water, 8.33 pounds per gallon*
Const	= *Constant, 1 therm/100,000 Btus, or .00029307107 kWh/Btu*
Efficiency	= *Assumed efficiency of water heater, see Table 37*
Fuel%	= *Percentage split between gas, electric, and propane water heating. When water heating fuel is known, used 100%. For kit-based and other program types for which the water heating fuel is not known, use territory-specific percentages. If territory-specific* values are not known, use default values of 50% gas and 50% electricity.[34]
ISR	= In-service rate, representing the proportion of distributed showerheads which are actually installed. For direct-install and downstream programs, use 1. For kit-based programs, use a territory-specific value. If a territory-specific value is not known, use a default value of *0.98*[35]

[33] Regional Technical Forum Version of 4.3 https://rtf.nwcouncil.org/measure/showerheads/

[34] US Energy Information Administration. https://www.eia.gov/consumption/commercial/data/2012/bc/cfm/b31.php The percentages shown are based on the West Mountain region in the table.

[35] Illinois Technical Reference Manual Version 12, Measure 4.3.3

Parameters used in this equation are drawn from the (Regional technical Forum) RTF measure and are defined in Table 37.

Table 37: Low-Flow Showerhead Parameters

Parameter	Application	Value
Time of Use (Hours)	Hospitality[36,37]	57.1833
	Health Care[38]	42.1333
	Commercial - Employee Shower[39]	31.5666
	School[40]	34.2833
	Any Commercial Application Except Fitness Center	50.4833
	Fitness Center[41]	948.2166
Water Heating Efficiency	Electric	98%
	Gas	80%
Temperature Usage (ºF)	All	101[42]
Temperature Cold (ºF)	All	Table 8 provides inputs for inlet water temperature based on climate zone.
FlowPre (gpm)	All	2.2[43]
FlowPost (gpm)[44]	2.00 gpm rated 1.5 gpm rated	1.8 gpm 1.5 gpm

[36] Gleick, P., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G., Cushing, K. K., et al. (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute. Value can be found on page 5 of Appendix D of the report. https://pacinst.org/wp-content/uploads/sites/21/2013/02/appendix_d3.pdf

[37] American Hotel and Lodging Association Website (http://www.ahla.com/content.aspx?id=34706), Annual Lodging Industry Profile.

[38] StateHealthFacts.org; Gleick et al, "Waste Not, Want Not"; Professional judgment of RTF Staff.

[39] Professional judgment that a commercial employee shower will use one half of RTF's residential shower usage

[40] Planning and Management Consultants, Ltd., Aquacraft, Inc., and John Olaf Nelson Water Resources Management. "Commercial and Institutional End Uses of Water". For the American Water Works Association. 2000.

[41] Phone survey of five PNW Fitness Centers conducted by RTF staff

[42] Cadmus and Opinion Dynamics Evaluation Team. Showerhead and Faucet Aerator Meter Study. For Michigan Evaluation Working Group. June 2013. Temperature sensors provided the mixed water temperature readings resulting in an average of 101 ºF

[43] Baseline: Median observed Flow Rate in 2007 SCL Study. Median used instead of mean because study included some high (> 2.5 gpm, nominal) flow rate showerheads. The federal standard has been 2.5 gpm since January 1, 1994. "Single Family 2007 Showerhead Kit Impact Evaluation". SBW Consulting; Seattle City Light. October 2008 [www.seattle.gov/light/Conserve/Reports/Evaluation_14.pdf]

[44] Ibid

3.7.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following formula:

$$Svgs = (\Delta kWh / Hours) * CF$$

Where:

Svgs	*= Annual demand savings, in kW*
ΔkWh	*= Calculated value above for electric energy savings*
Hours	*= Annual electric DHW hours for showerhead use*
	= Calculate if usage is custom, default value see Table 37.
CF	*= Coincidence factor for electric load reduction, 0.0278*[45]

3.7.5 NON-ENERGY BENEFITS

Deemed water savings per unit are shown in Table 38 based on facility type.

Table 38: Low-Flow Showerhead Water Savings (in gallons/year)

	1.5 gpm	2.0 gpm
K-12 School	1,440	823
Fitness center	39,825	22,757
Health patient shower	1,770	1,011
Employee shower	1,326	758
Hospitality	2,456	1,403
Other	2,120	1,212

3.7.6 MEASURE LIFE

The measure life expectancy is 10 years.[46]

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[45] Calculated as follows: Assume 11% showers take place during peak hours (based on: http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282001%29-Disaggregated-Hot-Water-Use-in-Single-FamilyHomes-Using-Flow-Trace-Analysis.pdf). There are 65 days in the summer peak period, so the percentage of total annual aerator use in peak period is 0.11*65/365.25 = 1.96%. The number of hours of recovery during peak periods is therefore assumed to be 1.96% * 369 = 7.23 hours of recovery during peak period where 369 equals the average annual electric DHW recovery hours for showerhead use including SF and MF homes with Direct Install and Retrofit/TOS measures. There are 260 hours in the peak period so the probability you will see savings during the peak period is 7.23/260 = 0.0278

[46] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

3.8 ANTI-SWEAT HEATER CONTROLS

This measure saves refrigeration energy by reducing the operating hours of anti-sweat heaters (ASH).

3.8.1 MEASURE OVERVIEW

Sector	Commercial
End use	Refrigeration
Fuel	Electricity
Measure category	Anti-Sweat Heater Controls
Delivery mechanism	Rebate
Baseline description	Glass door display case with Anti-Sweat Heater (ASH) operating at 100% duty cycle (i.e., no ASH controls installed).
Efficient case description	Installation of relative humidity sensors for the air outside of the display case and controls that reduce or turn off the glass door (if applicable) and frame anti-sweat heaters at low-humidity conditions.

3.8.2 SAVINGS

Deemed electric annual energy and demand savings per lineal foot of refrigerated space are shown in Table 39 based on climate zone.

Table 39: Energy and Demand Savings per Climate Zone for Anti-Sweat Heater Controls on Coolers and Freezers

	Medium Temperature Display Case (Cooler)		Low Temperature Display Case (Freezer)	
	Demand Savings kW/ft	Energy Savings kWh/ft	Demand Savings kW/ft	Energy Savings kWh/ft
Albuquerque	0.00753	423.9	0.00972	442.5
Santa Fe	0.00677	420.3	0.00868	436.5
Las Cruces	0.00795	416.2	0.01029	435.6
Roswell	0.00792	390.2	0.01025	408.4

ft = horizontal linear footage of the display case (i.e., the width of the display case)

3.8.3 ENERGY SAVINGS ESTIMATION

A door heater controller senses the dew point (DP) temperature in the store and cycles the power supplied to the heaters accordingly. The DP inside a building is primarily dependent on the moisture content of outdoor ambient air. Because the outdoor DP varies between climate zones, weather data from each climate zone must be analyzed to obtain a DP profile. The savings are on a per-linear foot of display case basis.

The energy savings for this measure are a result of both the reduction in heater operating hours and the reduction in refrigeration load. These savings are calculated using the following equations and assumptions:

$$ASH\ ON\% = (DP_{meas} - AllOFF_{SetPoint}) / (AllON_{SetPoint} - AllOFF_{SetPoint})$$

Where:

DPmeas	= *Measured dewpoint temperature inside the store.*
AllOFFSetPoint	= *Low end of the humidity scale where heaters are not needed (0% duty cycle).*
AllONSetPoint	= *High end of the humidity scale where heaters must operate all the time (100% duty cycle).*
	Setpoints can be changed based on the requirements of a particular store location; the following are typical setpoints for a 72 °F supermarket.
AllOFFSetPoint	= *42.89F DP (35% RH)*
AllONSetPoint	= *52.87F DP (50% RH)*

Measured dew point (DP_{meas}) is related to the outdoor dew point ($T_{dp\text{-}out}$) according to the equation:

$$DP_{meas} = 0.005379 \times T_{dp\text{-}out}^2 + 0.171795 \times T_{dp\text{-}out} + 19.87006$$ [47]

Where:

$$Tdp\text{-}out = Outdoor\ dew\ point$$ [48]

The controller only changes the run-time of the heaters. Instantaneous ASH power (kW_{ASH}) as a resistive load remains constant at:

$$kW_{ASH} = (0.37A/ft)\ (115V) = 0.04255kW/ft$$ [49]

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[47] Indoor and Outdoor Dew Point at a Supermarket in Fullerton, CA. (October 2005 to January 2006, 5-minute data)

[48] from National Solar Radiation Data Base, 1991- 2005 Update: Typical Meteorological Year 3.

[49] “Anti-Sweat Heat (ASH) Controls,” Workpaper WPSCNRRN0009. Southern California Edison Company. 2007.

Energy consumption for each hour is the product of power and run time. Total annual ASH energy consumption is the sum of all 1-hour consumption values across 8,760 hours/year.

$$kWh_{baseline} = \sum_{1\text{-}8760} kW_{ASH} \text{ x } 100\%$$

$$kWh_{efficient} = {}_{1\text{-}8760}\, kW_{ASH} \text{ x } ASH\ ON\%$$

$$kWh_{ASH} = kWh_{baseline} - kWh_{efficient}$$

Some of the heat generated by ASHs ends up as a load on the refrigeration system. Therefore, any reduction in ASH power will not only reduce the ASH electric demand but will also result in secondary benefits on the refrigeration side. As a result, compressor run time and energy consumption are reduced. The compressor power requirements are based on calculated cooling load and energy-efficiency ratios obtained from manufacturers' data.

$$kW_{comp} = Q_{ASH} / (EER \text{ x } 1000)$$

It is assumed that 35% of sensible heat generated by the ASH ends up as a cooling load (Q_{ASH}) inside the case.[50] The cooling load contribution from ASH is given by:

$$Q_{ASH} = 0.35 \text{ x } kW_{ASH} \text{ x } 3413\ Btu/hr/kW \text{ x } ASH\ ON\%$$

The EER for both medium- and low-temperature applications is a function of the saturated condensing temperature (SCT) and part load ratio (PLR) of the compressor. For medium-temperature refrigerated cases, the SCT is calculated as the design dry-bulb temperature of the ambient or adjacent space where the compressor/condensing units reside (Db_{adj}) plus 15 degrees. For low-temperature refrigerated cases, the SCT is Db_{adj} plus 10 degrees. PLR is the ratio of total cooling load to compressor capacity and is assumed to be a constant 0.87 (i.e., compressor over-sizing factor of 15%).

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[50] A Study of Energy Efficient Solutions for Anti-Sweat Heaters. Southern California Edison RTTC. December 1999

For medium and low-temperature compressors, the following equation is used to determine the EER.[51]

$$EER = a + (b * SCT) + (c * PLR) + (d * SCT^2) + (e * PLR^2) + (f * SCT * PLR) + (g * SCT^3) + (h * PLR^3) + (i * SCT * PLR^2) + (j * SCT^2 * PLR)$$

Where for medium-temp display cases (coolers):

a	= *3.75346018700468*
b	= *-0.049642253137389*
c	= *29.4589834935596*
d	= *0.000342066982768282*
e	= *-11.7705583766926*
f	= *0.212941092717051*
g	= *1.46606221890819E-06*
h	= *6.80170133906075*
i	= *.020187240339536*
j	= 0.000657941213335828

And for low-temp display cases (freezers):

a	= *9.86650982829017*
b	= *0.230356886617629*
c	= *22.905553824974*
d	= *0.00218892905109218*
e	= *2.48866737934442*
f	= *0.248051519588758*
g	= *7.57495453950879E-06*
h	= *2.03606248623924*
i	= *0.0214774331896676*
j	= *0.000938305518020252*

Db_{adj},[52] SCT, and the resulting EER for each climate zone are shown in Table 40.

[51] Per “Anti-Sweat Heat (ASH) Controls,” Workpaper WPSCNRRN0009. Southern California Edison Company. 2007, compressor performance curves were obtained from a review of manufacturer data for reciprocating compressors as a function of SCT, cooling load, and cooling capacity of the compressor.

[52] The hottest month was selected from ASHRAE Climatic Design Condition 2009; Monthly Design Dry Bulb; 5%. Taos station was used for Santa Fe. White Sands station was used for Las Cruces.

Table 40: EER per Climate Zone for Coolers and Freezers

		Medium Temperature Display Case (Cooler)		Low Temperature Display Case (Freezer)	
	Db_{adj} (F)	**SCT (F)**	**EER**	**SCT (F)**	**EER**
Albuquerque	93	108	6.75	103	5.23
Santa Fe	86	101	7.50	96	5.85
Las Cruces	97	112	6.34	107	4.90
Roswell	97	112	6.34	107	4.90

Energy consumption for each hour is the product of power and run time. Total annual compressor energy consumption (due to heat from ASHs) is the sum of all 1-hour consumption values across 8,760 hours/year.

$$kWh_{comp\text{-}baseline} = \sum_{1\text{-}8760} Q_{ASH} / (EER \times 1000) \times 100\%$$

$$kWh_{comp\text{-}efficient} = {}_{1\text{-}8760}\, Q_{ASH} / (EER \times 1000) \times ASH\ ON\%$$

$$kWh_{comp} = kWh_{comp\text{-}baseline} - kWh_{comp\text{-}efficient}$$

The total energy savings are a result of both the decrease in heater run time (kWh_{ASH}) and the reduction in refrigeration load (kWh_{comp}). Therefore:

$$kWhsavings = kWh_{ASH} + kWh_{comp}$$

3.8.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW during 3:00-6:00 pm on the hottest summer weekdays. Note: Because the controller does not alter the instantaneous demand of the ASH, no direct peak demand savings are claimed.

$$kW_{demand\text{-}savings} = kW_{comp\text{-}baseline} - kW_{comp\text{-}efficient}$$

Where:

$kW_{comp\text{-}baseline} = Q_{ASH} / (EER \times 1000) \times 100\%$

$kW_{comp\text{-}efficient} = Q_{ASH} / (EER \times 1000) \times ASH\ ON\%$; *the average of 3pm-6pm on the hottest days of summer*

3.8.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.8.6 MEASURE LIFE

The measure life for this measure is 12 years.[53]

3.9 HVAC VARIABLE FREQUENCY DRIVES

3.9.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electric
Measure category	Variable Frequency Drive (VFD)
Delivery mechanism	Rebate
Baseline description	HVAC fan or pump, not controlled by VFD
Efficient case description	HVAC fan or pump, 100 HP or less, of one of the following types, controlled by VFD • Supply Fan • Return Fan • Chilled water pump (central plant) • Hot water pump (central plant) • Cooling tower fan (central plant) • Water source heat pump (WSHP) circulation pump

3.9.2 SAVINGS

Annual energy savings per unit horsepower are shown in Table 41 through Table 43 for the installation of VFDs on AHU supply fans with outlet dampers, inlet dampers, and inlet guide vanes respectively, and by climate zone and building type.

[53] California Measurement Advisory Committee Public Workshops on PY 2001 Energy Efficiency Programs. September 2000, p. 59

**Table 41: Energy Savings (kWh per HP) for HVAC VFDs—
AHU Supply Fan Outlet Damper Baseline Savings**

Building Type	Climate Zone			
	Albuquerque	Santa Fe	Roswell	Las Cruses
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	1179.91	1198.55	1144.86	1138.64
Office—large, medium	738.03	753.67	709.10	707.74
Office—small	586.97	599.12	561.85	561.94
Education	644.64	658.34	618.40	618.25
Convenience store, service, strip mall	693.43	707.99	663.52	662.24
Stand-alone retail, supermarket	745.10	760.32	714.07	712.08
Restaurants	1014.05	1032.00	979.89	974.42
Warehouse	558.69	569.92	534.32	534.67
Assembly, worship	768.70	784.38	737.37	735.08
Other	558.69	569.92	534.32	534.67
Energy Savings (kW per motor HP)				
	0.143	0.143	0.143	0.141

**Table 42: Energy Savings (kWh per HP) for HVAC VFDs—
AHU Supply Fan Inlet Damper Baseline Savings**

Building Type	Climate Zone			
	Albuquerque	Santa Fe	Roswell	Las Cruses
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	1,866.43	1,916.96	1,775.88	1,761.93
Office—large, medium	1,152.84	1,191.70	1,080.35	1,079.96
Office—small	915.05	944.25	852.51	856.46
Education	1,006.84	1,041.13	940.99	944.39
Convenience store, service, strip mall	1,078.20	1,114.10	1,004.68	1,005.06
Stand-alone retail, supermarket	1,160.39	1,198.22	1,083.56	1,082.15
Restaurants	1,594.79	1,642.48	1,507.66	1,496.32
Warehouse	870.59	897.22	810.18	814.58
Assembly, worship	1,198.82	1,238.52	1,121.05	1,118.66
Other	870.59	897.22	810.18	814.58
Energy Savings (kW per motor HP)				
	0.235	0.235	0.235	0.230

Table 43: Energy Savings (kWh per HP) for HVAC VFDs— AHU Supply Fan Inlet Guide Vane Baseline Savings

Building Type	Climate Zone			
	Albuquerque	Santa Fe	Roswell	Las Cruses
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	398.54	413.05	373.09	369.44
Office—large, medium	243.64	254.36	223.56	223.85
Office—small	193.08	201.00	175.81	177.40
Education	212.76	222.25	194.50	195.95
Convenience store, service, strip mall	227.01	236.88	206.84	207.42
Stand-alone retail, supermarket	244.62	255.06	223.46	223.55
Restaurants	338.90	352.48	314.56	311.73
Warehouse	183.64	190.82	166.99	168.69
Assembly, worship	253.01	264.07	231.57	231.36
Other	183.64	190.82	166.99	168.69
Energy Savings (kW per motor HP)				
	0.052	0.052	0.052	0.050

Annual energy savings per unit horsepower are shown in Table 44 through Table 46 for the installation of VFDs on cooling tower fans, chilled water pumps, and hot water pumps respectively, and by climate zone and building type.

Table 44: Energy Savings (kWh per HP) for HVAC VFDs— Cooling Tower Fans Savings

Building Type	Climate Zone			
	Albuquerque	Santa Fe	Roswell	Las Cruses
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	2,843.90	3,227.22	2,762.19	2,564.39
Office—large, medium	1,740.90	1,955.21	1,672.13	1,561.38
Office—small	1,378.33	1,543.45	1,319.65	1,236.24
Education	1,517.87	1,709.44	1,456.74	1,366.86
Convenience store, service, strip mall	1,625.36	1,813.98	1,558.14	1,454.43
Stand-alone retail, supermarket	1,749.11	1,954.80	1,679.34	1,565.26
Restaurants	2,416.00	2,728.16	2,336.91	2,169.93
Warehouse	1,310.89	1,465.15	1,254.06	1,174.88
Assembly, worship	1,808.38	2,026.20	1,739.13	1,620.69
Other	1,310.89	1,465.15	1,254.06	1,174.88
Energy Savings (kW per motor HP)				
	0.278	0.403	0.367	0.250

Table 45: Energy Savings (kWh per HP) for HVAC VFDs— Chilled Water Pump Savings

Building Type	Climate Zone			
	Albuquerque	**Santa Fe**	**Roswell**	**Las Cruses**
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	1,505.25	1,426.73	1,606.86	1,613.95
Office—large, medium	998.30	958.03	1,066.26	1,051.01
Office—small	799.06	773.52	854.82	833.24
Education	872.79	835.56	934.07	912.55
Convenience store, service, strip mall	954.98	919.56	1,015.29	999.37
Stand-alone retail, supermarket	1,020.57	982.06	1,086.70	1,072.11
Restaurants	1,333.11	1,265.73	1,423.18	1,423.41
Warehouse	760.88	738.97	813.58	792.97
Assembly, worship	1,047.15	738.97	1,114.87	1,102.60
Other	760.88	738.97	813.58	792.97
Energy Savings (kW per motor HP)				
	0.288	0.288	0.288	0.288

Table 46: Energy Savings (kWh per HP) for HVAC VFDs— Hot Water Pump Savings

Building Type	Climate Zone			
	Albuquerque	**Santa Fe**	**Roswell**	**Las Cruses**
Energy Savings (kWh per motor HP)				
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	1737.39	1858.80	1658.24	1697.04
Office—large, medium	1100.01	1157.18	1027.23	1053.62
Office—small	874.65	919.61	813.89	837.80
Education	961.02	1011.54	897.08	923.65
Convenience store, service, strip mall	1042.62	1089.60	965.29	980.05
Stand-alone retail, supermarket	1116.87	1169.04	1039.36	1054.03
Restaurants	1499.30	1589.63	1420.51	1446.94
Warehouse	832.84	875.53	774.45	796.19
Assembly, worship	1152.02	1207.60	1074.10	1087.18
Other	832.84	875.53	774.45	796.19
Energy Savings (kW per motor HP)				
	0.279	0.284	0.221	0.137

3.9.3 ENERGY SAVINGS ESTIMATION

Hourly demand Savings are calculated over the course of the year:

Step 1: Determine the hourly percent flow rate (i)

For the installation of VFDs on AHU supply fans:

$$\%CFMi = m \times tdb,i + b$$

Where:

tdb,i = *The hourly dry bulb temperature (DBT) using TMY3*[54] *data*

m = *The slope of the relationship between DBT and CFM (see Table 56)*

b = *The intercept of the relationship between DSBT and CFM (see Table 47)*

The minimum flow rate is set to 60 percent cfm based on common design practice.55 Determination of the minimum dry bulb temperature assumes that cooling will only operate above the cooling reference temperature of 65°F dry bulb. The maximum DBT is the ASHRAE dry bulb design temperature.[56] Table 47 provides inputs for the installation of VFDs on HVAC supply fans to support the formula above based on climate zone.

Table 47: HVAC VFDs—AHU Supply Fan VFD percentage of CFM Inputs

Climate Zone	Condition	Minimum	Maximum	Slope (m)	Intercept (b)
Albuquerque	Flow rate (%cfm)	0.6	1	0.0108	-0.1023
	Dry bulb T (°F)	65	102.02		
Santa Fe	Flow rate (%cfm)	0.6	1	0.0126	-0.2176
	Dry bulb T (°F)	65	96.8		
Roswell	Flow rate (%cfm)	0.6	1	0.01	-0.0487
	Dry bulb T (°F)	65	105.08		
Las Cruses	Flow rate (%cfm)	0.6	1	0.0098	-0.0373
	Dry bulb T (°F)	65	105.8		

[54] National Renewable Energy Laboratory's (NREL) National Solar Radiation Data Base: 1991- 2005 Update for Typical Meteorological Year 3 (TMY3). Available at https://sam.nrel.gov/weather-data.html.

[55] For AHU, a 60% minimum setpoint strategy is assumed, so any results below 60% are set to 60%. Similarly, any results greater than 100% are set to 100%.

[56] ASHRAE 2021 Fundamentals, Ch 14 Appendix: design conditions for selected locations, 0.4% Cooling DB.

For the installation of VFDs on cooling towers:

$$\%CFMi = m \times twb\_i + b$$

Where:

twb_i	= the hourly wet bulb temperature (WBT) based on TMY3 data[57,58]
m	= the slope of the relationship between WBT and cfm (see Table 48)
b	= the intercept of the relationship between WBT and cfm (see Table 48)

The minimum flow rate is set to 40 percent cfm based on the ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual.87 Determination of the minimum WBT assumes that the cooling tower will only operate above the cooling reference temperature of 65°F dry bulb. The minimum WBT is calculated using TMY3 data as the average WBT when the DBT is between 64°F and 65°F dry bulb. The maximum WBT is the ASHRAE wet bulb design temperature.[59]

Table 48 provides inputs for the installation of VFDs on cooling towers to support the formula above based on climate zone.

Table 48: HVAC VFDs—Cooling Tower VFD Percentage of CFM Inputs

Climate Zone	Condition	Minimum	Maximum	Slope (m)	Intercept (b)
Albuquerque	Flow rate (%cfm)	0.4	1	0.0106	0.2812
	Wet bulb T (°F)	11.2	67.75		
Santa Fe	Flow rate (%cfm)	0.4	1	0.0067	0.3788
	Wet bulb T (°F)	3.18	93.12		
Roswell	Flow rate (%cfm)	0.4	1	0.0105	0.2438
	Wet bulb T (°F)	14.87	71.99		
Las Cruses	Flow rate (%cfm)	0.4	1	0.009	0.3551
	Wet bulb T (°F)	5	71.75		

57 TMY3 data does not include WBT. WBT was calculated from TMY3 data using the empirical formula from "Wet-bulb temperature from relative humidity and air temperature", Journal of Applied Meteorology and Climatology, https://doi.org/10.1175/JAMC-D-11-0143.1.

58 PNNL, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, page 3.240, cooling tower minimum speed default.

59 ASHRAE 2021 Fundamentals, Ch 14 Appendix: design conditions for selected locations, 0.4% Evaporation WB

For the installation of VFDs on chilled water and condenser water pumps:

$$\%GPMi = m \times tdb\_i + b$$

Where:

m = The slope of the relationship between DBT and GPM (see Table 58)

b = The intercept of the relationship between DSBT and GPM (see Table 58)

The minimum flow rate is set to 10 percent GPM based on the ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual.[89] Determination of the minimum dry bulb temperature assumes that cooling will only operate above the cooling reference temperature of 65°F dry bulb. The maximum DBT is the ASHRAE dry bulb design temperature.[90]

Table 49 provides inputs for the installation of VFDs on chilled water pumps to support the formula above based on climate zone.

Table 49: HVAC VFDs—Chilled Water and Condenser Water Pumps VFD Percentage of GPM Inputs

Climate Zone	Condition	Minimum	Maximum	Slope (m)	Intercept (b)
Albuquerque	Flow rate (%GPM)	0.1	1	0.0243	-1.4802
	Dry bulb T (°F)	65	102.02		
Santa Fe	Flow rate (%GPM)	0.1	1	0.0283	-1.7396
	Dry bulb T (°F)	65	96.8		
Roswell	Flow rate (%GPM)	0.1	1	0.0225	-1.3596
	Dry bulb T (°F)	65	105.08		
Las Cruses	Flow rate (%GPM)	0.1	1	0.0221	-1.3338
	Dry bulb T (°F)	65	105.8		

For the installation of VFDs hot water pumps:

$$\%GPMi = m \times tdb\_i + b$$

Where:

m = The slope of the relationship between DBT and GPM (see Table 59)

b = The intercept of the relationship between DSBT and GPM (see Table 59)

The minimum flow rate is set to 10 percent GPM based on the ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual.[60] Determination of the minimum dry bulb temperature assumes that heating will only operate below the heating reference temperature of 65°F dry bulb. The maximum DBT is the ASHRAE dry bulb design temperature.[61]

Table 50 provides inputs for the installation of VFDs on hot water pumps to support the formula above based on climate zone.

Table 50: HVAC VFDs— Hot Water Pump VFD Percentage of GPM Inputs

Climate Zone	Condition	Minimum	Maximum	Slope (m)	Intercept (b)
Albuquerque	Flow rate (%GPM)	0.1	1	-0.018	1.2719
	Dry bulb T (°F)	65	15.08		
Santa Fe	Flow rate (%GPM)	0.1	1	-0.0146	1.0466
	Dry bulb T (°F)	65	3.2		
Roswell	Flow rate (%GPM)	0.1	1	-0.0188	1.3203
	Dry bulb T (°F)	65	17.06		
Las Cruses	Flow rate (%GPM)	0.1	1	-0.015	1.075
	Dry bulb T (°F)	65	5		

Step 2 - Calculate the percentage of power (%power) for the applicable baseline scenario, and for the installation of VFD technology:

Baseline scenarios by equipment type:

AHU supply fans:[62]

$$\%power_{i,OutletDamper} = 0.00745 \times \%CFM_i^2 + 0.10983 \times \%CFM_i + 20.41905$$

$$\%power_{i,InletDamper} = 0.00013 \times \%CFM_i^3 - 0.01452 \times \%CFM_i^2 + 0.71648 \times \%CFM_i + 50.25833$$

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60 PNNL, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, page 3.249, pump minimum speed default.

61 ASHRAE 2017 Fundamentals, Ch 14 Appendix: design conditions for selected locations, 99.6% Heating DB.

62 https://focusonenergy.com/sites/default/files/Focus%20on%20Energy_TRM_January2015.pdf, page 225. Please note, the CFM2 coefficients in Equation 38 and Equation 39 have the wrong sign in the reference document.

$$\%power_{i,InletGuideVane} = 0.00009 \times \%CFM_i^3 - 0.00128 \times \%CFM_i^2 + 0.06808 \times \%CFM_i + 20$$

Note: %power for constant volume baseline technologies with no fan control is set equal to 1 for each hour where %power is less than 1 for the other baseline control types. When %power exceeds 1 for the other baseline control types, %power for no fan control is set equal to the maximum value from the other baseline control types.

Cooling towers:

$$\%power_{i,fan\ cycling} = if\ twb\_i > twb\_min, then\ 1, otherwise\ 0$$

Chilled, hot, and condenser water pumps[63]:

$$\%power_{base} = 2.5294 \times \%GPM_i^3 - 4.7443 \times \%GPM_i^2 + 3.2485 \times \%GPM_i + 0$$

Installed VFD scenarios:

For AHU supply fans[64]:

$$\%power_{VFD} = 0.00004 \times \%CFM_i^3 + 0.00766 \times \%CFM_i^2 - 0.19567 \times \%CFM_i + 5.9$$

For cooling towers[65]:

$$if\ twb\_i > twb\_min, then\ \%power_{VFD} = 0.9484823 \times \%CFM_i^3 + 0.60556507 \times \%CFM_i^2 - 0.88567609 \times \%CFM_i + 0.33162901,$$

$$otherwise\ 0$$

For chilled water, hot water, and condenser pumps[66]:

$$\%power_{VFD} = 0.7347 \times \%GPM_i^3 - 0.301 \times \%GPM_i^2 + 0.5726 \times \%GPM_i + 0$$

Note: for all applications, baseline %power should use a minimum of zero.

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63 PNNL, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, Table 87 Default Part-load CIRC-PUMP-FPLR Coefficients – Constant Speed, no VSD.

64 https://focusonenergy.com/sites/default/files/Focus%20on%20Energy_TRM_January2015.pdf, page 225.

65 PNNL, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, Table 85 Default Efficiency TWR-FAN-PLR Coefficients – VSD on Cooling Tower Fan.

66 PNNL, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, Table 87 Default Part-load CIRC-PUMP-FPLR Coefficients – Default (VSD, No Reset).

Step 3 - Calculate kWfull using the hp from the motor nameplate, load factor, and the applicable motor efficiency from ASHRAE 2013, Table 10.8-1 Minimum Nominal Efficiency for General Purpose Electric Motors; Use that result and the %power results to determine power consumption at each hour:

$$kWfull = 0.746 \times HP \times LF \eta$$

$$kWi = kWfull \times \%poweri$$

Where:

%poweri	*= Percentage of full load pump power at the i^th hour calculated by an equation based on the control type (outlet damper, inlet box damper, inlet guide vane-IGV, or VFD)*[67]
kWfull	*= Motor power demand operating at the fan design 100 percent CFM or pump design 100 percent GPM*
kWi	*= Fan or Pump real-time power at the i^th hour of a year*
HP	*= Rated horsepower of the motor*
LF	*= Load factor—ratio of the operating load to the nameplate rating of the motor—assumed to be 75 percent*
η =	*Motor efficiency of a standard efficiency Open Drip Proof (ODP) motor operating at 1,800 RPM taken from ASHRAE Standard 90.1-2013*
0.746 =	*Constant to convert from HP to kW*

Table 51 provides the motor efficiency values by horsepower.

Table 51: HVAC VFDs— Motor Efficiencies for Open Drip Proof Motors at 1,800 RPM68

Motor Horsepower	Full Load Efficiency
1	0.855
2	0.865
3	0.895
5	0.895
7.5	0.91
10	0.917
15	0.93
20	0.93
25	0.936
30	0.941

[67] Fan curves by control type are provided in the BPA ASD Calculator, https://www.bpa.gov/-/media/Aep/energy-efficiency/industrial/Industrial-files/ASDCalculators.

[68] For unlisted motor horsepower values, round down to the next lowest horsepower value.

Motor Horsepower	Full Load Efficiency
40	0.941
50	0.945
60	0.95
75	0.95
100	0.954

Step 4 - Calculate the kW savings for each of the top 20 hours within the applicable peak probability analysis for the building's climate zone from Volume 1. Sum the kW savings for each hour multiplied by the peak demand probability factor from the 20 individual hourly calculations, then divide by the sum of the PDPF for the 20 hours to get the average peak demand impact, and then calculate the total peak demand saved by adding peak demand interactive effects:

$$Hourly\ Savings\ Calculations\ (kWi)Saved=[(kWi)Baseline-(kWi)VFD]\times schedulei$$

Where:

schedulei = 1 when building is occupied, 0.2 when building is unoccupied (see Table 61)

Table 52 provides inputs for annual operating by building type.

Table 52: HVAC VFDs— Yearly Motor Operation Hours by Building Type[69,70]

Building Type	Weekday Schedule	Weekend Schedule	Annual Motor Operation Hours
Hospitals, healthcare, nursing home, hotel (common areas), large multifamily (common areas)	24-hr	24-hr	8,760
Office—large, medium	7am–11pm	7am–7pm (Saturday)	5,592
Office—small	7am–8pm	closed	4,466
Education	8am–11pm	closed	4,884

[69] Hours for all building types except for Assembly come from the Department of Energy Commercial Building Prototype Models, Scorecards, HVAC Operation Schedule. Motor hours are set to equal 1 when the HVAC Operation Schedule is "on" and 0.2 when the HVAC Operation Schedule is "off." https://www.energycodes.gov/development/commercial/prototype_models. Assembly occupied hours come from COMNET Appendix C—Schedules (Rev 3) https://comnet.org/appendix-c-schedules, updated 07/25/2016.

[70] Data centers are covered in 2.2.6 Computer Room Air Handler Motor Efficiency.

Building Type	Weekday Schedule	Weekend Schedule	Annual Motor Operation Hours
Convenience store, service, strip mall	9am–10pm	9am–8pm (Saturday) 10am–7pm (Sunday)	5,298
Stand-alone retail, supermarket	8am–10pm	8am–11pm (Saturday) 10am–7pm (Sunday)	5,674
Restaurants	6am–2am	6am–2am	7,592
Warehouse	7am–7pm	closed	4,258
Assembly, worship	9am–11pm	9am–11pm	5,840
Other[100]	7am–7pm	closed	4,258

Energy Savings are calculated in the following manner:

For both the baseline and new technology, calculate the sum of individual kWh consumption in each hour of the year:

$$Energy\ Savings\ [kWh] = \sum_{i=1}^{n8760} (kWi \times schedulei)$$

Where:

8,760 = Total of hours per year

3.9.4 DEMAND SAVINGS ESTIMATION

The demand savings are based on the NEEP demand savings values. The demand savings were not adjusted using New Mexico weather. The demand savings value for the cooling tower fan application was referenced from the Indiana TRM.

3.9.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.9.6 MEASURE LIFE

The lifetime for this measure is 15 years.[71]

[71] For unlisted motor horsepower values, round down to the next lowest horsepower value.

3.10 EFFICIENT BOILERS

This measure saves space heating energy by using less gas to heat water used in HVAC heating coils.

3.10.1 MEASURE OVERVIEW

Sector	Commercial
End-use	Space heating
Fuel	Natural Gas
Measure category	HVAC Boilers
Delivery mechanism	Rebate
Baseline description	Hot water boiler (300 - 2500 kBtuh, 80.0 Et, OA Reset from 140 to 165 F) Hot water boiler (> 2500 kBtuh, 80.0 Et, 82.0Ec, OA Reset from 140 to 165 F) Hot water boiler (< 300 kBtuh, 82.0 AFUE, OA Reset from 140 to 165 F) Steam boiler (300 - 2500 kBtuh, 79.0 Et, OA Reset from 140 to 165 F) Steam boiler (> 2500 kBtuh, 79.0 Et, 82.0Ec, OA Reset from 140 to 165 F) Steam boiler (< 300 kBtuh, 80.0 AFUE, OA Reset from 140 to 165 F)
Efficient case description	Similar boiler with higher efficiency and/or lower reset temperature (load or outdoor air)

3.10.2 SAVINGS

This measure is only applicable to hot water and steam boilers which are used to provide space heating to commercial buildings. Boilers used for other processes, or boilers used for both space heating and service water heating must use a custom approach.

Replace on Burnout

All gas savings for a boiler improvement are tabulated by climate, improvement type, building type, and climate zone in Tab through Tab. For multi-use buildings with distinct and quantifiable service areas, it is appropriate to use a weighted average of the tables based on floor area. For multifamily boilers, refer to the residential boiler measures. Gas savings are in therms per thousand Btu per hour boiler capacity (kBtuh).

These building types may be used for facilities which cannot be adequately classified by the other listed building types. Before using these building types, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” lighting hours).

Table 53: Savings for Water Boiler 300 to 2,500 kBtuh – Albuquerque (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	2.00	0.66	0.52	0.86	3.57	1.46	0.16	1.84	0.52	0.33	0.44
85.0 Et, OA Reset from 140 to 165 F	2.25	0.80	0.68	1.03	4.51	1.83	0.18	2.43	0.61	0.41	0.56
90.0 Et, condensing, OA reset from 115 to 140 F	2.96	1.44	1.18	1.80	6.23	2.83	0.40	3.18	1.06	0.74	1.05
90.0 Et, condensing, load reset from 115 to 140 F	3.27	1.58	1.25	1.92	7.58	2.61	0.47	3.79	1.17	0.80	1.09
90.0 Et, condensing, OA reset from 140 to 165 F	2.60	1.27	1.04	1.54	4.39	2.29	0.34	2.68	0.92	0.66	0.95
94.0 Et, condensing, OA reset from 115 to 140 F	3.37	1.66	1.43	2.06	7.83	3.45	0.43	4.20	1.20	0.86	1.24
94.0 Et, condensing, load reset from 115 to 140 F	3.66	1.81	1.50	2.18	9.10	3.24	0.49	4.79	1.30	0.92	1.28
94.0 Et, condensing, OA reset from 140 to 165 F	3.03	1.51	1.29	1.81	6.05	2.93	0.36	3.72	1.06	0.79	1.14

Table 54: Savings for Water Boiler 300 to 2,500 kBtuh – Roswell (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.20	0.57	0.63	0.72	5.43	2.29	0.19	1.89	0.68	0.39	0.42
85.0 Et, OA Reset from 140 to 165 F	1.34	0.66	0.73	0.82	6.33	2.59	0.21	2.30	0.75	0.45	0.50
90.0 Et, condensing, OA reset from 115 to 140 F	1.83	1.15	1.18	1.38	8.26	3.55	0.36	3.03	1.17	0.71	0.84
90.0 Et, condensing, load reset from 115 to 140 F	2.03	1.29	1.30	1.48	9.59	3.48	0.51	3.54	1.34	0.78	0.89
90.0 Et, condensing, OA reset from 140 to 165 F	1.62	1.04	1.06	1.24	6.55	3.01	0.28	2.63	1.01	0.64	0.77
94.0 Et, condensing, OA reset from 115 to 140 F	2.04	1.29	1.35	1.53	9.78	4.04	0.39	3.72	1.28	0.81	0.97
94.0 Et, condensing, load reset from 115 to 140 F	2.23	1.42	1.46	1.62	11.04	3.97	0.53	4.21	1.44	0.87	1.02
94.0 Et, condensing, OA reset from 140 to 165 F	1.84	1.18	1.23	1.39	8.14	3.53	0.32	3.34	1.13	0.74	0.90

able 55: Savings for Water Boiler 300 to 2,500 kBtuh – Santa Fe (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	2.58	0.85	0.67	1.11	4.60	1.88	0.20	2.37	0.67	0.43	0.57
85.0 Et, OA Reset from 140 to 165 F	2.90	1.04	0.87	1.33	5.81	2.36	0.23	3.14	0.78	0.53	0.73
90.0 Et, condensing, OA reset from 115 to 140 F	3.82	1.85	1.52	2.32	8.03	3.65	0.52	4.10	1.37	0.95	1.36
90.0 Et, condensing, load reset from 115 to 140 F	4.21	2.04	1.61	2.48	9.77	3.36	0.61	4.89	1.51	1.03	1.41
90.0 Et, condensing, OA reset from 140 to 165 F	3.36	1.64	1.34	1.98	5.66	2.95	0.43	3.45	1.19	0.85	1.22
94.0 Et, condensing, OA reset from 115 to 140 F	4.34	2.15	1.84	2.66	10.09	4.45	0.55	5.42	1.54	1.11	1.60
94.0 Et, condensing, load reset from 115 to 140 F	4.72	2.33	1.93	2.82	11.73	4.17	0.63	6.18	1.68	1.19	1.65
94.0 Et, condensing, OA reset from 140 to 165 F	3.91	1.95	1.67	2.34	7.81	3.77	0.47	4.80	1.36	1.02	1.47

Table 56: Savings for Water Boiler 300 to 2,500 kBtuh – Las Cruces (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.22	0.58	0.64	0.73	5.52	2.32	0.19	1.92	0.69	0.40	0.43
85.0 Et, OA Reset from 140 to 165 F	1.36	0.67	0.75	0.83	6.43	2.63	0.21	2.34	0.76	0.45	0.51
90.0 Et, condensing, OA reset from 115 to 140 F	1.86	1.17	1.20	1.41	8.40	3.61	0.37	3.08	1.19	0.72	0.86
90.0 Et, condensing, load reset from 115 to 140 F	2.06	1.31	1.32	1.50	9.74	3.53	0.52	3.60	1.36	0.79	0.90
90.0 Et, condensing, OA reset from 140 to 165 F	1.65	1.06	1.07	1.26	6.66	3.06	0.29	2.67	1.02	0.65	0.78
94.0 Et, condensing, OA reset from 115 to 140 F	2.07	1.31	1.38	1.55	9.93	4.10	0.40	3.78	1.30	0.82	0.99
94.0 Et, condensing, load reset from 115 to 140 F	2.27	1.44	1.48	1.65	11.22	4.03	0.54	4.28	1.47	0.88	1.03
94.0 Et, condensing, OA reset from 140 to 165 F	1.87	1.20	1.25	1.42	8.27	3.58	0.32	3.40	1.15	0.75	0.92

Table 57: Savings for Water Boiler Greater than 2,500 kBtuh – Albuquerque (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	2.00	0.66	0.52	0.86	3.57	1.46	0.16	1.84	0.52	0.33	0.44
85.0 Et, OA Reset from 140 to 165 F	2.25	0.80	0.68	1.03	4.51	1.83	0.18	2.43	0.61	0.41	0.56
90.0 Et, condensing, OA reset from 115 to 140 F	2.96	1.44	1.18	1.80	6.23	2.83	0.40	3.18	1.06	0.74	1.05
90.0 Et, condensing, load reset from 115 to 140 F	3.27	1.58	1.25	1.92	7.58	2.61	0.47	3.79	1.17	0.80	1.09
90.0 Et, condensing, OA reset from 140 to 165 F	2.60	1.27	1.04	1.54	4.39	2.29	0.34	2.68	0.92	0.66	0.95
94.0 Et, condensing, OA reset from 115 to 140 F	3.37	1.66	1.43	2.06	7.83	3.45	0.43	4.20	1.20	0.86	1.24
94.0 Et, condensing, load reset from 115 to 140 F	3.66	1.81	1.50	2.18	9.10	3.24	0.49	4.79	1.30	0.92	1.28
94.0 Et, condensing, OA reset from 140 to 165 F	3.03	1.51	1.29	1.81	6.05	2.93	0.36	3.72	1.06	0.79	1.14

Table 58: Savings for Water Boiler Greater Than 2,500 kBtuh – Roswell (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.20	0.57	0.63	0.72	5.43	2.29	0.19	1.89	0.68	0.39	0.42
85.0 Et, OA Reset from 140 to 165 F	1.34	0.66	0.73	0.82	6.33	2.59	0.21	2.30	0.75	0.45	0.50
90.0 Et, condensing, OA reset from 115 to 140 F	1.83	1.15	1.18	1.38	8.26	3.55	0.36	3.03	1.17	0.71	0.84
90.0 Et, condensing, load reset from 115 to 140 F	2.03	1.29	1.30	1.48	9.59	3.48	0.51	3.54	1.34	0.78	0.89
90.0 Et, condensing, OA reset from 140 to 165 F	1.62	1.04	1.06	1.24	6.55	3.01	0.28	2.63	1.01	0.64	0.77
94.0 Et, condensing, OA reset from 115 to 140 F	2.04	1.29	1.35	1.53	9.78	4.04	0.39	3.72	1.28	0.81	0.97
94.0 Et, condensing, load reset from 115 to 140 F	2.23	1.42	1.46	1.62	11.04	3.97	0.53	4.21	1.44	0.87	1.02
94.0 Et, condensing, OA reset from 140 to 165 F	1.84	1.18	1.23	1.39	8.14	3.53	0.32	3.34	1.13	0.74	0.90

Table 59: Savings for Water Boiler Greater Than 2,500 kBtuh – Santa Fe (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	2.58	0.85	0.67	1.11	4.60	1.88	0.20	2.37	0.67	0.43	0.57
85.0 Et, OA Reset from 140 to 165 F	2.90	1.04	0.87	1.33	5.81	2.36	0.23	3.14	0.78	0.53	0.73
90.0 Et, condensing, OA reset from 115 to 140 F	3.82	1.85	1.52	2.32	8.03	3.65	0.52	4.10	1.37	0.95	1.36
90.0 Et, condensing, load reset from 115 to 140 F	4.21	2.04	1.61	2.48	9.77	3.36	0.61	4.89	1.51	1.03	1.41
90.0 Et, condensing, OA reset from 140 to 165 F	3.36	1.64	1.34	1.98	5.66	2.95	0.43	3.45	1.19	0.85	1.22
94.0 Et, condensing, OA reset from 115 to 140 F	4.34	2.15	1.84	2.66	10.09	4.45	0.55	5.42	1.54	1.11	1.60
94.0 Et, condensing, load reset from 115 to 140 F	4.72	2.33	1.93	2.82	11.73	4.17	0.63	6.18	1.68	1.19	1.65
94.0 Et, condensing, OA reset from 140 to 165 F	3.91	1.95	1.67	2.34	7.81	3.77	0.47	4.80	1.36	1.02	1.47

Table 60: Savings for Water Boiler Greater than 2,500 kBtuh – Las Cruces (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.22	0.58	0.64	0.73	5.52	2.32	0.19	1.92	0.69	0.40	0.43
85.0 Et, OA Reset from 140 to 165 F	1.36	0.67	0.75	0.83	6.43	2.63	0.21	2.34	0.76	0.45	0.51
90.0 Et, condensing, OA reset from 115 to 140 F	1.86	1.17	1.20	1.41	8.40	3.61	0.37	3.08	1.19	0.72	0.86
90.0 Et, condensing, load reset from 115 to 140 F	2.06	1.31	1.32	1.50	9.74	3.53	0.52	3.60	1.36	0.79	0.90
90.0 Et, condensing, OA reset from 140 to 165 F	1.65	1.06	1.07	1.26	6.66	3.06	0.29	2.67	1.02	0.65	0.78
94.0 Et, condensing, OA reset from 115 to 140 F	2.07	1.31	1.38	1.55	9.93	4.10	0.40	3.78	1.30	0.82	0.99
94.0 Et, condensing, load reset from 115 to 140 F	2.27	1.44	1.48	1.65	11.22	4.03	0.54	4.28	1.47	0.88	1.03
94.0 Et, condensing, OA reset from 140 to 165 F	1.87	1.20	1.25	1.42	8.27	3.58	0.32	3.40	1.15	0.75	0.92

Table 61: Savings for Water Boiler Less than 300 kBtuh – Albuquerque (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.28	0.41	0.30	0.56	2.23	0.93	0.11	0.98	0.34	0.19	0.26
84.5 AFUE, OA Reset from 140 to 165 F	1.07	1.82	0.86	2.23	6.75	4.31	0.24	4.00	0.97	0.59	0.71
85.0 Et, OA Reset from 140 to 165 F	1.38	0.47	0.37	0.63	2.64	1.09	0.12	1.24	0.37	0.23	0.31
90.0 Et, condensing, OA reset from 115 to 140 F	1.59	0.59	0.50	0.77	3.43	1.40	0.14	1.74	0.45	0.29	0.41
90.0 Et, condensing, load reset from 115 to 140 F	2.04	1.07	0.83	1.36	4.10	1.99	0.34	1.81	0.81	0.53	0.77
90.0 Et, condensing, OA reset from 140 to 165 F	1.67	0.90	0.68	1.10	2.24	1.44	0.28	1.31	0.66	0.46	0.66
94.0 Et, condensing, OA reset from 115 to 140 F	2.40	1.27	1.05	1.60	5.52	2.55	0.37	2.73	0.93	0.65	0.94
94.0 Et, condensing, load reset from 115 to 140 F	2.69	1.41	1.12	1.72	6.82	2.33	0.43	3.33	1.04	0.71	0.98
94.0 Et, condensing, OA reset from 140 to 165 F	2.05	1.11	0.91	1.34	3.73	2.01	0.30	2.24	0.79	0.57	0.84

Table 62: Savings for Water Boiler Less than 300 kBtuh – Roswell (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	0.81	0.37	0.40	0.49	3.61	1.63	0.14	1.07	0.48	0.24	0.24
84.5 AFUE, OA Reset from 140 to 165 F	1.26	1.25	0.80	1.55	7.04	3.56	0.19	3.24	0.80	0.57	0.62
85.0 Et, OA Reset from 140 to 165 F	0.87	0.41	0.44	0.53	4.00	1.76	0.15	1.25	0.51	0.27	0.28
90.0 Et, condensing, OA reset from 115 to 140 F	0.98	0.48	0.53	0.61	4.75	2.02	0.16	1.60	0.58	0.32	0.35
90.0 Et, condensing, load reset from 115 to 140 F	1.34	0.88	0.87	1.07	5.68	2.65	0.30	1.86	0.91	0.52	0.60
90.0 Et, condensing, OA reset from 140 to 165 F	1.12	0.76	0.74	0.93	3.96	2.11	0.21	1.46	0.75	0.45	0.52
94.0 Et, condensing, OA reset from 115 to 140 F	1.52	1.00	1.02	1.21	7.04	3.08	0.32	2.49	1.01	0.60	0.71
94.0 Et, condensing, load reset from 115 to 140 F	1.71	1.13	1.13	1.30	8.30	3.02	0.46	2.99	1.18	0.67	0.76
94.0 Et, condensing, OA reset from 140 to 165 F	1.31	0.89	0.89	1.07	5.37	2.57	0.24	2.10	0.86	0.53	0.64

Table 63: Savings for Water Boiler Less than 300 kBtuh – Santa Fe (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	1.64	0.52	0.39	0.72	2.87	1.20	0.15	1.26	0.43	0.25	0.33
84.5 AFUE, OA Reset from 140 to 165 F	1.38	2.34	1.11	2.87	8.70	5.56	0.31	5.16	1.25	0.76	0.92
85.0 Et, OA Reset from 140 to 165 F	1.78	0.60	0.47	0.82	3.40	1.41	0.16	1.60	0.48	0.29	0.40
90.0 Et, condensing, OA reset from 115 to 140 F	2.06	0.76	0.64	1.00	4.42	1.81	0.18	2.25	0.58	0.38	0.53
90.0 Et, condensing, load reset from 115 to 140 F	2.63	1.37	1.07	1.76	5.29	2.57	0.44	2.34	1.04	0.69	0.99
90.0 Et, condensing, OA reset from 140 to 165 F	2.16	1.16	0.88	1.42	2.89	1.86	0.36	1.69	0.86	0.59	0.85
94.0 Et, condensing, OA reset from 115 to 140 F	3.09	1.64	1.36	2.06	7.12	3.28	0.47	3.52	1.20	0.83	1.21
94.0 Et, condensing, load reset from 115 to 140 F	3.48	1.82	1.45	2.22	8.80	3.00	0.56	4.29	1.34	0.91	1.26
94.0 Et, condensing, OA reset from 140 to 165 F	2.65	1.43	1.18	1.73	4.81	2.60	0.39	2.89	1.02	0.73	1.08

Table 64: Savings for Water Boiler Less than 300 kBtuh – Las Cruces (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
83.0 Et, OA Reset from 140 to 165 F	0.83	0.37	0.40	0.50	3.66	1.66	0.14	1.09	0.49	0.25	0.25
84.5 AFUE, OA Reset from 140 to 165 F	1.28	1.27	0.81	1.58	7.15	3.61	0.19	3.29	0.81	0.58	0.63
85.0 Et, OA Reset from 140 to 165 F	0.88	0.41	0.45	0.54	4.06	1.79	0.15	1.27	0.52	0.27	0.28
90.0 Et, condensing, OA reset from 115 to 140 F	1.00	0.49	0.54	0.62	4.83	2.05	0.17	1.62	0.59	0.32	0.35
90.0 Et, condensing, load reset from 115 to 140 F	1.36	0.89	0.88	1.09	5.77	2.69	0.30	1.89	0.93	0.53	0.61
90.0 Et, condensing, OA reset from 140 to 165 F	1.14	0.77	0.75	0.95	4.02	2.15	0.22	1.49	0.76	0.46	0.53
94.0 Et, condensing, OA reset from 115 to 140 F	1.54	1.02	1.03	1.23	7.15	3.13	0.33	2.53	1.03	0.61	0.72
94.0 Et, condensing, load reset from 115 to 140 F	1.74	1.15	1.15	1.32	8.43	3.06	0.47	3.03	1.20	0.68	0.77
94.0 Et, condensing, OA reset from 140 to 165 F	1.33	0.91	0.91	1.09	5.46	2.61	0.25	2.13	0.87	0.54	0.65

Table 65: Savings for Steam Boiler – Albuquerque (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
Steam Boiler 300 -2,500 kBtuh											
81.0 Et, OA Reset from 140 to 165 F	1.71	0.53	0.40	0.71	2.94	1.19	0.13	1.41	0.43	0.26	0.34
82.0 Et, OA Reset from 140 to 165 F	1.84	0.60	0.48	0.80	3.44	1.39	0.14	1.72	0.48	0.30	0.40
Steam Boiler Greater than 25,00 kBtuh											
80.0 Et, OA Reset from 140 to 165 F	1.57	0.46	0.32	0.62	2.43	0.99	0.12	1.08	0.39	0.22	0.28
81.0 Et, OA Reset from 140 to 165 F	1.71	0.53	0.40	0.71	2.94	1.19	0.13	1.41	0.43	0.26	0.34
82.0 Et, OA Reset from 140 to 165 F	1.84	0.60	0.48	0.80	3.44	1.39	0.14	1.72	0.48	0.30	0.40
Steam Boiler Less than 300 kBtuh											
82.0 AFUE, OA Reset from 140 to 165 F	1.11	0.36	0.26	0.50	2.07	0.86	0.10	0.85	0.30	0.16	0.22
83.0 AFUE, OA Reset from 140 to 165 F	1.22	0.42	0.33	0.57	2.50	1.03	0.11	1.12	0.34	0.20	0.27

Table 66: Savings for Steam Boiler – Roswell (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
Steam Boiler 300 -2,500 kBtuh											
81.0 Et, OA Reset from 140 to 165 F	1.04	0.47	0.52	0.60	4.70	1.98	0.16	1.50	0.59	0.32	0.33
82.0 Et, OA Reset from 140 to 165 F	1.10	0.51	0.57	0.65	5.18	2.13	0.17	1.72	0.63	0.35	0.37
Steam Boiler Greater than 2,500 kBtuh											
80.0 Et, OA Reset from 140 to 165 F	0.97	0.42	0.46	0.55	4.21	1.82	0.15	1.28	0.55	0.29	0.29
81.0 Et, OA Reset from 140 to 165 F	1.04	0.47	0.52	0.60	4.70	1.98	0.16	1.50	0.59	0.32	0.33
82.0 Et, OA Reset from 140 to 165 F	1.10	0.51	0.57	0.65	5.18	2.13	0.17	1.72	0.63	0.35	0.37
Steam Boiler Less than 300 kBtuh											
82.0 AFUE, OA Reset from 140 to 165 F	0.72	0.32	0.35	0.43	3.32	1.49	0.12	0.89	0.44	0.21	0.20
83.0 AFUE, OA Reset from 140 to 165 F	0.78	0.36	0.39	0.47	3.73	1.62	0.13	1.07	0.47	0.23	0.24

Table 67: Savings for Steam Boiler – Santa Fe (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
Steam Boiler 300 -25,00 kBtuh											
81.0 Et, OA Reset from 140 to 165 F	2.20	0.69	0.52	0.92	3.79	1.54	0.17	1.81	0.56	0.33	0.44
82.0 Et, OA Reset from 140 to 165 F	2.37	0.78	0.62	1.03	4.44	1.79	0.18	2.22	0.61	0.38	0.52
Steam Boiler Greater than 2,500 kBtuh											
80.0 Et, OA Reset from 140 to 165 F	2.03	0.59	0.41	0.80	3.13	1.28	0.16	1.40	0.50	0.28	0.36
81.0 Et, OA Reset from 140 to 165 F	2.20	0.69	0.52	0.92	3.79	1.54	0.17	1.81	0.56	0.33	0.44
82.0 Et, OA Reset from 140 to 165 F	2.37	0.78	0.62	1.03	4.44	1.79	0.18	2.22	0.61	0.38	0.52
Steam Boiler Less than 300 kBtuh											
82.0 AFUE, OA Reset from 140 to 165 F	1.43	0.46	0.34	0.65	2.67	1.11	0.13	1.09	0.39	0.21	0.28
83.0 AFUE, OA Reset from 140 to 165 F	1.57	0.54	0.42	0.74	3.22	1.32	0.14	1.44	0.43	0.25	0.35

Table 68: Savings for Steam Boiler – Las Cruces (Therms/kBtuh)

	Commercial Typical	Community College	Secondary School	University	Hospital	Hotel	Biotech	Nursing Home	Large Office	Small Office	Multistory Large Retail
Steam Boiler 300 -2500 kBtuh											
81.0 Et, OA Reset from 140 to 165 F	1.05	0.47	0.53	0.61	4.78	2.01	0.17	1.53	0.60	0.33	0.34
82.0 Et, OA Reset from 140 to 165 F	1.12	0.52	0.58	0.66	5.27	2.17	0.18	1.74	0.64	0.35	0.38
Steam Boiler Greater than 2500 kBtuh											
80.0 Et, OA Reset from 140 to 165 F	0.99	0.43	0.47	0.56	4.28	1.85	0.16	1.30	0.56	0.30	0.30
81.0 Et, OA Reset from 140 to 165 F	1.05	0.47	0.53	0.61	4.78	2.01	0.17	1.53	0.60	0.33	0.34
82.0 Et, OA Reset from 140 to 165 F	1.12	0.52	0.58	0.66	5.27	2.17	0.18	1.74	0.64	0.35	0.38
Steam Boiler Less than 300 kBtuh											
82.0 AFUE, OA Reset from 140 to 165 F	0.73	0.32	0.35	0.43	3.37	1.51	0.13	0.91	0.45	0.21	0.21
83.0 AFUE, OA Reset from 140 to 165 F	0.79	0.36	0.40	0.48	3.79	1.65	0.13	1.09	0.48	0.24	0.24

Early Replacement

The baseline efficiency standards for early replacement projects are based on the IECC 2021, as shown below.

Table 69: Commercial and Industrial Boiler Baseline Efficiencies

Size Category (Btu/hr)	Subcategory or Rating Condition	Baseline Efficiency[72,73]	Test Procedure
< 300,000	Hot Water	82% AFUE	DOE 10 CFR Part 430
	Steam	80% AFUE	
≥ 300,000 and ≤ 2,500,000	Hot Water	80% E_t	DOE 10 CFR Part 431.86
	Steam	79% E_t	
> 2,500,000	Hot Water	82% E_c	
	Steam	79% E_t[74]	

Early Replacement determination will be based on meeting the following conditions:

- The existing unit is operational when replaced, or
- The existing unit requires minor repairs (<$528).[75]

3.10.3 ENERGY SAVINGS ESTIMATION

Replace on Burnout

Energy Savings are taken from DEER 2016 simulation data for commercial water and steam boilers with federally established baseline efficiencies.[76] The data from the CA

72 E_c = Combustion efficiency (100 percent less flue losses). See reference document for detailed information.

73 E_t = Thermal efficiency. See reference document for detailed information.

74 IECC 2021 calls for an efficiency of 79% for steam boilers greater than 2,500,000 BTU/hr. However, because this is higher than the federal requirement, early retirement projects may use the replace on burnout baseline efficiency.

75 The Technical Advisory Committee agreed that if the cost of repair is less than 20% of the new baseline replacement cost it can be considered early replacement. Note the non-inflated cost is used as this would be a cost consideration in the program year.

76 DEER 2016, This file created on 10/05/2018 while connected to deeresources.net by READI (v2.5.1) tool.

climate zones were normalized to NM weather as described below. Data were separated by building types and boiler sizes.

To adjust simulations to different weather design conditions, heating degree-days were used for each climate zone.[77] TMY 3 data for New Mexico climate zones were used.

$$\Delta \frac{Therms}{KBtuh}_{Climate\ Adjusted\ Heating} = \Delta \frac{Therms}{KBtuh}_{Baseline\ Climate\ Heating} * \frac{HDD_{Target\ Climate}}{HDD_{Baseline\ Climate}}$$

California Climate Zones 4, 8, 9, 15 did not have TMY 3 data available for the representative city selected by the California energy commission. Climate Zone 1 (Arcata) was closest in HDD to Albuquerque and Santa Fe. Climate Zone 14 (China Lake) was closest in HDD to Roswell and Las Cruces.[78] DEER data was filtered to only include information from the most similar climate zone for heating.

Early Replacement

Annual kWh and kW should be calculated for two different time periods:

- The estimated remaining life of the equipment that is being removed, designated the Remaining Useful Life (RUL; see
- The remaining time in the EUL period, (i.e., EUL-RUL)

For Remaining Useful Life (RUL):

$$Therms_{savings,RUL} = Capacity \times EFLH_H \times \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{eff}}\right) \times \frac{1}{100{,}000}$$

Where:

$Therms_{savings,ER}$	= *Therms savings for Early Replacement*
Capacity	= *Rated equipment heating capacity, Btu/hr*
$EFLH_H$	= *Equivalent full-load hours for heating from Table 71, or custom entry of full-load hours if project is for non-space heating applications. If site-specific ELFH values are used, then*

[77] Day, T. (2006). *Degree-Days: Theory and Application.* London: The Chartered Institution of Building Services Engineers.

[78] HDD for CZ1 are 4295 and CZ14 are 2422. Degree days for CZ1 and CZ4 is used from "The Pacific Energy Center's Guide to: California Climate Zones". kftp://ftp2.cpuc.ca.gov/PG&E20150130ResponseToA1312012Ruling/2013/07/SB_GT&S_0882437.pdf

a full analysis showing how the EFLH are calculated shall be provided with any submittal information

η_{base} = *Efficiency of the existing boiler, or if unavailable, efficiency from Table 69. Alternately, participants can use measured boiler full load efficiency. If actual efficiency is used, then a full boiler efficiency test report shall be provided with any submittal information*

η_{eff} = *Efficiency of the new boiler*

100,000 = *Convert Btu to Therms*

For remaining time in the Estimated Useful period (EUL – RUL):

$$Therms_{Savings,EUL-RUL} = Capacity * EFLH_H * \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{eff}}\right) * \frac{1}{100{,}000}$$

Hence,

$$Lifetime\ Energy\ Savings\ = Therms_{Savings,RUL} * RUL + Therms_{Savings,EUL-RUL} * (EUL - RUL)$$

Where:

RUL = *Remaining Useful Life (Table 70)*

EUL = *Estimate Useful Life*

= *20 Years*

Table 70: Commercial Boilers Remaining Useful Life (RUL) of Replaced Systems[79]

Age of Replaced System (Years)	RUL (Years)
5	14.7
6	13.7
7	12.7
8	11.8
9	10.9
10	10
11	9.1
12	8.3
13	7.5
14	6.8

Age of Replaced System (Years)	RUL (Years)
15	6.2
16	5.5
17	5
18	4.5
19	4
20	3.6
21	3.2
22	2.9
23	2.6
24+	0

[79] Use of the early retirement baseline is capped at 23 years, representing the age at which 75 percent of existing equipment is expected to have failed. Equipment older than 23 years should use the ROB baseline.

Heating EFLH values are derived from the Texas TRM version 5, adjusting the Texas values based on heating degree-days comparisons between Amarillo, Albuquerque, and Santa Fe, and El Paso, Las Cruces, and Roswell. Values that are blank in the Texas TRM were entered as zero in Table 71.

Table 71: Heating EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0	0	0	0
Education - Community College	0	0	0	0
Education - Primary School	698	500	497	929
Education - Relocatable Classroom	733	528	525	975
Education - Secondary School	733	528	525	975
Education - University	0	0	0	0
Grocery	0	0	0	0
Health/Medical – Hospital	0	0	0	0
Health/Medical - Nursing Home	0	0	0	0
Lodging - Hotel	782	383	381	1,040
Manufacturing - Bio/Tech	339	179	178	450
Manufacturing - Light Industrial	339	179	178	450
Office - Small	339	179	178	450
Restaurant - Fast-Food	1,025	639	636	1,363
Restaurant - Sit-Down	1,119	751	747	1,488
Retail - Single-Story Large	903	470	468	1,202
Retail - Small	750	549	546	998
Storage - Conditioned	0	0	0	0
Warehouse - Refrigerated	0	0	0	0
Other[80]	339	179	178	450

3.10.4 DEMAND SAVINGS ESTIMATION

There are no demand savings for this measure.

[80] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” EFLH)

3.10.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.10.6 MEASURE LIFE

The lifetime of a zero-energy door is expected to be 20 years.[81]

3.11 ZERO-ENERGY DOORS

This measure saves energy by eliminating the need for electric resistive heaters on cooler and freezer doors.

3.11.1 MEASURE OVERVIEW

Sector	Commercial
End-use	Refrigeration
Fuel	Electricity
Measure category	Zero-Energy Doors
Delivery mechanism	Rebate
Baseline description	Cooler or freezer glass door that is continuously heated to prevent condensation.
Efficient case description	Cooler or freezer glass door that prevents condensation with multiple panes of glass, inert gas, and low-E coatings instead of using electrically generated heat.

3.11.2 SAVINGS

Deemed electric annual energy and demand savings per impacted door are shown in Table 72 based on the refrigeration type.

Table 72: Zero-Energy Doors Electric Energy and Demand Savings

	Demand Savings (kW)	Energy Savings (kWh)
Low-Temp Freezer	0.2600	2,278
Medium-Temp Cooler	0.0900	788
High-Temp Cooler	0.0825	723

[81] DEER 2014 EUL Table

3.11.3 ENERGY SAVINGS ESTIMATION

Savings are calculated using the formula below:

$$kWh_{savings} = (kW_{baseline} - kW_{efficient}) \ x \ BF \times 8760 \ hours/yr$$

Where:

$kW_{baseline}$	= *Connected load of a typical reach-in cooler or freezer door with a heater. The values shown in Table 73 are based on a range of wattages from two manufacturers and metered data.*[82]
BF	= *Bonus factor for reduced cooler or freezer load from eliminating heat generated by the door heater. BF = 1+0.65/COP; based on the assumption that 65% of the heat generated by the door enters the refrigerated case. The values shown in Table 73 are based on the average standard compressor efficiencies with the listed saturated suction temperatures and a condensing temperature of 90°F.*[83]
$kW_{efficient}$	= *Connected load of a zero-energy door = 0.0 kW by definition.*

Table 73 provides inputs by equipment type to support the equations above.

Table 73: Connected Load and Bonus Factor for Typical Cooler and Freezer Doors

Equipment Type	$kW_{baseline}$	Saturated Suction Temperature (^{0}F)	COP	BF
Low-Temp Freezer	0.200	-20	2.0	1.30
Medium-Temp Cooler	0.075	20	3.5	1.20
High-Temp Cooler	0.075	45	5.4	1.10

3.11.4 DEMAND SAVINGS ESTIMATION

Demand savings are based on the following equation.

$$kW_{savings} = (kW_{baseline} - kW_{efficient}) \ x \ BF$$

See the section directly above for details on parameter definitions and values.

3.11.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

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[82] Main Technical Reference Manual TRM 2015, Table 36 on page 108.

[83] Ibid

3.11.6 MEASURE LIFE

The lifetime of a zero-energy door is expected to be 10 years.[84]

3.12 GUEST ROOM ENERGY MANAGEMENT

3.12.1 MEASURE OVERVIEW

Sector	Commercial
End use	Lighting and HVAC Control
Fuel	Electricity
Measure category	Guest Room Energy Management
Delivery mechanism	Direct Install, On-bill Financing, Rebates
Baseline description	Manual Heating/Cooling Temperature Setpoint and Fan On/Off/Auto Thermostat
Efficient case description	Guest room temperature set point must be controlled by automatic occupancy detectors or keycard that indicates the occupancy status of the room. During unoccupied periods, the default setting for controlled units differs by at least 5 degrees from the operating set point. Theoretically, the control system may also be tied into other electric loads, such as lighting and plug loads, to shut them off when occupancy is not sensed. This measure bases savings on improved HVAC controls. If the system is connected to lighting and plug loads, additional savings would be realized. The incentive is per guestroom controlled, rather than per sensor, for multi-room suites. Replacement or upgrades of existing occupancy-based controls are not eligible for an incentive.

3.12.2 SAVINGS

Deemed electric annual energy and demand savings for motel, hotels and dormitories, categorized by equipment type and climate zone, are presented in Table 74, Table 75 and Table 76, respectively.

[84] Maine Technical Reference User Manual (TRM) No. 2010-1, 8/31/2010, page 96.

Table 74: Guest Room Energy Management Energy and Demand Savings - Motel

Motel per Room Energy and Peak Demand Savings								
	Heat Pump				Electrical Resistance Heat			
	HVAC Only		HVAC and Lighting		HVAC Only		HVAC and Lighting	
Climate Zone	kW	kWh	kW	kWh	kW	kWh	kW	kWh
5- degree setup/setback offset								
Albuquerque	0.067	266	0.083	402	0.067	300	0.083	431
Las Cruces	0.063	251	0.078	379	0.063	283	0.078	406
Roswell	0.067	265	0.082	401	0.067	299	0.082	429
Santa Fe	0.077	307	0.095	463	0.077	346	0.095	496
10- degree setup/setback offset								
Albuquerque	0.125	458	0.141	595	0.125	511	0.141	644
Las Cruces	0.118	432	0.133	561	0.118	482	0.133	607
Roswell	0.125	457	0.141	593	0.125	509	0.141	641
Santa Fe	0.144	528	0.163	686	0.144	589	0.163	742

Table 75: Guest Room Energy Management Energy and Demand Savings - Hotel

Hotel per Room Energy and Peak Demand Savings								
	Heat Pump				Electrical Resistance Heat			
	HVAC Only		HVAC and Lighting		HVAC Only		HVAC and Lighting	
Climate Zone	kW	kWh	kW	kWh	kW	kWh	kW	kWh
5- degree setup/setback offset								
Albuquerque	0.059	189	0.080	382	0.059	208	0.080	403
Las Cruces	0.056	178	0.075	360	0.056	196	0.075	380
Roswell	0.059	188	0.079	380	0.059	207	0.079	402
Santa Fe	0.044	139	0.058	281	0.044	153	0.058	296
10- degree setup/setback offset								
Albuquerque	0.112	331	0.134	508	0.112	359	0.134	532
Las Cruces	0.106	312	0.126	479	0.106	338	0.126	501
Roswell	0.112	330	0.133	506	0.112	357	0.133	529
Santa Fe	0.130	381	0.154	586	0.130	413	0.154	612

Table 76: Guest Room Energy Management Energy and Demand Savings - Dormitory

Dormitory per Room Energy and Peak Demand Savings								
Climate Zone	Heat Pump				Electrical Resistance Heat			
	HVAC Only		HVAC and Lighting		HVAC Only		HVAC and Lighting	
	kW	kWh	kW	kWh	kW	kWh	kW	kWh
5- degree setup/setback offset								
Albuquerque	0.033	117	0.063	347	0.033	117	0.063	346
Las Cruces	0.031	110	0.059	327	0.031	110	0.059	326
Roswell	0.033	116	0.062	346	0.033	116	0.062	345
Santa Fe	0.024	86	0.046	255	0.024	86	0.046	254
10- degree setup/setback offset								
Albuquerque	0.048	160	0.064	475	0.048	162	0.064	477
Las Cruces	0.045	151	0.060	448	0.045	153	0.060	450
Roswell	0.048	160	0.063	473	0.048	162	0.063	476
Santa Fe	0.055	185	0.073	548	0.055	187	0.073	550

3.12.3 ENERGY AND DEMAND SAVINGS ESTIMATION

Electric annual energy and demand savings are equal to the deemed values provided in the tables above. Savings values are based on energy simulation runs performed using EnergyPro Version 5. Building prototype models were developed for a hotel, motel, and dormitory building types. The base case for each prototype model assumed a uniform temperature setting and was calibrated to a baseline energy use. Occupancy patterns based on both documented field studies[85] and prototypical ASHRAE 90.1-1999 occupancy schedules were used in the energy simulation runs to create realistic vacancy schedules. The prototype models were then adjusted to simulate an occupancy control system, which was compared to the baseline models.

3.12.4 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

[85] Texas TRM V10

3.12.5 MEASURE LIFE

The lifetime of Guest Room Energy Management is expected to be 15 years.[86]

3.13 EFFICIENT WATER HEATERS

3.13.1 MEASURE OVERVIEW

Sector	Commercial
End use	Water Heating
Fuel	Natural Gas
Measure category	Efficient water heaters
Delivery mechanism	Rebate
Baseline description	Federal standard minimum efficiency levels
Efficient case description	Energy Star or Consortium for Energy Efficiency (CEE) efficiency level, varies with type of water heater

3.13.2 SAVINGS

Savings are based on the California Database for Energy Efficiency Resources (DEER)[87] values for commercial water heaters. Water heaters can be either residential or commercial style. Residential water heaters are rated with an Energy Factor (EF). Residential storage water heaters are rated at less than 75,000 Btu per hour (kBtuh).[88] Residential instantaneous water heaters are rated at less than 200 kBtuh and have less than or equal to 2 gallons of storage. Commercial water heaters are rated with a thermal efficiency (Et).[89] The DEER values vary slightly based on climate zone. The values here are based on the Southern California Gas (SCG) region-wide zone.

Deemed electric annual energy and demand savings are provided in Table 77 and Table 78 by building type, and EnergyStar tier. Please reference Table 3 for building type abbreviations. The "Com" building type can be used as an average across all commercial buildings.

Table 79 and Table 80 provide savings in therms per kBtuh by buidling type for different equipment types.

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[86] DEER 2008 value for energy management systems.

[87] Deeresources.com, accessed on Oct 6, 2015, with READI version 2.3.0.

[88] Federal standards for residential water heaters, https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27

89 Federal standards for commercial water heaters, https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/51

Table 77: Energy Savings for Residential Style, EF Rated, Water Heaters, Therms per Unit per Year, Part 1

Small (< 55 gallons) storage	Com	Asm	ECC	EPr	ERC	ESe	EUD	EUn	Gro	HGR	Hsp	Htl	MBT
CEE Tier 1 (Energy Star) EF=0.67	63	69	55	46	46	46	37	64	86	51	89	112	57
CEE Tier 2 EF=0.8	189	215	162	127	127	127	118	197	278	168	295	375	169
Large (> 55 gallons) storage													
Energy Star EF=0.77	78	83	62	49	50	49	42	77	110	64	114	153	70
Instantaneous less than 200 kBtuh, less than 2 gal													
CEE Tier 1 EF=0.82	301	344	276	225	223	225	185	317	421	250	447	552	278
CEE Tier 2 (Energy Star) EF=0.9	618	727	541	418	416	418	395	637	912	563	983	1,240	558

Table 78: Energy Savings for Residential Style, EF Rated, Water Heaters, Therms per Unit per Year, Part 2

Small (< 55 gallons) storage	MLI	Mtl	Nrs	OfL	OfS	RFF	RSD	Rt3	RtL	RtS	SCn	SUn	WRf
CEE Tier 1 (Energy Star) EF=0.67	58	64	98	56	53	52	54	59	65	54	70	69	116
CEE Tier 2 EF=0.8	170	200	326	167	154	156	163	178	202	162	206	204	369
Large (> 55 gallons) storage													
Energy Star EF=0.77	70	74	130	69	64	53	57	65	75	59	100	100	179
Instantaneous less than 200 kBtuh, less than 2 gal													
CEE Tier 1 EF=0.82	282	320	488	270	258	266	278	298	323	277	302	294	498
CEE Tier 2 (Energy Star) EF=0.9	562	664	1088	542	507	530	557	609	670	555	613	604	1097

Table 79: Energy Savings for Commercial Style, Et Rated, Water Heaters, Therms per kBtuh per Year, Part 1

Storage, greater than 75 kBtuh	Com	Asm	ECC	EPr	ERC	ESe	EUn	Gro	Hsp	Htl	MBT	MLI
CEE Tier 1 Et=0.9	1.85	2.54	2.13	1.36	1.46	1.49	2.47	3.08	4.50	3.14	1.52	1.81
CEE Tier 2 (Energy Star) Et=0.94	2.48	3.40	2.86	1.82	1.96	2.00	3.31	4.13	6.03	4.21	2.04	2.43
Instantaneous	**Com**	**Asm**	**ECC**	**EPr**	**ERC**	**ESe**	**EUn**	**Gro**	**Hsp**	**Htl**	**MBT**	**MLI**
CEE Tier 1 Et=0.9	2.20	2.91	2.47	1.72	1.85	1.86	2.90	3.21	4.83	3.28	1.89	2.17
CEE Tier 2 (Energy Star) Et=0.94	2.94	3.90	3.30	2.31	2.47	2.49	3.89	4.30	6.47	4.40	2.53	2.90

Table 80: Energy Savings for Commercial Style, Et Rated, Water Heaters, Therms per kBtuh per Year, Part 2

Storage, greater than 75 kBtuh	Mtl	Nrs	OfL	OfS	RFF	RSD	Rt3	RtL	RtS	SCn	SUn	WRf
CEE Tier 1 Et=0.9	1.46	3.27	2.22	0.44	1.28	2.21	0.95	0.61	1.22	1.70	1.70	3.26
CEE Tier 2 (Energy Star) Et=0.94	1.96	4.38	2.98	0.58	1.72	2.96	1.27	0.82	1.64	2.28	2.28	4.37
Instantaneous	**Mtl**	**Nrs**	**OfL**	**OfS**	**RFF**	**RSD**	**Rt3**	**RtL**	**RtS**	**SCn**	**SUn**	**WRf**
CEE Tier 1 Et=0.9	1.83	3.63	2.58	0.79	1.65	2.59	1.31	0.97	1.59	2.07	2.05	3.71
CEE Tier 2 (Energy Star) Et=0.94	2.45	4.86	3.46	1.06	2.21	3.47	1.75	1.31	2.13	2.77	2.74	4.97

3.13.3 ENERGY SAVINGS ESTIMATION

Savings derived here are based on slightly different efficiency levels than those assumed by DEER. Following the approach of SCG[90] DEER savings are adjusted according to efficiency level as follows. Energy Savings are based on the following formula.

$$EnergySvgs = \frac{EHW}{Eff_{Baseline}} - \frac{EHW}{Eff_{Measure}}$$

Where:

EnergySvgs	= *Annual savings in therms*
EHW	= *Net energy that effectively heats the water, after losses, in therms*
Eff	= *Efficiency of water heater*

Since this equation applies to both the DEER savings and the TRM savings, we can derive the following formula to adjust DEER savings to TRM savings.

$$Svgs_{TRM} = Svgs_{DEER} * \left(\frac{\left(\frac{1}{Eff_{BaselineTRM}} - \frac{1}{Eff_{MeasureTRM}}\right)}{\left(\frac{1}{Eff_{BaselineDEER}} - \frac{1}{Eff_{MeasureDEER}}\right)} \right)$$

The adjustments to DEER savings are most needed to be consistent with current commercial Energy Star standards, which require an Et of 94%, while DEER estimated savings using an Et of 90%.

3.13.4 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.13.5 MEASURE LIFE

The lifetime of storage water heaters is 15 years.[91] The lifetime for instantaneous water heaters is 20 years.[92]

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[90] Southern California Gas Company, Workpaper WPSCGNRWH120206B Revision 3 Tankless Water Heaters, 2012

[91] Pacific Gas & Electric Company, Work Paper PGECODHW103 Non-res Gas Storage Water Heater Revision # 3, 2012, based on DEER

[92] Southern California Gas Company, Workpaper WPSCGNRWH120206B Revision 3 Tankless Water Heaters, 2012, based on DEER

3.14 REFRIGERATED WALK-IN EFFICIENT EVAPORATOR FAN MOTOR

This measure promotes the retrofit of shaded pole (SP) motors with electronically commutated motors (ECMs) for evaporator fans in refrigerated walk-in spaces.

3.14.1 MEASURE OVERVIEW

Sector	Commercial
End-use	Refrigeration
Fuel	Electricity
Measure category	Efficient Motors
Delivery mechanism	Rebate
Baseline description	Evaporator fan driven by shaded pole motor.
Efficient case description	Evaporator fan driven by ECM in one of the following applications 1) Low temperature walk-in case (freezer) 2) Medium temperature walk-in case (cooler) 3) Average walk-in case

3.14.2 SAVINGS

Energy and demand savings are shown in Table 81.

Table 81: Energy and Demand Savings of Walk-in Evaporator Fan ECM's per Motor

	Energy Savings (kWh)	Demand Savings (kW)
Medium Temperature walk-in evaporator fan ECM	1,263	0.144
Low Temperature walk-in evaporator fan ECM	1,317	0.158
Average walk-in evaporator fan ECM	1,281	0.149

3.14.3 ENERGY SAVINGS ESTIMATION

Savings are based on the work of the Regional Technical Forum (RTF) of the Northwest Power & Conservation Council.[93] The RTF relied on data from the Energy Smart Grocer (ESG) program

[93] https://rtf.nwcouncil.org/measure/ecms-walk-ins/

of Portland Energy Conservation, Inc. (PECI). ESG audit data showed the following distribution of walk-in evaporator fan motor sizes.

Table 82: Walk-in Evaporator Motor Size Distribution

Motor Size	Distribution
1/20 HP and 1/15 HP (> 23 Watt)	75%
16-23 Watt (≤ 23 Watt)	25%
Of the > 23 Watt:	
1/20 HP	15%
1/15 HP	85%

In addition, 33% of walk-in units were freezers, and 67% were coolers. Savings are the sum of direct savings and refrigeration savings, where direct savings are determined with the following equation.

$$DirectSvgs = (kW_{Baseline} - kW_{Installed}) \times FLH$$

Where:

DirectSvgs	*= Annual motor savings, kWh*
kW	*= Power draw of motor, see Table 83*
FLH	*= Full load hours, 8766 for cooler, and 8328 for freezer (includes defrost cycle)*

Motor power is shown in Table 83, based on manufacturer data.

Table 83: Walk-in Evaporator Motor Power

Motor Output (watts) for Walk-In	SP Input Watts	ECM Input Watts	ECM Efficiency	SP Efficiency
37.3 (1/20 HP)	142	56	67%	26%
37.3 (1/20 HP)	136	44	85%	28%
49.7 (1/15 HP)	191	75	66%	26%
16-23 (19.5)	75	29	66%	26%

Refrigeration savings are based on the following formula.

$$RefrigSvgs = DirectSvgs \times \frac{ConvConst}{EER}$$

Where:

RefrigSvgs	*= Annual refrigeration savings due to reduced waste heat, kWh*
ConvConst	*= 3.413 Btu/Wh*
EER	*= Efficiency of walk-in refrigeration, see Table 84 below, Btu/Wh*

EER values were derived for reach-in cases for New Mexico climate for the ASH measure. Assume that these are good approximations of the walk-in values. Average New Mexico values are shown below.

Table 84: New Mexico Average Grocery EER

Medium temperature EER (Btu/Wh)	Low Temperature EER (Btu/Wh)
6.74	5.22

3.14.4 DEMAND SAVINGS ESTIMATION

Since the motors are assumed to run full time, demand savings are the average kW savings over the year.

3.14.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.14.6 MEASURE LIFE

The lifetime for this measure is 15 years, based on the RTF measure.

3.15 REFRIGERATED REACH-IN EFFICIENT EVAPORATOR FAN MOTOR

This measure promotes the replacement of shaded pole (SP) motors with electronically commutated motors (ECMs) for evaporator fans in refrigerated reach-in display cases.

3.15.1 MEASURE OVERVIEW

Sector	Commercial
End use	Refrigeration
Fuel	Electricity
Measure category	Efficient motors
Delivery mechanism	Rebate
Baseline description	Evaporator fan driven by shaded pole (SP) motor
Efficient case description	Evaporator fan driven by ECM in one of the following applications 1) Low temperature reach-in case (freezer) 2) Medium temperature reach-in case (cooler) 3) Average reach-in case

3.15.2 SAVINGS

Deemed electric annual energy and demand savings per installed motor are shown in Table 85 based on refrigeration equipment type.

Table 85: Reach-in Evaporator Fan ECM's Electric Energy and Demand Savings

Refrigeration Equipment Type	Savings (kWh/year)	Savings (kW)
Medium Temperature reach-in evaporator fan ECM	687	0.078
Low Temperature reach-in evaporator fan ECM	754	0.086
Average reach-in evaporator fan ECM	709	0.081

3.15.3 ENERGY SAVINGS ESTIMATION

Savings are based on the work of the Regional Technical Forum (RTF) of the Northwest Power & Conservation Council.[94] The RTF relied on data from the Energy Smart Grocer (ESG) program of Portland Energy Conservation, Inc. (PECI). ESG audit data showed the following average motor capacity and efficiency for reach-in evaporator fan motors. The equivalent SP motor capacity and efficiency derived from DOE-reported efficiency. Walk-in evaporator motor information is shown in Table 86.

Table 86: Walk-in Evaporator Motor Capacity and Efficiency

Motor Output (watts) for Display Case[1]	SP Input Watts	ECM Input Watts	ECM Efficiency[2]	SP Efficiency[2]
14.94	75	23	66%	20%

[1] EnergySmart Grocer Invoice Data.

[2] From DOE TSD for commercial refrigeration. Data corroborated from the US DOE Report: Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment.

The distribution of low temperature vs. medium temperature is assumed to be equal to the following based on the walk-in units: 33% for freezers, and 67% for coolers. Savings are equal to the sum of direct motor savings and savings due to the reduction in refrigeration load, where direct savings are determined with the following equation.

[94] https://rtf.nwcouncil.org/measure/ecms-display-cases/

$$DirectSvgs = (kW_{Baseline} - kW_{Installed}) \times FLH$$

Where:

DirectSvgs = *Annual motor savings, kWh*

kW = *Power draw of motor, see*

Table 86.

FLH = *Full load hours, 8,760*

Refrigeration savings are based on the following formula.

$$RefrigSvgs = DirectSvgs \times \frac{ConvConst}{EER}$$

Where:

RefrigSvgs = *Annual refrigeration savings due to reduced waste heat, kWh*

ConvConst = *3.413 Btu/Wh*

EER = *Efficiency of walk-in refrigeration, see Table 87, Btu/Wh*

EER values were derived for reach-in cases for the New Mexico climate for the ASH measure. Average New Mexico values are shown in Table 87.

Table 87: New Mexico Average Grocery EER for Medium and Low Temperature Walk-ins

Medium Temperature EER (Btu/Wh)	Low Temperature EER (Btu/Wh)
6.74	5.22

3.15.4 DEMAND SAVINGS ESTIMATION

Since the motors are assumed to run full time, demand savings are equal to the average kW savings over the year.

3.15.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.15.6 MEASURE LIFE

The lifetime for this measure is 15 years, based on the RTF measure.

3.16 CHILLERS

Savings are provided for the installation of electric chillers. This document covers assumptions made about baseline equipment efficiencies for replace-on-burnout (ROB) and new construction (NC) situations based on current and previous efficiency standards. Early retirement (ER) projects should claim savings using the ROB/NC baseline.

Applicable efficient measure types include:[95]

- Compressor Types: Centrifugal or Positive displacement (Screw, Scroll, or Reciprocating)
- Condenser/Heat Rejection Type: Air-cooled or Water-cooled System Type Conversions.
- Chiller Type Conversions: Conversion from an air-cooled chiller system to a water-cooled chiller system is also addressed in this measure. An additional adjustment is made to the basic chiller savings to account for the auxiliary equipment associated with a water-cooled chiller.

3.16.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity
Measure category	Chillers
Delivery mechanism	Direct Install, Rebate
Baseline description	Chiller with Code-minimum efficiency
Efficient case description	Chiller exceeding Code-minimum efficiency

3.16.2 SAVINGS

Baseline efficiency levels for chillers are provided in Table 88 which includes both full load and Integrated Part Load Value (IPLV) ratings. The IPLV accounts for chiller efficiency at part-load operation for a given duty cycle. These baseline efficiency levels reference the 2021 IECC, adopted as New Mexico’s state energy code. The Code contains two paths for compliance: Path A or Path B. According to ASHRAE 90.1-2007 Addenda M, Path A is intended for applications where significant operating time is expected at full-load conditions, while Path B is an alternative set of efficiency levels for chillers intended for applications where significant

[95] Savings can also be claimed by a retrofit involving a change in equipment type (i.e., Air cooled packaged DX system to a water-cooled centrifugal chiller, or a split system air cooled heat pump to an air-cooled non-centrifugal chiller). If this type of retrofit is performed, the tables from the following HVAC measure templates will need to be referenced: HVAC – Chillers, Split System/Single Packaged Heat Pumps and Air Conditioners

time is spent at part-load operation (such as with a VSD chiller). Either Path can be used for compliance on any chiller, however the chiller must meet the minimum requirements for both full and part-load efficiency that are set forth in the following sections.

Table 88: Baseline Efficiencies for ROB and NC Air-Cooled and Water-Cooled Chillers[96]

System Type [Efficiency Units]		Efficiency Units	Capacity [Tons]	Path A		Path B	
				Full-Load	IPLV.IP	Full-Load	IPLV.IP
Air-Cooled Chiller		EER (Btu/Wh)	< 150	≥ 10.100	≥ 13.700	≥ 9.700	≥ 15.800
			≥ 150	≥ 10.100	≥ 14.000	≥ 9.700	≥ 16.100
Water-Cooled Chiller	Screw/ Scroll/Recip.	kW/ton	< 75	≤ 0.750	≤ 0.600	≤ 0.780	≤ 0.500
			≥ 75 and < 150	≤ 0.720	≤ 0.560	≤ 0.750	≤ 0.490
			≥ 150 and < 300	≤ 0.660	≤ 0.540	≤ 0.680	≤ 0.440
			≥ 300 and < 600	≤ 0.610	≤ 0.520	≤ 0.625	≤ 0.410
			≥ 600	≤ 0.560	≤ 0.500	≤ 0.585	≤ 0.380
Water-Cooled Chiller	Centrifugal	kW/ton	< 150	≤ 0.610	≤ 0.550	≤ 0.695	≤ 0.440
			≥ 150 and < 300	≤ 0.610	≤ 0.550	≤ 0.635	≤ 0.400
			≥ 300 and < 400	≤ 0.560	≤ 0.520	≤ 0.595	≤ 0.390
			≥ 400 and < 600	≤ 0.560	≤ 0.500	≤ 0.585	≤ 0.380
			≥ 600	≤ 0.560	≤ 0.500	≤ 0.585	≤ 0.380

Chillers must exceed the minimum efficiencies specified in Table 88 for either Path A or Path B. For whichever path is used, the chiller must exceed the minimum baseline efficiency for both Full-load and IPLV of that path to qualify. To qualify for the use of this measure, no additional measures may be installed that directly affect the operation of the cooling equipment (i.e., control sequences, cooling towers, and condensers).

3.16.3 ENERGY SAVINGS ESTIMATION

Savings can be determined using the equations presented below based on equipment type.

Water-Cooled Chillers:

$$\Delta kWh = Tons * \left(\left(IPLV_{base} \right) - \left(IPLV_{ee} \right) \right) * EFLH$$

Air-Cooled Chillers:

$$\Delta kWh = Tons * \left(\left(\frac{12}{IPLV_{base}} \right) - \left(\frac{12}{IPLV_{ee}} \right) \right) * EFLH$$

Where:

[96] IECC 2021 Table C403.3.2.(3).

TONS	*= chiller actual installed cooling capacity in tons (note: 1 ton = 12,000 Btu/hr)*
IPLVbase	*= efficiency of baseline equipment expressed as Integrated Part Load Value (kW/ton) obtained from current IECC Minimum Efficiency Table – Path (A). Refer to Baseline Efficiency Values by Chiller Type and Capacity in Table 88*
IPLVee	*= Actual installed efficiency of high efficiency equipment expressed as Integrated Part Load Value (kW/ton)*
EFLH	*= Equivalent Full Load Hours for cooling in Existing Buildings or New Construction are provided in (See Table 89 through Table 92).*

Coincidence factor (CF) and equivalent full-load hour (EFLH) values are presented by building type for Albuquerque, Las Cruces, Roswell, and Santa Fe in Table 89, Table 90, Table 91, and Table 92, respectively. EFLH and CF values are derived from the values in the Texas TRM version 5. EFLH values were adjusted based on a cooling degree-day comparison of Amarillo, Albuquerque, and Santa Fe, and a comparison of El Paso, Las Cruces, and Roswell. CF values were adjusted considering cooling degree-days for the months of June through August.[97]

These tables also include an "Other" building type, which can be used for business types that are not explicitly listed. The CF and EFLH values used for Other are the most conservative values from the explicitly listed building types. When the Other building type is used, a description of the actual building type, the primary business activity, the business operating hours, and the HVAC schedule must be collected for the project site and stored in the utility tracking data system.

Table 89: CF and EFLH – Albuquerque

Building Type	Principal Building Activity	Chiller			
		Air Cooled		Water Cooled	
		CF	EFLHc	CF	EFLHc
Education	College	0.84	1,061	0.66	1,183
	Primary School	0.43	548	0.51	924
	Secondary School	0.68	763	0.56	1,686
Healthcare	Hospital	0.68	1,909	0.63	2,579
Large Multifamily	Midrise Apartment	0.40	401	0.49	1,045

[97] TX Value x (NM CDD / TX CDD) = NM Value.

Building Type	Principal Building Activity	Chiller			
		Air Cooled		Water Cooled	
		CF	EFLHc	CF	EFLHc
Lodging	Large Hotel	0.56	1,221	0.57	1,478
	Nursing Home	0.40	407	0.49	1,061
Mercantile	Stand-Alone Retail	0.51	465	0.52	684
	24Hr Retail	0.65	648	0.60	927
Office	Large Office	0.68	1,149	0.59	1,433
Public Assembly	Public Assembly	0.43	736	0.51	1,243
Religious Worship	Religious Worship	0.51	280	0.52	412
Other98	Other	0.40	280	0.49	412

Table 90: CF and EFLH - Las Cruces

Building Type	Principal Building Activity	Chiller			
		Air Cooled		Water Cooled	
		CF	EFLHc	CF	EFLHc
Education	College	0.98	1,259	1.01	1,436
	Primary School	0.64	740	0.56	1,096
	Secondary School	0.81	1,023	0.57	2,163
Healthcare	Hospital	0.75	2,319	0.62	2,946
Large Multifamily	Midrise Apartment	0.59	828	0.55	1,529
Lodging	Large Hotel	0.66	1,787	0.61	2,007
	Nursing Home	0.59	841	0.55	1,553
Mercantile	Stand-Alone Retail	0.67	711	0.58	934
	24Hr Retail	0.64	871	0.63	1,350
Office	Large Office	0.81	1,420	0.63	1,657
Public Assembly	Public Assembly	0.64	995	0.56	1,473
Religious Worship	Religious Worship	0.67	428	0.58	562
Other[99]	Other	0.59	428	0.55	562

[98] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office” EFLH and CF

[99] Ibid

Table 91: CF and EFLH - Roswell

Building Type	Principal Building Activity	Chiller			
		Air Cooled		Water Cooled	
		CF	EFLHc	CF	EFLHc
Education	College	0.88	1,149	0.91	1,310
	Primary School	0.58	675	0.50	1,000
	Secondary School	0.73	934	0.51	1,974
Healthcare	Hospital	0.68	2,117	0.56	2,689
Large Multifamily	Midrise Apartment	0.53	756	0.49	1,396
Lodging	Large Hotel	0.60	1,631	0.55	1,832
	Nursing Home	0.53	768	0.49	1,417
Mercantile	Stand-Alone Retail	0.61	649	0.52	852
	24Hr Retail	0.58	794	0.57	1,232
Office	Large Office	0.73	1,296	0.57	1,513
Public Assembly	Public Assembly	0.58	908	0.50	1,344
Religious Worship	Religious Worship	0.61	391	0.52	513
Other[100]	Other	0.53	391	0.49	513

Table 92: CF and EFLH - Santa Fe

Building Type	Principal Building Activity	Chiller			
		Air Cooled		Water Cooled	
		CF	EFLHc	CF	EFLHc
Education	College	0.55	631	0.43	703
	Primary School	0.28	326	0.34	549
	Secondary School	0.44	454	0.37	1,002
Healthcare	Hospital	0.44	1,135	0.41	1,534
Large Multifamily	Midrise Apartment	0.26	238	0.32	621
Lodging	Large Hotel	0.37	726	0.37	879
	Nursing Home	0.26	242	0.32	631
Mercantile	Stand-Alone Retail	0.33	277	0.34	407
	24Hr Retail	0.42	385	0.39	551
Office	Large Office	0.44	683	0.39	852
Public Assembly	Public Assembly	0.28	438	0.34	739
Religious Worship	Religious Worship	0.33	166	0.34	245
Other[101]	Other	0.26	166	0.32	245

[100] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office” EFLH and CF

[101] Ibid

3.16.4 DEMAND SAVINGS ESTIMATION

$$\Delta kW = Tons * \left(\left(FLV_{base} \right) - \left(FLV_{ee} \right) \right) * CF$$

Where:

CF = *Seasonal peak demand factor for newly installed equipment for appropriate climate zone, building type, and equipment type; (See tables above)*

FLV_{base} = *Rated full-load cooling efficiency of standard baseline equipment [IPLV, Btu/W-h; for units rated in kW/ton, convert to Btu/W-h using 12 / (kW/ton) = Btu/W-h] (see Table 88)*

FLV_{ee} = *Rated full-load cooling efficiency of the newly installed equipment [EER, Btu/W-h; for units rated in kW/ton, convert to Btu/W-h using 12 / (kW/ton) = Btu/W-h] (Must exceed minimum standards in Table 88)*

Example:

Air-cooled chiller (IPLV=13.7, FLV=10.1) is replaced with an efficient chiller (IPLV=17.43, FLV =8.96) of capacity 746,400 Btuh in a College in Albuquerque.

$Energy\ (Cooling)\ [kWh_{Savings,C}]$ *= (746,400 Btuh/ 12,000 Btu/h) * (12/ 13.7 kW/ton –12/17.43 kW/ton) x 1061 hours x = 12,370 kWh*

$Peak\ Demand\ [kW_{Savings}]$ *= (746,400 Btuh/ 12,000 Btu/h) *(10.1 kW/ton –8.96 kW/ton) x 0.84 = 59.56 kW Non-energy Benefits*

There are no non-energy benefits.

3.16.5 MEASURE LIFE

The estimated useful life (EUL) for chillers is provided below:

- Screw/Scroll/Reciprocating Chillers: 20 years[102]
- Centrifugal Chillers: 25 years[103]

3.17 OZONE LAUNDRY

A new ozone laundry system(s) is added-on to new or existing commercial washing machine(s) using hot water heated with natural gas. The system generates ozone (O3), a naturally occurring molecule, which helps clean fabrics by chemically reacting with soils in cold

[102] PUCT Docket No. 36779. The original source was DEER 2008, but DEER 2014 provides the same value of 20 years for "High Efficiency Chillers". DEER does not differentiate between centrifugal and non-centrifugal chillers.

[103] PUCT Docket No. 40885, review of multiple studies looking at the lifetime of Centrifugal Chillers as detailed in petition workpapers.

water. Adding an ozone laundry system(s) will reduce the amount of chemicals, detergents, and hot water needed to wash linens.

Natural gas energy savings will be achieved at the hot water heater as it will be required to produce less hot water to wash each load of laundry. Electric energy savings will be achieved through reduced washer cycle length and reduced water pumping load. The decrease in hot water usage will increase cold water usage, but overall water usage at the facility will decrease.

In the commercial sector, water heating for laundry purposes is usually done using gas boilers or gas water heaters since they are much cheaper to operate and are more economical to use for large batches of water. Hence, the measure lists savings for gas-heated water. If the energy efficiency programs encounter electric water heaters for this measure on a large scale, adjustments can be made to the measure upon request.

3.17.1 MEASURE OVERVIEW

Sector	Commercial
End use	Efficient Laundry
Fuel	Electricity and Natural Gas
Measure category	Efficient Laundry Appliances
Delivery mechanism	Prescriptive
Baseline description	Conventional Washing Machine with no Ozone Generator
Efficient case description	Ozone System added to a new or existing Washing Machine

3.17.2 SAVINGS

Electric savings can be realized through reduced washer cycle length and reduced pumping load at the boiler feeding the commercial washers. The increased usage associated with operating the ozone system should also be accounted for when determining total kWh impact.

This incentive only applies to the following facilities with on-premise laundry operations:[104]

- Hotels/motels

[104] The results included in this analysis are based heavily on analysis provided in Illinois TRM v12.0, for the mentioned facility types and may not apply to facilities outside of this list due to variances in number of loads and average pound (lbs.)-capacity per project site. More facilities need to be analyzed in the future to be included in this measure.

- Fitness and recreational sports centers.
- Healthcare (excluding hospitals)
- Assisted living facilities
- Laundromats

In the efficient case, a new ozone laundry system(s) is added to a new or existing commercial washing machine(s) using hot water heated with natural gas. The ozone laundry system(s) must transfer ozone into the water through:

- Venturi Injection
- Bubble Diffusion
- Additional applications may be considered upon program review and approval on a case-by-case basis.

Natural gas energy savings will be achieved at the hot water heater/boiler as they will be required to produce less hot water to wash each load of laundry. The decrease in hot water usage will increase cold water usage, but overall water usage at the facility will decrease.

The base case equipment is a conventional washing machine system with no ozone generator installed. The washing machines are provided with hot water from a gas-fired boiler.

3.17.3 ENERGY SAVINGS ESTIMATION

Electric savings can be realized through reduced washer cycle length and reduced pumping load at the boiler feeding the commercial washers. There is also an increased usage associated with operating the ozone system.

$$\Delta kWh_{pump} = HP * Conversion\ Factor * Hours * \%Water_{savings}$$

Where:

ΔkWh_{pump}	= Electric savings from reduced pumping load
HP	= Brake horsepower of boiler feed water pump; *Actual or* use 5 HP if unknown[105]
Conversion Factor	= Conversion from horsepower to kW; 0.746

[105] Assumed average horsepower for boilers connected to applicable washer (IL TRM v12.0).

Hours	=	Actual associated boiler feed water pump hours; *800 hours*[106] *if unknown*
$\%Water_{savings}$	=	*Water reduction* factor, i.e., how much more efficient an *ozone injection washing machine is compared t*o a typical *conventional washing machine as a rate of hot and cold water reduction; 10% or 25%*107

Table 93 lists the percentage of water savings by application.

Table 93: Percentage of Water Savings by Application

Application	Percentage of Water Savings (% water savings)
Laundromat	10%
Hotel/Motel	25%
Fitness and Recreation	
Healthcare	
Assisted Living	

Natural gas energy savings will be achieved at the hot water heater/boiler as they will be required to produce less hot water to wash each load of laundry.

$$\Delta Therms = Therm_{Baseline} * HWRF$$

Where:

$\Delta Therms$ = *Gas Savings resulting from a reduction in hot water use, in therms*

$Therm_{Baseline}$ = *Annual Gas Baseline consumption*

$$Therm_{Baseline} = \frac{(TempUsage - TempCold) * HeatCapacity * Density * Const}{Efficiency} * UF_{Washer} * HWUF$$

Where:

TempUsage	=	*Boiler water temperature (if unknown, 140°F)*
TempCold	=	*Temperature of inlet water,* HeatCapacity =*Heat capacity of water, 1 Btu per pound per ˚F*
Density	=	*Density of water, 8.33 pounds per gallon*

[106] Engineering estimate from analysis of Nicor custom projects done by CLEAResult and presented in Illinois Technical Resource Manual v12.0.

[107] Average water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR) implemented by Nicor Gas. (Source: Illinois TRM v12.0).

Constant	= *Constant, 1 therm/100,000 Btus, or .00029307107 kWh/Btu*
Efficiency	= *Assumed boiler efficiency, 80%*
UF_{Washer}	= *Washer Utilization Factor: Annual pounds of clothes washed per year;*
	= *Actual, if unknown the values below*
HWUF	= *Hot Water Usage Factor: amount of hot water a typical conventional washing machine utilizes, normalized per pounds of clothes washed.*
HWRF	= *Hot Water Reduction Factor, how much more efficient an ozone injection washing machine is, compared to a typical conventional washing machine, as a rate of hot water reduction, as shown in Table* 94.

Table 94 lists the water utilization factor by application, Table 95 lists the hot water usage factor, and Table 96 lists the hot water reduction factor.

Table 94: Washer Utilization Factor by Application

Application	Washer Utilization Factor
Laundromat	2,190 cycles per year*Lbs-Capacity
Hotel/Motel	916,150 lbs (Approx 4,745 cycles per year) per site
Fitness and Recreation	
Healthcare	
Assisted Living	

Table 95: Hot Water Usage Factor

Application	Hot Water Usage Factor
Laundromat	0.64 gallons/lb
Hotel/Motel	1.19 gallons/lb
Fitness and Recreation	
Healthcare	
Assisted Living	

Table 96: Hot Water Reduction Factor

Application	Hot Water Reduction Factor
Laundromat	100%
Hotel/Motel	81%
Fitness and Recreation	
Healthcare	

Example:

Using defaults from above for an ozone laundry system in Albuquerque:

$$Therm_{Baseline} = \frac{(140.0-69.2)*1*8.33}{0.8*100{,}000} * 916{,}150 * 1.19 \text{ therms}$$

$$= 8{,}037 \text{ therms}$$

Using defaults from above:

$$\Delta Therms = Therm_{Baseline} * \%Hot\ Water_{savings}$$

$$= 8{,}037 * 0.81 \text{ therms}$$

$$= 6{,}510 \text{ therms}$$

3.17.4 DEMAND SAVINGS ESTIMATION

At this moment, peak demand savings cannot be associated with this measure, as not enough study has been done regarding the operation of ozone laundry systems and coincident peak demand.

3.17.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.17.6 MEASURE LIFE

The measure equipment's effective useful life (EUL) is estimated at 10 years based on typical lifetime of the ozone generator's corona discharge unit.[108]

3.18 WATER HEATER PIPE INSULATION

This measure involves the installation of pipe insulation on un-insulated domestic water heater pipes.

3.18.1 MEASURE OVERVIEW

Sector	Commercial (DHW only)
End use	Insulation
Fuel	Electric, Natural Gas
Measure category	Water Heater
Delivery mechanism	Prescriptive
Baseline description	Uninsulated Hot Water Pipe
Efficient case description	Insulated Hot Water Pipe

[108] Based on data presented in Illinois TRM v12.0 (confirmed via vendor interviews)

3.18.2 SAVINGS

The baseline is assumed to be a typical water heater (electric, gas, or heat pump varieties) with no heat traps and no insulation on water heater pipes.

New construction and retrofits involving the installation of new water heaters are not eligible for this new measure.

The efficiency standard requires an insulation thickness R-3. The International Residential Code (IRC) 2018 section N1103.3: Mechanical system piping insulation requires R-3 insulation.

3.18.3 ENERGY SAVINGS ESTIMATION

Hot water pipe insulation energy savings are calculated using the formula below.

$$Annual\ Energy\ Savings = (U_{Pre} - U_{Post}) * A * \left(T_{Pipe} - T_{Ambient}\right) * \left(\frac{1}{Eff}\right) * Hours_{Total} * \frac{1}{Conversion\ Factor}$$

Where:

U_{Pre}[109]	= *1/(2.03 +* R_{Pipe}*) Btu/hr sq. ft. °F, (*R_{Pipe} *is assumed to be 0 given the high conductivity of bare metal pipe) = 0.4926*
U_{Post}	= *1/(2.03+*R_{Pipe}+$R_{insulation}$*) Btu/hr sq. ft. °F*
$R_{insulation}$	= *R-value of insulation*
A	= *Pipe surface area insulated in square feet* (πDL) *with L (length) and D (pipe diameter) in feet, use Table 97.*
T_{Pipe}	= *Average temperature of the heated water in the pipe, use 127.5 °F*[110]
$T_{Ambient}$	= *Average annual temperature, use Table 98.*
Eff	= *System Efficiency (AFUE for gas water heater) of installed water heater. If unknown, use 0.98 as a default for electric resistance water heaters or 0.80 for natural gas storage or instantaneous water heaters*
$Hours_{Total}$	= *8,760 hours per year*

[109] 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.

[110] Preliminary visits to schools in New Mexico has shown water heater temperatures set at 125 – 130°F, within typical range for domestic hot water. Average of 127.5 °F used.

Conversion Factor = *3,412 Btu/kWh, for Electric Water Heater*

= 100,000 Btu/Therm, for Gas Water Heater

Table 97 and Table 98 provide inputs to support the energy savings algorithms shown above.

Table 97: Pipe Surface Area and Pipe Diameter

Pipe Diameter (inches)	Pipe Surface Area (sq. ft.)
0.5	0.13 * Pipe Length Insulated (in feet)
0.75	0.20 * Pipe Length Insulated (in feet)
1.0	0.26 * Pipe Length Insulated (in feet)
1.25	0.33 * Pipe Length Insulated (in feet)
1.5	0.39 * Pipe Length Insulated (in feet)
2.0	0.52 * Pipe Length Insulated (in feet)

Table 98: Annual Ambient Temperature for Unconditioned and Conditioned Spaces

Climate Zone	$T_{ambient}$ (Unconditioned)[111]	$T_{ambient}$ (Conditioned)
Albuquerque	61.6°F	72.0 °F[112]
Roswell	67.5°F	
Santa Fe	56.5°F	
Las Cruces	68.2 °F	

Example: Insulation (R-3) added to an uninsulated natural gas water heater pipe with diameter 0.5 inches and 20 feet total length.

Annual Energy Savings = [(1/(2.03 + 0) – 1/(2.03 + 0 + 3)] Btu/hr sq. ft. °F x (0.13 x 20) sq. ft. x (127.5 – 61.6) °F x 1/0.80 x 8760 hours x 1/(100,000 BTU/Therm) = 5.5 Therms

3.18.4 DEMAND SAVINGS ESTIMATION

Peak kW demand savings for tank insulation are calculated with the equation below. Please note this equation only applies to electric or heat pump water heater applications:

$$Demand\ Savings = \frac{Annual\ Energy\ Savings}{8{,}760}$$

[111] Average ambient temperatures were taken from TMY3 data. 5-F was added to each average to approximate the difference between outdoor temperature and unconditioned interior temperature.

[112] As per OSHA Office Temperature Guidelines, office temperature varies between 68 -76°F. Hence, averaged to 72°F
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=interpretations&p_id=24602

3.18.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.18.6 MEASURE LIFE

As per 2014 California Database for Energy Efficiency Resources (DEER), the EUL for this measure is listed as 13 years.[113]

Sector	Commercial
End use	Pool Water Pumping
Fuel	Electricity
Measure category	Water Pumping
Delivery mechanism	Rebate
Baseline description	0.5 – 3 HP standard-efficiency single-speed pool pump
Efficient case description	0.5 – 3 HP ENERGY STAR® qualified multi-speed or variable-speed pool pump

3.18.7 SAVINGS

Savings are calculated using the algorithms and assumptions found in the ENERGY STAR® Pool Pump Calculator.[114] To be eligible for this measure, the installed pool pump must be either a multi-speed or variable-speed pump and must meet the energy efficiency requirements for ENERGY STAR® qualified pool pumps, which state that a pump must have a minimum energy factor (EF) of 3.8 for the most efficient speed.[115] The most efficient speed is defined as the speed with the highest EF for a given pump.

The savings for this measure is based on an assumed pipe diameter of 2.5” and Pump Performance Curve C.

3.18.8 ENERGY SAVINGS ESTIMATION

Savings are determined by the following equations.

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[113] 2014 California Database for Energy Efficiency Resources.

[114] Savings Calculator for ENERGY STAR® Certified Inground Pool Pumps, Updated December 2013: https://www.energystar.gov/sites/default/files/asset/document/Pool%20Pump%20Calculator.xlsx

[115] ENERGY STAR® Pool Pumps Key Product Criteria, Version 1.1, Effective February 15, 2013: https://www.energystar.gov/products/other/pool_pumps/key_product_criteria

$$kWh_{savings} = kWh_{conventional} - kWh_{ENERGY\ STAR}$$

Where:

$kWh_{savings}$ = *Annual energy savings, kWh*

$kWh_{conventional}$ = *Annual energy consumption of a conventional single-speed pool pump, derived with the equation below, kWh*

$kWh_{ENERGYSTAR}$ = *Annual energy consumption of an ENERGY STAR® qualified multi-speed or variable-speed pool pump, derived with the equation below, kWh*

$$kWh_{conventional} = \frac{PFR_{conventional} * 60 * hours_{conventional} * days}{EF_{conventional} * 1{,}000}$$

$$kWh_{ENERGYSTAR} = kWh_{HS} + kWh_{LS}$$

$$kWh_{HS} = \frac{PFR_{HS} * 60 * hours_{HS} * Days}{EF_{HS} * 1{,}000}$$

$$kWh_{LS} = \frac{PFR_{LS} * 60 * hours_{LS} * Days}{EF_{LS} * 1{,}000}$$

Where:

kWh_{HS} = *ENERGY STAR® variable speed pool pump energy at high speed, kWh*

kWh_{LS} = *ENERGY STAR® variable speed pool pump energy at low speed, kWh*

$hours_{conventional}$ = *Conventional single-speed pump daily operating hours; 24 hours for 24/7 operation, 12 hours for limited operation*

$hours_{HS}$ = *ENERGY STAR® variable speed pump high speed daily operating hours; 12 hours for 24/7 operation, 6 hours for limited operation*

$hours_{LS}$ = *ENERGY STAR® variable speed pump low speed daily operating hours; 12 hours for 24/7 operation, 6 hours for limited operation*

Days = *Operating days per year; actual, if not available, 365 days (default)*

$PFR_{conventional}$ = *Conventional single-speed pump flow rate, gal/min*

PFR_{HS} = *ENERGY STAR® variable speed pump high speed flow rate, gal/min*

PFR_{LS} = *ENERGY STAR® variable speed pump low speed flow rate, gal/min*

$EF_{conventional}$ = *Conventional single-speed pump energy factor, gal/W·hr*

EF_{HS} = *ENERGY STAR® variable speed pump high speed energy factor, gal/W·hr*

EF_{LS} = *ENERGY STAR® variable speed pump low speed energy factor, gal/W·hr*

60 = *Constant to convert between minutes and hours*

1,000 = *Constant to convert from kilowatts to watts*

Table 99 lists the conventional pool pumps assumptions while Table 100 lists ENERGY STAR® pool pumps assumptions, where both tables provide PFR and EF values by rated horsepower.

Table 99: Conventional Pool Pumps PFR and EF by Horsepower116

Rated Horsepower (HP)	PFRConventional	EFConventional
≤ 1.25	75.5000	2.5131
1.25 < HP ≤ 1.75	78.1429	2.2677
1.75 < HP ≤ 2.25	88.6667	2.2990
2.25 < HP ≤ 2.75	93.0910	2.1812
2.75 < HP ≤ 3.00	101.6667	1.9987

Table 100: ENERGY STAR® Pool Pumps PFR and EF by Horsepower117

Rated Horsepower (HP)	PFRHS	PFRLS	EFHS	EFLS
HP ≤ 1.25	70.00	40.33	3.01	6.78
1.25 < HP ≤ 1.75	78.00	41.75	2.74	6.71
1.75 < HP ≤ 2.25	89.71	44.75	2.4	6.50
2.25 < HP ≤ 2.75	90.00	45.67	2.44	5.96
2.75 < HP ≤ 3.00	102.00	51.00	1.99	6.07

3.18.9 DEMAND SAVINGS ESTIMATION

The following algorithm is used to determine demand savings:

$$kW_{Savings} = \left[\frac{kWh_{conventional}}{hours_{conventional}} - \left(\frac{kWh_{HS} + kWh_{LS}}{hours_{HS} + hours_{LS}}\right)\right] * \frac{DF}{Days}$$

Where:

$kWh_{conventional}$ = *Annual energy consumption of a conventional single-speed pool pump, kWh*

kWh_{HS} = *ENERGY STAR® variable speed pool pump energy at high speed, kWh*

kWh_{LS} = *ENERGY STAR® variable speed pool pump energy at low speed, kWh*

$hours_{conventional}$ = *Conventional single-speed pump daily operating hours*

$hours_{HS}$ = *ENERGY STAR® variable speed pump high speed daily operating hours*

[116] Conventional pump PFR and EF values are taken from pump curves found in the ENERGY STAR® Pool Pump Savings Calculator

[117] ENERGY STAR® turnover and EF values are taken from pump curves found in the ENERGY STAR® Pool Pump Savings Calculator.

$hours_{LS}$	= *ENERGY STAR® variable speed pump low speed daily operating hours*
Days	= *Operating days per year = 365 days (default)*
DF	= *Demand Factor, see Table 101.*

Table 101 provides summer and winter demand by factor based on the operation of the facility.

Table 101: Demand Factor

Operation	Summer DF	Winter DF
24/7 Operation	1.0	1.0
Seasonal/Limited Hours	1.0	0.5

Example:

ENERGY STAR® pool pump (capacity = 2 HP) is installed in place of standard efficiency single speed pool pump.

$kWh_{conventional}$ = *88.67 gal/min x 60 x 24 hours x 365 days / (2.3 gal/W·hr x 1000) = 20,263 kWh*

$kWh_{Energy\ Star}$ = *[89.71 gal/min x 60 x 12 hours x 365 days / (2.4 gal/W·hr x 1000)] + [44.75 gal/min x 60 x 12 hours*
x 365 days / (6.5 gal/W·hr x 1,000)] = 11,633 kWh

$kWh_{Savings}$ = *20,263 kWh – 11,633 kWh = 8,631 kWh*

$kW_{Savings}$ = *[20,263 kWh/24 hours – 11,632 kWh/(12 hours + 12 hours)] x 1 / 365 days = 0.985 kW*

3.18.10 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.18.11 MEASURE LIFE

According to DEER 2014, the Estimated Useful Life for this measure is 10 years.[118]

3.19 PACKAGED TERMINAL AIR CONDITIONERS, HEAT PUMPS, AND ROOM AIR CONDITIONERS

Savings are provided for the installation of Packaged Terminal Air Conditioners (PTAC), Packaged Terminal Heat Pumps (PTHP), and Room AC (RAC) systems. This document covers

[118] Database for Energy Efficient Resources (2014).

assumptions made for baseline equipment efficiencies for replace-on-burnout (ROB) and new construction (NC) situations based on current efficiency standards. Early retirement (ER) projects should claim savings using the ROB/NC baseline.

Applicable efficient measure types include:

Packaged Terminal Air Conditioners and Heat Pumps. Both standard and non-standard size equipment types are covered. Standard size refers to equipment with wall sleeve dimensions having an external wall opening greater than or equal to 16 inches high, or greater than or equal to 42 inches wide and a cross-sectional area greater than 670 in2. Non-standard size refers to equipment with existing wall sleeve dimensions having an external wall opening of less than 16 inches high, or less than 42 inches wide and a cross-sectional area less than 670 in^2.

Room Air Conditioners. Includes all equipment configurations covered by the federal appliance standards,[119] including with or without reverse cycle, louvered or non-louvered sides, casement-only, and casement-slide.

3.19.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity
Measure category	PTAC/PTHP, RAC
Delivery mechanism	Direct Install, Rebate
Baseline description	Minimum federal efficiency standards for PTAC/PTHP and RAC
Efficient case description	PTAC/PTHP or RAC exceeding minimum federal efficiency standards

3.19.2 SAVINGS

Table 102 shows the minimum efficiency standards for PTAC/PTHP units and reflects the federal standards for Packaged Terminal Air Conditioners and Heat Pumps reflected in 10 CFR 431.97(c).

[119] 10 CFR 430.32(b)

Table 102: Minimum Efficiency Levels for PTAC/PTHP ROB and NC Units[120,121]

Equipment	Cooling Capacity [Btuh]	Minimum Cooling Efficiency [EER]	Minimum Heating Efficiency [COP]
PTAC Standard size (Cooling mode)	< 7,000 Btu/h	11.9 EER	--
	≥ 7,000 Btu/h and ≤ 15,000 Btu/h	14.0 - (0.300 x Cap/1000) EER	-
	> 15,000 Btu/h	9.5 EER	-
PTAC Non-Standard size (Cooling mode)	< 7,000 Btu/h	9.3 EER	--
	≥ 7,000 Btu/h and ≤ 15,000 Btu/h	10.8 - (0.213 x Cap/1000) EER	-
	> 15,000 Btu/h	7.6 EER	-
PTHP Standard size	< 7,000 Btu/h	11.9 EER	3.3 COP
	≥ 7,000 Btu/h and ≤ 15,000 Btu/h	14.0 - (0.300 x Cap/1000) EER	3.7 - (0.052 x Cap/1000) COP
	> 15,000 Btu/h	9.5 EER	2.9 COP
PTHP Non-Standard size	< 7,000 Btu/h	9.3 EER	2.7 COP
	≥ 7,000 Btu/h and ≤ 15,000 Btu/h	10.8 - (0.213 x Cap/1000) EER	2.9 - (0.026 x Cap/1000) COP
	> 15,000 Btu/h	7.6 EER	2.5 COP
Single Packaged Vertical Air Conditioner (cooling mode) (SPVAC)	< 65,000 Btu/h	11.0EER	--
	≥ 65,000 Btu/h and < 135,000 Btu/h	10 EER	--
	≥ 135,000 Btu/h and < 240,000 Btu/h	10 EER	--
Single Packaged Vertical Heat Pump (SPVHP)	< 65,000 Btu/h	11.0 EER	3.3 COP
	≥ 65,000 Btu/h and < 135,000 Btu/h	10.0 EER	3.0 COP
	≥ 135,000 Btu/h and < 240,000 Btu/h	10.1 EER	3.0 COP

Table 103 lists the federal standards for Room Air Conditioners specified in 10 CFR 430.32(b).

[120] IECC 2021 Table C403.3.2(4)

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

Table 103: Minimum Efficiency Levels for Room Air Conditioners ROB and NC Units[122]

Category	Cooling Capacity` [Btuh]	Minimum Cooling Efficiency [CEER]
Without reverse cycle, with louvered sides	< 8,000	11.0
	≥ 8,000 and < 14,000	10.9
	≥ 14,000 and < 20,000	10.7
	≥ 20,000 and < 28,000	9.4
	≥ 28,000	9.0
Without reverse cycle, without louvered sides	< 8,000	10.0
	≥ 8,000 and < 11,000	9.6
	≥ 11,000 and < 14,000	9.5
	≥ 14,000 and < 20,000	9.3
	≥ 20,000	9.4
With reverse cycle, with louvered sides	< 20,000	9.8
	≥ 20,000	9.3
With reverse cycle, without louvered sides	< 14,000	9.3
	≥ 14,000	8.7
Casement-only	All capacities	9.5
Casement-slider	All capacities	10.4

The high efficiency condition must exceed the minimum federal standards from Table 102 and Table 103. The high efficiency retrofits must also meet the following criteria:

- Non-Standard Size PTAC/PTHPs cannot be used for New Construction.
- No additional measures are installed that directly affect the operation of the cooling equipment (i.e., control sequences).

Deemed coincidence factor (CF) and equivalent full-load hour (EFLH) values are presented by building type and climate zone for PTAC/PTHP and RAC. EFLH and CF values are derived from the values listed in Section 3.6 and a comparison of EFLH and CF values for the Air Conditioner/Heat Pump and PTAC/PTHP measures in the Texas TRM, as PTAC/PTHP are expected to have a slightly different operating profile than packaged AC/HP. In the Texas TRM, for Amarillo, dividing the PTAC/PTHP value by the Air Conditioner/Heat Pump value gives 0.88,

122 IECC 2021 Table C403.3.2(4)

0.93, and 0.46 for CF, cooling EFLH, and heating EFLH, respectively. For El Paso, dividing the PTAC/PTHP value by the Air Conditioner/Heat Pump value gives 0.97, 1.01, and 0.66 for CF, cooling EFLH, and heating EFLH, respectively. These factors were multiplied by the CF and EFLH values listed in Section 3.6 to determine the values for this measure. The Albuquerque and Santa Fe values were derived based on the Amarillo factors, and the Las Cruces and Roswell values were derived based on the El Paso factors.

3.19.3 ENERGY SAVINGS ESTIMATION

Savings can be determined for this measure for both heating and cooling applications using the following algorithms:

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

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

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

Where:

$Cap_{C/H,pre}$	= *Rated equipment cooling/heating capacity of the existing equipment at AHRI standard conditions [BTUH]. If there is no existing equipment (e.g. new construction) set $Cap_{C/H,pre}$ equal to $Cap_{C/H,post}$; 1 ton = 12,000 Btuh*
$Cap_{C/H,post}$	= *Rated equipment cooling/heating capacity of the newly installed equipment at AHRI standard conditions [Btuh]; 1 ton = 12,000 Btuh*
$\eta_{baseline,C}$	= *Cooling efficiency of standard baseline equipment [EER or CEER, Btu/W-h] (See Table 104 and Table 105)*
$\eta_{baseline,H}$	= *Heating efficiency of standard baseline equipment [COP] (See Table 104 and Table 105)*
$\eta_{installed,C}$	= *Rated cooling efficiency of the newly installed equipment [EER or CEER, Btu/W-h]) (Must exceed minimum federal standards from(See Table 104 and Table 105)*
$\eta_{installed,H}$	= *Rated heating efficiency of the newly installed equipment [COP] (Must exceed minimum federal standards from (See Table 104 and Table 105)*
$EFLH_{C/H}$	= *Cooling/heating equivalent full-load hours for newly installed equipment based on appropriate climate zone, building type, and equipment type [hours] (See Table 104, Table 105 and Table 106)*

Table 104, Table 105, and Table 106 provide values for cooling EFLH, heating EFLH, and CF, respectively by building type and climate zone.

Table 104: Cooling EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	1,364	1,360	1,596	753
Education - Community College	1,006	1,306	1,377	583
Education - Primary School	404	514	561	268
Education - Relocatable Classroom	455	567	603	328
Education - Secondary School	417	485	562	198
Education - University	957	1,249	1,341	596
Grocery	764	973	1,051	363
Health/Medical – Hospital	1,103	1,196	1,405	560
Health/Medical - Nursing Home	913	970	1,221	446
Lodging - Hotel	1,411	1,700	1,820	903
Manufacturing - Bio/Tech	1,034	1,254	1,349	737
Manufacturing - Light Industrial	689	970	962	481
Office - Small	1,005	1,189	1,308	714
Restaurant - Fast-Food	1,179	1,283	1,395	699
Restaurant - Sit-Down	1,147	1,234	1,378	632
Retail - Single-Story Large	1,333	1,489	1,623	821
Retail - Small	1,202	1,378	1,456	786
Storage - Conditioned	456	707	706	312
Warehouse - Refrigerated	1,370	1,517	1,616	691
Other[123]	958	1,123	1,228	572

Table 105: Heating EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0	0	0	0
Education - Community College	0	0	0	0
Education - Primary School	321	332	330	427
Education - Relocatable Classroom	337	351	349	448
Education - Secondary School	337	351	349	448
Education - University	0	0	0	0
Grocery	0	0	0	0
Health/Medical – Hospital	0	0	0	0
Health/Medical - Nursing Home	0	0	0	0
Lodging - Hotel	359	254	253	478
Manufacturing - Bio/Tech	156	119	118	207

[123] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the "Office – Small" EFLH.

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Manufacturing - Light Industrial	156	119	118	207
Office - Small	156	119	118	207
Restaurant - Fast-Food	471	425	423	626
Restaurant - Sit-Down	514	499	496	684
Retail - Single-Story Large	415	312	311	552
Retail - Small	345	365	363	459
Storage - Conditioned	0	0	0	0
Warehouse - Refrigerated	0	0	0	0
Other[124]	156	119	118	207

Table 106: CF by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0.69	0.88	0.62	0.69
Education - Community College	0.69	0.84	0.67	0.69
Education - Primary School	0.69	0.88	0.62	0.69
Education - Relocatable Classroom	0.69	0.88	0.62	0.69
Education - Secondary School	0.69	0.84	0.67	0.69
Education - University	0.69	0.84	0.67	0.69
Grocery	0.65	0.78	0.66	0.65
Health/Medical – Hospital	0.68	0.79	0.70	0.68
Health/Medical - Nursing Home	0.69	0.85	0.66	0.69
Lodging - Hotel	0.54	0.61	0.56	0.54
Manufacturing - Bio/Tech	0.30	0.37	0.28	0.30
Manufacturing - Light Industrial	0.30	0.37	0.28	0.30
Office - Small	0.67	0.79	0.70	0.67
Restaurant - Fast-Food	0.66	0.74	0.71	0.66
Restaurant - Sit-Down	0.70	0.74	0.80	0.70
Retail - Single-Story Large	0.70	0.78	0.78	0.70
Retail - Small	0.69	0.80	0.73	0.69
Storage - Conditioned	0.48	0.73	0.33	0.48
Warehouse - Refrigerated	0.48	0.73	0.33	0.48
Other[125]	0.30	0.37	0.28	0.30

[124] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” EFLH.

[125] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” EFLH.

Example:

Efficient PTAC (20,000 Btuh capacity) is installed in place of standard PTAC in a hotel in Albuquerque.

$kWh_{Savings,C}$ = *(20,000 Btuh/9.3 – 20,000 Btuh/10.5) x 1,411 hours x 1 kW/1000 W*

= *347 kWh*

$Peak\ Demand\ [kW_{Savings}]$ = *(20,000 Btuh/9.3 – 20,000 Btuh/10.4) x 0.54 x 1 kW/1000 W*

= *0.133 kWD*

3.19.4 DEMAND SAVINGS ESTIMATION

Demand savings can be calculated using the following algorithm:

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

Where:

CF = *Coincidence factor for appropriate climate zone, building type, and equipment type (See Table 106)*

The remaining variables are defined above in the kWh savings subsection.

3.19.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.19.6 MEASURE LIFE

The measure life for PTAC/PTHPs is 15 years. The measure life for RACs is 9 years. These values are consistent with the EULs reported in the 2014 California Database for Energy Efficiency Resources (DEER).[126]

3.20 VENDING MACHINE AND MERCHANDISE COOLER CONTROLS

Savings are presented for the installation of Vending Machine and Merchandise Cooler controls to reduce energy usage during periods of inactivity. These controls reduce energy usage by powering down the refrigeration and lighting systems when the control device signals that there is no human activity near the machine. If no activity or sale is detected over the manufacturer's programmed time duration, the device safely de-energizes the

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[126] 2014 California Database for Energy Efficiency Resources.

compressor, condenser fan, evaporator fan, and any lighting. For refrigerated machines, it will power up occasionally to maintain cooling to meet the machine's thermostat set point. When activity is detected, the system returns to full power. The energy and demand savings are determined on a per-vending machine basis.

3.20.1 MEASURE OVERVIEW

Sector	Commercial
End use	Appliance
Fuel	Electricity
Measure category	Vending Machine and Merchandise Cooler Controls
Delivery mechanism	Direct Install, Rebate
Baseline description	Vending machine, or non-refrigerated snack machine, or merchandise cooler without controls
Efficient case description	Controlled refrigerated vending machine, or non-refrigerated snack machine, or merchandise cooler

3.20.2 SAVINGS

Deemed energy savings are listed in the following tables. Values are per-controlled machine and are sorted by building type and vending machine type. Vending machine values are given for machines manufactured before January 8, 2019, and on or after January 8, 2019. If the vending machine manufacture date is unknown, use the values for machines manufactured on or after January 8, 2019. Merchandise cooler values are given for machines manufactured before March 27, 2017, and on or after March 27, 2017. If the merchandise cooler manufacture date is unknown, use the values for machines manufactured on or after March 27, 2017.

Per federal standards,[127] vending machine types are defined as follows:

Class A means a refrigerated bottled or canned beverage vending machine that is not a combination vending machine and in which 25 percent or more of the surface area on the front side of the beverage vending machine is transparent.

[127] 10 CFR 431.296

Class B means a refrigerated bottled or canned beverage vending machine that is not considered to be Class A and is not a combination vending machine.

Combination vending machine means a bottled or canned beverage vending machine containing two or more compartments separated by a solid partition, that may or may not share a product delivery chute, in which at least one compartment is designed to be refrigerated, as demonstrated by the presence of temperature controls, and at least one compartment is not.

Combination A means a combination vending machine where 25 percent or more of the surface area on the front side of the beverage vending machine is transparent.

Combination B means a combination vending machine that is not considered to be Combination A.

If the type of vending machine is unknown, use the values for Class B machines.

Merchandise coolers are self-contained commercial reach-in refrigerators with transparent doors which display refrigerated goods for sale.

Table 107 shows deemed vending machine control energy savings, while Table 108 shows deemed vending machine demand savings.

Table 109 shows deemed merchandise cooler energy savings, while Table 110 shows deemed merchandise cooler demand savings.

Table 107: Deemed Vending Machine Controls Energy Savings (kWh/yr per Vending Machine)

		Manufactured before 1/8/2019		Manufactured on or after 1/8/2019			
Building Type	**Uncooled**	**Class A**	**Class B**	**Class A**	**Class B**	**Combin-ation A**	**Combin-ation B**
Assembly	69	1,116	1,361	1,067	1,009	1,304	1,280
Education - Community College	59	965	1,177	923	873	1,128	1,107
Education - Primary School	68	1,110	1,354	1,062	1,004	1,297	1,273
Education - Relocatable Classroom	70	1,141	1,392	1,091	1,032	1,334	1,309
Education - Secondary School	65	1,048	1,279	1,003	949	1,225	1,203
Education - University	61	991	1,209	948	897	1,159	1,138
Grocery	36	592	722	566	536	692	680

		Manufactured before 1/8/2019		Manufactured on or after 1/8/2019			
Building Type	**Uncooled**	**Class A**	**Class B**	**Class A**	**Class B**	**Combin-ation A**	**Combin-ation B**
Hospital	33	538	656	515	487	629	617
Hotel	68	1,104	1,347	1,056	999	1,290	1,267
Manufacturing - BioTech	59	956	1,167	915	865	1,118	1,097
Manufacturing - Light Industrial	58	942	1,149	901	852	1,101	1,081
Motel	70	1,135	1,384	1,085	1,027	1,326	1,302
Nursing Home	43	702	856	671	635	820	805
Office - Large	60	978	1,193	936	885	1,143	1,122
Office - Small	65	1,057	1,290	1,011	956	1,236	1,213
Restaurant - Fast Food	44	713	870	682	646	834	819
Restaurant - Sit Down	51	825	1,006	789	746	964	946
Retail - 3 Story or Larger	32	513	626	491	464	600	589
Retail - Large	51	835	1,019	799	755	976	958
Retail - Small	54	880	1,074	842	796	1,029	1,010
Storage - Conditioned	61	984	1,200	941	890	1,150	1,129
Storage - Unconditioned	62	1,007	1,229	964	911	1,178	1,156
Warehouse - Refrigerated	39	627	765	600	568	733	720

Table 108: Deemed Vending Machine Demand Savings (kW/yr per Vending Machine)

	Manufactured before 1/8/2019		Manufactured on or after 1/8/2019			
Uncooled	**Class A**	**Class B**	**Class A**	**Class B**	**Combination A**	**Combination B**
0.0007	0.0134	0.0165	0.0128	0.0121	0.0158	0.0155

Table 109: Deemed Merchandise Cooler Energy Savings (kWh/yr per Cooler)

	Manufactured before 3/27/2017				Manufactured on or after 3/27/2017			
Building Type	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**
Assembly	1,139	1,561	2,164	3,007	467	818	1,320	2,023
Education - Community College	986	1,350	1,871	2,601	404	708	1,142	1,750

	Manufactured before 3/27/2017				Manufactured on or after 3/27/2017			
Building Type	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**
Education - Primary School	1,134	1,553	2,152	2,991	464	814	1,313	2,012
Education - Relocatable Classroom	1,165	1,597	2,213	3,075	477	837	1,350	2,069
Education - Secondary School	1,071	1,467	2,033	2,826	439	769	1,241	1,901
Education - University	1,013	1,387	1,922	2,672	415	727	1,173	1,798
Grocery	605	829	1,148	1,596	248	434	701	1,074
Hospital	550	753	1,043	1,450	225	395	637	976
Hotel	1,128	1,545	2,141	2,975	462	810	1,306	2,002
Manufacturing - BioTech	977	1,338	1,854	2,577	400	701	1,132	1,734
Manufacturing - Light Industrial	962	1,318	1,826	2,538	394	691	1,114	1,707
Motel	1,159	1,588	2,200	3,058	475	832	1,343	2,057
Nursing Home	717	982	1,361	1,892	294	515	831	1,273
Office - Large	999	1,369	1,897	2,636	409	717	1,158	1,774
Office - Small	1,080	1,479	2,050	2,849	442	775	1,251	1,917
Restaurant - Fast Food	729	998	1,384	1,923	299	523	844	1,294
Restaurant - Sit Down	842	1,154	1,599	2,223	345	605	976	1,495
Retail - 3 Story or Larger	524	718	995	1,383	215	376	607	931
Retail - Large	853	1,168	1,619	2,250	349	612	988	1,514
Retail - Small	899	1,232	1,707	2,372	368	646	1,042	1,596
Storage - Conditioned	1,005	1,377	1,908	2,652	412	722	1,164	1,784
Storage - Unconditioned	1,029	1,410	1,954	2,715	422	739	1,192	1,827
Warehouse - Refrigerated	641	878	1,216	1,691	262	460	742	1,137

Table 110: Deemed Merchandise Cooler Demand Savings (kW/yr per Cooler)

Manufactured before 3/27/2017				Manufactured on or after 3/27/2017			
Under Counter	**Single Door**	**Double Door**	**Triple Door**	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**
0.0142	0.0194	0.0269	0.0374	0.0058	0.0102	0.0164	0.0252

3.20.3 ENERGY SAVINGS ESTIMATION

Energy Savings are derived based on the methodology in the SCE workpapers SCE17CS005.0 Beverage Merchandise Controller[128]. Savings can be achieved for three different scenarios:

1) Uncooled snack vending machines (method 1)

2) Cooled vending machines (methods 2 and 3)

3) Merchandise coolers (method 3)

Method 1 - Energy Savings for the reduction in lighting use from turning off an interior display light

In uncooled snack vending machines, a display light typically illuminates the products inside the vending machine. The SCE workpaper calculations assumed that illumination is provided by one 2-foot T8 linear fluorescent lamp. However, it is expected that vending machine lighting will increasingly transition to LED lamps. Therefore, the TRM calculations assume illumination is provided by one 2-foot 9-Watt LED tube lamp.

To estimate the specific energy savings, the DEER2017 linear fluorescent lighting effective full load operating hours will be used to represent when the unit is assumed to be enabled. The savings for occupancy based vending control will occur in a load profile complimentary to an 8,760 load shape.

$$Energy\ Savings = (8{,}760\ hrs - OccSnsrBldgHrs) \times Fixture\ Wattage$$

Annual operating hours for occupancy sensors are show in Table 111[129] by building type.

Table 111: Occupancy Sensor Annual operating Hours

Building Type	OccSnsrBldgHrs
Assembly	1,130
Education - Community College	2,160
Education - Primary School	1,170
Education - Relocatable Classroom	957
Education - Secondary School	1,590

128 http://deeresources.net/workpapers

[129] Derived from SDG&E workpaper WPSDGEENRCS0001

Building Type	OccSnsrBldgHrs
Education - University	1,980
Grocery	4,710
Hospital	5,080
Hotel	1,210
Manufacturing - BioTech	2,220
Manufacturing - Light Industrial	2,320
Motel	1,000
Nursing Home	3,960
Office - Large	2,070
Office - Small	1,530
Restaurant - Fast Food	3,880
Restaurant - Sit Down	3,120
Retail - 3 Story or Larger	5,250
Retail - Large	3,050
Retail - Small	2,740
Storage - Conditioned	2,030
Storage - Unconditioned	1,870
Warehouse - Refrigerated	4,470

For example, in a small office, the DEER2017 occupancy sensor-based lighting effective full load operating hours is 1,530 hours; therefore, the amount of time the vending machine control would turn the internal lights off would be 8,760 hours minus 1,530 hours, resulting in 7,230 hours of off time. The savings are calculated using the energy savings equation above.

Method 2 - Energy Savings for the reduction in lighting use from turning off a backlit display

The energy savings from reduction in backlit display lighting usage will be calculated using the same algorithm as method 1 above. The only deviation will be the wattage controlled. According to E Source tech Update TU-96-7,[130] the typical backlit display for a cooled beverage vending machine consists of two 5-foot linear fluorescent lamps. For the purposes of the calculation, the backlighting is assumed to be provided by two 4-foot 12-Watt LED tubes, for a

[130] Houghton, David PE (1996). Refrigerated Vending Machines - Overlooked Devices Hold Opportunities for Efficiency, New Services. E Source Tech Update, TU-96-7

total of 24 Watts for backlighting. Refer to Equation 1 for the general form of the savings calculation.

Method 3 - Energy Savings for the reduction in refrigeration time for refrigerated canned and bottled beverage vending machines and merchandise coolers

For vending machines, the base case energy usage is established using the federal standards for vending machines.[131] The Federal Energy Management Program (FEMP) used a 21 ft^3 refrigerated volume when calculating efficient vending machine savings,[132] and the savings for this measure are based on this volume.

Example: The three methods described above are further clarified through the following detailed examples, which illustrate their application. These examples provide a step-by-step understanding of how each method can be implemented effectively to achieve the desired outcomes.

Vending machines manufactured before January 8, 2019:

Class A

$$\text{Maximum Daily Energy Consumption (kWh)} = 0.055*V+2.56$$

Where,

V = volume (ft^3)

= 21 ft^3

Maximum Daily Energy Consumption (kWh) = 0.055*21 + 2.56 = 3.715 kWh

Maximum Power (kW) = Maximum Daily Energy Consumption (kWh) / 24 hrs

= 3.715 / 24 = 0.155 kW

Class B

$$\text{Maximum Daily Energy Consumption (kWh)}=0.073*V+3.16$$

Where,

V = Refrigerated volume (ft^3)

= 21 ft^3

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[131] 10 CFR 431.296

[132] https://www.energy.gov/eere/femp/purchasing-energy-efficient-refrigerated-beverage-vending-machines

Maximum Daily Energy Consumption (kWh) $= 0.073*21+3.16$

$=4.693$ *kWh*

Maximum Power (kW) = *Maximum Daily Energy Consumption (kWh) / 24 hrs*

$= 4.693 / 24$

$= 0.196$ *kW*

Vending machines manufactured on or after January 8, 2019:

Class A

Maximum Daily Energy Consumption (kWh) $= 0.052*V+2.43$

Where,

$V=$ *Refrigerated volume* (ft^3)

$= 21\ ft^3$

Maximum Daily Energy Consumption (kWh) $= 0.052*21+2.43$

$= 3.522$ *kWh*

Maximum Power (kW) = *Maximum Daily Energy Consumption (kWh) / 24 hrs*

$= 3.522/24$

$= 0.147$ *kW*

Class B

Maximum Daily Energy Consumption (kWh)$=0.052*V+2.20$

Where,

V =*Refrigerated volume* (ft^3)

$= 21\ ft^3$

Maximum Daily Energy Consumption (kWh) $= 0.052*21+2.20$

$= 3.292$ *kWh*

Maximum Power (kW) = *Maximum Daily Energy Consumption (kWh) / 24 hrs*

$= 3.292 / 24$

$= 0.137$ *kW*

Combination A

Maximum Daily Energy Consumption (kWh)$=0.086*V+2.66$

Where,

V = *Refrigerated volume* (ft^3)

$= 21\ ft^3$

Maximum Daily Energy

Consumption (kWh) = 0.086*21+2.66

= 4.466 kWh

Maximum Power (kW) = Maximum Daily Energy Consumption (kWh)/24 hrs

= 4.466 / 24

= 0.186 kW

Combination B

*Maximum Daily Energy Consumption (kWh)=0.111*V+2.04*

Where,

V= Refrigerated volume (ft^3)

= 21 (ft^3)

Maximum Daily Energy Consumption (kWh) = 0.111*21+2.04

= 4.371 kWh

Maximum Power (kW) = Maximum Daily Energy Consumption (kWh) / 24 hrs

= 4.371 / 24

=0.182 kW

For merchandise coolers, the base case energy usage is established using the federal standards for commercial refrigerators.[133] The SCE workpaper assumes volumes of 10 ft^2 for under-counter coolers, 24 ft^2 for single-door coolers, 44 ft^2 for double-door coolers, and 72 ft^2 for triple-door coolers, and the savings for this measure are based on these volumes.

Refrigerators with transparent doors manufactured before March 27, 2017:

*Maximum Daily Energy Consumption (kWh) = 0.12*V + 3.34*

Maximum Power (kW) = kWh / 24

Under Counter: 4.54 kWh, 0.189 kW

Single Door: 6.22 kWh, 0.259 kW

Double Door: 8.62 kWh, 0.359 kW

Triple Door: 11.98 kWh, 0.499 kW

133 10 CFR 431.66

Self-Contained Commercial Refrigerators and Commercial Freezers with Doors, Vertical Closed Transparent (VCT), Medium temperature, manufactured on or after March 27, 2017:

*Maximum Daily Energy Consumption (kWh) = 0.1*V + 0.86*

Maximum Power (kW)=kWh / 24

Under Counter: 1.86 kWh, 0.078 kW

Single Door: 3.26 kWh, 0.136 kW

Double Door: 5.26 kWh, 0.219 kW

Triple Door: 8.06 kWh, 0.336 kW

The amount of time that the refrigeration system will be on is equal to the occupancy sensor hours assumed for the lighting savings, and the amount of time that the refrigeration system will be turned on automatically in order to maintain the refrigerated temperature. Based on vending machine controls product literature, it is assumed that the compressor will automatically turn on after 90 minutes (1.5 hours) of being off. The duration of an automatic refrigeration cycle is assumed to be 24 minutes (0.4 hours).[134] Therefore, the amount of time the refrigeration system will be automatically turned on is calculated as follows:

$$Auto - On\ Hours = \left[\frac{(8{,}760 - OccSnsrBldgHrs)}{(1.5\ hours + 0.4\ hours)}\right] \times 0.4\ hours$$

Thus, the total time the refrigeration system will be on is calculated as follows:

$$On_{Hours} = OccSnsrBlgHrs + Auto\_on\ Hours$$

Annual kWh savings associated with the refrigeration system are calculated by multiplying the maximum power by the number of off hours:

$$Refrigeration\ kWh\ Savings = Maximum\ Power\ \times (8{,}760 - On_{Hours})$$

Total annual kWh savings are calculated by adding the refrigeration kWh savings to the lighting kWh savings.

[134] Based on the Vending Miser savings calculator created by Sanders and Associates: http://www.vendingenergymisers.com/documents/calculator.xlsx

3.20.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following formula:

$$kW_{Savings} = \left(kW_{Lighting} + kW_{Refrigeration}\right) \times DSF$$

Where:

$kW_{Savings}$ = *Peak demand savings, kW*

$kW_{Lighting}$ = *Connected lighting load, kW*

$kW_{Refrigeration}$ = *Maximum refrigeration power, kW*

DSF = *Demand Savings Factor, 0.075135*

Table 112 shows the connected lighting loads.

Table 113 shows maximum refrigeration power for vending machines. Table 114 shows maximum refrigeration power for merchandise coolers.

Table 112: Connected Lighting Load, kW

Uncooled Machines	Refrigerated Vending Machines	Merchandise Coolers
0.009	0.024	0

Table 113: Maximum Refrigeration Power for Vending Machines, kW

	Manufactured Before 1/8/2019		Manufactured on or After 1/8/2019			
Uncooled	**Class A**	**Class B**	**Class A**	**Class B**	**Combination A**	**Combination B**
0.00	0.155	0.196	0.147	0.137	0.186	0.182

Table 114: Maximum Refrigeration Power for Merchandise Coolers, kW

Manufactured before 3/27/2017				Manufactured on or after 3/27/2017			
Under Counter	**Single Door**	**Double Door**	**Triple Door**	**Under Counter**	**Single Door**	**Double Door**	**Triple Door**
0.189	0.259	0.359	0.499	0.078	0.136	0.219	0.336

[135] Arkansas TRM v7.0

3.20.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.20.6 MEASURE LIFE

The estimated useful life (EUL) for vending machine and merchandise cooler controls is five years. This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[136]

3.21 WINDOW TREATMENTS

Savings are provided for the installation of window films and solar screens, which decreases the window-shading coefficient and reduces the solar heat transmitted to the building space. During months when perimeter cooling is required in the building, this measure decreases cooling energy use.

3.21.1 MEASURE OVERVIEW

Sector	Commercial
End use	Building Envelope
Fuel	Electricity
Measure category	Window Treatments
Delivery mechanism	Direct Install, Rebate
Baseline description	Clear glass without existing window treatments
Efficient case description	Eligible window treatments installed on eligible windows

3.21.2 SAVINGS

This measure is applicable for the treatment of single-paned windows that do not have existing solar films or solar screens, are not shaded by exterior awnings or overhangs, and are in buildings that are mechanically cooled (DX or chilled water).

The baseline condition is clear glass without existing window treatment. Interior and exterior shading (including blinds, shades, and drapes; excluding exterior awnings and overhangs) is acceptable but should be considered in the savings calculation using the shading coefficients

[136] 2014 California Database for Energy Efficiency Resources.

specified in Table 117. The high-efficiency condition is an eligible window treatment applied to eligible windows. No changes should be made to awnings or overhangs in order to claim savings from this measure.

The demand and energy savings equations in this section originated in calculations by the Texas EUMMOT utilities as presented in the EUMMOT program manual Commercial Standard Offer Program: Measurement and Verification Guidelines for Retrofit and New Construction Projects.[137]

The methodology estimates the reduction in solar heat gain attributable to a given window treatment using shading coefficients for the treated and untreated window, and solar heat gain estimates by window orientation according to ASHRAE Fundamentals.

Energy Savings Estimation

The following algorithms are used to determine savings:[138]

$$Energy\ Savings = \Sigma(Cooling\ Energy\ Savings\_o + Heating\ Energy\ Savings\_o\ )$$

$$Cooling\ Energy\ Savings_o = \frac{A_{film,o} \times Cooling\ SHG_o \times (SC_{pre,o} - SC_{post,o})}{Cooling\ Efficiency_{PL} \times 1{,}000}$$

$$Heating\ Energy\ Savings_o = -\left(\frac{A_{film,o} \times Heating\ SHG_o \times (SC_{pre,o} - SC_{post,o})}{Heating\ Efficiency \times Heating\ Conversion}\right)$$

Where:

$Cooling\ Energy\ Savings_o$ = *Cooling energy savings per window orientation*

$Heating\ Energy\ Savings_o$ = *Heating energy savings (consumption) per window orientation due to reduced natural heat in winter*

$A_{film,o}$ = *Area of window film applied to orientation [ft²]*

$Cooling\ SHG_o$ = *Cooling season solar heat gain for orientation of interest [Btu/ft²-year]. See Table 115.*

$SC_{pre,o}$ = *Shading coefficient for existing glass/interior-shading device. See Table 115.*

$SC_{post,o}$ = *Shading coefficient for new film/interior-shading device, from manufacturer specs*

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[137] For example, section 5.4 of the Equipment Efficiency Standards Appendices to the AEP companies' 2013 Commercial & Industrial Standard Offer Program Manual.

[138] Note that facilities with electric cooling and gas heating will have cooling savings in units of kWh and heating savings in units of therms. These savings values cannot be added and must be reported separately. The algorithm above shows the sum of cooling and heating savings to demonstrate that both cooling and heating effects must be considered when analyzing this measure.

$Cooling\ Efficiency_{PL}$	= *Average part load cooling efficiency of commercial and industrial spaces, Assumed to be 12.64 SEER*[139]
1,000	= *Conversion factor [W/kW]*
$Heating\ SHG_o$	= *Heating season solar heat gain for orientation of interest [Btu/ft^2-year]. See Table 116.*
$Heating\ Efficiency$	= *Average heating efficiency of commercial and industrial spaces, Assumed to be 3.2 COP for electric heat and 80% for gas heat*[140]
$Heating\ Conversion$	= *Conversion factor based on units of Heating Efficiency* *For gas heat, 100,000 Btu/therm* *For electric heat COP, 3,412 Btu/kWh*

Table 115 and Table 116 provide the solar heat gain factors for the cooling and heating seasons respectively.

Table 115: Cooling Season Solar Heat Gain Factors[141]

Orientation	Cooling Solar Heat Gain [Btu/ft2-year]			
	Albuquerque	Las Cruces	Roswell	Santa Fe
North	67,108	69,897	68,618	67,995
North-East	102,259	103,459	98,399	103,426
East	145,112	141,559	137,424	145,519
South-East	148,340	141,019	140,248	147,647
South	132,595	126,016	126,800	129,217
South-West	140,262	139,677	139,550	134,108
West	133,326	139,363	137,442	127,718
North-West	93,741	100,581	99,132	91,707

139 Weighted average of HVAC cooling part load system efficiency of commercial buildings in the DEER 2008 database

140 Weighted average of HVAC heating system efficiency of commercial buildings in the DEER 2008 database

141 Values are derived using NREL's PVWatts calculator, entering a 90-degree (i.e., vertical) tilt and varying the azimuth (i.e., orientation). Values for each direction listed are the average across the 45 degrees containing the listed direction at the center (i.e., the value listed for North is the average of the values for North-North-West, North, and North-North-East). The cooling season is assumed to be April through October.

Table 116: Heating Season Solar Heat Gain Factors[142]

Orientation	Heating Solar Heat Gain [Btu/ft2-year]			
	Albuquerque	Las Cruces	Roswell	Santa Fe
North	22,308	24,006	22,897	22,314
North-East	32,262	36,081	32,039	33,000
East	67,251	67,945	64,193	69,307
South-East	110,075	111,174	104,885	112,062
South	132,481	139,068	130,078	131,758
South-West	110,730	117,062	113,505	107,898
West	68,023	74,039	72,174	65,854
North-West	32,685	36,119	34,766	32,185

Table 117 provides the shading coefficient for different pre-existing shade types.

Table 117: Recommended Shading Coefficient (SC) for Different Pre-Existing Shade Types

Shading Type	Shading Coefficient[143]	Source[144]
Single-Pane - None	0.93	Table 10: Based on ¼” clear single-pane glass (ID 1b)
Single-Pane - Roller Shade	0.60	Table 13G: Based on ID 1b, dark opaque
Single-Pane - Louvered Interior Shades	0.56	Table 13A: Based on ID 1b, 0.50 reflection, excluded beam
Single-Pane - Draperies—Open Weave	0.67	Table 13G: Based on ID 1b, Medium Open Weave
Single-Pane - Draperies—Closed Weave	0.56	Table 13G: Based on ID 1b, Medium Closed Weave
Double-Pane - None	0.80	Table 10: Based on ¼” clear double-pane glass (ID 5b)
Double -Pane - Roller Shade	0.62	Table 13G: Based on ID 5b, dark opaque
Double -Pane - Louvered Interior Shades	0.58	Table 13B: Based on ID 5b, 0.50 reflection, excluded beam
Double -Pane - Draperies—Open Weave	0.64	Table 13G: Based on ID 5b, Medium Open Weave
Double -Pane - Draperies—Closed Weave	0.58	Table 13G: Based on ID 5b, Medium Closed Weave

[142] Values are derived using NREL’s PVWatts calculator, entering a 90-degree (i.e., vertical) tilt and varying the azimuth (i.e., orientation). The heating season is assumed to be November through March.
[143] For shading devices, IAC is multiplied by unshaded SC to determine listed shading coefficient.
[144] Table numbers and shading coefficients provided are from 2009 ASHRAE Fundamentals Handbook, Chapter 15.

3.21.3 DEMAND SAVINGS ESTIMATION

The following equations are used to determine demand savings:

$$Peak\ Demand\ Savings\ [kW] = DemandSaving_{o,max}$$

$$Demand\ Savings_o\ [kW] = \frac{A_{film,o} \times Peak\ SHG_o \times (SC_{pre,o} - SC_{post,o})}{1{,}000 \times Cooling\ Efficiency_{FL}}$$

Where:

Demand Savings$_{o,max}$ = *Peak demand savings for the orientation with the highest peak demand savings*

Demand Savings$_o$ = *Peak demand savings per window orientation*

Peak SHG$_o$ = *Peak solar heat gain factor for orientation of interest [Btu/hr-ft^2-year]. See Table 118.*

Cooling Efficiency$_{FL}$ = *Average cooling full load efficiency of commercial and industrial spaces; assumed to be 10.17 EER*[145]

Table 118 provides the SHGC factors by window orientation per climate zone.

Table 118: Peak Hourly Solar Heat Gain Factors[146]

Orientation	Peak Hour Solar Heat Gain [Btu/hr-ft^2-year]			
	Albuquerque	Las Cruces	Roswell	Santa Fe
North	37	39	38	37
North-East	55	55	53	56
East	71	70	67	73
South-East	64	61	60	65
South	50	46	48	49
South-West	58	59	60	54
West	63	67	67	58
North-West	49	53	53	46

[145] Weighted average of HVAC cooling full load system efficiency of commercial buildings in the DEER 2008 database

[146] Values are derived using NREL's PV

3.21.4 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.21.5 MEASURE LIFE

The estimated useful life (EUL) for window film and solar screens is 10 years. This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[147]

3.22 COOL ROOFS

This section presents the deemed savings methodology for the installation of an ENERGY STAR® certified roof. The installation of an ENERGY STAR® roof decreases the roofing heat transfer coefficient and reduces the solar heat transmitted to the building space, thus impacting the cooling and heating energy use.

3.22.1 MEASURE OVERVIEW

Sector	Commercial
End use	Building Envelope
Fuel	Electricity
Measure category	Cool Roofs
Delivery mechanism	Direct Install, Rebate
Baseline description	Thermal resistance (R-value) of the existing roof make-up and solar reflectance and emissivity of the surface layer
Efficient case description	Depending on project scope, either adding surface layer only, adding insulation and surface layer, or rebuilding entire roof assembly

3.22.2 SAVINGS

Deemed Energy Savings Factors (ESF) and Peak Summer Demand Factors (PSDF) are listed in Table 121, Table 122, Table 123, and Table 124 provide cool roof savings factors for each unique climate zone by building type.

[147] 2014 California Database for Energy Efficiency Resources.

ESF values are in units of kWh/SF and PSDF values are in units of 10^{-5} kW/SF. See Sections 3.22.3 and 3.22.4 for how to apply these factors to determine savings.

Measures installed through utility programs must be a roof that meets the NM IECC 2021 code requirements and is rated by the CRRC-1 Roof Product Rating Program (CRRC-1Program). For nonresidential facilities, these criteria for a high-efficiency roof include:

- An existing roof undergoing retrofit conditions as further defined under high-efficiency condition below; a roof installed in a new construction application is not eligible for applying these methodologies.
- A roof with a low-slope of 2:12 or less[148]
- An initial solar reflectance of greater than or equal to 65%
- Maintenance of a three-year-aged solar reflectance greater than or equal to 55% and a three-year-aged thermal emittance greater than or equal to 75%.[149]AND/OR maintenance of a three-year-aged solar reflectance index of 64.[150]75 percent of the roof surface over conditioned space must be replaced
- No significant obstruction of direct sunlight to roof
- The facility must be conditioned with cooling, heating, or both
- Be listed on the CRRC Rated Roof Products Directory.[151]

The baseline is the thermal resistance (i.e., R-value) of the existing roof make-up, and the solar reflectance and emissivity of the surface layer. The R-value is estimated based on code envelope requirements applicable in the year of construction. Solar reflectance and emissivity of the surface layer are assumed to be 0.2 and 0.9 respectively, based on roof properties listed in the LBNL Roofing Materials Database.[152]

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[148] As defined in proposed ASTN Standard E 1918-97.

[149] C402.3 Roof Solar Reflectance and Thermal Emittance, New Mexico IECC (2021)

[150] Ibid.

[151] CRRC Rated Roof Products Directory: https://coolroofs.org/directory/roof

[152] Lawrence Berkeley National Lab Cool Roofing Material Database. https://heatisland.lbl.gov/resources/cool-roofing-materials-database. Accessed August 2018. Values are determined by taking an average of the reflectance and emissivity of the following materials: Black EPDM, Gray EPDM, Smooth Bitumen, White Granular Bitumen, Dark Gravel on Built-Up Roof, Light Gravel on Built-Up Roof.

The cooling and heating efficiencies are assumed based on the space conditioning of the top floor of the building and are based on typical code requirements applicable in the year of construction. Assumed cooling efficiencies are shown in Table 119.

Table 119: Assumed Cooling Efficiencies (COP)

Year of Construction: Applicable Code	RTU	Heat Pump Cooling	Heat Pump Heating	Air Cooled Chiller	Water Cooled Chiller
Before 2011; 2000 IECC	2.9	2.9	2.9	2.5	4.2
2011 and later; 2009 IECC	3.8	3.1	2.9	2.8	5.5

The high-efficiency condition depends on the project scope. The project scope is defined as one of the following:

- Adding surface layer only
- Adding insulation and surface layer
- Rebuilding the entire roof assembly

If the project scope is only to add a new CRCC-rated cool roof as the new surface layer and does not include additional insulation, then the R-value used for the baseline condition is used for the high-efficiency condition. If the project scope is to add insulation and a CRCC-rated cool roof as the new surface layer, then the high-efficiency condition is calculated by adding the R-value of the additional insulation to the R-value used for the baseline condition. If the entire roof assembly is rebuilt, then the R-value for each layer of the new roof construction is summed to get a total new R-value.

ESF and PSDF values were derived using the savings values from the Texas TRM, version 5. Savings were first apportioned to estimate the savings resulting from the increased roof reflectance, and the savings resulting from the increased roof insulation. The reflectance savings values were adjusted based on a comparison of annual solar radiation for the Texas representative cities and the New Mexico representative cities. Solar radiation values were taken from NREL's PVWatts tool, with inputs representing a horizontal surface (i.e., tilt = 0 degrees). The insulation savings values were adjusted based on a comparison of annual cooling degree-days for the Texas representative cities and the New Mexico representative cities. Peak demand savings were adjusted using radiation and cooling degree-days for the months of June through August.

The savings values in the Texas TRM were estimated using EnergyPlus v8.3.0 whole-building simulation. The savings represent the difference between the modeled energy use of the baseline condition and the high efficiency condition divided by square foot of roof area. The demand savings are calculated based on peak conditions occurring on summer weekday afternoons.

If the existing insulation levels are unknown, use the mapping in Table 120 to estimate the R-value based on the year of construction.

Table 120: Estimated R-value Based on Year of Construction

Year of Construction	Estimated R-value[153]
Before 2011	R ≤ 13
2011 and later	13 > R ≤ 20

Table 121, Table 122, Table 123, and Table 124 provide cool roof savings factors for each unique climate zone by building type.

Table 121: Albuquerque Cool Roof Savings Factors

Building Type[154]	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Retail	R ≤ 13	R ≤ 13	0.76	19.84
	R ≤ 13	13 > R ≤ 20	1.27	36.31
	R ≤ 13	20 < R	1.26	38.59
	13 > R ≤ 20	13 > R ≤ 20	0.14	4.96
	13 > R ≤ 20	20 < R	0.12	6.56
	20 < R	20 < R	0.09	3.42
Education - Chiller	R ≤ 13	R ≤ 13	0.68	12.15
	R ≤ 13	13 > R ≤ 20	1.11	21.82
	R ≤ 13	20 < R	1.25	25.48
	13 > R ≤ 20	13 > R ≤ 20	0.27	5.00
	13 > R ≤ 20	20 < R	0.38	7.86
	20 < R	20 < R	0.18	3.50
Education - RTU	R ≤ 13	R ≤ 13	0.27	8.50
	R ≤ 13	13 > R ≤ 20	0.44	15.51
	R ≤ 13	20 < R	0.49	18.16
	13 > R ≤ 20	13 > R ≤ 20	0.13	4.23
	13 > R ≤ 20	20 < R	0.18	6.72
	20 < R	20 < R	0.08	2.99

[153] Estimated R-values are based on applicable code requirements in the year of construction.

[154] Building Types are derived from the US Energy Information Administration (EIA) Commercial Building Energy Consumption Survey (CBECS).

Building Type[154]	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Office - Chiller	R ≤ 13	R ≤ 13	0.22	7.00
	R ≤ 13	13 > R ≤ 20	0.32	3.74
	R ≤ 13	20 < R	0.34	19.14
	13 > R ≤ 20	13 > R ≤ 20	0.10	17.07
	13 > R ≤ 20	20 < R	0.11	6.73
	20 < R	20 < R	0.06	2.43
Office - RTU	R ≤ 13	R ≤ 13	0.30	7.68
	R ≤ 13	13 > R ≤ 20	0.86	15.47
	R ≤ 13	20 < R	1.07	18.51
	13 > R ≤ 20	13 > R ≤ 20	0.16	4.24
	13 > R ≤ 20	20 < R	0.37	6.77
	20 < R	20 < R	0.11	3.01
Hotel	R ≤ 13	R ≤ 13	0.07	1.37
	R ≤ 13	13 > R ≤ 20	0.07	1.85
	R ≤ 13	20 < R	0.07	2.05
	13 > R ≤ 20	13 > R ≤ 20	0.04	0.84
	13 > R ≤ 20	20 < R	0.04	1.02
	20 < R	20 < R	0.03	0.62
Warehouse	R ≤ 13	R ≤ 13	0.04	3.94
	R ≤ 13	13 > R ≤ 20	0.11	7.01
	R ≤ 13	20 < R	0.14	8.06
	13 > R ≤ 20	13 > R ≤ 20	0.01	1.39
	13 > R ≤ 20	20 < R	0.04	2.26
	20 < R	20 < R	0.01	0.92
Other	R ≤ 13	R ≤ 13	0.04	1.37
	R ≤ 13	13 > R ≤ 20	0.07	1.85
	R ≤ 13	20 < R	0.07	2.05
	13 > R ≤ 20	13 > R ≤ 20	0.01	0.84
	13 > R ≤ 20	20 < R	0.04	1.02
	20 < R	20 < R	0.01	0.62

Table 122: Las Cruces Cool Roof Savings Factors

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Retail	R ≤ 13	R ≤ 13	0.67	16.63
	R ≤ 13	13 > R ≤ 20	1.00	27.45
	R ≤ 13	20 < R	1.01	29.48
	13 > R ≤ 20	13 > R ≤ 20	0.19	5.86
	13 > R ≤ 20	20 < R	0.19	7.33
	20 < R	20 < R	0.15	4.76

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Education - Chiller	R ≤ 13	R ≤ 13	0.70	9.13
	R ≤ 13	13 > R ≤ 20	0.97	14.73
	R ≤ 13	20 < R	1.07	16.95
	13 > R ≤ 20	13 > R ≤ 20	0.36	4.82
	13 > R ≤ 20	20 < R	0.44	6.58
	20 < R	20 < R	0.29	3.92
Education - RTU	R ≤ 13	R ≤ 13	0.30	8.25
	R ≤ 13	13 > R ≤ 20	0.41	13.74
	R ≤ 13	20 < R	0.46	15.90
	13 > R ≤ 20	13 > R ≤ 20	0.18	5.18
	13 > R ≤ 20	20 < R	0.22	7.22
	20 < R	20 < R	0.14	4.16
Office - Chiller	R ≤ 13	R ≤ 13	0.29	9.76
	R ≤ 13	13 > R ≤ 20	0.39	18.02
	R ≤ 13	20 < R	0.42	20.95
	13 > R ≤ 20	13 > R ≤ 20	0.17	6.71
	13 > R ≤ 20	20 < R	0.20	9.38
	20 < R	20 < R	0.14	5.41
Office - RTU	R ≤ 13	R ≤ 13	0.31	9.97
	R ≤ 13	13 > R ≤ 20	0.55	16.96
	R ≤ 13	20 < R	0.64	19.79
	13 > R ≤ 20	13 > R ≤ 20	0.20	5.78
	13 > R ≤ 20	20 < R	0.29	7.91
	20 < R	20 < R	0.16	4.72
Hotel	R ≤ 13	R ≤ 13	0.10	1.34
	R ≤ 13	13 > R ≤ 20	0.08	1.60
	R ≤ 13	20 < R	0.08	1.71
	13 > R ≤ 20	13 > R ≤ 20	0.07	0.95
	13 > R ≤ 20	20 < R	0.06	1.05
	20 < R	20 < R	0.06	0.81
Warehouse	R ≤ 13	R ≤ 13	0.04	2.77
	R ≤ 13	13 > R ≤ 20	0.09	5.03
	R ≤ 13	20 < R	0.15	8.57
	13 > R ≤ 20	13 > R ≤ 20	0.02	1.32
	13 > R ≤ 20	20 < R	0.07	4.13
	20 < R	20 < R	0.01	0.76
Other	R ≤ 13	R ≤ 13	0.04	1.34
	R ≤ 13	13 > R ≤ 20	0.08	1.60
	R ≤ 13	20 < R	0.08	1.71

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
	13 > R ≤ 20	13 > R ≤ 20	0.02	0.95
	13 > R ≤ 20	20 < R	0.06	1.05
	20 < R	20 < R	0.01	0.76

Table 123: Roswell Cool Roof Savings Factors

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Retail	R ≤ 13	R ≤ 13	0.64	16.44
	R ≤ 13	13 > R ≤ 20	0.94	26.22
	R ≤ 13	20 < R	0.95	28.06
	13 > R ≤ 20	13 > R ≤ 20	0.18	5.79
	13 > R ≤ 20	20 < R	0.18	7.13
	20 < R	20 < R	0.15	4.70
Education - Chiller	R ≤ 13	R ≤ 13	0.67	9.02
	R ≤ 13	13 > R ≤ 20	0.92	14.09
	R ≤ 13	20 < R	1.01	16.09
	13 > R ≤ 20	13 > R ≤ 20	0.34	4.76
	13 > R ≤ 20	20 < R	0.41	6.36
	20 < R	20 < R	0.27	3.88
Education - RTU	R ≤ 13	R ≤ 13	0.29	8.15
	R ≤ 13	13 > R ≤ 20	0.39	13.11
	R ≤ 13	20 < R	0.43	15.07
	13 > R ≤ 20	13 > R ≤ 20	0.17	5.12
	13 > R ≤ 20	20 < R	0.21	6.96
	20 < R	20 < R	0.14	4.11
Office - Chiller	R ≤ 13	R ≤ 13	0.28	9.65
	R ≤ 13	13 > R ≤ 20	0.36	17.12
	R ≤ 13	20 < R	0.39	19.76
	13 > R ≤ 20	13 > R ≤ 20	0.16	6.63
	13 > R ≤ 20	20 < R	0.19	9.05
	20 < R	20 < R	0.14	5.35
Office - RTU	R ≤ 13	R ≤ 13	0.29	9.86
	R ≤ 13	13 > R ≤ 20	0.51	16.17
	R ≤ 13	20 < R	0.59	18.73
	13 > R ≤ 20	13 > R ≤ 20	0.19	5.71
	13 > R ≤ 20	20 < R	0.27	7.64
	20 < R	20 < R	0.16	4.67
Hotel	R ≤ 13	R ≤ 13	0.09	1.33
	R ≤ 13	13 > R ≤ 20	0.08	1.56
	R ≤ 13	20 < R	0.08	1.66

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
	13 > R ≤ 20	13 > R ≤ 20	0.07	0.94
	13 > R ≤ 20	20 < R	0.06	1.03
	20 < R	20 < R	0.06	0.80
Warehouse	R ≤ 13	R ≤ 13	0.04	2.74
	R ≤ 13	13 > R ≤ 20	0.08	4.78
	R ≤ 13	20 < R	0.14	7.98
	13 > R ≤ 20	13 > R ≤ 20	0.02	1.30
	13 > R ≤ 20	20 < R	0.06	3.84
	20 < R	20 < R	0.01	0.75
Other	R ≤ 13	R ≤ 13	0.04	1.33
	R ≤ 13	13 > R ≤ 20	0.08	1.56
	R ≤ 13	20 < R	0.08	1.66
	13 > R ≤ 20	13 > R ≤ 20	0.02	0.94
	13 > R ≤ 20	20 < R	0.06	1.03
	20 < R	20 < R	0.01	0.75

Table 124: Santa Fe Cool Roof Savings Factors

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
Retail	R ≤ 13	R ≤ 13	0.73	18.84
	R ≤ 13	13 > R ≤ 20	1.03	29.57
	R ≤ 13	20 < R	1.03	31.06
	13 > R ≤ 20	13 > R ≤ 20	0.13	4.70
	13 > R ≤ 20	20 < R	0.12	5.75
	20 < R	20 < R	0.09	3.25
Education - Chiller	R ≤ 13	R ≤ 13	0.66	11.53
	R ≤ 13	13 > R ≤ 20	0.91	17.84
	R ≤ 13	20 < R	1.00	20.23
	13 > R ≤ 20	13 > R ≤ 20	0.26	4.74
	13 > R ≤ 20	20 < R	0.33	6.61
	20 < R	20 < R	0.17	3.32
Education - RTU	R ≤ 13	R ≤ 13	0.26	8.07
	R ≤ 13	13 > R ≤ 20	0.36	12.64
	R ≤ 13	20 < R	0.39	14.37
	13 > R ≤ 20	13 > R ≤ 20	0.12	4.02
	13 > R ≤ 20	20 < R	0.15	5.64
	20 < R	20 < R	0.08	2.84
Office - Chiller	R ≤ 13	R ≤ 13	0.21	6.64
	R ≤ 13	13 > R ≤ 20	0.27	4.52
	R ≤ 13	20 < R	0.28	14.56

Building Type	Pre R-Value	Post R-Value	ESF (kWh/SF)	PSDF (10^{-5} kW/SF)
	13 > R ≤ 20	13 > R ≤ 20	0.10	16.20
	13 > R ≤ 20	20 < R	0.10	9.46
	20 < R	20 < R	0.06	2.31
Office - RTU	R ≤ 13	R ≤ 13	0.29	7.29
	R ≤ 13	13 > R ≤ 20	0.62	12.37
	R ≤ 13	20 < R	0.75	14.35
	13 > R ≤ 20	13 > R ≤ 20	0.15	4.03
	13 > R ≤ 20	20 < R	0.28	5.68
	20 < R	20 < R	0.11	2.85
Hotel	R ≤ 13	R ≤ 13	0.07	1.30
	R ≤ 13	13 > R ≤ 20	0.07	1.62
	R ≤ 13	20 < R	0.07	1.74
	13 > R ≤ 20	13 > R ≤ 20	0.04	0.80
	13 > R ≤ 20	20 < R	0.04	0.92
	20 < R	20 < R	0.03	0.59
Warehouse	R ≤ 13	R ≤ 13	0.04	3.74
	R ≤ 13	13 > R ≤ 20	0.08	5.74
	R ≤ 13	20 < R	0.09	6.43
	13 > R ≤ 20	13 > R ≤ 20	0.01	1.32
	13 > R ≤ 20	20 < R	0.03	1.89
	20 < R	20 < R	0.01	0.88
Other	R ≤ 13	R ≤ 13	0.04	1.30
	R ≤ 13	13 > R ≤ 20	0.06	1.62
	R ≤ 13	20 < R	0.06	1.74
	13 > R ≤ 20	13 > R ≤ 20	0.01	0.80
	13 > R ≤ 20	20 < R	0.03	0.92
	20 < R	20 < R	0.01	0.59

Example:

Cool roof and insulation are installed in an Albuquerque retail building with a roof area of 5,000 sq. ft., original R-value of 12, post R-value of 15.

$$\textit{Energy Savings} = 5{,}000 \text{ sq. ft. } x\ 1.27 = 6{,}350 \text{ kWh}$$

$$\textit{Demand Savings} = 5{,}000 \text{ sq. ft. } x\ 36.31\ x\ 10^{-5} = 1.82 \text{ kW}$$

3.22.3 ENERGY SAVINGS ESTIMATION

The deemed energy and demand savings factors are used in the following formulas to calculate savings:

$$Energy\ Savings = Roof\ Area \times ESF$$

Where:

Roof Area	*= Total area of CRRC-rated cool roof in square feet*
ESF	*= Energy Savings Factor from above tables by climate zone, building type, pre/post insulation levels, and heating/cooling system.*

3.22.4 DEMAND SAVINGS ESTIMATION

The following deemed factors are used in the formula below to calculate demand savings:

$$Peak\ Summer\ Demand\ Savings = Roof\ Area \times PSDF \times 10^{-5}$$

Where:

PSDF	*= Peak Summer Demand Factor from above tables by climate zone, building type, pre/post insulation levels, and heating/cooling system.*
10^{-5}	*= Scaling factor, as PSDF values are scaled up for ease of display*

3.22.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.22.6 MEASURE LIFE

The estimated useful life (EUL) for cool roofs is 15 years. This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[155]

3.23 ENERGY STAR® COMBINATION OVENS

This section covers the deemed savings methodology for the installation of ENERGY STAR® combination ovens. Combination ovens are convection ovens with added capability to inject steam into the oven cavity and offers typically at least three distinct cooking modes: combination mode to roast or bake with moist heat, convection mode to operate purely as a convection oven providing dry heat, or as a straight pressure-less steamer. This deemed savings methodology determines energy and demand savings on a per-oven-basis.

[155] 2014 California Database for Energy Efficiency Resources.

3.23.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Cooking
Fuel	Electricity, Gas
Measure category	Food Service Equipment
Delivery mechanism	Rebate
Baseline description	Standard Commercial Combination Oven
Efficient case description	ENERGY STAR® certified Commercial Combination Oven

3.23.2 ELIGIBLITY CRITERIA

Eligible units must meet ENERGY STAR® qualifications, with half-size and full-size ovens as defined by ENERGY STAR® and a pan capacity ≥ 3 and ≤ 40.[156]

- Half-size combination oven: capable of accommodating a single 12.7 x 20.8 x 2.5-inch steam table pan per rack position, loaded from front-to-back or lengthwise.
- Full-size combination oven: capable of accommodating two 12.7 x 20.8 x 2.5-inch steam table pans per rack position, loaded from front-to-back or lengthwise

Two-thirds-size combination ovens were added to the current ENERGY STAR® specification but are excluded from this measure until the ENERGY STAR® food service calculator is updated to include category specific input assumptions.

This specification is intended for commercial food-grade ovens. Ovens designed for residential, or laboratory applications cannot be certified for ENERGY STAR® under this specification. The following oven types and sub-types are ineligible for ENERGY STAR®:

The following products are excluded from the ENERGY STAR® eligibility criteria:

- Half-size gas convection ovens
- Dual-fuel heat source combination ovens

[156] ENERGY STAR® Program Requirements for Commercial Ovens. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%203.0%20Commercial%20Ovens%20Final%20Specification.pdf

- Hybrid ovens not listed in Section 2.A, above, such as those incorporating microwave settings in addition to convection
- Conventional or standard ovens; conveyor; slow cook-and-hold; deck; hearth; microwave; range; rapid cook; reel-type; and rotisserie
- Half- and full-size gas combination ovens with a pan capacity of less than five or greater than 40
- Half- and full-size electric combination ovens with a pan capacity less than three or greater than 40
- Mini and quadruple gas rack ovens. ENERGY STAR® Program Requirements for Commercial Ovens – Eligibility Criteria 5
- Electric rack ovens
- 2/3-size electric combination ovens with a pan capacity greater than five.

Eligible building types include independent restaurants, chain restaurants, elementary and secondary schools, colleges and universities, corporate foodservice operations, healthcare, hospitality, and supermarkets.[157]

3.23.3 SAVINGS

The high-efficiency combination ovens must be compliant with the current ENERGY STAR® v3 specification, effective January 12, 2023. To achieve this, they must meet the following minimum energy efficiency and idle energy rate requirements, as shown in Table 125.

Table 125: Cooking Energy Efficiency and Idle Energy Rate Requirements[158]

Electric: 5-40 Pan Capacity		
Operation	**Idle Rate, kW**	**Cooking-Energy Efficiency, %**
Steam Mode	≤ 0.133 P + 0.6400	≥ 55
Convection Mode	≤ 0.083 P + 0.35	≥ 78
Gas: 5-40 Pan Capacity		
Operation	**Idle Rate, Btu/h**	**Cooking-Energy Efficiency, %**

[157] CEE Commercial Kitchens Initiative's overview of the Food Service Industry: https://forum.cee1.org/system/files/library/4203/CEE_CommKit_InitiativeDescription_Aug2021.pdf

[158] ENERGY STAR Version 3.0 Commercial Ovens Final Specification

Steam Mode	≤ 200 P + 6,511	≥ 41
Convection Mode	≤ 140 P + 3,800	≥ 57
Electric 3-4 Pan Capacity and 2/3-size with 3-5 Pan Capacity		
Operation	**Idle Rate, kW**	**Cooking-Energy Efficiency, %**
Steam Mode	≤ 0.60P	≥ 51
Convection Mode	≤ 0.05P+0.55	≥ 70

Note: Where P = Pan capacity

3.23.4 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula.

$$Energy\ Savings\ (kWh) = kWh_{base} - kWh_{ES}$$

Baseline or Efficient case energy consumption is a Combination (addition) of Energy consumed during Convection and/or Steam mode used during the operation of the Combination oven. It is expressed in the following formulas:

$$kWh_{base} = kWh_{ph,base} kWh_{conv} + kWh_{st}$$

$$kWh_{eff} = kWh_{ph,ES} + kWh_{conv} + kWh_{st}$$

The energy consumption (kWh) in any mode (convection, steam, or combination) of oven operation is expressed as follows:

$$kWh = 〚E_{ph} + \left(W_{food} \times \frac{E_{food} \times 50\%}{\eta_{cooking}}\right) + E_{idle} \times \left(\left(t_{on} - \frac{W_{food}}{PC}\right) \times 50\%\right)\Bigg) \times \frac{t_{days}}{1000}$$

Where:

kWh_{base}	= *Baseline annual energy consumption kWh*
kWh_{ES}	= *ENERGY STAR® annual energy consumption kWh*
E_{ph}	= *Preheat energy [Wh/BTU]. See Table 126*
t_{days}	= *Facility operating days per year. See Table 126*
t_{on}	= *Equipment operating hours per day. See Table 126*
CF	= *Coincident Factor, adjusts the gross kW savings to account foroverlap with the peak period. See Table 126*
W_{food}	= *Pounds of food cooked per day, lb/day. See Table 126*
E_{food}	= *ASTM energy to food, Wh/lb. (Differs for Convection-Mode and Steam Mode for Baseline and ENERGY STAR®. See Table 126*
E_{Idle}	= *Idle energy rate, W. (Differs for Convection-Mode and Steam-Mode, for Baseline and ENERGY STAR®. See Table 126*

$\eta_{cooking}$	= *Cooking energy efficiency, %. (Differs for Convection-Mode and Steam-Mode, for Baseline and ENERGY STAR®. SeeTable 126*
PC	= *Production capacity per pan, lb/hr. (Differs for Convection-Mode and Steam-Mode, for Baseline and ENERGY STAR®. See Table 126.*
P	= *Pan Capacity (lbs)*
1,000	= *Wh to kWh conversion*

3.23.5 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure between 3:00-6:00 pm on the hottest summer weekdays.

Demand savings are derived with the following equation:

$$Peak\ Demand\ Savings\ (kW) = \frac{\triangle\ kWh}{t_{on} \times t_{days}} \times CF$$

Where:

ΔkW	= *Demand savings, in kW*
t_{on}	= *Equipment operating hours per day, see Table 126*
t_{days}	= *Facility operating days per year, see Table 126*
CF	= *Coincident Factor, adjusts the gross kW savings to account for overlap with the peak period, see Table 126.*
P	= *Pan Capacity (lbs)*

Table 126: Combination Ovens Deemed Variables for Energy and Demand Savings Calculations[159]

		Convection Mode		Steam Mode	
Parameter		**Baseline**	**ENERGY STAR®**	**Baseline**	**ENERGY STAR®**
E_{ph}	P < 15	3,000		1,500	
	P ≥ 15	3,750		2,000	
W_{food}	P < 15	200			
	P ≥ 15	250			
E_{food}		73.2		30.8	
η_{cook}	3 ≥ P < 5	70%	70%	49%	51%
	P ≥ 5	72%	76%	49%	55%
Eidle	3 ≥ P < 5	1,320	(0.05P + 0.55) x 1,000	5,260	0.60P x 1,000
	5 ≥ P < 15	1,320	(0.083P + 0.35) x 1,000	5,260	(0.133P + 0.64) x 1,000

[159] Texas Technical Reference Manual Version 11.0 Volume 3: Nonresidential Measures Program Year 2023 TRMv10.0 Volume 3 EEIP (texasefficiency.com) (TRMv11.0 Volume 3 EEIP (texasefficiency.com)

	P ≥ 15	2,280	(0.083P + 0.35) x 1,000	8,710	(0.133P + 0.64) x 1,000
PC[160]	P < 15	79	119	126	177
	P ≥ 15	166	201	295	349
t_{on}	12				
t_{days}	365				
CF[159,161]	0.90				

3.23.6 NATURAL GAS SAVINGS ESTIMATION

Natural Gas Energy Savings are derived with the following formula[162]. Table 127 through Table 130 embedded in the section provide inputs to the formulas.

$$\Delta\,Therms = \begin{pmatrix}\Delta CookingEnergy_{ConvGas} + \Delta CookingEnergy_{SteamGas} + \\ \Delta IdleEnergy_{ConvGas} + \Delta IdleEnergy_{SteamGas}\end{pmatrix} \times\ Days\ \div\ 100{,}000$$

Where:

$$\Delta CookingEnergy_{ConvGas} = LB_{Gas}\,x\,\left(\frac{EFOOD_{ConvGas}}{GasEFF_{ConvBase}} - \frac{EFOOD_{ConvGas}}{GasEFF_{ConvEE}}\right) x\ \%Conv$$

$$\Delta CookingEnergy_{SteamGas} = LB_{Gas}\,x\,\left(\frac{EFOOD_{SteamGas}}{GasEFF_{SteamBase}} - \frac{EFOOD_{SteamGas}}{GasEFF_{SteamEE}}\right) x\ \%Steam$$

$$\Delta IdleEnergy_{ConvGas} = \left[\left(GasIDLE_{ConvBase} \times \left(HOURS - \frac{LB_{Gas}}{GasPC_{ConvBase}}\right) \times \%_{Conv}\right) - \left(GasIDLE_{ConvEE} \times \left(HOURS - \frac{LB_{Gas}}{GasPC_{ConvEE}}\right)\right) \times \%_{Conv}\right]$$

$$\Delta IdleEnergy_{SteamGas} = \left[\left(GasIDLE_{SteamBase} \times \left(HOURS - \frac{LB_{Gas}}{GasPC_{SteamBase}}\right) \times \%_{Steam}\right) - \left(GasIDLE_{SteamEE} \times \left(HOURS - \frac{LB_{Gas}}{GasPC_{SteamEE}}\right)\right) \times \%_{Steam}\right]$$

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160 The 3/2021 ENERGY STAR® calculator update no longer varies Ccap by pan capacity. However, this is assumed to be an error. The values specified for pan capacity of 15 or greater are specified in the previous calculator version.

161 Itron, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study. Final Report." Prepared for Southern California Edison. December 2005. Table 3-14, p. 3-17.

162 Natural Gas Savings Formula and Assumptions are derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

Where:

ΔCookingEnergy$_{ConvGas}$	*= Change in total daily cooking energy consumed by gas oven in convection mode*
ΔCookingEnergy$_{SteamGas}$	*= Change in total daily cooking energy consumed by gas oven in steam mode*
ΔIdleEnergy$_{ConvGas}$	*= Change in total daily idle energy consumed by gas oven in convection mode*
ΔIdleEnergy$_{SteamGas}$	*= Change in total daily idle energy consumed by gas oven in steam mode*
LB_{Gas}	*= Estimated mass of food cooked per day for gas oven (lbs/day)*

= Custom, or if unknown:

For P < 15: 200 lbs

For 15 ≤ P ≤ 30: 250 lbs

For P ≥ 30: 400 lbs

P *= Pan Capacity (lbs)*

$EFOOD_{ConvGas}$ *= Energy absorbed by food product for gas oven in convection mode*
= Custom or if unknown, use 250 Btu/lb

$GasEFF$ *= Cooking energy efficiency of gas oven*
= Custom or if unknown, use values from Table 127.

Table 127: Cooking Efficiency of Gas Oven

Oven Type	Base	EE
$GasEFF_{Conv}$	52%	56%
$GasEFF_{Steam}$	39%	41%

$EFOOD_{SteamGas}$ *= Energy absorbed by food product for gas oven in steam mode*

= Custom or if unknown, use 105 Btu/lb

$GasIDLE_{Base}$ *= Idle energy rate (Btu/hr) of baseline gas oven= Custom or if unknown, use values from Table 128.*

Table 128: Baseline Idle Energy Rate for Gas Ovens

Pan Capacity (P)	Convection Mode ($GasIDLE_{ConvBase}$)	Steam Mode ($GasIDLE_{SteamBase}$)
< 15	8,747	18,656
15-30	10,788	24,562
>30	13,000	43,300

$GasPC_{Base}$ *= Production capacity (lbs/hr) of baseline gas oven*

= Custom or if unknown, use values from Table 129.

Table 129: Baseline Production Capacity for Gas Ovens

Pan Capacity (P)	Convection Mode $(GasPC_{ConvBase})$	Steam Mode $(GasPC_{SteamBase})$
< 15	125	195
15-30	176	211
>30	392	579

$GasIDLE_{ConvEE}$ = Idle energy rate of ENERGY STAR® gas oven in convection mode

= 150 x P + 5,425, See Table 129

$GasPC_{EE}$ = Production capacity (lbs/hr) of ENERGY STAR® gas oven

= Custom or if unknown, use values from Table 130

Table 130: Production Capacity for ENERGY STAR® Gas Oven

Pan Capacity (P)	Convection Mode $(GasPC_{ConvEE})$	Steam Mode $(GasPC_{SteamEE})$
< 15	124	172
15-30	210	277
>30	394	640

$GasIDLE_{SteamEE}$ = Idle energy rate of ENERGY STAR® gas oven in steam mode

= 200 x P + 6,511 See Table 130.

10,000 = Conversion factor from Btu to therms

3.23.7 DEEMED ENERGY AND DEMAND SAVINGS

The energy and demand savings of High Efficiency Combination Ovens in Table 131 are calculated in the Savings Calculator for ENERGY STAR® Qualified Commercial Kitchen Equipment using the default parameters shown above in Table 130. Customer specific parameters can be input into the algorithms above to provide more relevant savings values when customer specific details are known

Table 131: Combination Ovens Deemed Energy and Demand Savings Values[163]

kWh_{base}	kWh_{post}	Annual Energy Savings [kWh]	Peak Demand Savings [kW]	Annual Gas Savings [Therms]
18,282	11,914	6,368	1.338	278

[163] https://www.energystar.gov/ia/products/downloads/Commercial_kitchen_equipment_calculator_1-12-16.xlsx

3.23.8 NON-ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

3.23.9 MEASURE LIFE

The EUL has been defined for this measure as 12 years, consistent with the ENERGY STAR® calculator and with the DEER 2014 EUL update (EUL ID—Cook-ElecCombOven).[164]

3.24 ENERGY STAR® ELECTRIC CONVECTION OVENS

This section covers the savings from retrofit or new installation of a full-size or half-size ENERGY STAR® electric convection ovens. Convection ovens cook their food by forcing hot dry air over the surface of the food product. The rapidly moving hot air strips away the layer of cooler air next to the food and enables the food to absorb the heat energy. The energy and demand savings are deemed and based on oven energy rates, cooking efficiencies, operating hours, production capacities, and building type. Average energy and demand consumption, used to calculate the savings, are determined using these assumed default input values on a per-oven basis.

3.24.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Cooking
Fuel	Electricity
Measure category	Food Service
Delivery mechanism	Prescriptive
Baseline description	Standard Commercial Electric Convection Oven
Efficient case description	ENERGY STAR® certified Commercial Electric Convection Oven

3.24.2 SAVINGS

The energy and demand savings are deemed and are based on minimum cooking energy efficiency, as well as a maximum idle energy rate. The cooking energy efficiency is the ratio of

[164] DEER READI. http://www.deeresources.com/index.php/readi.

energy absorbed by the food item to the total energy consumed by the oven during the whole cooking process. The idle energy rate is the energy consumed by the oven while maintaining a stable temperature, without cooking any food item. Other factors like the operating hours and the capacity of the oven have an impact on the savings values of the convection oven.

The products that are included in the category of ENERGY STAR® Electric Convection Ovens as specified by the ENERGY STAR® qualification criteria are as follows:

- Full-size gas convection oven
- Full and half-size electric convection oven

The size of the oven and the corresponding pan size are shown in Table 132.

Table 132: Standard Oven and Pan Size

Convection Oven Size165	Standard Pan Size
Half	18 x 13 x 1-inch
Full	18 x 26 x 1-inch

Convection ovens eligible for rebate do not include ovens that can heat the cooking cavity with saturated or superheated steam. However, eligible convection ovens may have moisture injection capabilities (e.g., baking ovens and moisture-assist ovens). Ovens that include a “hold feature” are eligible under this specification if convection is the only method used to fully cook the food.

This specification is intended for commercial food-grade ovens. Ovens designed for residential, or laboratory applications cannot be certified for ENERGY STAR® under this specification. The products that are excluded from the category of ENERGY STAR® Electric Convection Ovens as specified by the ENERGY STAR® qualification criteria are as follows:

- Half-size gas convection ovens.
- Dual-fuel heat source combination ovens.
- Hybrid ovens not listed in Section 2.A, above, such as those incorporating microwave settings in addition to convection.

[165] ENERGY STAR Version 3.0 Commercial Ovens Final Specification

- Conventional or standard ovens; conveyor; slow cook-and-hold; deck; hearth; microwave; range; rapid cook; reel-type; and rotisserie.
- Half- and full-size gas combination ovens with a pan capacity of < 5 or > 40.
- Half- and full-size electric combination ovens with a pan capacity < 3 or > 40.
- Mini and quadruple gas rack ovens. ENERGY STAR® Program Requirements for Commercial Ovens – Eligibility Criteria 5
- Electric rack ovens.
- 2/3-size electric combination ovens with a pan capacity >5.

Energy Efficiency Requirements[166] for Convection Ovens are shown in Table 133.

Table 133: Electric Oven Cooking Energy Efficiency and Idle Rate requirements

Oven Size	Idle Rate, kW	Cooking Energy Efficiency, %
Full size ≥ 5 pans	≤ 1.40	≥ 76
Full size < 5 pans	≤ 1.00	≥ 76
Half size	≤ 1.00	≥ 71

3.24.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following equation.

$$Energy\ Savings\ [\Delta kWh] = kWh_{base} - kWh_{ES}$$

$$kWh_{base} = kWh_{ph,base} + kWh_{cook,base} + kWh_{idle,base}$$

$$kWh_{ES} = kWh_{ph,ES} + kWh_{cook,ES} + kWh_{idle,ES}$$

Where:

kWh_{base}	=	*Baseline annual energy consumption [kWh]*
kWh_{ES}	=	*ENERGY STAR® annual energy consumption [kWh]*
E_{ph}	=	*Preheat energy [Wh/BTU]. See Table* 134
ΔE_{ph}	=	*Difference in baseline and ENERGY STAR® preheat energy. See Table* 134
E_{food}	=	*ASTM energy to food of energy absorbed by food product during cooking [Wh/lb]*

166 www.energystar.gov/sites/default/files/Commercial%20Ovens%20Final%20Version%202.2%20Specification_0.pdf

See Table 134

E_{Idle}	=	*Idle energy rate [W] . See Table* 134
W_{food}	=	*Pounds of food cooked per day [lb/day]. See Table* 134
η_{cook}	=	*Cooking energy efficiency [%]. See Table* 134
PC	=	*Production capacity per pan [lb/hr]. See Table* 134
t_{on}	=	*Equipment operating hours per day [hr/day] See Table* 134
t_{days}	=	*Facility operating days per year [days/year] See Table* 134
1,000	=	*Constant to convert from W to kW*

3.24.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00-6:00 pm on the hottest summer weekdays.

Demand savings are derived with the following equation.

$$Peak\ Demand\ Savings\ (kW) = \frac{\Delta kWh - \left(\frac{\Delta Eph\ x\ t_{days}}{1000}\right)}{t_{on}\ \times t_{days}} \times CF$$

Where:

ΔkWh	=	*Energy Savings*
E_{ph}	=	*Preheat energy [Wh/BTU]. See Table 134.*
t_{on}	=	*Equipment operating hours per day [hr/day]. See Table 134.*
t_{days}	=	*Facility operating days per year [days/year]. See Table 134.*
1,000	=	*Constant to convert from W to kW*
CF	=	*Peak coincidence factor. See Table 134.*

Table 134: Electric Oven Variables for Energy and Demand Savings Calculations[167]

	Full Size ≥ 5 pans		Full Size < 5 pans		Half Size	
Parameter	**Baseline**	**ENERGY STAR®**	**Baseline**	**ENERGY STAR®**	**Baseline**	**ENERGY STAR®**
E_{ph}	1,563	1,389	1,563	1,389	890	700
W_{food}	100					
E_{food}	73.2					
η_{cook}	65%	76%	65%	76%	68%	71%
E_{idle}	2,000	1,400	2,000	1,000	1,030	1,000
PC	90	90	90	90	45	50
t_{on}	12					
t_{days}	365					
CF[168]	0.90					

3.24.5 NATURAL GAS SAVINGS ESTIMATION

Natural Gas Energy Savings are derived with the following equation.[169]

$$\Delta Therms = (\Delta DailyIdle\ Energy + \Delta DailyPreheat\ Energy + \Delta DailyCooking\ Energy) \times Days/100{,}000$$

Where:

$$\Delta DailyIdle\ Energy = (IdleBase \times IdleBaseTime) - (IdleENERGYSTAR \times (IdleENERGYSTARTime)$$

$$\Delta DailyPreheat\ Energy = (\text{PreHeatNumberBase} \times (\text{PreheatTimeBase}/60) \times \text{PreheatRateBase})$$

$$- (\text{PreHeatNumberENENRGYSTAR} \times (\text{PreheatTimeENERGYSTAR}/60) \times \text{PreheatRateENERGYSTAR})$$

$$\Delta\text{DailyCooking Energy} = \left(\frac{\text{LB} \times \text{EFOOD}}{\text{EffBase}}\right) - \left(\frac{\text{LB} \times \text{EFOOD}}{\text{EffENERGYSTAR}}\right)$$

Where:

$Hoursday$	= *Average daily operation*
	= *Custom or if unknown, use 12 hours*
$Days$	= *Annual days of operation*

[167] TRMv10.0 Volume 3 EEIP (texasefficiency.com)

[168] Itron, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study. Final Report." Prepared for Southern California Edison. December 2005. Table 3-14, p. 3-17.

[169] Natural Gas Savings Formula and Assumptions are Derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator.

= *Custom or if unknown, use 365.25 days a year*

$EffENERGYSTAR$ = *Cooking Efficiency ENERGY STAR®*

= *Custom or if unknown, use 46%*

$EffBase$ = *Cooking Efficiency Baseline*

= *Custom or if unknown, use 30%*

$PCENERGYSTAR$ = *Production Capacity ENERGY STAR®*

= *Custom or if unknown use 80 pounds/hr*

$PCBase$ = *Production Capacity base*

= *Custom or if unknown, use 70 pounds/hr*

$PreheatNumberENERGYSTAR$ = *Number of preheats per day*

= *Custom or if unknown, use 1*

$PreheatNumberBase$ = *Number of preheats per day*

= *Custom or if unknown, use 1*

$PreheatTimeENERGYSTAR$ = *Preheat length in time*

= *Custom or if unknown, use 15 minutes*

$PreheatTimeBase$ = *Preheat length in time*

= *Custom or if unknown, use 15 minutes*

$PreheatRateENERGYSTAR$ = *Preheat energy rate high efficiency*

= *Custom or if unknown, use 44,000 Btu/h*

PreheatRateBase = *Preheat energy rate baseline*

= *Custom or if unknown, use 76,000 Btu/h*

$IdleENERGYSTAR$ = *Idle energy rate*

= *Custom or if unknown, use 12,000 Btu/h*

$IdleBase$ = *Idle energy rate*

= *Custom or if unknown, use 18,000 Btu/h*

$IdleENERGYSTARTime$ = *ENERGY STAR® Idle time*

= *HOURsday – LB/PCENERGYSTAR –TimeENERGYSTAR/60*

= *12 – 100/80 – 15/60*

= *10.5 hours*

$IdleBaseTime$ = *BASE Idle Time*

= *HOURsday – LB/PCbase –*

PreHeat Time Base/60

= *12 – 100/70 – 15/60*

= *10.3 hours*

$EFOOD$ = *ASTM energy to food*

= *250 Btu/pound*

3.24.6 DEEMED ENERGY AND DEMAND SAVINGS

The energy and demand savings of high efficiency convection ovens are deemed values based on an assumed capacity (see Table 134) for the average convection oven installed. Table 135 provides these deemed values.

Table 135: Deemed Energy and Demand Savings Values

Oven Size	kWh Savings	kW Savings
Full size ≥ 5 pans	3,043	0.612
Full size < 5 pans	4,633	0.939
Half size	244	0.036

3.24.7 NON-ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

3.24.8 MEASURE LIFE

The EUL has been defined for this measure as 12 years, consistent with ENERGY STAR® research and with the DEER 2014 EUL update (EUL ID—Cook-ElecConvOven).[170]

3.25 ENERGY STAR® ELECTRIC FRYERS

This section covers the deemed savings methodology for the installation of ENERGY STAR® electric fryers. Energy efficient fryers that have earned the ENERGY STAR® rating offer shorter cook times and higher production rates through advanced burner and heat exchanger designs. Fry pot insulation reduces standby losses resulting in a lower idle energy rate. The energy and demand savings are determined on a per-fryer basis.

3.25.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Cooking / Frying
Fuel	Electricity
Measure category	Food Service Equipment
Delivery mechanism	Prescriptive
Baseline description	Standard Commercial Electric Fryer
Efficient case description	ENERGY STAR® certified Commercial Electric Fryer

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

3.25.2 SAVINGS

Eligible units must meet ENERGY STAR® qualifications, either counter-top or floor type designs, with standard-size and large vat fryers as defined by ENERGY STAR®.[171]

- **Standard Fryer**: A fryer with a vat that measures greater than or equal to 12 inches and less than 18 inches wide, and a shortening capacity greater than or equal to 25 pounds and less than or equal to 65 pounds.
- **Large Vat Fryer**: A fryer with a vat that measures greater than or equal to 18 inches and less than or equal to 24 inches wide, and a shortening capacity greater than 50 pounds.
- **Split Vat Fryer**: A standard or large vat fryer with an internal wall that separates the vat into two equal sides.

Eligible building types include independent restaurants, chain restaurants, elementary and secondary schools, colleges and universities, corporate foodservice operations, healthcare, hospitality, and supermarkets.[172] The following products are excluded from the ENERGY STAR® eligibility criteria:

- Fryers with vats measuring less than 12 inches wide, or greater than 24 inches wide

Baseline fryers can be existing or new electric standard-size fryers greater than or equal to 12 inches less than 18 inches wide or large vat fryers greater than 18 inches and less than 24 inches wide that do not meet ENERGY STAR® product criteria.

New electric standard fryers greater than or equal to 12 inches and less than 18 inches wide and large vat fryers greater than 18 inches and less than 24 inches wide that meet or exceed the ENERGY STAR® requirements listed in Table 136.

Table 136: High-efficiency Requirements for Electric Fryers[173]

Inputs	Standard	Large-Vat
Heavy-Load Cooking energy efficiency	≥ 83%	≥ 80%
Idle energy rate [W]	≤ 800	≤ 1,100

[171] Commercial Fryers Version 3.0 Specification (energystar.gov)

[172] CEE Commercial Kitchens Initiative's overview of the Food Service Industry: http://library.cee1.org/sites/default/files/library/4203/CEE_CommKit_InitiativeDescription_June2014.pdf. Link not working

[173] Commercial Fryers Version 3.0 Specification (energystar.gov)

3.25.3 ENERGY SAVINGS ESTIMATION

The savings are determined with the following equation:

$$Energy\ Savings\ [\Delta kWh] = kWh_{base} - kWh_{ES}$$

$$kWh_{base} = kWh_{ph,base} + kWh_{cook,base} + kWh_{idle,base}$$

$$kWh_{ES} = kWh_{ph,\ ES} + kWh_{cook,ES} + kWh_{idle,ES}$$

kWh_{ph}, kWh_{cook}, and kWh_{idle} are each calculated the same for both the baseline and ENERGY STAR® cases, as shown in equation below, except they require their respective input assumptions relative to preheat, cooking, and idle operation as shown in Table 137.

$$kWh = \left(E_{ph} + \left(\frac{W_{food} x E_{food}}{\eta_{cook}}\right) + E_{idle} x \left(t_{on} - \frac{t_{ph}}{60} - \frac{W_{food}}{PC}\right)\right) x \frac{t_{days}}{1000}$$

Where:

kWh_{base}	= *Baseline annual energy consumption [kWh]. See*
kWh_{ES}	= *ENERGY STAR® annual energy consumption [kWh]*
Eph	= *Preheat energy [Wh/BTU]*
ΔE_{ph}	= *Difference in baseline and ENERGY STAR® preheat energy*
E_{food}	= *ASTM energy to food of energy absorbed by food product during cooking [Wh/lb]*
E_{Idle}	= *Idle energy rate [W]*
W_{food}	= *Pounds of food cooked per day [lb/day]*
η_{cook}	= *Cooking energy efficiency [%]*
PC	= *Production capacity per pan [lb/hr]*
t_{on}	= *Equipment operating hours per day [hr/day]*
t_{ph}	= *Preheat time [min/day]*
t_{days}	= *Facility operating days per year [days/year]*
60	= *Constant to convert from min to hr*
1,000	= *Constant to convert from W to kW*

3.25.4 DEMAND SAVINGS ESTIMATION

This section presents the deemed savings methodology for the installation of an ENERGY STAR® Electric Fryer.

The demand savings are determined with the equation below. The deemed algorithm variable inputs are show in Table 137.

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{\Delta kWh - \left(\frac{\Delta E_{ph}\ x\ t_{days}}{1{,}000}\right)}{t_{on}\ x\ t_{days}} x\ CF$$

Where:

Demand Savings = *Annual demand savings, in kW*

CF = *Peak coincidence factor*

Table 137: Deemed Variables for Energy and Demand Savings Calculations[174]

	Standard-sized Vat		Large Vat	
Parameter	**Baseline**	**ENERGY STAR®**	**Baseline**	**ENERGY STAR®**
E_{ph}	2,400	1,900	2,400	1,900
W_{food}	150			
E_{food}	167			
η_{cook}	75%	83%	70%	80%
E_{idle}	1,200	800	1,350	1,100
PC	65	70	100	110
t_{on}	16		12	
t_{ph}	15			
t_{days}	365			
CF[175]	0.90			

3.25.5 NATURAL GAS SAVINGS ESTIMATION

The natural gas energy savings are determined with the following equation[176]:

$$\Delta Therms = (\Delta DailyIdle\ Energy + \Delta DailyCooking\ Energy) \times Days/100{,}000$$

Where:

$$\Delta DailyIdle\ Energy$$

[174] Deemed input values come from ENERGY STAR® Commercial Kitchen Equipment Calculator. https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator_0.xlsx

[175] Itron, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report." Prepared for Southern California Edison. December 2005. Table 3-14, p. 3-17.

[176] Natural Gas Savings Formula and Assumptions are derived from ENERGY STAR® Commercial Kitchen Equipment Savings Calculator.

$$= \left(GasIdle_{Base} \times \left(HOURS - \frac{LB}{GasPC_{Base}}\right)\right) - \left(GasIdle_{ESTAR} \times \left(HOURS - \frac{LB}{GasPC_{ESTAR}}\right)\right)$$

$$\Delta DailyCooking\ Energy$$

$$= \left(\frac{LB \times EFOOD_{Gas}}{GasEff_{Base}}\right) - \left(\frac{LB \times EFOOD_{Gas}}{GasEff_{ESTAR}}\right)$$

Where:

100,000	= *Btu to therms conversion factor*
$GasIdle_{Base}$	= *Idle energy rate of baseline gas fryer*
	= *14,000 Btu/hr for standard fryer and 16,000 Btu/hr for large vat fryer*
$GasIdle_{ESTAR}$	= *Idle energy rate of ENERGY STAR® gas fryer*
	= *Custom or if unknown, use 9,000 Btu/hr for standard fryer and 12,000 Btu/hr for large vat fryer*
$GasPC_{Base}$	= *Production capacity of baseline gas fryer*
	= *60 lb/hr for standard fryer and 100 lb/hr for large vat fryer*
$GasPC_{ESTAR}$	= *Production capacity of ENERGY STAR® gas fryer*
	= *Custom or if unknown, use 65 lb/hr for standard fryer and 110 lb/hr for large vat fryer*
$EFOOD_{Gas}$	= *ASTM energy to food*
	= *570 Btu/lb*
$GasEff_{Base}$	= *Cooking efficiency of baseline gas fryer*
	= *35% for both standard and large vat fryer*
$GasEff_{ESTAR}$	= *Cooking efficiency of ENERGY STAR® gas fryer*
	= *Custom or if unknown, use 50% for both standard and large vat fryer*

3.25.6 DEEMED ENERGY AND DEMAND SAVINGS

Table 138 shows the energy and demand deemed savings values for each of the electric fryer sizes.

Table 138: Deemed Energy and Demand Savings Values by Fryer Type[177]

Fryer Type	kWh Savings	kW Savings
Standard	3,272	0.476
Large vat	2,696	0.516

[177] Deemed energy and demand savings values come from ENERGY STAR® Commercial Kitchen Equipment Calculator.

3.25.7 NON-ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

3.25.8 MEASURE LIFE

The EUL has been defined for this measure as 12 years.[178]

3.26 ENERGY STAR® ELECTRIC STEAM COOKERS

This measure provides the savings methodology for the installation of ENERGY STAR® electric steam cookers. ENERGY STAR® certified steam cookers offer shorter cook times, higher production rates, and reduced heat loss due to better insulation and more efficient steam delivery systems.

3.26.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Cooking
Fuel	Electricity
Measure category	Food Service Equipment
Delivery mechanism	Rebate
Baseline description	Standard Commercial Electric Steam Cookers
Efficient case description	ENERGY STAR® certified Commercial Electric Steam Cookers

3.26.2 SAVINGS

The energy and demand savings are determined on a per-cooker basis.

The eligible products can pan capacities between three and six, or greater. A list of eligible equipment is found on the ENERGY STAR® list of qualified equipment.[179]

Eligible baseline conditions for retrofit situations are electric steam cookers that are not ENERGY STAR® certified.

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[178] The EUL has been defined for this measure as 12 years per the PUCT approved Texas EUL filing (Docket No. 36779) and by the DEER 2014 EUL update (EUL ID—Cook-ElecFryer)

[179] ENERGY STAR Program Requirements for Commercial Steam Cookers

High-efficiency electric steam cookers are assumed to be ENERGY STAR® certified and have the characteristics shown in Table 139.

Table 139: ENERGY STAR® Energy Efficiency and Idle Rate Requirements for Electric Steam Cookers[180]

Pan Capacity	Heavy Load Cooking Energy Efficiency	Idle Rate, Watts
3-Pan	50%	400
4-Pan	50%	530
5-Pan	50%	670
6-Pan and Larger	50%	800

3.26.3 ENERGY SAVINGS ESTIMATION

Savings are determined with the following equation:

$$Svgs = kWh_{base} - kWh_{eff}$$

$$kWh_{base} = W_{food} \times \frac{E_{food}}{\eta_{base}} + \left((1 - \eta_{tSteam}) \times E_{idleRate,base} + \eta_{tSteam} \times C_{pan} \times N_{pan} \times \frac{E_{food}}{\eta_{base}}\right) \times \left(t_{days} - \frac{W_{food}}{\eta_{base} \times N_{pan}}\right) \times \frac{N_{OpDays}}{1000}$$

$$kWh_{eff} = W_{food} \times \frac{E_{food}}{\eta_{eff}} + \left((1 - \eta_{tSteam}) \times E_{idleRate,eff} + \eta_{tSteam} \times C_{pan} \times N_{pan} \times \frac{E_{food}}{\eta_{base}}\right) \times \left(t_{days} - \frac{W_{food}}{\eta_{eff} \times N_{pan}}\right) \times \frac{N_{OpDays}}{1000}$$

Where:

Svgs = *Annual energy savings, in kWh*

kWh_{base} = *Baseline annual energy consumption, in kWh. See Table 141*

kWh_{eff} = *Efficient annual energy consumption, in kWh. See Table 141*

W_{food} = *Pounds of food cooked per day, in lb/day. See Table* 140

[180] ENERGY STAR® Program Requirements Product Specification for Commercial Steam Cookers v1.2 https://www.energystar.gov/sites/default/files/specs//private/Commercial_Steam_Cookers_Program_Requirements%20v1_2.pdf

E_{food}	= *ASTM energy to food is equal to 30.8*[181] *in Wh/pound. See Table* 140
η_{base}	= *Baseline Cooking energy efficiency (Differs for boiler-based or steam generator equipment). See Table* 140
η_{eff}	= *Efficient cooking energy efficiency. See Table* 140
η_{tSteam}	= *Percent of time in constant steam mode, in %. See Table* 140
C_{pan}	= *Production capacity per pan, in lb/hr. See Table* 140
$E_{idleRate,base}$	= *Idle energy rate, in W (Differs for boiler-based or steam-generator equipment). See Table* 140
$E_{idleRate,eff}$	= *Idle energy rate, in W. See Table* 140
N_{pan}	= *Number of pans. See Table* 140
N_{OpDays}	= *Facility operating days per year. See Table* 140
1000	= *Wh to kWh conversion factor*

3.26.4 DEMAND SAVINGS ESTIMATION

The demand savings are determined with the following equation:

$$Peak\ Demand\ Savings\ [\Delta kW]\ =\ \frac{kWh_{base}\ -\ kWh_{eff}}{t_{hrs}\ \times\ t_{days}}\times CF$$

Where:

ΔkW	= *Demand savings, in kW*
kWh_{base}	= *the annual energy usage of the baseline equipment calculated using baseline values, in kWh*
kWh_{eff}	= *the annual energy usage of the efficient equipment calculated using efficient values, in kWh*
t_{hrs}	= *Average daily operating hours per day*
	= *if average daily operating hours are unknown, assume default of 12 hours/day.*
t_{days}	= *Operating days per year*
	= *if annual days of operation are unknown, assume default of 365 days.*
CF	= *Peak coincid*ence factor, see Table *140*

[181] ENERGY STAR®. "Savings Calculator for ENERGY STAR® Qualified Commercial Kitchen Equipment." https://www.energystar.gov/ia/products/downloads/Commercial_kitchen_equipment_calculator_1-12-16.xlsx

Table 140: Electric Steam Cooker Deemed Variables for Energy and Demand Savings Calculations[182,183]

Parameter	Baseline Value	Efficient Value
W_{food}	100	
E_{food}	30.8	
η	Boiler-based Efficiency: 26% Steam-Generator Efficiency: 30%	50%
η_{tSteam}	40%	
$E_{idleRate}$	Boiler-based Idle Rate: 1,000 Steam-Generator Idle Rate: 1,200	3-Pan: 400 4-Pan: 530 5-Pan: 670 6-Pan: 800
Parameter	**Baseline Value**	**Efficient Value**
C_{pan}	23.3	16.7
N_{pan}	3, 4, 5 or 6	
t_{hrs}	12	
N_{OpDays}	365	
CF184	0.90	

3.26.5 NATURAL GAS SAVINGS ESTIMATION

The natural gas savings are determined with following equation.[185]

$$\Delta Therms = Therms_{base} - Therms_{eff}$$

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[182] https://www.energystar.gov/sites/default/files/asset/document/CFS_calculator_07-15-2021.xlsx

[183] Natural Gas Savings Formula and Assumptions are derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator. https://www.energystar.gov/ia/products/downloads/Commercial_kitchen_equipment_calculator_1-12-16.xlsx

[184] Itron, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report." Prepared for Southern California Edison. December 2005. Table 3-14, p. 3-17.

[185] Natural Gas Savings Formula and Assumptions are derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator.https://www.energystar.gov/ia/products/downloads/Commercial_kitchen_equipment_calculator_1-12-16.xlsx

Where:

$$Therms_{base} = \left[LB \times \frac{E_{FOOD}}{EFF_{base}} + \left((1 - PCT_{Steam}) \times IDLE_{base} + PCT_{Steam} \times PC_{Base} \times PANS \times \frac{E_{Food}}{EFF_{Base}}\right) \times \left(Hours_{Day} - \frac{LB}{PC_{Base} \times PANS}\right)\right] \times DAYS$$

$$Therms_{eff} = \left[LB \times \frac{E_{FOOD}}{EFF_{eff}} + \left((1 - PCT_{Steam}) \times IDLE_{eff} + PCT_{Steam} \times PC_{eff} \times PANS \times \frac{E_{Food}}{EFF_{Base}}\right) \times \left(Hours_{Day} - \frac{LB}{PC_{eff} \times PANS}\right)\right] \times DAYS$$

Where:

$Therms_{base}$	*= The annual energy usage, in therms, of the baseline equipment calculated using baseline values.*
$Therms_{eff}$	*= The annual energy usage, in therms, of the efficient equipment calculated using efficient values.*
E_{FOOD}	*= ASTM Energy to Food (kWh/lb); the amount of energy absorbed by the food during cooking, per pound of food.*
	= 0.000105
$IDLE$	*= Idle energy rate (kW)*
	= See Table 140 for default baseline values. If actual efficient values are unknown, assume default values from the Table 140
PC	*= Production capacity per pan lb/hr*
	= Default baseline production capacity per pan is 23.3. If actual efficient production capacity per pan is unknown, assume default of 20.
$Hours_{Day}$	*= Average daily operation hours.*
	= If average daily operating hours are unknown, assume default of 12 hrs/day
$PANS$	*= Number of pans per unit.*
	= actual installed number of pans per unit.
PCT_{Steam}	*= Percent of time in constant steam mode*
	= Of percent of time in constant steam mode is unknown, assume default of 40%.
EFF	*= Heavy load cooking energy efficiency in %*
	= See above Table 140 for default values. If actual efficient values are unknown, assume default values from Table 140
LB	*= Pounds of food cooked per day lb/day.*
	= If average pounds of food cooker per day is unknown, assume default of 100 lbs/day.
$Days$	*= Annual days of operation.*
	= If annual days of operation are unknown, assume default of 365 days.

3.26.6 DEEMED ENERGY AND DEMAND SAVINGS

Table 141 provides the deemed values for energy and demand savings for the efficient steam cooker measure by cooker type.

Table 141: Electric Steam Cooker Deemed Energy and Demand Savings Values[186]

Steam Cooker Type	N_{pan}	kWh_{base}	kWh_{eff}	Annual Energy Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (Therms)
Boiler Based	3-Pan	19,416	7,632	11,784	2.475	865
	4-Pan	24,330	9,777	14,553	3.057	-
	5-Pan	29,213	11,946	17,268	3.627	1,153
	6-Pan and Larger	34,080	14,090	19,990	4.199	1,291
Steam Generator	3-Pan	17,599	7,632	9,967	2.093	766
	4-Pan	21,884	9,777	12,107	2.543	-
	5-Pan	26,132	11,946	14,186	2.980	962
	6-Pan and Larger	30,360	14,090	16,270	3.417	1,054

3.26.7 NON-ENERGY BENEFITS

The deemed annual water savings per steam cooker, based on ENERGY STAR® "Savings Calculator for ENERGY STAR® Qualified Commercial Kitchen Equipment," are shown in Table 142.

Table 142: Annual Water Consumption and Savings of Electric Steam Cooker

Type of Steam Cooker	Water Consumption in Conventional Steam Cooker	Water Consuption in ENERGY STAR® Steam Cooker	Annual Water Savings in Gallons
Electric	175,200	13,140	162,060

3.26.8 MEASURE LIFE

Based on the ENERGY STAR® "Savings Calculator for ENERGY STAR® Qualified Commercial Kitchen Equipment," the measure life for an ENERGY STAR® Electric Steam Cooker is 12 years.

[186] The pre- and post- energy values are calculated using the ENERGY STAR® calculator https://www.energystar.gov/ia/products/downloads/Commercial_kitchen_equipment_calculator_1-12-16.xlsx

3.27 ENERGY STAR® HOT FOOD HOLDING CABINETS

This measure involves installation of an ENERGY STAR® certified hot food holding cabinets, which incorporates better insulation to reduce heat loss. The equipment offers better temperature uniformity within the cabinet from top to bottom and keeps the external cabinet cooler. In addition, many certified holding cabinets may include energy saving devices such as magnetic door gaskets, auto-door closures, or Dutch doors.

3.27.1 MEASURE OVERVIEW

Sector	Commercial
End use	Hot Food Storage
Fuel	Electricity
Measure category	Food Service Equipment
Delivery mechanism	Prescriptive
Baseline description	Standard Commercial Hot Food Holding Cabinet
Efficient case description	ENERGY STAR® certified Commercial Hot Food Holding Cabinet

3.27.2 SAVINGS

The energy and demand savings are based on the interior volume range of the holding cabinets and the building type. An average wattage has been calculated for each volume range, half size, three-quarter size, and full size. The energy and demand savings are determined on a per-cabinet basis.

A commercial hot food holding cabinet is a heated, fully enclosed compartment with one or more solid or transparent doors designed to maintain the temperature of hot food that has been cooked using a separate appliance.

Eligible baseline equipment is a half-size, three-quarter size, or full-size hot food holding cabinet with a maximum idle energy rate of less than 40 watts/ft^3 for all equipment sizes[187].

[187]http://www.texasefficiency.com/images/documents/RegulatoryFilings/DeemedSavings/PY2023%20TRM%2010.0%20Vol%203%20Nonresidential_2022-11-08_FINAL.pdf

This specification is intended for commercial food-grade equipment only. Hot food holding cabinets qualifying under this specification must be certified by a third-party to the following standards:

- ANSI/NSF Standard 4 International Standard for Commercial Cooking, Rethermalization and Powered Hot Food Holding Transport Equipment
- ANSI/UL Standard 197 Commercial Electric Cooking Appliances.

Eligible equipment is set by ENERGY STAR® and based on the cabinet's interior volume. Table 143 summarizes idle energy rates per ENERGY STAR® v2.0 specification.

Table 143: Hot Food Holding Cabinets Maximum Idle Energy Rate Requirements ENERGY STAR® Qualification[188]

Product Interior Volume (ft^3)	Idle Energy Rate (W)
0 < V < 13	≤ 21.5 V
13 ≤ V < 28	≤ 2.0 V + 254.0
28 ≤ V	≤ 3.8V + 203.5

Ineligible hot food holding cabinets include:

- Dual function equipment (e.g., "cook-and-hold" and proofing units)
- Heated transparent merchandising cabinets
- Drawer warmers

3.27.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula:

$$Energy\ Savings\ [\Delta kWh] = (E_{IdleBase} - E_{IdleES}) \times \frac{1}{1000} \times t_{on} \times t_{days}$$

Where:

Energy Savings = *Annual energy savings, in kWh*

$E_{IdleBase}$ = *Baseline idle energy rate, in W. See* Table 144

[188] https://www.energystar.gov/sites/default/files/specs//private/Commercial_HFHC_Program_Requirements_2.0.pdf

E_{IdleES} = *Idle energy rate after installation rate, in W.See Table 144*

V[189] = *Product Interior Volume, in ft^3. See Table 144*

t_{on} = *Equipment operating hours per day, in hours. See Table 144*

t_{days} = *Facility operating days per year. See Table 144*

Demand savings are calculated using the following formula:

$$\Delta kW = (E_{IdleBase} - E_{IdleES}) \times \frac{1}{1000} \times CF$$

Where:

ΔkW = *Peak demand savings, in kW*

$E_{IdleBase}$ = *Baseline idle energy rate, in W. See Table 144*

E_{IdleES} = *Idle energy rate after installation, in W. See Table 144*

CF =*Peak Coincidence factor. See Table 144*

Table 144 provides input variables based on the size of the cabinet.

Table 144: Hot Food Holding Cabinets Deemed Variables for Energy and Demand Savings Calculations

Input Variable	Half-Size	Three-Quarter Size	Full-Size
Product Interior Volume (ft^3)	12	20	30
Baseline Equipment Idle Energy Rate ($E_{IdleBase}$)	480	800	1,200
Efficient Equipment Idle Energy Rate ($E_{IdleEff}$)	258	294	318
Operating Hours per Day (t_{on})	15		
Facility Operating Days per Year (t_{days})	365		
Peak Coincidence Factor (CF)[190]	0.92		

3.27.4 DEEMED ENERGY AND DEMAND SAVINGS TABLES

The deemed energy and demand savings values for electric hot food holding cabinets are shown below in Table 145.

[189] V = Interior Volume = Interior Height x Interior Width x Interior Depth

[190] California End Use Survey (CEUS), Building workbooks with load shapes by end use. http://capabilities.itron.com/CeusWeb/Chart.aspx.

Table 145: Deemed Energy and Demand Savings Values by Hot Food Holding Cabinet Size

Size	Annual Energy Savings (kWh)	Peak Demand Savings (kW)
Half	1,215	0.204
Three-Quarter	2,770	0.466
Full	4,832	0.812

3.27.5 NON-ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

3.27.6 MEASURE LIFE

The EUL has been defined for this measure as 12 years per ENERGY STAR®'s Savings Calculator.[191]

3.28 ENERGY STAR® COMMERCIAL ICE MAKERS

This measure presents energy and demand savings for automatic commercial ice makers. Commercial ice makers can be classified into batch-type (also called cube-type) and continuous-type. Batch-type ice makers harvest ice with alternating freezing and harvesting periods and are generally used to generate ice for use in beverages. Continuous-type ice makers produce ice through a continuous freeze and harvest process and include flake and nugget ice makers.

An ENERGY STAR® certified commercial ice maker reduces energy and water consumption through the use of one or more efficient features, such as the use of higher efficiency compressors, fan motors and water pumps, an increase in air-cooled condenser surface area, or improved evaporator insulation.

3.28.1 MEASURE OVERVIEW

Sector	Commercial
End use	Ice harvesting
Fuel	Electricity

[191] ENERGY STAR® measure life based on Food Service Technology Center (FSTC) research on available models, 2009. ENERGY STAR®. "Savings Calculator for ENERGY STAR® Qualified Commercial Kitchen Equipment." https://www.energystar.gov/sites/default/files/asset/document/commercial_kitchen_equipment_calculator.xlsx

Measure category	Food Service equipment
Delivery mechanism	Direct Install
Baseline description	An automatic air-cooled commercial ice maker with capacities between 50 and 4,000 pounds per 24-hour period manufactured on or after January 28, 2018[192]
Efficient case description	ENERGY STAR® rated automatic commercial ice maker

3.28.2 SAVINGS

Eligible commercial ice makers include:[193]

- Air-cooled batch-type and continuous-type (i.e., flake and nugget) ice makers. Designs include ice-making head (IMH), self-contained (SCU), and remote condensing units (RCU)
- Air-cooled RCU units designed for connection to remote rack compressors that are alternately sold with a dedicated remote condensing unit are also eligible

Ineligible products include the following:

- Water-cooled ice makers
- Ice and water dispensing systems
- Air-cooled RCU units that are designed only for connection to remote rack compressors

The efficiency conditions of the baseline commercial ice makers are based on Federal Standards published in 10 CFR 431. A summary of those standards is shown in Table 146.

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[192] https://ecfr.io/Title-10/Section-431.132

[193] ENERGY STAR® Program Requirements Product Specifications for Commercial Ice Makes. Eligibility Criteria Version 3.0. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Draft%20Version%203.0%20Automatic%20Commercial%20Ice%20Maker%20Specification.pdf

Table 146: Commercial Air-Cooled Ice Makers Baseline Efficiency[194]

Equipment Type	Harvest Rate (lbs ice per 24 Hrs)	Max Energy Use Rate (kWh/100 lb ice) H=harvest rate
Batch - Type		
IMH	< 300	10 – 0.01233H
	≥ 300 and < 800	7.05 – 0.0025H
	≥ 800 and < 1,500	5.55 – 0.00063H
	≥ 1,500 and < 4,000	4.61
RCU (but not remote compressor)	< 988	7.97 -0.00342H
	≥ 988 and < 4,000	4.59
RCU and Remote Compressor	< 930	7.97 – 0.00342H
	≥ 930 and < 4,000	4.79
SCU	< 110	14.79 – 0.0469H
	≥ 110 and < 200	12.42 – 0.02533H
	≥ 200 and < 4,000	7.35
Continuous-Type		
IMH	< 310	9.19 – 0.00629H
	≥ 310 and < 820	8.23 - 0.0032H
	≥ 820 and < 4,000	5.61
RCU (but not remote compressor)	< 800	9.7 - 0.0058H
	≥ 800 and < 4,000	5.06
RCU and Remote Compressor	< 800	9.9 – 0.0058H
	≥ 800 and < 4,000	5.26
SCU	< 200	14.22 – 0.03H
	≥ 200 and < 700	9.47 – 0.00624H
	≥ 700 and < 4,000	5.1

The ENERGY STAR® requirements to qualify for the rating are shown in Table 147.

[194] Code of Federal Regulations, Title 10 Part 431 for automatic commercial ice maker with capacities between 50 and 4,000 pounds per 24-hour period manufactured on or after January 28, 2018. https://ecfr.io/Title-10/Section-431.132

Table 147: Automatic Ice Makers – ENERGY STAR® Efficiency Criteria[195]

Equipment Type	Harvest Rate (lbs ice per 24 Hrs)	Max Energy Use Rate (kWh/100 lb ice) H=harvest rate	Potable Water Use (gal/100 lbs ice)
Batch - Type			
IMH	H < 300	≤ 9.20 – 0.01134H	≤ 20.0
	300 ≤ H < 800	≤ 6.49 - 0.0023H	
	800 ≤ H < 1500	≤ 5.11 - 0.00058H	
	1500 ≤ H ≤ 4000	≤ 4.24	
RCU	H < 988	≤ 7.17 – 0.00308H	≤ 20.0
	988 ≤ H ≤ 4,000	≤ 4.13	
SCU	H < 110	≤ 12.57 – 0.0399H	≤ 25.0
	110 ≤ H < 200	≤10.56 – 0.0215H	
	200 ≤ H ≤ 4,000	≤ 6.25	
Continuous-Type			
IMH	H < 310	≤ 7.90 – 0.005409H	≤ 15.0
	310 ≤ H < 820	≤ 7.08 - 0.002752H	
	820 ≤ H ≤ 4,000	≤ 4.82	
RCU	H < 800	≤ 7.76 – 0.00464H	≤ 15.0
	800 ≤ H ≤ 4,000	≤ 4.05	
SCU	H < 200	≤ 12.37 – 0.0261H	≤ 15.0
	200 ≤ H < 700	≤ 8.24 – 0.005429H	
	700 ≤ H ≤ 4,000	≤ 4.44	

3.28.3 ENERGY SAVINGS ESTIMATION

Savings are derived using the following equation:

$$\Delta kWh = \frac{UseRate_{Base} - UseRate_{Eff}}{100} \times Duty\ Cycle \times Days \times H$$

[195] ENERGY STAR® Commercial Ice Maker Key Product Criteria Version 3.0, https://www.energystar.gov/products/commercial_food_service_equipment/commercial_ice_makers/key_product_criteria

Where:

ΔkWh	*= Annual energy savings, in kWh*
$UseRate_{Base}$	*= The rated energy consumption, in kWh per 100 pounds of ice of the baseline unit. Select the most appropriate value from Table 147.*
$UseRate_{Eff}$	*= The rated energy consumption, in kWh per 100 pounds of ice, for the efficient unit.*
H	*= Harvest rate (lb ice/24 hours) of the efficient equipment*
Duty Cycle	*= Machine duty cycle, 80%*[196]
Days	*= Number of days per year. Default is 365, based on continuous use for both batch and continuous type ice makers.*

3.28.4 DEMAND SAVINGS ESTIMATION

The demand savings are derived by using the following equation:

$$\Delta kW = Annual\ Energy\ Savings\ \times PLS$$

Where:

ΔkW	= Peak demand savings, in kW
PLS	= Probability-weighted peak load share, as *per Table 148.*

Table 148 provides the probability weighted peak load share by climate zone.

Table 148: Probability-weighted Peak Load Share - Ice Makers

Climate Zone	Summer Peak
All	0.00012

3.28.5 DEEMED ENERGY AND DEMAND SAVINGS

There are no deemed energy or peak demand savings for this measure.

196 Duty cycle value of 80% is taken from a PGE Emerging Technologies study, ET Project #ET12PGE3151 Food Service Technology—Efficient Ice Machines and Load Shifting, average duty cycle of preexisting machines in tables ES1 and ES2.

3.28.6 NON-ENERGY BENEFITS

There are no water savings for continuous type commercial ice maker machines. The water savings for batch type commercial ice maker machines are shown in Table 149. [197]

Table 149: Annual Water Savings for Batch Type ENERGY STAR® Commercial Ice Maker

Equipment Type	Annual Water Savings in Gallons
Ice Making Head	3,322
Self-Contained Unit	3,526
Remote Condensing Unit (Batch)	2,631
Remote Condensing Unit (Continuous)	0

3.28.7 MEASURE LIFE

The estimated useful life (EUL) for automatic ice makers is 8.5 years.[198]

3.29 STEAM TRAP REPLACEMENT OR REPAIR

The measure applies to the repair or replacement of steam traps in the failed open state that allow steam to escape the steam distribution system or return to the condensate receiver leading to increased steam generation. The measure is applicable to commercial applications, commercial HVAC (low pressure steam) including multifamily buildings, low pressure industrial applications, medium pressure industrial applications, and high-pressure industrial applications.

3.29.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity or Gas
Measure category	Steam Traps
Delivery mechanism	Direct Install
Baseline description	Faulty steam trap in the failed open or leaking state
Efficient case description	Repair or replacement of faulty steam traps

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[197] Savings Calculator for ENERGY STAR Certified Commercial Kitchen Equipment. http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx

[198] Department of Energy, Energy Conservation Program: Energy Conservation Standards for Automatic Commercial Ice Makers, 80 FR 4698, https://www.federalregister.gov/d/2015-00326/p-4698

3.29.2 DEFINITION OF BASELINE EQUIPMENT

The baseline criterion is a faulty steam trap in the failed open or leaking state. No minimum leak rate is required. Any leaking or blow through trap can be repaired or replaced. Savings are adjusted if a commercial customer chooses to repair or replace all the steam traps at the facility without verification. Savings for full commercial replacement projects are reduced by the percentage of traps found to be leaking on average from the studies listed. If an audit is performed on a commercial site, then the leaking and blowdown can be adjusted.

3.29.3 DEFINITION OF EFFICIENT EQUIPMENT

Customers must have leaking traps to qualify for rebates. However, if a commercial customer opts to replace all traps without inspection, rebates and the savings are discounted to take into consideration the fact that some traps are being replaced that have not yet failed.

3.29.4 ENERGY SAVINGS ESTIMATION

Natural Gas Savings can be determined using the formula below:

$$\Delta Therms = Sa * \left(H_v + H_s * (T_1 - T_{source})\right) * Hours * \frac{L}{(100{,}000 * \eta_B)}$$

$$\Delta Therm = Sa * \left(\frac{Hv}{B}\right) * Hours * \frac{L}{(100{,}000 * \eta_B)}$$

For systems used in space heating applications that operate at 5 psig or lower, use the following equation to calculate Sa:

$$Sa = 1519.3 * P_1 * D * \left[\left(\frac{1}{T_1}\right) * \left(\frac{\gamma}{\gamma - 1}\right) * \left(\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\left(\frac{(\gamma+1)}{\gamma}\right)}\right)\right]^{0.5} * A * FF$$

The condensate return system pressure, P_2, will typically be atmospheric pressure, 14.696 psia.

For all other steam systems and applications, use the following equation:

$$Sa = 24.24 * P_1 * D^2 * A \, x \, FF$$

Where:

Sa	*=Steam loss per leaking trap (lbs/hr), see Table 150.*
1519.3	*=Constant lb/(hr-psia-in2)*
P_1	*= Average steam trap inlet pressure (absolute, psia). If not available, use defaults provided in Table 150 (note that defaults are provided in psig, not psia).*

D	= *Diameter of orifice, inches. Actual value should be used wherever possible as this value has a significant impact on steam flowrate value, see Table 150*
T_1	= *Temperature of Saturated Steam (°R)*
	$= 507.89 * P_1^{0.0962}$
507.89	= *Constant,* $°R*(in^2 /lb_f)^{0.0962}$
γ	= *Heat Capacity Ratio (unitless)*
	$= 5.071 * 10^{-4} * P_1 + 1.332$
P_2	= *Average steam trap outlet pressure (absolute psia). If unknown, assume atmospheric pressure, 14.696 psia.*
A	=*Adjustment factor*
	= *50%,*[199] *all steam systems. This factor accounts for reduction in the maximum theoretical steam flow to the average steam flow (the Enbridge factor), see Table 150*
FF	= *Flow Factor. In addition to the Adjustment factor (A), an additional 50 percent flow factor adjustment is recommended for medium and high-pressure steam systems to address industrial float and thermostatic style traps where additional blockage is possible, see Table 150*
24.24	= *Constant* $lbm/(hr\text{-}psia\text{-}in^2)$
Hv	=*Heat of vaporization of steam, (Btu/lbm), see Table 151.*
Hs	= *Specfic heat of water, (Btu/(lbm * °R))*
	= *1.001*
T_{source}	= *Incoming water temperature*
	= *513.67°R200*
η_B	= *Boiler efficiency*
	= *custom, if unknown:*
	= *80.7% for steam boilers, except multifamily low-pressure*[201]
	= *64.8% for multifamily low-pressure steam boilers202*
Hours	= *Annual hours when steam system is pressurized*
	= *custom, if unknown, see Table 152.*
L	= *Leaking & blow-thru, see Table 153*

[199] Enbridge adjustment factor used as referenced in CLEAResult "Work Paper Steam Traps Revision #2" Revision 3 dated March 2, 2012, and DOE Federal Energy Management Program Steam Trap Performance Assessment.

[200] US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL.

[201] Ibid.

[202] Katrakis, J. and T.S. Zawacki. "Field-Measured Seasonal Efficiency of Intermediate-sized Low-Pressure Steam Boilers". ASHRAE V99, pt. 2, 1993.

Table 150 provides several inputs based on the facility steam system.

Adjustment factor and flow factor is 1.0 when applied to the replacement of an individual leaking trap. If several steam traps are replaced and the system has not been audited, the adjustment factor and flow factor are applied to reflect failed close and partially failed open traps. A custom value can be utilized if supported by a detailed steam trap audit or evaluation research.

Table 151 provides the average inlet pressure and heat of vaporization per steam system.

Table 150: Default Steam Loss per Trap (Sa) and Average Inlet Pressure

Steam System	Average Steam Trap Inlet Pressure psig[203]	Diameter of Orifice (in)	Adjustment Factor	Flow Factor	Average Actual Steam Loss per Leaking Trap (lbm/hr/trap)[204]
Commercial Dry Cleaners	82.8	0.125	50%	100%	18.5
Multifamily LPS Space Heating – calculate Sa as provided above. If using default value, cap total savings at 20% of building consumption	-	-	50%	100%	6.9
Commercial LPS Space Heating	11.2	0.2100	50%	100%	13.8
Industrial or Process Low Pressure, <15 psig	11.2	0.2100	50%	100%	13.8
Medium Pressure >15 psig < 30 psig	16	0.1875	50%	50%	6.5
Medium Pressure ≥30 < 75 psig	47	0.25	50%	50%	23.4
High Pressure ≥75 < 125 psig	101	0.25	50%	50%	43.8
High Pressure ≥125 < 175 psig	146	0.25	50%	50%	60.9
High Pressure ≥175 < 250 psig	202	0.25	50%	50%	82.1
High Pressure ≥250 ≤ 300 psig	263	0.25	50%	50%	105.2

[203] Commercial and Industrial low pressure steam trap inlet pressure based on Franklin Energy and Opinion Dynamics analysis of data collected by Armstrong for 120,833 steam traps. Data covered coil, process, and radiator steam trap applications on modulating and constant pressure systems less than 15psi.

Medium and high-pressure steam trap inlet pressure based on Navigant analysis of source collected during program implementation by Nicor Gas for GPY1 through GPY4. For each steam trap project, the data provided measure savings description, operating pressure, installation Zip code, business building type, program year, and annual operating hours. Dry cleaning steam trap inlet pressure based on C5 Steam Traps – Nicor FINAL 10.27.11.

[204] For applications where inlet pressures and orifice diameters are provided in the table, default values are directly calculated using the equation above. For applications where inlet pressures and orifice diameters are not provided in the table, default values are assumptions based on engineering judgement and will be revisited in future years.

Table 151: System Average Inlet Pressure and Heat of Vaporization

Steam System	Average Inlet Pressure, psig	Heat of Vaporization[205] (Btu/lbm)
Commercial Dry Cleaners	82.8	890
Commercial Space Heating (including Multifamily) LPS	11.2	951
Industrial and Process Low Pressure ≤15 psig	11.2	951
Medium Pressure >15 psig < 30 psig	16	944
Medium Pressure ≥ 30 <75 psig	47	915
High Pressure ≥ 75 psig <125 psig	101	880
High Pressure ≥ 125 psig	146	859
High Pressure ≥ 175 psig	202	837
High Pressure ≥ 250 ≤ 300 psig	263	816
High Pressure > 300 psig	--	Custom

Table 152 provides the typical operating hours per steam system and climate zone.

Table 152: Annual Operating Hours for Steam Systems

Steam System	Zone (where applicable)	Hours/Yr[206]
Commercial Dry Cleaners	All Climate Zones	2,425
Industrial and Process Low Pressure ≤15 psig		8,282
Medium Pressure >15 psig < 30 psig		8,282
Medium Pressure ≥30 <75 psig		8,282
High Pressure ≥75 psig <125 psig		8,282
High Pressure ≥125 psig <175 psig		8,282
High Pressure ≥175 psig <250 psig		8,282
High Pressure ≥250		8,282
Commercial Space Heating (including Multifamily) LPS	Albuquerque	2,220
	Las Cruces	1,178
	Roswell	1,592
	Santa Fe	3,136

Table 153 provides the leaking and blowing through value per steam system.

205 Heat of vaporization of steam at the inlet pressure to the steam trap. Implicit assumption that the average boiler nominal pressure where the vaporization occurs, is essentially the same pressure. Referenced in CLREAResult "Work Paper Steam Trap Revision #2" Revision 3 dates March 2, 2012.

206 Medium and high-pressure steam trap annual operating hours based on Navigant analysis of source collected during program implementation by Nicor Gas for GPY1 through GPY4. For each steam trap project, the data provided measure savings description, operating pressure, installation zip code, business building type, program year, and annual operating hours.

Table 153: Steam System Leaking and Blow-through

Steam System	L (%)[207]
Custom	Custom
Commercial Dry Cleaners	27%
Industrial and Process Low Pressure ≤15 psig	27%
Medium Pressure >15 psig < 30 psig	16%
Medium Pressure ≥30 <75 psig	16%
High Pressure ≥75 psig <125 psig	16%
High Pressure ≥125 psig <175 psig	16%
High Pressure ≥175 psig <250 psig	16%
High Pressure > 300 psig	16%

L is 1.0 when applied to the replacement of an individual leaking trap. If several steam traps are replaced and the system has not been audited, the leaking and blow-thru is applied to reflect the assumed percentage of steam traps that were actually leaking and need to be replaced. A custom value can be utilized if supported by a detailed steam system audit or evaluation research.

Table 154 provides inputs for steam loss and water volume saved by steam system.

Table 154: Average Actual Steam Loss per Leaking Trap

Steam System	Average Actual Steam Loss per Leaking Trap (lbm/hr/trap)	Average Actual Water Volume Saved per Leaking Trap Atmospheric Venting (gal/hr/trap)
Commercial Dry Cleaners	19.1	2.29
Commercial Heating (including Multifamily) LPS	6.9	0.83
Industrial or Process Low Pressure, <15 psig	6.9	0.83
Medium Pressure >15 psig < 30 psig	6.5	0.78
Medium Pressure ≥30 <75 psig	23.4	2.81
High Pressure ≥75 <125 psig	43.8	5.26
High Pressure ≥125 <175 psig	60.9	7.31
High Pressure ≥175 <250 psig	82.1	9.86
High Pressure ≥250 ≤300 psig	105.2	12.63
High Pressure > 300 psig	Calculated	Calculated Steam Loss / 8.33

[207] Dry cleaners survey data as referenced in CLEAResult "Work Paper Steam Traps Revision #2" Revision 3 dated March 2, 2012.

3.29.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.29.6 MEASURE LIFE

The measure life is six years.[208]

3.30 COMPUTER ROOM AIR CONDITIONERS

This section summarizes the deemed savings methodology for the installation of computer room air conditioning (CRAC) systems. A CRAC unit is a device that monitors and maintains the temperature, air distribution, and humidity in a network room or data center. This measure covers assumptions made for baseline equipment efficiencies for early retirement (ER) based on the age of the replaced equipment and replace-on-burnout (ROB) and new construction (NC) situations based on efficiency standards. Savings calculations incorporate the use of only part-load efficiency values, as these types of units are only rated in units of seasonal coefficient of performance (SCOP). For ER, the actual age of the baseline system should be determined from the equipment nameplate or other physical documentation whenever possible. If the actual age of the unit is unknown, default values are provided.

3.30.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity
Measure category	Computer Room Air Conditioner
Delivery mechanism	Prescriptive
Baseline description	IECC 2021 efficiency
Efficient case description	Efficiency must exceed IECC 2021

[208] Source paper is the CLEAResult "Steam Traps Revision #1" dated August 2011. Primary studies used to prepare the source paper include Enbridge Steam Trap Survey, KW Engineering Steam Trap Survey, Enbridge Steam Saver Program 2005, Armstrong Steam Trap Survey, DOE Federal Energy Management Program Steam Trap Performance Assessment, Oak Ridge National Laboratory Steam System Survey Guide, KEMA Evaluation of PG&E's Steam Trap Program, Sept. 2007. Communication with vendors suggested an inverted bucket steam trap life typically in the range of 5 - 7 years, float and thermostatic traps 4 to 6 years, float and thermodynamic disc traps of 1 to 3 years. Cost does not include installation.

3.30.2 ELIGIBILITY CRITERIA

For a measure to be eligible, the following conditions must be met:

- The existing and proposed cooling equipment is electric
- The climate zone is determined from the county-to-climate-zone mapping table
- The building type is a network room or data center
- Rated for sensible coefficient of performance (SCOP)
- For early retirement projects: ER projects involve the replacement of a working system. Additionally, the ER approach cannot be used for projects involving renovation where a major structural change or internal space remodel has occurred. A ROB approach should be used for these scenarios.
- If these conditions are not met, the deemed savings approach cannot be used, and the Simplified M&V Methodology or the Full M&V Methodology must be used.

3.30.3 DEFINITION OF BASELINE EQUIPMENT

The baseline conditions related to efficiency and system capacity for early retirement and replace-on-burnout/new construction are as follows:

Early Retirement

Early retirement projects should claim savings using the replace-on-burnout/new construction baseline, as no additional savings are specified for early retirement projects. This section will not apply until the current baseline is updated, allowing the measure to refer to the existing baseline for early retirement projects.

Replace-on-Burnout (ROB) and New Construction (NC)

Baseline efficiency levels for CRACs are provided in Table 155 and Table 156 for floor mounted and ceiling mounted units respectively. These baseline efficiency levels reflect the minimum efficiency requirements from IECC 2021, which uses the Sensible Coefficient of Performance (SCOP) as the standard efficiency metric.

Table 155: Floor Mounted Baseline Efficiency Levels for ROB and NC CRACs[209]

System Type	Standard Model	Net Sensible Cooling Capacity [Btu/hr]	Minimum Net Sensible COP
Air conditioners, Air cooled	Downflow	< 80,000	2.70
		≥ 80,000 and < 295,000	2.58
		> 295,000	2.36
	Upflow - Ducted	< 80,000	2.67
		≥ 80,000 and < 295,000	2.55
		> 295,000	2.33
	Upflow – Non Ducted	< 65,000	2.16
		≥ 65,000 and < 240,000	2.04
		> 240,000	1.89
	Horizontal	< 65,000	2.65
		≥ 65,000 and < 240,000	2.55
		> 240,000	2.47
Air conditioners, Air cooled with fluid economizer	Downflow	< 80,000	2.70
		≥ 80,000 and < 295,000	2.58
		> 295,000	2.36
	Upflow - Ducted	< 80,000	2.67
		≥ 80,000 and < 295,000	2.55
		> 295,000	2.33
	Upflow - Non-Ducted	< 65,000	2.09
		≥ 65,000 and < 240,000	1.99
		> 240,000	1.81
	Horizontal	< 65,000	2.65
		≥ 65,000 and < 240,000	2.55
		> 240,000	2.47
Air conditioners,	Downflow	< 80,000	2.82

209 IECC 2021 TableC403.3.2(10).

System Type	Standard Model	Net Sensible Cooling Capacity [Btu/hr]	Minimum Net Sensible COP
Water cooled		≥ 80,000 and < 295,000	2.73
		> 295,000	2.67
	Upflow - Ducted	< 80,000	2.79
		≥ 80,000 and < 295,000	2.70
		> 295,000	2.64
	Upflow - Non-Ducted	< 65,000	2.43
		≥ 65,000 and < 240,000	2.32
		> 240,000	2.20
	Horizontal	< 65,000	2.79
		≥ 65,000 and < 240,000	2.68
		> 240,000	2.60
Air conditioners, Water cooled with fluid economizer	Downflow	< 80,000	2.77
		≥ 80,000 and < 295,000	2.68
		> 295,000	2.61
	Upflow - Ducted	< 80,000	2.74
		≥ 80,000 and < 295,000	2.65
		> 295,000	2.58
	Upflow - Non-Ducted	< 65,000	2.35
		≥ 65,000 and < 240,000	2.24
		> 240,000	2.12
	Horizontal	< 65,000	2.71
		≥ 65,000 and < 240,000	2.60
		> 240,000	2.54
Air conditioners, Glycol cooled	Downflow	< 80,000	2.56
		≥ 80,000 and < 295,000	2.24
		> 295,000	2.21
	Upflow - Ducted	< 80,000	2.53
		≥ 80,000 and < 295,000	2.21

System Type	Standard Model	Net Sensible Cooling Capacity [Btu/hr]	Minimum Net Sensible COP
		> 295,000	2.18
	Upflow - Non-Ducted	< 65,000	2.08
		≥ 65,000 and < 240,000	1.90
		> 240,000	2.81
	Horizontal	< 65,000	2.48
		≥ 65,000 and < 240,000	2.18
		> 240,000	2.18
Air conditioners, Glycol cooled with fluid economizer	Downflow	< 80,000	2.51
		≥ 80,000 and < 295,000	2.19
		> 295,000	2.15
	Upflow - Ducted	< 80,000	2.48
		≥ 80,000 and < 295,000	2.16
		> 295,000	2.12
	Upflow - Non-Ducted	< 65,000	2.00
		≥ 65,000 and < 240,000	1.82
		> 240,000	1.73
	Horizontal	< 65,000	2.44
		≥ 65,000 and < 240,000	2.10
		> 240,000	2.10

Table 156: Ceiling Mounted Baseline Efficiency Levels for ROB and NC CRACs[210]

System Type	Net Sensible Cooling Capacity [Btu/hr]	Minimum Net Sensible COP (Ducted/Non-Ducted)	Source
Air conditioners, Air cooled with free air discharge condenser	< 29,000	2.05 / 2.08	IECC 2021
	≥ 29,000 and < 65,000	2.02 / 2.05	
	> 65,000	1.92 / 1.94	
Air conditioners, Air cooled with free air discharge condenser with fluid economizer	< 29,000	2.01 / 2.04	
	≥ 29,000 and < 65,000	1.97 / 2.00	
	> 65,000	1.87 / 1.89	
Air conditioners, Air cooled with ducted condenser	< 29,000	1.86 / 1.89	
	≥ 29,000 and < 65,000	1.83 / 1.86	
	> 65,000	1.73 / 1.75	
Air conditioners, Air cooled with fluid economizer and ducted condenser	< 29,000	1.82 / 1.85	
	≥ 29,000 and < 65,000	1.78 / 1.81	
	> 65,000	1.68 / 1.70	
Air conditioners, Water cooled	< 29,000	2.38 / 2.41	
	≥ 29,000 and < 65,000	2.28 / 2.32	
	> 65,000	2.18 / 2.20	
Air conditioners, Water cooled with fluid economizer	< 29,000	2.33 / 2.36	
	≥ 29,000 and < 65,000	2.23 / 2.26	
	> 65,000	2.13 / 2.16	
Air conditioners, Glycol cooled	< 29,000	1.97 / 2.00	
	≥ 29,000 and < 65,000	1.93 / 1.98	
	> 65,000	1.78 / 1.81	
Air conditioners, Glycol cooled with fluid economizer	< 29,000	1.92 / 1.95	
	≥ 29,000 and < 65,000	1.88 / 1.93	
	> 65,000	1.73 / 1.76	

3.30.4 DEFINITION OF EFFICIENT EQUIPMENT

Package and split systems must exceed the minimum efficiencies specified in Table 155.

3.30.5 ENERGY SAVINGS ESTIMATION

$$\Delta kWh = \left(\frac{Btu_{cool,sensible}}{hr} \times \frac{1\ kW}{3{,}412\ Btu}\right) \times \left(\frac{1}{SCOP_{base}} - \frac{1}{SCOP_{ee}}\right) \times\ EFLH_c$$

[210] IECC 2021 TableC403.3.2(10).

Where:

$Btu_{cool,sensible}$	= *Rated sensible cooling capacity of the existing equipment at AHRI standard conditions [Btuh]; 1 ton = 12,000 Btuh*
$SCOP_{base}$	= *Sensible Cooling efficiency of baseline equipment (*Table 155*)*
$SCOP_{ee}$	= *Sensible cooling efficiency of the newly installed equipment*
DF	= *Seasonal peak demand factor for appropriate climate zone, building type, and equipment type (*Table 158*)*
$EFLH_C$	= *Cooling equivalent full-load hours for appropriate climate zone, building type, and equipment type [hours](*Table 158*)*

3.30.6 DEMAND SAVINGS ESTIMATION

$$\Delta kW = \left(\frac{Btu_{cool,sensible}}{hr} \times \frac{1\,kW}{3{,}412\,Btu}\right) \times \left(\frac{1}{SCOP_{base}} - \frac{1}{SCOP_{ee}}\right) \times DF$$

Deemed peak demand factor (DF) and equivalent full-load hour (EFLH) values are presented by building type and climate zone in Table 1578. A description of the building types that are eligible to use this measure is presented in Table 158. These building types are derived from the EIA CBECS study.[211]

Table 157: Commercial CRAC Building Type Descriptions and Examples

Building Type	Principal Building Activity	Definition	Detailed Business Type Examples[212]
Data Center	Data Center	Buildings used to house computer systems and associated components.	1) Data Center

[211] The Commercial Building Energy Consumption Survey (CBECS) implemented by the US Energy Information Administration includes a principal building activity categorization scheme that separates the Commercial sector into 29 categories and 51 subcategories based on principal building activity (PBA). For its purposes, the CBECS defines Commercial buildings as those buildings greater than 1,000 square feet that devote more than half of their floorspace to activity that is neither residential, manufacturing, industrial, nor agricultural. The high-level building types adopted for the TRM are adapted from this CBECS categorization, with some building types left out and one additional building type—Large Multifamily—included.

[212] Principal Building Activities are based on sub-categories from the 2003 CBECS questionnaire.

Table 158: Commercial CRAC DF and EFLH Values for All Climate Zones[213]

Climate Zone	Building Type and Principal Building Activity	CRACs	
		DF	$EFLH_C$
Albuquerque	Data Center	0.96	1,850
Santa Fe		0.92	975
Roswell		0.99	2,455
Las Cruces		1.00	2,595

3.30.7 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.30.8 MEASURE LIFE

The EUL for CRACs is 15 years, consistent with the EUL specified for split and packaged air conditioners and heat pumps.[214]

3.31 ENTRANCE AND EXIT DOOR AIR INFILTRATION

This measure applies to the installation of weather stripping or door sweeps on entrance and exit doors for a contained, pressurized space. Entrance and exit doors often leave clearance gaps to allow for proper operation. The gaps around the doors allow for the infiltration of unconditioned air into the building, adding to the cooling and heating load of the HVAC system. Weatherstripping and door sweeps are designed to be installed along the bottom and jambs of exterior doors to prevent air infiltration into the conditioned space.

Weatherstripping or door sweeps must be installed on doors of a conditioned and/or heated space. Treated doors must have visible gaps of at least 1/8 to 3/4 inches along the outside edge of the door. A space with interior vestibule doors is not eligible.

[213] EFLH and DF values are derived from the values in the Texas TRM version 7

[214] The EUL of 15 years has been cited in several places - PUCT Docket No. 36779, DOE 77 FR 28928, 10 CFR Part 431, and in the DEER 2014 update.

3.31.1 MEASURE OVERVIEW

Sector	Commercial
End use	Space heating and cooling
Fuel	Electricity
Measure category	Building Envelope
Delivery mechanism	Prescriptive
Baseline description	Exterior doors not sealed from unconditioned space
Efficient case description	Exterior doors sealed from unconditioned space using weather stripping and/or brush style door sweeps

3.31.2 DEFINITION OF BASELINE EQUIPMENT

The baseline standard for this measure is a commercial building with exterior doors that are not sealed from unconditioned space.

3.31.3 DEFINITION OF EFFICIENT EQUIPMENT

The high-efficiency condition for this measure is a commercial building with exterior doors that have been sealed from unconditioned space using weather stripping and/or brush-style door sweeps.

3.31.4 ENERGY SAVINGS ESTIMATION

The savings methodology was derived by analyzing TMY3 weather data for the representative city for each Texas weather zone.

Derivation of Pre-Retrofit Air Infiltration Rate

This savings methodology was derived by analyzing TMY3 weather data for the representative city for each Texas weather zone.

The pre-retrofit air infiltration rate for each crack width is calculated by applying the methodologies presented in Chapter 5 of the ASHRAE Cooling and Heating Load Calculation Manual (CHLCM).[215] Building Type characteristics for a typical commercial building were found

[215] ASHRAE Cooling and Heating Load Calculation Manual, p. 5.8. 1980. http://portal.hud.gov/hudportal/documents/huddoc?id=doc_10603.pdf.

in the DOE study PNNL-20026,[216] and an average building height of 20 feet is assumed for the deemed savings approach.

Because air infiltration is a function of differential pressure due to stack effect, wind speed, velocity head, and the design conditions of the building, TMY3 data for the representative city for each Texas weather zone was applied to account for the varying weather conditions that are characteristic throughout an average year.

Figure 5.13 from the ASHRAE CHLCM provides the infiltration rate based on various crack width and the corresponding pressure difference across a door. Figures 5.1 and 5.2 in the referenced document provide the differential pressure due to stack and wind pressure necessary to determine the total pressure difference across the door.

Applying a regression analysis to the information presented in Figure 5.1 returns an equation that allows solving for the pressure difference due to stack effect, Δp_s. The aggregate curve fit for Figure 5.1 is shown below where x is based on the dry bulb temperature from the TMY3 data, and the design temperature based on the appropriate seasonal condition.

$$\frac{\Delta p_s}{C_d} = 0.0000334003x - 0.00014468$$

Where C_d is an assumed constant, 0.63, and the neutral pressure distance is 10 feet.

$\Delta p_w/C_p$ is determined by applying a polynomial regression, which returns an equation for solving for the pressure difference due to wind, Δp_w. The curve fit for the equation is shown below where x is the wind velocity based on TMY3 data.

$$\frac{\Delta p_w}{C_p} = 0.00047749x^2 - 0.00013041x$$

Where C_p is an assumed constant, 0.13[217].

This yields the total pressure difference across the door, Δp_{Total}:

$$\Delta p_{Total} = \Delta p_s + \Delta p_w$$

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[216] Cho, H., K. Gowri, and B. Liu, "Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings." November 2010. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20026.pdf

[217] Average Wind Pressure Coefficient from Table 5.5 in the ASHRAE CHCLM

Solving for Δp_{Total} allows for the air infiltration rate per linear foot to be determined in Figure 5.13 (CHLCM). Applying a power regression analysis for each crack width (described in inches) represented in Figure 5.13 returns the equations listed below. In these equations, Q is the infiltration rate in cubic feet per minute through cracks around the door, and P is the perimeter of the door in feet.

$$\frac{Q}{P_{\frac{1}{8}"}} = (41.572x)^{0.5120}$$

$$\frac{Q}{P_{\frac{1}{4}"}} = (81.913x)^{0.5063}$$

$$\frac{Q}{P_{\frac{1}{2}"}} = (164.26x)^{0.5086}$$

$$\frac{Q}{P_{\frac{3}{4}"}} = (246.58x)^{0.5086}$$

These infiltration rates were based on TMY3 average monthly day and night conditions.

Derivation of Design and Average Outside Ambient Temperatures

Taking average daytime and nighttime outdoor temperature values, standard set points, and setbacks for daytime and nighttime design cooling and heating will yield the temperature difference needed for the sensible heat equation:

$$\Delta T = T_{design} - T_{avg\ outside\ ambient}$$

Where:

T_{design} = *Daytime and nighttime design temperature (°F, see Table 159)*

$T_{avg\ outside\ ambient}$ = *Average outside ambient temperature, specified by month (°F, see* Times New Roman*)*

Table 159 provides the monthly monthly ambient temperatures for each climate zone.

Table 159: Average Monthly Ambient Temperatures (°F)[218]

Month	Albuquerque		Santa Fe		Roswell		Las Cruces	
	Day	Night	Day	Night	Day	Night	Day	Night
Jan	42.5	30.9	36.4	25.8	47.2	33.4	46.7	36.7
Feb	45.6	33.9	41.4	30.5	54.9	42.8	52.2	41.1
Mar	54.6	41.0	54.7	39.6	61.6	46.9	57.6	43.9
April	62.7	51.4	59.5	43.3	71.2	55.2	68.0	56.3
May	69.8	58.3	68.4	53.3	80.8	64.2	79.9	64.8
June	81.2	66.3	79.2	61.2	85.1	70.4	87.6	71.9
July	84.8	71.5	77.2	64.3	86.3	73.9	92.4	78.2
Aug	81.4	69.3	77.0	62.6	88.8	75.0	87.6	74.7
Sept	75.1	62.6	67.6	54.3	77.7	64.1	83.4	70.4
Oct	62.1	51.3	58.5	43.4	71.6	54.3	69.3	57.6
Nov	48.6	40.4	43.8	32.2	57.0	45.9	57.6	44.5
Dec	39.6	31.9	35.2	24.1	51.3	38.5	53.8	39.6

Table 160 provides the design temperatures for day and night.

Table 160: Daytime and Nighttime Design Temperatures

Temperature Description	T_{design} (°F)
Daytime Cooling Design Temperature	74
Daytime Heating Design Temperature	72
Nighttime Cooling Design Temperature[219]	78
Nighttime Heating Design Temperature[220]	68

Savings Algorithms and Input Variables

To calculate HVAC load associated with air infiltration, the following sensible heat equation is used:

Electric Cooling Energy Savings

$$Cooling\ Energy\ Savings\ [kWh]_{Day} = \frac{CFM_{pre,day} \times CFM_{reduction} \times 1.08 \times \Delta T \times 1.0\ \frac{kW}{ton} \times Hours_{day}}{12{,}000\,\frac{Btuh}{ton}}$$

[218] NOAA

[219] Assuming 4-degree setback.

[220] Ibid.

$$Cooling\ Energy\ Savings\ [kWh]_{Night} = \frac{CFM_{pre,night} \times CFM_{reduction} \times 1.08 \times \Delta T \times 1.0\frac{kW}{ton} \times Hours_{night}}{12{,}000\frac{Btuh}{ton}}$$

$$Cooling\ Energy\ Savings\ [kWh] = Cooling\ Energy\ Savings\ [kWh]_{Day} + Cooling\ Energy\ Savings\ [kWh]_{Night}$$

Electric Heating Energy Savings

$$Heating\ Energy\ Savings\ [kWh]_{Day} = \frac{CFM_{pre,day} \times CFM_{reduction} \times 1.08 \times \Delta T \times 1.0\frac{kW}{ton} \times Hours_{day}}{COP \times 3{,}412\frac{Btuh}{kW}}$$

$$Heating\ Energy\ Savings\ [kWh]_{Night} = \frac{CFM_{pre,night} \times CFM_{reduction} \times 1.08 \times \Delta T \times 1.0\frac{kW}{ton} \times Hours_{night}}{COP \times 3{,}412\frac{Btuh}{kW}}$$

$$Heating\ Energy\ Savings\ [kWh] = Heating\ Energy\ Savings\ [kWh]_{Day} + Heating\ Energy\ Savings\ [kWh]_{Night}$$

3.31.5 DEMAND SAVINGS ESTIMATION

Electric Cooling Demand Savings (weighted by climate zone peak hour probability)

$$Summer\ Demand\ Savings\ [kW]_{Day} = \frac{CFM_{pre,day} \times CFM_{reduction} \times 1.08 \times \Delta T \times 1.0\frac{kW}{ton}}{12{,}000\frac{Btuh}{ton}}$$

Where

CFMpre = *Calculated pre-retrofit air infiltration (cubic feet per minute)*

CFMreduction = *59% * TDF*[221]

TDF = *Technical degradation factor = 85%*[222]

1.08 = *Sensible heat equation conversion* [223]

ΔT = *Change in temperature across gap barrier [°F]*

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221 CLEAResult, "commercial Door Infiltration Memo". March 18, 2015. Average reduction in Arkansas based on test results from the CLEAResult Brush Weather Stripping Testing Method and Results (59% infiltration reduction)

222 This factor is applied to account for the difference the laboratory test from the "Commercial Door Infiltration Memo" and the real-world ability to seal the openings around a door. In the absence of research regarding the actual difference, this factor was set to 0.85.

223 2013 ASHRAE Handbook of Fundamentals; Equation 33, p.16.11.

3.31.6 DEEMED ENERGY AND DEMAND SAVINGS

Deemed energy and demand savings per linear foot of installed weather stripping or door sweep are specified below in Table 161 to Table 165 based on climate zone and existing door gap width (inches). Heating savings are specified for both electric resistance (ER) and heat pump (HP) heating. Cooling savings are available for buildings with electric cooling and gas heat, but no heating savings should be claimed for buildings with gas heat.

Table 161: Deemed Cooling Energy Savings per Linear Foot of Weather Stripping/Door Sweep

Climate Zone	Climate Zone Gap Width (inches)			
	1/8	1/4	1/2	3/4
Albuquerque	2.38	4.82	9.56	14.35
Santa Fe	1.06	2.14	4.24	6.37
Roswell	4.67	9.44	18.74	28.12
Las Cruces	5.06	10.25	20.33	30.52

Table 162: Deemed ER Heating Energy Savings per Linear Foot of Weather Stripping/Door Sweep

Climate Zone	Climate Zone Gap Width (inches)			
	1/8	1/4	1/2	3/4
Albuquerque	128.19	259.17	514.35	772.11
Santa Fe	174.55	352.70	700.12	1050.98
Roswell	87.14	176.27	349.76	525.04
Las Cruces	90.70	183.30	363.83	546.16

Table 163: Deemed HP Heating Energy Savings per Linear Foot of Weather Stripping/Door Sweep

Climate Zone	Climate Zone Gap Width (inches)			
	1/8	1/4	1/2	3/4
Albuquerque	38.85	78.54	155.86	233.97
Santa Fe	52.89	106.88	212.16	318.48
Roswell	26.41	53.42	105.99	159.10
Las Cruces	27.49	55.54	110.25	165.50

Table 164: Deemed Summer Demand Savings per Linear Foot of Weather Stripping/Door Sweep

Climate Zone	Climate Zone Gap Width (inches)			
	1/8	1/4	1/2	3/4
Albuquerque	0.002304	0.004662	0.009249	0.013884
Santa Fe	0.001714	0.003468	0.006881	0.010329
Roswell	0.00385	0.007787	0.015451	0.023195
Las Cruces	0.004563	0.009243	0.018329	0.027515

Table 165: Deemed Natural Gas Heating Savings (therms) per Linear Foot of Weather Stripping/Door Sweep

Climate Zone	Climate Zone Gap Width (inches)			
	1/8	1/4	1/2	3/4
Albuquerque	5.47	11.05	21.94	32.93
Santa Fe	7.44	15.04	29.86	44.82
Roswell	3.72	7.52	14.92	22.39
Las Cruces	3.87	7.82	15.52	23.29

3.31.7 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.31.8 MEASURE LIFE

The EUL for this measure is 11 years, according to the California Database of Energy Efficiency Resources (DEER 2014).[224] This measure life is consistent with the residential air infiltration measure in the Texas TRM.

3.32 SMALL COMMERCIAL EVAPORATIVE COOLING

This measure promotes the installation of a high-efficiency evaporative cooler. This measure could apply to the replacement of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building.

[224] Database for Energy Efficient Resources (2014). http://www.deeresources.com/.

3.32.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity
Measure category	Evaporative Cooling
Delivery mechanism	Rebate
Baseline description	IECC 2021 efficiency for split/packaged AC < 65,000 Btu/h
Efficient case description	Direct evaporative cooling (no expansion cooling) with the following characteristics: cooling flow is three times the flow use for the code baseline buildings, effectiveness = 0.85

3.32.2 ENERGY SAVINGS ESTIMATION

Savings are calculated by multiplying the baseline consumption of a code-compliant split or packaged air conditioner against deemed cooling equivalent full-load hours (EFLH) and coincidence factors (CF) specified per climate zone and building type. Baseline consumption is determined according to deemed cooling load specified per climate zone and code-level efficiency requirement as described below. A reduction factor comparing evaporative and refrigerated cooling consumption is applied to deemed EFLH/CF values to represent the savings for installing evaporative cooling in lieu of refrigerated cooling.

Savings for all unit capacities (typically 3,000-25,000 cfm)[225] are determined with the following equation:

$$Cooling\ Savings = Cooling\ Capacity \times \frac{1}{SEER_{Base}} \times Cooling\ EFLH \times CRF$$

[225] Department of Energy, https://www.energy.gov/energysaver/home-cooling-systems/evaporative-coolers.

Where:

Cooling Savings	= *Annual cooling energy savings, in kWh*
Cooling Capacity	= *System cooling capacity, in kBtu/h*
$SEER_{Base}$	= *Baseline Seasonal Energy Efficiency Ratio, nominal rating of system, see Table 166 for baseline values, Btu/Wh*
Cooling EFLH	= *Effective full load cooling hours, see Table 168.*
CRF	= *Consumption reduction factor = 75%*[226]

Baseline efficiencies are shown in Table 166.[227]

Table 166: Packaged AC system baseline efficiency ratings

Equipment Type	Size Category	Subcategory or rating condition	Minimum Efficiency
Air Conditioners, air cooled	< 65,000 Btu/h	Split system	13.0 SEER
		Single package	14.0 SEER

Table 167 provides the default refrigerated cooling load for evaporative coolers per climate zone.

Table 167: Default Refrigerated Cooling Load for Evaporative Cooling

Climate Zone	Cooling Capacity kBtu/h
Santa Fe	24
Albuquerque	30
Roswell	36
Las Cruces	36

Cooling EFLH values, derived from eQuest simulations of DEER building prototypes, are shown in Table 168.

[226] Ibid.

[227] IECC 2021

Table 168: Cooling EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	1,471	1,343	1,576	812
Education - Primary School	436	508	554	289
Education - Relocatable Classroom	490	560	595	354
Education - Secondary School	450	479	555	213
Grocery	824	961	1,038	391
Manufacturing - Light Industrial	743	958	950	519
Office - Small	1,083	1,174	1,292	770
Restaurant - Fast-Food	1,271	1,267	1,377	754
Restaurant - Sit-Down	1,236	1,218	1,361	681
Retail - Small	1,296	1,361	1,438	847
Storage - Conditioned	492	698	697	336
Other[228]	1,033	1,109	1,213	617

Example: An evaporative cooler with a saturation effectiveness of 0.85 is installed in a small office in Las Cruces.

Cooling savings	= 36 kBtu/h x (1 W-hr/13 Btu) x 1,174 hours x 75%
	= 2,438 kWh
$SEER_{Baseline}$	$= -0.02 \times (13)^2 + 1.12 \times 13 = 11.18$
Demand Savings	= 36 kBtu/h x (1/11.18) x 0.81 x 75%
	= 1.96 kW

3.32.3 DEMAND SAVINGS ESTIMATION

Peak savings are determined with the following equation.

$$PeakSvgs = Cooling\ Capacity \times \frac{1}{EER_{Base}} \times CF \times CRF$$

[228] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the “Office – Small” EFLH.

Where:

EER_{Base}	= *Baseline Energy Efficiency Ratio, nominal rating of system, calculated by converting from baseline SEER in Table 166*[229]
CF	= *Coincidence Factor, see Table 169*

Other parameters are as defined above for energy savings.

Coincidence factors are shown in Table 169. These values were derived from the Texas TRM version 5. The value for El Paso was used for Las Cruces, the value for Amarillo was used for Roswell, and the average of these two values was used for Albuquerque and Santa Fe.

Table 169: CF by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0.78	0.91	0.64	0.78
Education - Primary School	0.78	0.91	0.64	0.78
Education - Relocatable Classroom	0.78	0.91	0.64	0.78
Education - Secondary School	0.78	0.87	0.69	0.78
Grocery	0.74	0.80	0.68	0.74
Manufacturing - Light Industrial	0.34	0.38	0.29	0.34
Office - Small	0.76	0.81	0.72	0.76
Restaurant - Fast-Food	0.75	0.76	0.73	0.75
Restaurant - Sit-Down	0.80	0.76	0.83	0.80
Retail - Small	0.79	0.83	0.75	0.79
Storage - Conditioned	0.55	0.75	0.34	0.55
Other[230]	0.34	0.38	0.29	0.34

3.32.4 NON-ENERGY BENEFITS

Evaporative coolers supply a continuous stream of fresh air. They also add moisture to the air which can be beneficial for regions with low relative humidity. This can improve occupancy, comfort and productivity.

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[229] Code specified SEER values converted to EER using EER = -0.02 x $SEER^2$ + 1.12 x SEER. National Renewable Energy Laboratory (NREL) 2010, "Building America House Simulation Protocols." U.S. DOE. Revised October www.nrel.gov/docs/fy11osti/49246.pdf.

[230] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g., a medical administration building could potentially be assessed using the "Office – Small" CF

3.32.5 MEASURE LIFE

The lifetime for this measure is 15 years.[231]

3.33 SMALL BUSINESS FURNACE AND ROOFTOP UNIT TUNE-UP

This measure is for a fossil fuel furnace or Gas-Fired Rooftop Unit that provides space heating for a Small Business facility. The tune-up will improve furnace or gas-fired rooftop unit performance by inspecting, cleaning, and adjusting the furnace or rooftop unit and appurtenances for correct and efficient operation. Additional savings may be realized through a complete system tune-up.

3.33.1 MEASURE OVERVIEW

Sector	Commercial
End use	Space Heating
Fuel	Natural Gas
Measure category	High Efficiency Gas Furnaces
Delivery mechanism	Rebate
Baseline description	Steady state furnace efficiency before tune-up
Efficient case description	Steady state furnace efficiency after tune-up

3.33.2 SAVINGS

The baseline equipment is a furnace or gas-fired rooftop unit assumed not to have had a tune-up in the past 3 years.

To qualify for this measure an approved technician must complete the tune-up requirements listed below:[232]

- Measure combustion efficiency using an electronic flue gas analyzer
- Check and clean the blower assembly and components per manufacturer's recommendations
- Where applicable, lubricate the motor, and inspect and replace the fan belt if required

[231] DEER 2008

[232] American Standard Heating & Air Conditioning, Maintenance for Indoor Units

- Inspect for gas leaks
- Clean the burner per manufacturer's recommendations and adjust as needed
- Check and clean the ignition and systems, and adjust as needed
- Check and clean the heat exchanger per manufacturer's recommendations
- Inspect the exhaust/flue for proper attachment and operation
- Inspect the control box, wiring, and controls for proper connections and performance
- Check the air filter and clean or replace it per manufacturer's recommendations
- Inspect the duct work connected to the furnace for leaks or blockages
- Measure the temperature rise and adjust flow as needed
- Check for correct line and load volts/amps
- Check that the thermostat operation is per manufacturer's recommendations. N
    - Note, if adjustments are made, refer to the 'Small Commercial Programmable Thermostat Adjustment' measure for savings estimates.
- Perform a carbon monoxide test and adjust the heating system until results are within standard industry acceptable limits

3.33.3 ENERGY SAVINGS ESTIMATION

Electric savings are calculated based on the following formula:

$$\Delta kWh = \Delta Therms \times F_e \times 29.3$$

Where:

$\Delta Therms$	= *as calculated below*
F_e	= *Furnace fan energy consumption as a percentage of annual fuel consumption*
	= *7.7%*[233]
29.3	= *kWh per therm of natural gas*

233 Fe is estimated using TRM models for the three most popular building types for programmable thermostats: low-rise office (10.2%), sit-down restaurant (8.6%), and retail – strip mall (4.4%). 7.7% reflects the average Fe of the three building types. IL TRM v.12.0 Vol. 2

Gas savings are calculated based on the following formula:

$$\Delta Therms = Capacity \times EFLH \times \frac{\left(\frac{Eff_{before} + E_i}{Eff_{before}} - 1\right)}{100{,}000}$$

Where:

Capacity = *Furnace gas input size (Btu/hr)*

EFLH = *heating equivalent full load hours for the appropriate weather zone (from Table 170)*

Eff_{before} = *Efficiency of the furnace before the tune-up*

Note: Contractors should select a mid-level firing rate that appropriately represents the average building operating condition over the course of the heating season and take readings at a consistent firing rate for pre and post tune-up.

E_i = *Actual efficiency Improvement of the furnace tune-up measure*

100,000 = *Converts Btu to therms*

Table 170 provides the heating EFLH values per building type and climate zone.

Table 170: Heating EFLH by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0	0	0	0
Education - Community College	0	0	0	0
Education - Primary School	698	500	497	929
Education - Relocatable Classroom	733	528	525	975
Education - Secondary School	733	528	525	975
Education - University	0	0	0	0
Grocery	0	0	0	0
Health/Medical – Hospital	0	0	0	0
Health/Medical - Nursing Home	0	0	0	0
Lodging - Hotel	782	383	381	1,040
Manufacturing - Bio/Tech	339	179	178	450
Manufacturing - Light Industrial	339	179	178	450
Office - Small	339	179	178	450
Restaurant - Fast-Food	1,025	639	636	1,363
Restaurant - Sit-Down	1,119	751	747	1,488
Retail - Single-Story Large	903	470	468	1,202
Retail - Small	750	549	546	998
Storage - Conditioned	0	0	0	0
Warehouse - Refrigerated	0	0	0	0
Other	339	179	178	450

Example:

A 100 kBtu furnace in a Santa Fe large single story retail facility records an efficiency prior to tune-up of 82% AFUE, and a 1.8% improvement in efficiency after tune-up:

$$\Delta therms = \frac{\left(100{,}000 \times 1{,}202 \times \left(\left(\frac{0.82 + 0.018}{0.82}\right) - 1\right)\right)}{100{,}000} = 26.4\ therm$$

3.33.4 DEMAND SAVINGS ESTIMATION

N/A

3.33.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.33.6 MEASURE LIFE

The measure life for the gas furnace tune-up is 3 years.[234]

3.34 HIGH EFFICIENCY POOL PUMPS (NEW/REPLACEMENT)

This measure includes the installation of a new ENERGY STAR® or CEE T1 variable speed commercial pool pump motor. This measure supports Time of Sale and New Construction baselines where a new efficient pump is installed in lieu of the federal standard, and an Early Replacement baseline which is equal to a pre-existing standard single speed motor of equivalent horsepower.

3.34.1 MEASURE OVERVIEW

Sector	Commercial
End use	Pool Water Pumping
Fuel	Electricity
Measure category	Water Pumping
Delivery mechanism	Rebate
Baseline description	Two speed commercial pool pump meeting the Federal Standard
Efficient case description	0.5 – 3 HP ENERGY STAR® or CEE T1 qualified multi-speed or variable-speed pool pump

[234] Assumed consistent with other tune-up measures.

3.34.2 SAVINGS

Commercial outdoor pool pumps can be single speed, two/multi speed or variable speed. However, the federal standard 82 FR 5650 (effective July 19, 2021) effectively requires new pumps to be at least two speeds.

Single speed pumps are often oversized and run frequently at constant flow regardless of load. Single speed pool pumps require that the motor be sized for the task that requires the highest speed. As such, energy is wasted as the pumps run at high speed when load may be low. Two speed and variable speed pool pumps reduce speed when less flow is required, such as when filtering is needed but not cleaning, and have timers that encourage programming for fewer operating hours. Variable speed pool pumps use advanced motor technologies to achieve efficiency ratings of 90% while the average single speed pump will have efficiency ratings between 30% and 70%.

The high efficiency equipment is an ENERGY STAR® or CEE Tier commercial pool pump meeting the ENERGY STAR minimum qualifications in Table 171 for either in-ground or above ground pools. ENERGY STAR® version 3.0 specification takes effect on July 19, 2021. Note that for in ground pools, the CEE Tier 1 is the same as the new Federal Standard, and Tier 2 is the same as ENERGY STAR® V3 for the standard size pumps, so savings for CEE Tier 1 is only provided for above ground pools where there is an increment in efficiency.

Table 171: Minimum Qualifications for High Efficiency Pool Pumps

Pump Sub-Type	Size Class	ENERGY STAR® Version 3.0 Energy Efficiency Level (Effective 7/19/2021)	CEE Tier 1	CEE Tier 2
Self-Priming (Inground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 13.40	N/A	N/A
	Small (hhp > 0.13 and < 0.711)	WEF ≥ -2.45 x ln (hhp) + 8.40	WEF ≥ -1.30 x ln (hhp) + 4.95	WEF ≥ -2.83 x ln (hhp) + 8.84
	Standard Size (hhp ≥ 0.711)	WEF ≥ -2.45 x ln (hhp) + 8.40	WEF ≥ -2.3 x ln (hhp) + 6.59	WEF ≥ -2.45 x ln (hhp) + 8.4
Non-Self Priming (Aboveground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 4.92	N/A	N/A
	Standard Size (hhp > 0.13)	WEF ≥ -1.00 x ln (hhp) + 3.85	WEF ≥ -1.60 x ln (hhp) + 9.10	N/A

Baseline equipment is a two-speed commercial pool pump meeting the Federal Standard, effective July 19, 2021, provided in Table 172.

Table 172: Federal Standard for Baseline Pool Pumps

Pump Sub-Type	Size Class	Baseline (Effective 7/19/2021)
Self-Priming (Inground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 5.55
	Small (hhp > 0.13 and < 0.711)	WEF ≥ -1.30 x ln (hhp) + 2.90
	Standard Size (hhp ≥ 0.711)	WEF ≥ -2.30 x ln (hhp) + 6.59
Non-Self Priming (Aboveground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 4.60
	Standard Size (hhp > 0.13)	WEF ≥ -0.85 x ln (hhp) + 2.87

For early replacement, the baseline equipment is the existing single speed commercial pool pump.

3.34.3 ENERGY SAVINGS ESTIMATION[235]

Savings can be calculated using the equations below based on the baseline event type:

For Time of Sale and New Construction:

$$\Delta kWh = ((Gallons * Turnovers * (1/WEF\_base - 1/WEF\_ESTAR) * Days))/1{,}000$$

For Early Replacement:

$$\Delta kWh = ((Gallons * Turnovers * (1/EF\_Exist - 1/WEF\_ESTAR) * Days))/1{,}000$$

Where:

Gallons	= *Actual capacity of the pool. If unknown refer to Table 173*
Turnovers	= *Desired number of pool water turnovers per day = 2*[236]
WEF_{base}	= *Weighted Energy Factor of baseline pump (gal/Wh)*[237]
WEF_{ESTAR}	= *Weighted Energy Factor of ENERGY STAR® pump (gal/Wh)*[238]
EF_{Exist}	= *Energy Factor of existing single speed pump (gal/Wh)*
	= *2.3*[239]

[235] The methodology followed is consistent with the most recent version of the 2020 ENERGY STAR calculator (Pool_Pump_Calculator_2020.05.05_FINAL.xls), however this has not been updated to account for the new federal standard.

[236] Consistent with assumption in the 2020 ENERGY STAR calculator.

[237] Based on applying the federal standard specifications to the average Curve-C rated hydraulic horsepower (hhp) from the ENERGY STAR Qualified Products List, accessed 3/31/2021.

[238] Based on applying the ENERGY STAR and CEE Tier 1 specifications to the average Curve-C rated hydraulic horsepower (hhp) from the ENERGY STAR Qualified Products List, accessed 3/31/2021

[239] Consistent with assumption in the 2020 ENERGY STAR calculator, assuming 1.5 HP pump.

Days = *Number of days per year that the swimming pool is operational*

= *122,*[240]

1,000 = *Conversion factor from Wh to kWh*

Table 173 provides the typical volume for both in ground and above ground pool types.

Table 173: Typical Pool Volume Based on Type

Pool Type	Gallons
In ground	22,000[241]
Above ground	7,540[242]

Table 174 provides the baseline weighted energy factor for both in ground and above ground pools.

Table 174: Pool Pump Baseline Weighted Energy Factor Based on Type

Pool Type	WEF_{Base}
In ground	4.63
Above ground	2.57

The Weighted Energy Factor of ENERGY STAR® Pumps are detailed in Table 175.

Table 175: Weighted Energy Factor of Energy Star Pump Required

Pool Type	WEF_{ESTAR}	
	ENERGY STAR®	CEE Tier 1
In ground	6.31	N/A
Above ground	3.49	8.53

Based on the defaults provided above, the deemed annual energy savings (ΔkWh) are detailed in Table 176.

Table 176: Annual Energy Savings (ΔkWh)

	ΔkWh			
Pool Type	TOS/NC		Retrofit	
	ENERGY STAR®	CEE T1	ENERGY STAR®	CEE T1
In ground	307.7	N/A	1512.1	N/A
Above ground	189.5	499.5	283.7	593.6

240 Consistent with assumption in the 2020 ENERGY STAR calculator.

241 Consistent with assumption in the 2020 ENERGY STAR calculator.

242 Based on typical pool sizes from “Evaluation of Potential Best Management Practices - Pools, Spas, and Fountains, The California Urban Water Conservation Council”, 2010.

3.34.4 DEMAND SAVINGS ESTIMATION

For Time of Sale and New Construction:

$$\Delta kW = \left(\frac{\frac{kWh}{day_{base}}}{\frac{Hrs}{day_{base}}}\right) - \left(\frac{\frac{kWh}{day_{ESTAR}}}{\frac{Hr}{day_{ESTAR}}}\right) * CF$$

For Early Replacement:

$$\Delta kW = \left(\frac{\frac{kWh}{day_{Exist}}}{\frac{Hrs}{day_{Exist}}}\right) - \left(\frac{\frac{kWh}{day_{ESTAR}}}{\frac{Hr}{day_{ESTAR}}}\right) * CF$$

Where:

kWh/day = *daily energy consumption of pool pump, as defined above.*

= *Actual, defaults provided below:*

Hrs/day_{base} = *daily run hours of pool pump*

= *(Gallons * Turnover) / GPM*

CF = *Summer Peak Coincidence Factor for measure*

= *0.831*[243]

The daily energy consumption of a pool pump (ΔkWh/day) are detailed in Table 177.

Table 177: Daily Energy consumption of pool pump (ΔkWh/day)

	ΔkWh/day			
Pool Type	**TOS/NC Baseline**	**ENERGY STAR®**	**CEE T1**	**Retrofit Baseline**
In ground	9.5	7	N/A	19.4
Above ground	5.9	4.3	1.8	6.6

The daily run-time hours of a pool pump are detailed in Table 178.

[243] Based on assumptions of daily load pattern through pool season. Assumption was developed for Efficiency Vermont but is considered a reasonable estimate for New Mexico.

Table 178: Daily Run Hours of Pool Pump

Pool Type	Equipment Type	Weighted Average GPM	Hours/Day
In ground	TOS/NC Baseline	43.6	16.8
	Efficient	32.2	22.8
	Retrofit Baseline	78	9.4
Above ground	TOS/NC Baseline	44.7	5.6
	Efficient	27.3	9.2
	Retrofit Baseline	78.1	3.2

The demand energy consumption of a pool pump (ΔkW) is detailed in Table 179.

Table 179: Energy Demand of Pool Pump (ΔkW)

	ΔkW			
Pool Type	TOS/NC		Retrofit	
	ENERGY STAR®	CEE T1	ENERGY STAR®	CEE T1
In ground	0.2152	N/A	1.4641	N/A
Above ground	0.4793	0.7094	1.3285	1.5586

3.34.5 NON-ENERGY BENEFITS

N/A

3.34.6 MEASURE LIFE

The estimated useful life for a two-speed or variable speed pool pump is 7 years.[244]

3.35 HIGH EFFICIENCY BATHROOM EXHAUST FANS (NEW)

This market opportunity measure is for the installation of a new bathroom fan to be used in either a typical usage or continuous usage application (i.e., to meet the need for continuous mechanical ventilation due to reduced air-infiltration from a tighter building shell.)

[244] As recommended in Navigant 'ComEd Effective Useful Life Research Report', May 2018.

3.35.1 MEASURE OVERVIEW

Sector	Residential
End use	Building Shell
Fuel	Electric
Measure category	Exhaust Fans
Delivery mechanism	Rebate
Baseline description	New standard efficiency exhaust-only ventilation fan
Efficient case description	New efficient ENERGY STAR® or ENERGY STAR® Most Efficient exhaust-only ventilation fan, quiet (<2.0 sones) operating in accordance with recommended ventilation rate indicated by ASHRAE 62.2 – 2016.[245]

3.35.2 SAVINGS

ENERGY STAR® specifications (effective October 1, 2015) and 2018 ENERGY STAR® "Most Efficient" specifications are provided in Table 180.

Table 180: Bathroom Exhaust Fan ENERGY STAR® Specifications

Efficiency Level	Fan Capacity	Minimum Efficacy Level (CFM/Watts)	Maximum Allowable Sound Level (sones)
ENERGY STAR®	10 – 89 CFM	2.8	2.0
	90 – 200 CFM	3.5	
ENERGY STAR® Most Efficient	All	10	

This measure applies to Standard Usage and Continuous Usage categories. The deemed electric savings are provided in Table 181 and Table 182 for annual and demand savings respectively.

[245] Bi-level controls may be used by efficient fans larger than 50 CFM

Table 181: High Efficiency Bathroom Exhaust Fan savings (annual kWh)[246]

					Energy Star®		Energy Star® Most Efficient	
Application	**Min CFM**	**Max CFM**	**Average CFM**	**Base CFM/Watts**	**CFM/Watts**	**ΔkWh Savings**	**CFM/Watts**	**ΔkWh Savings**
Standard Usage	10	89	70.6	1.7	4.9	28.9	12.0	38.2
	90	200	116.1	2.6	5.6	25.3	13.9	38.7
	Unknown		92.4	2.2	5.3	27.4	12.9	38.6
Continuous Usage	N/A		50	1.7	5.1	170.7	11.2	216.9

Table 182: High Efficiency Bathroom Exhaust Fan savings (kW)

Application	Min CFM	Max CFM	Average CFM	Energy Star® ΔkW Savings	Energy Star® Most Efficient ΔkW Savings
Standard Usage	10	89	70.6	0.0036	0.0047
	90	200	116.1	0.0031	0.0048
	Unknown		92.4	0.0034	0.0048
Continuous Usage	N/A		50	0.0195	0.0247

3.35.3 ENERGY SAVINGS ESTIMATION

Savings are derived from the following formula.

$$Svgs = CFM \times \frac{\left(\frac{1}{\eta_{Baseline}} - \frac{1}{\eta_{Efficient}}\right)}{1000} \times Hours$$

Where:

Svgs = *Annual energy savings, in kWh*

CFM = *Actual Nominal Capacity of the exhaust fan. Actual or use defaults provided in Table 182*[247]

$\eta_{Baseline}$ = *Average efficacy for Baseline fan (CFM/Watt). See Table 181.*

$\eta_{Efficient}$ = *Average efficacy for Efficient fan (CFM/Watt). See Table 181.*

[246] Based on review of Bathroom Exhaust Fan product available on CEC Appliance Database, accessed 6/18/2018. See 'CEC Bath Fan.xls' for more information.

[247] 50CFM is the closest available fan size to ASHRAE 62.2 Section 4.1 Whole House Ventilation rates based upon typical square footage and bedrooms.

Hours = *assumed annual hours*

= *1,089 for standard usage*[248]

= *8,760 for continuous usage*

3.35.4 DEMAND SAVINGS ESTIMATION

Demand Savings are calculated using the following equation:

$$PeakSvgs = CFM \times \frac{\left(\frac{1}{\eta_{Baseline}} - \frac{1}{\eta_{Efficient}}\right)}{1{,}000} \times CF$$

Where:

CF = *Summer Peak Coincidence Factor*

= *0.135 for standard usage*[249]

= *1.0 for continuous usage*

3.35.5 NON-ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

3.35.6 MEASURE LIFE

The expected measure life is assumed to be 19 years.[250]

3.36 IRRIGATION PUMP VFD (NEW)

This measure applies to variable speed drives (VSD) installed on irrigation pump motors for the agriculture industry.

[248] Assumed to be consistent with Residential Indoor Lighting hours of use.

[249] Sourced from the IL TRM v12.0

[250] Conservative estimate based upon GDS Associates Measure Life Report “Residential and C&I Lighting and HVAC measures” 25 years for whole-house fans, and 19 for thermostatically controlled attic fans.

3.36.1 MEASURE OVERVIEW

Sector	Commercial
End use	Water
Fuel	Electric
Measure category	Variable Frequency Drive (VFD)
Delivery mechanism	Rebate
Baseline description	Irrigation Pump not controlled by VFD
Efficient case description	Irrigation Pump controlled by VFD

3.36.2 SAVINGS

The baseline is a pre-existing irrigation pump and motor operating without automated controls. The pre-existing irrigation pump may or may not include bypass damper, guide vanes, throttling valves, or other methods of manual control. This information shall be collected from the customer.

The efficient case involves the installation of VFD to the existing pump. The VFD will modulate the speed of the motor when it does not need to run at full load. Since the power of the motor is proportional to the cube of the speed for these types of applications, significant energy savings will result. This law does not apply to positive displacement pumps.

3.36.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula.

$$Svgs = kWh_{Base} - kWh_{VFD}$$

$$kWh_{Base} = \sum_{1}^{n} HP_n \times 0.746 \frac{kW}{HP} \times Hours_{year} \times \%Hours_n$$

$$kWh_{VFD} = \sum_{1}^{n} HP_{VFD,n} \times 0.746 \frac{kW}{HP} \times Hours_{year} \times \%Hours_n$$

$$HP_n = \frac{Flow_n \times Head_n}{3{,}960 \times (Eff_{pump} \times Eff_{motor})}$$

$$HP_n = \frac{Flow_n \times Head_{VFD,n}}{3960 \times (Eff_{pump} \times Eff_{VFD} \times Eff_{motor})}$$

$$Hours_{year} = \frac{Acres \times Irrigation}{12\frac{in}{ft} \times 60\frac{min}{hr} \times GPM_{system} \Big/ \left(7.481\frac{gal}{ft^3} \times 43{,}560\frac{ft^2}{acre}\right)}$$

Where:

Svgs	= *Annual energy savings, in kWh*
kWh_{base}	= *Annual energy required for the baseline pump condition*
kWh_{base}	= *Annual energy required with a VFD pump installed*
HP_n	= *Baseline horsepower required for a given flow rate*
$HP_{VFD,n}$	= *Horsepower required for a given flow rate with the VFD installed*
$Hours_{year}$	= *Annual Hours of irrigation*
$\%Hours_n$	= *Percent of time irrigation pump will be operating at a given flow rate*
n	= *Number of data points needed or collected*
$Flow_n$	= *Flow rate at a given data point in gallons per minute, use actual values*
$Head_n$	= *Pressure head at a given data point in feet, use actual values*
$Head_{VFD,n}$	= *Pressure head at a given data point in feet with a VFD*
Eff_{pump}	= *Percent efficiency of the pump, taken from manufacturers pump curve*
Eff_{motor}	= *Percent efficiency of the pump motor*
Eff_{VFD}	= *Percent efficiency of the VFD* = *97%*[251]
Acres	= *Size of the field that is being irrigated in acres*
Irrigation	= *Gross irrigation required in inches per year*
GPM_{system}	= *Required system flow rate in gallons per minute*

Table 183 provides the NEMA motor efficiencies based on the motor specifications.

[251] Estimated typical VFD efficiency, as sourced from; "Chapter 18: Variable Frequency Drive Evaluation Protocol", The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, NREL, December 2014 (pg. 2)

Table 183: NEMA Premium Efficiency Motors Default Efficiencies[252]

Size HP	Open Drip Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	# of Poles			# of Poles		
	6	4	2	6	4	2
	Speed (RPM)			Speed (RPM)		
	1200	1800 (Default)	3600	1200	1800	3600
1	0.825	0.855	0.77	0.825	0.855	0.77
1.5	0.865	0.865	0.84	0.875	0.865	0.84
2	0.875	0.865	0.855	0.885	0.865	0.855
3	0.885	0.895	0.855	0.895	0.895	0.865
5	0.895	0.895	0.865	0.895	0.895	0.885
7.5	0.902	0.91	0.885	0.91	0.917	0.895
10	0.917	0.917	0.895	0.91	0.917	0.902
15	0.917	0.93	0.902	0.917	0.924	0.91
20	0.924	0.93	0.91	0.917	0.93	0.91
25	0.93	0.936	0.917	0.93	0.936	0.917
30	0.936	0.941	0.917	0.93	0.936	0.917
40	0.941	0.941	0.924	0.941	0.941	0.924
50	0.941	0.945	0.93	0.941	0.945	0.93
60	0.945	0.95	0.936	0.945	0.95	0.936
75	0.945	0.95	0.936	0.945	0.954	0.936
100	0.95	0.954	0.936	0.95	0.954	0.941
125	0.95	0.954	0.941	0.95	0.954	0.95
150	0.954	0.958	0.941	0.958	0.958	0.95
200	0.954	0.958	0.95	0.958	0.962	0.954
250	0.954	0.958	0.95	0.958	0.962	0.958
300	0.954	0.958	0.954	0.958	0.962	0.958
350	0.954	0.958	0.954	0.958	0.962	0.958
400	0.958	0.958	0.958	0.958	0.962	0.958
450	0.962	0.962	0.958	0.958	0.962	0.958
500	0.962	0.962	0.958	0.958	0.962	0.958

Example: A 20 HP TEFC 1,800 rpm irrigation pump is installed with a VFD. The pump efficiency is 65%. The operation data points are given below. The pump runs for 4 hours every day throughout the year (1,460 hours). The required system flow rate is 100 gallons per minute.

[252] Douglass, J. (2005). Induction Motor Efficiency Standards. Washington State University and the Northwest Energy Efficiency Alliance, Extension Energy Program, Olympia, WA, October 2005.

Electric Savings are calculated for every data point and then added.

Table 184: Energy Consumption (kWh) Comparison – Pre and Post VFD Installation

Sr. No.	Flow	Head	$Head_{VFD}$	%Hours	HP	HP_{VFD}	kWh_{Base}	kWh_{VFD}
1	250	130	130	0	13.6	14.0	0.0	0.0
2	225	155	105.3	5	14.6	10.2	793.4	555.7
3	200	175	83.2	10	14.6	7.2	1592.5	780.5
4	175	190	63.7	10	13.9	4.8	1512.8	522.9
5	150	210	46.8	30	13.2	3.0	4299.6	987.8
6	125	215	32.5	20	11.2	1.7	2445.6	381.1
7	100	220	20.8	20	9.2	0.9	2001.9	195.1
8	75	227.5	11.7	5	7.1	0.4	388.2	20.6
9	50	230	5.2	0	4.8	0.1	0.0	0.0
10	25	232.5	1.3	0	2.4	0.0	0.0	0.0

$$kWh_{Base} = 13{,}034\ kWh;\ kWh_{VFD} = 3{,}444\ kWh$$

$$\Delta kWh = kWh_{Base} - kWh_{VFD} = 9{,}590\ kWh$$

3.36.4 DEMAND SAVINGS ESTIMATION

The installation of a VFD on an irrigation pump should not cause any energy reduction during peak runtimes.

3.36.5 NON-ENERGY BENEFITS

While there may be water savings from the installation of a VFD on an irrigation pump, they are not being included at this time. Any water savings calculations should be calculated using site specific details.

3.36.6 MEASURE LIFE

The expected measure life is 15 years.[253]

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[253] DEER 2008.

3.37 KITCHEN DEMAND CONTROL VENTILATION CONTROLS (NEW)

This measure includes the installation of commercial kitchen demand ventilation controls that vary the ventilation based on cooking load and/or time of day.

3.37.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Cooking/Frying
Fuel	Electricity and Natural Gas
Measure category	Food Service Equipment
Delivery mechanism	Rebate
Baseline description	Kitchen ventilation that has constant speed ventilation motor
Efficient case description	Kitchen demand ventilation motor controls

3.37.2 SAVINGS

IECC 2021 specifies that Kitchen Demand Control Ventilation is a mandatory compliance pathway for systems over 5,000 CFM of exhaust airflow. As stated within IECC 2021, each kitchen exhaust hood shall comply with one of the following:

- Not < 50% of all replacement air shall be transfer air that would otherwise be exhausted.
- Demand ventilation systems on not < 75% of the exhaust air that are configured to provide not less than 50% reduction in exhaust and replacement air system airflow rates including controls necessary to modulate airflow in response to appliance operation and maintain full capture and containment of smoke, effluent, and combustion products during cooking and idle.
- Listed energy recovery devices with a sensible heat recovery effectiveness not < 40% on not less than 50% of the total exhaust airflow.

If one of these alternate compliance options is met, kitchen demand ventilation controls would not be required by code. If demand ventilation controls were installed in these scenarios, then the energy savings would likely be reduced as demand controls would be considered redundant. As a result, this measure is only applicable to new kitchens/systems under 5,000 CFM of exhaust airflow.

To qualify for this measure the installed equipment must be a control system that varies the exhaust rate of kitchen ventilation (exhaust and/or makeup air fans) based on the energy and effluent output from the cooking appliances (i.e., the more heat and smoke/vapors generated, the more ventilation is needed). There are three main demand control ventilation systems available that can achieve this type of modulation:

- Temperature sensors only. These systems ramp ventilation up and down based solely on the temperature from the cooking activity as measured in the ductwork or capture tank of the hood.
- Temperature and optical sensors. These systems offer the same functionality as systems with only temperature sensors plus the ability to change the ventilation rate based on the presence of smoke or steam.
- Temperature and infrared cooking sensors. These systems offer the same functionality as systems with only temperature sensors plus the ability to measure ventilation up and down based on when cooking starts.

3.37.3 ENERGY SAVINGS ESTIMATION

Electric savings for this measure are deemed are assumed to be 4,966 kWh per horsepower of the fan.[254]

$$kWh\ annual = 4{,}966\ \times HP$$

Where:

HP = *actual horsepower of the motor. If unknown assume 7.75 HP*

Therm savings are calculated based on the following formula:

$$\Delta Therms = CFM \times HP \times \frac{AHL}{Eff_{Heat} \times 100{,}000}$$

Where:

CFM = *the average airflow reduction with ventilation controls per hood*

= *430 cfm/HP*[255]

HP = *actual if known, otherwise assume 7.75 HP*[256]

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[254] Based on data provided in PGE Workpaper, Commercial Kitchen Demand Ventilation Controls, PGECOFST116, June 1, 2009. See ‘Kitchen DCV.xls’ for details

[255] Ibid

[256] Average of units in PGE Workpaper, Commercial Kitchen Demand Ventilation Controls, PGECOFST116, June 1, 2009

AHL = *Annual heating energy required to heat fan exhaust make-up air, Btu/cfm dependent on location specified in* Table 185.[257]

Eff_Heat = *Heat Efficiency*

= *actual if known, otherwise assume 80%*[258]

100,000 = *Converts Btu to therms*

Table 185 provides the annual heating load per climate zone.

Table 185: Annual Heating Loads for New Mexico Climate Zones

Zone (where applicable)	Annual Heating Load (AHL), Btu/cfm
Santa Fe	120,971
Albuquerque	94,751
Roswell	76,774
Las Cruces	64,923

3.37.4 DEMAND SAVINGS ESTIMATION

Electric kW demand savings are deemed and are assumed to be 0.68 kW per horsepower of the fan.[259]

3.37.5 MEASURE LIFE

The expected measure life is assumed to be 20 years.[260]

[257] Food Service Technology Center Outside Air Load Calculator, with inputs of one cfm, and hours from Commercial Kitchen Demand Ventilation Controls (Average 17.8 hours a day 4.45 am to 10.30 pm~~.~~ Regression analysis was used to calculate the annual heating loads for New Mexico based on HDD for the applicable climate zones and annual heating loads as published in the IL TRM v10.0.

[258] Work Paper WPRRSGNGRO301 CLEAResult "Boiler Tune-Up" which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010.

[259] Based on data provided in PGE Workpaper, Commercial Kitchen Demand Ventilation Controls, PGECOFST116, June 1, 2009. See ‘Kitchen DCV.xls’ for details.

[260] “Commercial Kitchen Ventilation: An Energy Efficiency Program Administrator’s Guide to Demand Control Ventilation”, CEE, October 2010 (pg. 9). The 20-year measure life estimate is based on interviews with manufacturer and industry experts.

3.38 REFRIGERATED WALK-IN AND REACH-IN PERMANENT MAGNET SYNCHRONOUS MOTOR (PMSM) EVAPORATOR FAN MOTOR (NEW)

This measure covers the replacement of single-phase shaded pole (SP) or permanent split capacitor (PSC) evaporator fan motors with electronically commutated (EC) motors in walk-in and reach-in refrigerated cases.

3.38.1 MEASURE OVERVIEW

Sector	Commercial
End use	Walk-in and Reach-in Refrigerated cases
Fuel	Electric
Measure category	Grocery store
Delivery mechanism	Rebate
Baseline description	Single-phase Shaded Pole (SP) or Permanent Split Capacitor (PSC) or Electronically Commutated (EC) evaporator fan motors
Efficient case description	Permanent Magnet Synchronous Motor (PMSM) evaporator fan motors

3.38.2 SAVINGS

The high-efficiency motors save energy by reducing evaporator fan power, and through interactive effects with the system's compressor. Permanent magnet synchronous motors (PMSMs) provide increased efficiency over other motors as they require less energy to operate and introduce less heat into the refrigerated case, which reduces the total refrigeration load.

The baseline condition for walk-in coolers or freezers manufactured on or after January 1, 2009, is an EC motor[261] with full load efficiency as prescribed by federal energy conservation standards for electric motors in 10 CFR 431.446 and 10 CFR 431.25, as applicable. The baseline condition for walk-in coolers or freezers manufactured before January 1, 2009, and reach-in refrigerated display cases is equivalent to the equipment being replaced (shaded pole or PSC motor). Baseline equipment shall be assumed to be of equivalent speed and horsepower to the efficient case.

[261] 10 CFR 431.306

The compliance condition is a PMSM installed in a commercial refrigerated reach-in display case or walk-in cooler/freezer with full-load efficiency exceeding that prescribed by federal energy conservation standards for electric motors in 10 CFR 431.446 or 10 CFR 431.25, as applicable.

3.38.3 ENERGY SAVINGS ESTIMATION

Annual electric energy savings can be calculated using the following algorithm:

$$\Delta kWh = units \times \left(\frac{W_{ee}}{1{,}000}\right) \times \left(\frac{1}{Eff_{baseline}} - \frac{1}{Eff_{ee}}\right) x \left(1 + \frac{1}{COP_{ref}}\right) x\ hrs$$

Where:

ΔkWh	= Annual electric energy savings
units	= Number of measures installed under the program
W_{ee}	= Rated motor wattage (energy efficient)
Eff	= Motor efficiency
hrs	= Annual operating hours
COP_{ref}	= Coefficient of performance of refrigeration equipment
1,000	= Conversion factor, one kW equals 1,000 W

Table 186 lists a summary of variable and data sources to inform the equations above.

Table 186: Refrigerated Walk-in Motor Replacement - Summary of Variable and Data Sources

Variable	Value	Source
W_{ee}	Site specific, or default	From application
hrs (Walk-In)	Control Type: On/Off Control: 5,571 Multistep Control: 6,062 No Cooler Control: 8,567	Based on refrigeration control type[262]
hrs (Refrigerated Case)	8,573	PG&E Workpaper[263]

[262] Cadmus, Commercial Refrigeration Loadshape Project, October 2015, Table 4. Average Parameters – EF Motors pg. 6. The study analyzes reach-in and walk-in coolers and freezers. The annual operating hours of a walk-in cooler or freezer evaporator fan motor without controls is derived as 97.8% x 8,760 = 8,567 hours. The effective full load annual run time of evaporator fans with on/off control are assumed to be 63.6% x 8,760 = 5,571 hours, while the effective full load annual run time of evaporator fans with multispeed control are assumed to be 69.2% x 8,760 = 6,062 hours.

[263] PG&E Work Paper PGE3PREF124 Revision 2. Average of operating hours of medium temperature applications and low temperature applications.

Variable	Value	Source
$Eff_{Baseline}$	Shaded Pole: 0.20 PSC: 0.29 EC: 0.66	For replacement of motors in reach-in cases, look up based on existing motor type.[264] For new construction, unknown existing conditions and walk-in coolers and freezers, use value associated with EC motors
Eff_{ee}	0.73	Oak Ridge National Laboratory[265]
COP_{ref}	Site specific, or default	From application, COP = 3.517/(kW/ton), where kW/ton is the rated efficiency of the compressor in input kW per ton of refrigeration capacity

3.38.4 DEMAND SAVINGS ESTIMATION

Summer peak coincident demand savings can be calculated using the following algorithm:

$$\Delta kW = \frac{\Delta kWh}{hrs} \times CF$$

Where:

CF = 1.0266

hrs = Annual operating hours

3.38.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

3.38.6 MEASURE LIFE

The measure equipment effective useful life (EUL) is estimated at 15 years.[267]

3.39 COMMERCIAL SOLID AND GLASS DOOR REFRIGERATORS AND FREEZERS (NEW)

This measure relates to the installation of a new reach-in commercial refrigerator or freezer meeting ENERGY STAR® efficiency standards. ENERGY STAR® labeled commercial

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[264] U.S. DOE, Technical Support Document Commercial Refrigeration Equipment, Chapter 5, Table 5.6.4: Details for Evaporator Fan Motor Design Option.

[265] ORNL, Q-Sync Motors in Commercial Refrigeration: Preliminary Test Results and Projected Benefits.

[266] It is safe to assume evaporator fans will be operational in active facilities during peak period.

[267] DEER 2014 EUL ID: GrocDispFEvapFanMtr

refrigerators and freezers are more energy efficient than non-ENERGY STAR® certified equipment because they are designed with components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors. The efficient equipment is assumed to be a new ENERGY STAR® certified vertical closed solid or glass door refrigerator or freezer meeting energy consumption requirements as determined by door type (solid or glass) and refrigerated volume (V).

3.39.1 MEASURE OVERVIEW

Sector	Commercial
End use	Food Refrigeration
Fuel	Electricity
Measure category	Food Service Equipment
Delivery mechanism	TOS and NC
Baseline description	New NON-ENERGY STAR® Certified Refrigerator and Freezer
Efficient case description	ENERGY STAR® Certified Refrigerator and Freezer

3.39.2 ENERGY SAVINGS ESTIMATION

Savings are calculated using the following equations:

$$\Delta kWh = (kWh_{base} - kWh_{ee}) * 365.25$$

Where

kWh_{base} = *baseline maximum daily energy consumption in kWh. calculated using actual chilled or frozen compartment volume (V) of the efficient unit as shown in Table 187.*

kWh_{ee}[268] = *efficient maximum daily energy consumption in kWh calculated using actual chilled or frozen compartment volume (V) of the efficient unit as shown in Table 188*

Table 187 and Table 188 provide calculations for the maximum daily energy consumption for baseline and ENERGY STAR® (Version 4.0, Effective March 27, 2017) respectively based on equipment type and volume. Daily energy consumption should be calculated based on the actual volume (V) of the units.

[268] ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers Partner Commitments Version 4.0, effective March 27, 2017

Table 187: Baseline Maximum Daily Energy Consumption

Type	Maximum Daily Energy Consumption (kWh/day)
Solid Door Refrigerator	0.05 * V + 1.36
Glass Door Refrigerator	0.1 * V + 0.86
Solid Door Freezer	0.22 * V + 1.38
Glass Door Freezer	0.29 * V + 2.95

Table 188: ENERGY STAR® Maximum Daily Energy Consumption

		Maximum Daily Energy Consumption (kWh/day)	
Equipment	**Volume (ft^3)**	**Refrigerator**	**Freezer**
Solid Door	0 < V < 15	≤ 0.022V + 0.97	≤ 0.21V + 0.9
Solid Door	15 ≤ V < 30	≤ 0.066V + 0.31	≤ 0.12V + 2.248
Solid Door	30 ≤ V < 50	≤ 0.04V + 1.09	≤ 0.285V -2.703
Solid Door	V ≥ 50	≤ 0.024V + 1.89	≤ 0.142V + 4.445
Glass door	0 < V < 15	≤ 0.095V + 0.445	≤ 0.232V + 2.36
Glass door	15 ≤ V < 30	≤ 0.05V + 1.12	
Glass door	30 ≤ V < 50	≤ 0.076V + 0.34	
Glass door	V ≥ 50	≤ 0.105V – 1.111	

3.39.3 DEMAND SAVINGS ESTIMATION

Summer coincident peak demand savings can be calculated using the following equation:

$$\Delta kW = \frac{\Delta kWh}{Hours}\ x\ CF$$

Where:

HOURS = *annual operating hours. Equipment is assumed to operate continuously, 24 hours per day, 365 days per year. = 8,760*

CF = *Summer Peak Coincidence Factor for measure= 0.937*[269]

3.39.4 NON ENERGY BENEFITS

There are no non-energy benefits associated with this measure.

[269] The CF for Commercial Refrigeration was calculated based upon the Ameren provided eShapes

3.39.5 MEASURE LIFE

The expected measure life is assumed to be 12 years.[270]

3.40 COMMERCIAL SMART THERMOSTATS (NEW)

This measure characterizes the energy savings from the installation of either a programmable or an advanced thermostat to reduce heating and cooling consumption in a commercial building.

The thermostat must be installed to control a single-zone HVAC system. This measure is limited to packaged HVAC units of 10 tons or less. This measure only applies to the installation of a programmable thermostat for a pre-existing HVAC system. The measure does not apply when HVAC systems are being replaced, in new construction applications, or whenever code compliance is required.

3.40.1 MEASURE OVERVIEW

Sector	Commercial
End use	HVAC
Fuel	Electricity and Natural Gas
Measure category	Commercial Smart Thermostats
Delivery mechanism	Rebate
Baseline description	Manual or programmable thermostat
Efficient case description	Advanced Thermostat

3.40.2 SAVINGS

The savings for this measure are based on studies as summarized in the Illinois Statewide Technical Reference Manual for Energy Efficiency (Version 12.0).

Heating savings are based upon a percentage of savings from the residential version of this measure.

[270] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, “Effective/Remaining Useful Life Values”, California Public Utilities Commission, December 16, 2008.

Cooling savings are based on research on small commercial programmable thermostat installations[271].

Future research on heating savings percentages for small commercial applications, and heating and cooling savings percentages for advanced thermostat applications should be conducted to improve these assumptions.

3.40.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula:

$$\Delta kWh = \Delta kWh_{heating} + \Delta kWh_{cooling}$$

$$\Delta kWh_{heating} = \left(\%ElecHeat * \frac{kBtu}{hr}_{heat} * \frac{1}{HSPF} * EFLH_{heat} * Heating_{Reduction} * BAF\right) + (\Delta Therms * Fe * 29.3)$$

$$\Delta kWh_{cool} = \frac{kBtu}{hr}_{cool} * \frac{1}{SEER} * EFLH_{cool} * Cooling_{Reduction} * BAF$$

Where:

%ElecHeat	*= Percentage of heating savings assumed to be electric*
	= 1 if electric heat, 0 if gas heat. If unknown, assume 0.08[272]*.*
$kBtu/hr_{heat}$	*= Capacity of the heating equipment in kBtu per hour.*
	= Actual. If unknown assume 114.5[273]
HSPFbase	*= Heating Seasonal Performance Factor of the baseline equipment*
	= Actual, if unknown efficiency, assume Code baseline for equipment type. Refer to Table 194 *and Table* 195*. If equipment type unknown, determine efficiency through inspection.*
EFLHheat	*= Heating mode equivalent full load hours. Refer to Table* 189.
Heating_Reduction	*= Assumed percentage reduction in total building heating energy consumption due to thermostat*

[271] See "Small Commercial Thermostats Research," memorandum from Guidehouse to ComEd dated May 15, 2020

[272] Based on percentage of customers in ComEd Small Business Thermostat program with electric heat.

[273] Average capacity of 705 installs of thermostats in Ameren Illinois territory installed from 2015-2020.

	= 8.8%274
Fe	*= Furnace Fan energy consumption as a percentage of annual fuel consumption*
	= 7.7%275
29.3	*= kWh per therm*
kBtu/hrcool	*= Capacity of the cooling equipment actually installed in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/hr)*
	= Actual. If unknown assume 61.0276
SEER	*= Seasonal Energy Efficiency Ratio of the cooling equipment*
	= Actual, is unknown assume Code baseline. Refer to Table 191.
$EFLH_{cool}$	*= Equivalent Full Load Hours for cooling. Refer to Table 190.*
Cooling_Reduction	*= Average percentage reduction in total building cooling energy consumption due to installation of thermostat:*
	= 17.7%[277]

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[274] Assumed equal to assumption for Residential Advanced Thermostats with manual thermostat baseline, before adding savings from Thermostat Optimization (which is not applicable to small commercial customers). Note that a Guidehouse billing study in CY2020 did not find a statistically significant basis for adjusting this assumption for commercial applications, see "Small Commercial Thermostats TRM Research" memo. April 21, 2021.

Estimates of heating and cooling reduction factors are based on consumption data analyses with matching to non-participants and are therefore net with respect to participant spillover and between net and gross with respect to free ridership. Like all consumption data analyses, they are gross with respect to non-participant spillover. For more detail, see Table 5-3 in Volume 4 of the IL-TRM. Consistent with Section 7.2 of the Illinois EE Policy Manual, applicable net-to-gross adjustments to these factors will be determined as part of the annual SAG net-to-gross process.

[275] Fe is estimated using TRM models for the three most popular building types for programmable thermostats: low-rise office (10.2%), sit-down restaurant (8.6%), and retail – strip mall (4.4%). 7.7% reflects the average Fe of the three building types. See "Fan Energy Factor Example Calculation 2021-06-23.xlsx" for reference.

[276] Average capacity of 639 installs of thermostats on units less than or equal to 10 tons in Ameren Illinois territory installed from 2015-2020 and 706 installs on units less than or equal to 10 tons in ComEd territory in 2021.

[277] Based on research conducted by Guidehouse on a sample of IL Small Commercial programmable thermostat installations, which found a range of savings values depending on the modeling assumptions used. Guidehouse recommended selecting the midpoint of this range, which it deemed preferable to continuing to rely on Residential assumptions, while also accounting for the relative uncertainties involved. See "Small Commercial Thermostats Research" memo completed in 2020. Estimates of heating and cooling reduction factors are based on consumption data analyses with matching to non-participants and are therefore net with respect to participant spillover and between net and gross with respect to free ridership. Like all consumption data analyses, they are gross with respect to non-participant spillover. For more detail, see Table 5-3 in Volume 4 of the IL-TRM. Consistent with Section 7.2 of the Illinois EE Policy Manual, applicable net-to-gross adjustments to these factors will be determined as part of the annual SAG net-to-gross process.

BAF = *Baseline adjustment factor.*

= *1.0, if the baseline thermostat was manual type*

= *0.6, if the baseline thermostat was programmable type*[278]

= *0.8, if the baseline is unknown*[279]

Natural gas savings for gas heating systems can be calculated using the following equation:

$$\Delta Therms = (1 - \%ElectricHeat) * EFLH_{heat} * Capacity * \frac{1}{AFUE} * Heating_{Reduction} * BAF * \frac{1}{100{,}000}$$

Capacity = *Nominal Heating Input Capacity (Btu/hr) of heating system*

= *Actual*

AFUE = *Annual Fuel Utilization Efficiency Rating*

= *Actual, if unknown use 80% for natural gas water heaters*

100,000 = *Conversion from Btu to Therms*

Heating EFLH values are shown in Table 189. Heating EFLH values are derived from the Texas TRM version 5, adjusting the Texas values based on heating degree-days comparisons between Amarillo, Albuquerque, and Santa Fe, and El Paso, Las Cruces, and Roswell. Values that are blank in the Texas TRM were entered as NP (Not provided) in Table 189.

Table 189: Heating EFLH by Building Type and Climate Zone for Smart Thermostats

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	NP	NP	NP	NP
Education - Community College	NP	NP	NP	NP
Education - Primary School	698	500	497	929
Education - Relocatable Classroom	733	528	525	975
Education - Secondary School	733	528	525	975
Education - University	NP	NP	NP	NP
Grocery	NP	NP	NP	NP

278 This factor represents the ratio of thermostat adjustment savings to thermostat replacement savings. It is based on actual thermostat algorithm data (i.e., degrees of setback, hours values, fan modes) from two years of ComEd AirCare Plus Program data (PY9+ and CY2018), including 382 thermostat adjustment installations and 3,847 thermostat replacement installations. An analysis of the data showed that on average, thermostat adjustments saved 61% and 59% of the thermostat replacement cooling savings and heating savings, respectively. For simplicity, a value of 0.6 was selected for both cooling and heating savings adjustment. See IL TRM Workpaper "4.4.48 Small Commercial Thermostats", Guidehouse, 6/23/2021 for details.

279 Review of ComEd's 2020 Baseline Study and 2019-2020 Program Data indicates that approximately half of installs are in buildings with existing manual thermostats, and half with existing programmable thermostats

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Health/Medical – Hospital	NP	NP	NP	NP
Health/Medical - Nursing Home	NP	NP	NP	NP
Lodging - Hotel	782	383	381	1,040
Manufacturing - Bio/Tech	339	179	178	450
Manufacturing - Light Industrial	339	179	178	450
Office - Small	339	179	178	450
Restaurant - Fast-Food	1,025	639	636	1,363
Restaurant - Sit-Down	1,119	751	747	1,488
Retail - Single-Story Large	903	470	468	1,202
Retail - Small	750	549	546	998
Storage - Conditioned	NP	NP	NP	NP
Warehouse - Refrigerated	NP	NP	NP	NP
Other[280]	339	179	178	450

Cooling EFLH values, derived from eQuest simulations of DEER building prototypes, are shown in Table 190.

Table 190: Cooling EFLH by building type and climate zone for Smart Thermostats

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	1,471	1,343	1,576	812
Education - Community College	1,085	1,290	1,360	629
Education - Primary School	436	508	554	289
Education - Relocatable Classroom	490	560	595	354
Education - Secondary School	450	479	555	213
Education - University	1,032	1,233	1,324	643
Grocery	824	961	1,038	391
Health/Medical – Hospital	1,189	1,181	1,387	604
Health/Medical - Nursing Home	984	958	1,206	481
Lodging - Hotel	1,521	1,679	1,797	974
Manufacturing - Bio/Tech	1,115	1,238	1,332	795
Manufacturing - Light Industrial	743	958	950	519
Office - Small	1,083	1,174	1,292	770
Restaurant - Fast-Food	1,271	1,267	1,377	754
Restaurant - Sit-Down	1,236	1,218	1,361	681
Retail - Single-Story Large	1,437	1,470	1,603	885

[280] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g. a medical administration building could potentially be assessed using the "Office – Small" EFLH

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Retail - Small	1,296	1,361	1,438	847
Storage - Conditioned	492	698	697	336
Warehouse - Refrigerated	1,477	1,498	1,596	745
Other[281]	1,033	1,109	1,213	617

Baseline efficiencies are shown in Table 191.[282]

Table 191: Packaged AC System Baseline Efficiency Ratings

Equipment Type	Size Category	Subcategory or Rating Condition	Minimum Efficiency[b]
Air Conditioners, Air cooled	< 65,000 Btu/h	Split system	13.0 SEER (before 1/1/2023) 13.0 SEER2 (after 1/1/2023)
		Single package	14.0 SEER (before 1/1/2023) 13.4 SEER2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.2 EER 12.9 IEER (before 1/1/2023) 14.8 IEER (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	11.0 EER 12.4 IEER (before 1/1/2023) 14.2 IEER (after 1/1/2023)
	≥240,000 Btu/h and <760,000 Btu/h	Split system and single package	10.0 EER 11.6 IEER (before 1/1/2023) 13.2 IEER (after 1/1/2023)
	≥760,000 Btu/h	Split system and single package	9.7 EER 11.2 IEER (before 1/1/2023) 12.5 IEER (after 1/1/2023)

281 This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g. a medical administration building could potentially be assessed using the “Office – Small” EFLH.

282 IECC 2021 Table C403.3.2(1) and Table C403.3.2(2)

Deduct 0.2 from the required EERs and IEERs for units with a cooling section other than electric resistance. Table 192 shows the heat pump system baseline efficiency ratings.

Table 192: Heat Pump System Baseline Efficiency Ratings

Equipment Type	Size Category	Subcategory or rating condition	Minimum Efficiency[b,c]
Heat Pumps, Air cooled (Cooling mode)	< 65,000 Btu/h	Split system	14.0 SEER (before 1/1/2023) 14.3 SEER2 (after 1/1/2023)
		Single package	14.0 SEER (before 1/1/2023) 13.4 SEER2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h	Split system and single package	11.0 EER 12.2 IEER (before 1/1/2023) 14.1 IEER (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h	Split system and single package	10.6 EER 11.6 IEER (before 1/1/2023) 13.5 IEER (after 1/1/2023)
	≥240,000 Btu/h	Split system and single package	9.5 EER 10.6 IEER (before 1/1/2023) 12.5 IEER (after 1/1/2023)
Heat Pumps, Air cooled (Heating mode)	< 65,000 Btu/h (cooling capacity)	Split system	8.2 HSPF (before 1/1/2023) 7.5 HSPF2 (after 1/1/2023)
		Single package	8.0 HSPF (before 1/1/2023) 6.7 HSPF2 (after 1/1/2023)
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	47-F db/43-F wb Outdoor air	3.3 COP (before 1/1/2023) 3.4 COP (after 1/1/2023)
	≥135,000 Btu/h and <240,000 Btu/h (cooling capacity)	47-F db/43-F wb Outdoor air	3.2 COP (before 1/1/2023) 3.3 COP (after 1/1/2023)
	≥240,000 Btu/h	47-F db/43-F wb Outdoor air	3.2 COP

[b] IPLVs are only applicable to equipment with capacity modulation

[c] Deduct 0.2 from the required EERs, SEERs and IEERs for units with a heating section other than electric resistance heat

Example:

If a small retail shop in Santa Fe retrofits a programmable thermostat with a smart thermostat the estimated savings can be calculated using:

$$\Delta kWh = \Delta kWh_{heating} + \Delta kWh_{cooling}$$

$$\Delta kWh = (0.08 * 114.5 * 1/3.412 * 998 * 0.088 * 0.6) + ((0.92 * (0.92 * 998 * 114500 * 1/0.8 * 0.088 * 0.6/100{,}000) * 0.077 * 29.3) + (24 * 1/13 * 847 * 0.177 * 0.6)$$

$$= 256.7 + 166.1 = 422.8\ kWh$$

3.40.4 DEMAND SAVINGS ESTIMATION

Electric demand savings can be calculated using the following equation:

$$\Delta kW = \frac{kBtu}{hr}_{cool} * \frac{1}{EER} * Cooling_{Reduction} * BAF * CF$$

Where:

EER = *Energy Efficiency Ratio of the equipment*

= *Actual, if unknown assume Code baseline. For air-cooled units <65 kBtu/hr, assume the following conversion from SEER to EER for calculation of peak savings:*[283]

$EER = (-0.02 * SEER^2) + (1.12 * SEER)$

CF = *Coincidence Factor, see Table* 193.

Remaining variables are defined in the kWh savings section above.

Coincidence factors are shown in Table 193. These values were derived from the Texas TRM version 5. The value for El Paso was used for Las Cruces, the value for Amarillo was used for Roswell, and the average of these two values was used for Albuquerque and Santa Fe.

[283] Based on Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Master's Thesis, University of Colorado at Boulder. Note this is appropriate for single speed units only.

Table 193: CF by Building Type and Climate Zone

Building Type	Albuquerque	Las Cruces	Roswell	Santa Fe
Assembly	0.78	0.91	0.64	0.78
Education - Community College	0.78	0.87	0.69	0.78
Education - Primary School	0.78	0.91	0.64	0.78
Education - Relocatable Classroom	0.78	0.91	0.64	0.78
Education - Secondary School	0.78	0.87	0.69	0.78
Education - University	0.78	0.87	0.69	0.78
Grocery	0.74	0.80	0.68	0.74
Health/Medical – Hospital	0.77	0.81	0.72	0.77
Health/Medical - Nursing Home	0.78	0.88	0.68	0.78
Lodging - Hotel	0.61	0.63	0.58	0.61
Manufacturing - Bio/Tech	0.34	0.38	0.29	0.34
Manufacturing - Light Industrial	0.34	0.38	0.29	0.34
Office - Small	0.76	0.81	0.72	0.76
Restaurant - Fast-Food	0.75	0.76	0.73	0.75
Restaurant - Sit-Down	0.80	0.76	0.83	0.80
Retail - Single-Story Large	0.80	0.80	0.80	0.80
Retail - Small	0.79	0.83	0.75	0.79
Storage - Conditioned	0.55	0.75	0.34	0.55
Warehouse - Refrigerated	0.55	0.75	0.34	0.55
Other[284]	0.34	0.38	0.29	0.34

For the above-mentioned example of a small retail shop in Santa Fe retrofitting a programmable thermostat with a smart thermostat, the demand savings can be calculated using:

$$\Delta kW = 24 * \frac{1}{((-0.02 * 132) + (1.12 * 13))} * 0.177 * 0.6 * 0.79 = 0.18\,kW$$

[284] This building type may be used for facilities which cannot be adequately classified by the other listed building types. Before using this building type, care should be taken to consider if any of the other building types reasonably represent the operation of the facility in question (e.g. a medical administration building could potentially be assessed using the "Office – Small" CF

3.40.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.40.6 MEASURE LIFE

The expected measure life is assumed to be 11 years.[285]

3.41 HAND DRYER (NEW)

This measure consists of installing efficient hand dryers that save energy by drying with air movement, using motion sensors, and reducing drying time. Energy efficient hand dryers use less energy per dry than standard hand dryers. Hand dryers are applicable in retail, commercial, and industrial settings.

To qualify for this measure, pre-existing hand dryer equipment must currently utilize 2,036 watts or more with a runtime of 37 seconds or more, which is equivalent to 5 watt-hour (Wh) per use, and replacement hand dryers must consume no more than 5 Wh per use.

3.41.1 MEASURE OVERVIEW

Sector	Commercial
End use	Hand Drying
Fuel	Electricity
Measure category	Commercial Hand Dryer
Delivery mechanism	Direct Install
Baseline description	5 or more Wh per use. Usually, these hand dryers are push-button activated.
Efficient case description	Installing efficient hand dryers that use less energy per dry

3.41.2 SAVINGS

Allowable methods of deriving savings are described below:

[285] Based on 2017 Residential Smart Thermostat Workpaper, prepared by SCE and Nest for SCE (Work Paper SCE17HC054, Revision #0). Estimate ability of smart systems to continue providing savings after disconnection and conduct statistical survival analysis which yields 9.2-13.8 year range.

3.41.3 ENERGY SAVINGS ESTIMATION

Electric Energy Savings

The energy savings from the installation of efficient hand dryers are due to the decrease in power and/or runtime of the efficient hand dryers over the pre-retrofit equipment. The energy savings are calculated using the following equations:

$$\Delta kWh = \frac{UPD * DPY * (\Delta Wh)}{1{,}000}$$

Where:

UPD = *Number of uses per day.*

= *If not known, use assumption from the table below.*

DPY = *Number of days the facility operates per year.*

= *If not known, use assumption from the table below*

$$\Delta Wh = \frac{(Power * Cycle\ Time)_{Baseline} - (Power * Cycle\ Time)_{Efficient}}{3{,}600\,\frac{Sec}{Hr}}$$

Where:

ΔWh = *Change in Watt-hours from baseline to efficient case.*

Power = *Unit wattage. If not known, use assumption from the table below.*

Cycle Time = *Runtime seconds per use. If not known, use assumption from Table 194.*

Table 194 provides inputs for UPD and DPY inputs based on building type.

Table 194: Hand Dryers - UPD and DPY Inputs

Building Type	Usage	Uses per Day[286]	Days per Year[287]
Office / Warehouse	Low	50	250
Restaurant / Small Grocery / Retail	Medium/Moderate	250	365
School/University / Theater / Conference Center	High	500	200
Large Grocery / Retail	High-Grocery	500	365
Transportation Center / Stadium / Airport	Heavy Duty/ Extreme	2500	365

[286] Industry Standard. Medium/Moderate Uses per day is supported by both Excel Dryer Data (Cost Savings with Hand Dryers vs Average Cost of Paper Towels https://www.exceldryer.com/calculator-dial/) and World Dryer Data (http://staging.worlddryer.com/savings-calculator)

[287] Illinois TRM v12.0, Days per year, from 4.3.2 Low Flow Faucet Aerators

Table 195 Provides the Cycle Time Input for Baseline and Efficient Conditions

Table 195: Hand Dryers - Cycle Time Input

Assumption	Power (Watts)	Cycle Time (Seconds)
Baseline[288]	2036	37
Efficient[289]	1,066	12

Example:

A new efficient hand dryer replacing a baseline hand dryer at a large grocery store, with unknown uses per day and unknown days per year:

ΔkWh = *(500 * 365 * (((2036*37) - (1066*12)) /3600)) /1000*

= *3,170.4 kWh*

3.41.4 DEMAND SAVINGS ESTIMATION

Electric demand savings can be calculated using the following equation:

$$\Delta kW = \frac{\Delta kWh}{HOU} * CF$$

Where:

HOU = *Use building hours, if known.*

= *If hours are not known, hours are selected from the fixture hours column of the lighting reference table in Section 3.3 for each building type.*

CF = *Coincident Factor, use 1.0.*

Example:

A new efficient hand dryer replacing a baseline hand dryer at a large grocery store, with unknown uses per day and unknown days per year:

ΔkW = *3,170.4 / 5,468 * 1.0*

= *0.58 kW*

288 CLEAResult survey of 24 hand dryers in convenience stores in Arkansas. See Hand_Dryer_Analysis.xlsx. 1567
289 CLEAResult cost/specification survey of 10 unique efficient hand dryers. See Hand_Dryer_Analysis.xlsx

3.41.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

3.41.6 MEASURE LIFE

The measure life for a new energy efficient hand dryer is 10 years[290].

3.42 BUILDING OPERATOR CERTIFICATE (NEW)

The Building Operator Certification (BOC) is a training and certification program for commercial and public sector building operators. The curriculum teaches participants how to improve building comfort and efficiency by optimizing the building's systems. BOC curriculums provide participants with knowledge about system operations, proper maintenance practices, occupant communication, and occupant comfort. Participants realize energy savings by utilizing the knowledge gained to improve their building operations through O&M and capital measures.

3.42.1 MEASURE OVERVIEW

Sector	Commercial
End use	Building Management System
Fuel	Electric and Natural Gas
Measure category	BOC
Delivery mechanism	Rebate
Baseline description	Building operations before participant completed BOC course
Efficient case description	Facilities operated by participants who completed a BOC course

3.42.2 SAVINGS

The building operator certification program evaluations began in 2000[291]. Evaluations from across the country show that BOC programs deliver tangible net energy savings to participants' facilities. Deemed savings for this measure represent a convergence of analyses'

[290] Based on studies conducted by two separate parties; Comparative Environmental Life Cycle Assessment of Hand Drying Systems by Quantis (pg 2) and Guidelines to Reduce/Eliminate Paper Towel Use by Installing Electric Hand Dryers by Partners in Pollution Prevention P3 (pg 17)

[291] https://www.theboc.info/why-boc/energy-savings-evaluation-reports/

results from multiple BOC program evaluations that estimated net savings and were developed per square foot of building area to account for building size diversity.

Participants must complete either the BOC Level I or Level II course and obtain a certificate of completion to be eligible for savings. Eligible BOC must cover the following subject areas:

BOC Level I	BOC Level II
• Efficient Operation of HVAC Systems • Measuring and Benchmarking Energy • Efficient Lighting Fundamentals • HVAC Controls Fundamentals • Indoor Environmental Quality • Common Opportunities for Low-Cost Operational Improvement	• Building Scoping and Operational Improvements • Optimizing HVAC Controls for Energy Efficiency • Introduction to Building Commissioning • Water Efficiency for Building Operators • Project Peer Exchange

The BOC course must include formal instruction (i.e., lectures), individual projects, and group exercises, bringing the total course time to at least 61 hours. Participants must obtain a training certificate of completion to be eligible for savings. Individuals who participate are not eligible for savings more than twice over the measure life, once for BOC Level I and another for BOC Level II. The entire floor area for any given building can only be used once over the measure life, and evaluators will verify attendees' participation year-over-year.

The savings factors for this measure were developed based on an examination of savings using a weighted average approach from several similar BOC programs. It is important to note that the savings information referenced is net. Therefore, this measure does not require the additional application of a net-to-gross ratio. Average net savings per participant from the evaluations are referenced in Table 196.

Table 196: Summary of BOC Studies Referenced to Calculate Savings

Sponsor	Year	Participants	MWh per Participant	kW per Participant	Therms per Participant	Building Square Footage	Costs
NEEA	2014	212	234	-	6,059	432,768	-
MEEA	2011	50	46	-	2,529	194,500	-
NEEP	2005	94	111	-	4,312	616,045	-
NEEP	2002	49	121	-	13,436	671,804	-
NEEP	2001	107	90	-	0	645,461	-
Ameren Illinois[292]	2020	10	60.002	0.83	987	140,137	$253.94

[292] Opinion Dynamics, 'Ameren Illinois Company 2020 Business Program Impact Evaluation Report, Final', April 28, 2021

Sponsor	Year	Participants	MWh per Participant	kW per Participant	Therms per Participant	Building Square Footage	Costs
Ameren Illinois[293]	2019	12	64.421	12.8	3,615	408,309	$114.93
ComEd[294]	2020	33	132.600	14.7	0	319,068	$8,878.79
Ameren Illinois[295]	2021	8	23.650	0.0	0	502,944	$0.00
Nicor Gas[296]	2021	3	0	0.0	234	517,250	0
ComEd[297]	2021	2		1.55	0	517,250	$9,310.50

3.42.3 ENERGY SAVINGS ESTIMATION

Energy Savings can be calculated using the equation below. As mentioned above, the savings calculated using this approach is a direct-to-net value, so a net-to-gross ratio does not need to be applied to the calculated savings.

$$\Delta kWh = C_e * Area$$

Where

Area = *Building area operated by the participant* (ft^2)

C_e = *unit area kWh savings constant per participant, 0.336* kWh/ft^2*/participant*

Note, the maximum eligible area per participant is 500,000 ft^2. In the event there are multiple participants who operate the same building (i.e., service address) or group of buildings, the program administrator can only claim savings on building square footage once (i.e., they cannot claim savings based on the same square footage for multiple participants), unless the managed square footage exceeds 500,000 ft^2; in which case, the program administrator can continue to claim savings up to the 500,000 ft^2 per participant cap until the total building square footage has been accounted for.

293 Opinion Dynamics, 'Ameren Illinois Company 2019 Business Program Impact Evaluation Report, Final', April 30, 2020.

294 The ComEd evaluation includes both 2018 and 2019 participants. The interview sample did not stratify by program year, so the savings per participant are the same for each year. Guidehouse, 'ComEd Building Operator Certification Pilot Impact Evaluation Report', April 12, 2021.

295 Opinion Dynamics, 'Ameren Illinois Company 2019 Business Program Impact Evaluation Report, Final', April 29, 2022

296 Guidehouse completed follow-up interviews with 2018 – 2020 participants from ComEd's program, which also had gas service. Three interviews were completed, and all were Nicor Gas customers who completed no cost scheduling and usage tracking. The savings for these participants was calculated following the methodology used to determine the savings for ComEd's CY2022 Building Operator Certification Pilot.

297 Guidehouse, 'ComEd Building Operator Certification Pilot Impact Evaluation Report', April 19th, 2022.

3.42.4 DEMAND SAVINGS ESTIMATION

Summer peak demand savings can be calculated using the following formula:

$$kW = C_d * Area / 1{,}000$$

Where

C_d	= Unit demand savings constant, 0.028 W/ft^2 (capped)/participant Average net demand savings per participant calculated from the evaluations referenced. See table of evaluations referenced above in Table 193.
1,000	= unit conversion from W to kW

3.42.5 NATURAL GAS SAVINGS

Natural gas savings can be calculated using the formula below.

$$\Delta Therms = C_g * Area$$

Where

Cg	= Unit gas savings constant, 0.01 $therms/ft^2$ (capped)/participant

3.42.6 NON-ENERGY BENEFITS

This measure does not carry any deemed non-energy benefits.

3.42.7 MEASURE LIFE

BOC typically involves capital and O&M measures, each of which has a different expected useful life. The lifetime of capital measures from the researched studies was 13 years. Based on research analyzed, 42% of BOC savings are derived from O&M measures with a four-year measure life. Therefore, the overall weighted average useful life for BOC savings is 9.2 years.

3.43 INDOOR AGRICULTURE LIGHTING (NEW)

3.43.1 MEASURE OVERVIEW

This measure is designed for interior horticultural applications that use artificial light stimulation in an indoor conditioned space.

Sector	Commercial
End use	Lighting
Fuel	Electricity
Measure category	Agriculture
Delivery mechanism	Rebate
Baseline description	HID/T5 fixtures
Efficient case description	LED fixtures

3.43.2 SAVINGS

LED lamp technology offers reduced energy and maintenance costs when compared with conventional light sources. LED technology has a significantly larger useful life lasting 30,000 hours or more and significantly reduces maintenance costs. The savings and costs for this measure are evaluated with the replacement of HID grow lights with LED fixtures. LED lamps offer a more robust lighting source, longer lifetime, and greater electrical efficiency than conventional supplemental grow lights.

The baseline equipment is the industry established grow light based on the horticultural application, as detailed in Table 197. HID fixtures are assumed to be flowering and vegetative crops. T5 high-output fixtures are assumed for seedling and microgreen crops. Table 197 lists the baseline PPE and wattage values for various crop types.

Table 197: Horticultural Baseline PPE and Fixture Wattages

Crop Type	Baseline Technology Type	Baseline PPE (μmol/J)[298]	Baseline Fixture Wattage[299]
Flowering Crops (Tomatoes and Peppers)	High Pressure Sodium	1.7	1,100 W
Vegetative Growth	Metal Halide	1.25[300]	640 W
Microgreens[301]	T5 HO Fixture	1.0[302]	358 W
Propagation[303]	T5 HO Fixture	1.0304	234 W
Medical/Recreational Cannabis – Flowering Stage	High Pressure Sodium	1.7	1,100 W
Medical/Recreational Cannabis – Vegetative Stage	Metal Halide	1.25	640 W
Medical/Recreational Cannabis – Cloning, Seeding and Propagation	T5 HO Fixture	1.0	234 W

298 Erik Runkle and Bruce Bugbee "Plant Lighting Efficiency and Efficacy: μmols per joule". Accessed 4/21/2020.

299 Jesse Remillard and Nick Collins, "Trends and Observations of Energy Use in the Cannabis Industry," ACEEE, accessed April 17, 2020. Baseline watts per square foot were taken by using typical fixture technology by crop type and dividing by 16 sqft per fixture (a 4'x4' area is a typical coverage amount for one grow light fixture).

300 Jacob A. Nelson, Bruce Bugbee, "Economic Analysis of Greenhouse Lighting: Light Emitting Diodes vs. High Intensity Discharge Fixtures." Utah State University. Accessed 5/6/2020

301 Microgreens T5 fixture is based on a 6-lamp high output fixture, based on IL TRM v12.0.

302 D.S. de Villiers, L.D. Albright, and R. Tuck, "Next Generation, Energy Efficient, Uniform Supplemental Lighting for ClosedSystem Plant Production." International Society for Horticultural Science

303 Propagation T5 fixture is based on a 6-lamp high output fixture, based on IL TRM v12.0

304 D.S. de Villiers, L.D. Albright, and R. Tuck, "Next Generation, Energy Efficient, Uniform Supplemental Lighting for ClosedSystem Plant Production." International Society for Horticultural Science.

Efficient LED fixtures must have a reduced wattage, be listed on the Design Lights Consortium (DLC) qualified products list[305], be UL Listed, have a power factor (PF) ≥0.90, a photosynthetic photon efficacy (PPE) of no less than 1.9 micromoles per joule, a minimum rated lifetime of 50,000 hours, and a minimum warranty of 5 years. If DLC PPE requirements for LED grow lighting exceeds the current requirements, the new PPE will become the efficient equipment standard.

3.43.3 ENERGY SAVINGS ESTIMATION

Energy Savings can be calculated using the equation below, which is in accordance with the PPF equivalence method:

$$\Delta \text{kWh} = \left[\left(\frac{PPF_{Total,i}}{PPE_{BL,i} \times 1000}\right) - kW_{ee,i}\right] \times Hours \times WHF_e$$

$$PPF_{Total,i} = PPF_{Fixture,i} \times Qty_i$$

Where:

$PPF_{Total,I}$	= *Total Photosynthetically-active Photon Flux output of the installed efficient fixtures for a specific growth phase, i in units of µmol/s. Equal to the number of fixtures installed multiplied by the PPF output per fixture.*
$PPE_{BL,i}$	= *Photosynthetically-active Photon Flux Efficiency of the assumed baseline fixture for a specific growth phase, i in units of µmol/J. Can be found in the table above.*
$PPF_{Fixture,i}$	= *The Photosynthetically-active Photon Flux output of an individual fixture installed for a specific growth phase, i in units of µmol/s.*[306]
Qty_i	= *The installed quantity of efficient fixtures.*
i	= *An indicator used to separate growth phases of products or different plants. "i" can be used to separate "Flowering" and "Vegetative", or different crop types, such as "Flowering Crops (tomatoes and peppers)" and "Microgreens".*
1000	= *Watts to kilowatts conversion factor*
$kW_{ee,i}$	= *Total power of the installed fixtures for a specific growth phase, i.*
Hours	= *Annual operating hours. See Table 198 for typical hours of operation breakdown by crop type.*

[305] Design Light Consortium – Horticultural Lighting, Testing and Reporting Requirements for LED-Based Horticultural Lighting, version 3.0, effective March31, 2023. To date, all horticultural lamps certified by the DLC specification are LEDs.

[306] Individual fixture PPF can be sourced directly from the DLC horticulture qualified products list, Design Light Consortium – Horticultural Lighting, Testing and Reporting Requirements for LED-Based Horticultural Lighting, version 2.1, effective September 1, 2021.

WHFe = 1.21[307] *if cooling or unknown or 1.00 if none; waste heat factor for energy to account for cooling savings from efficient lighting in cooled buildings.*

Table 198 provides annual operating hours by horticultural application.

Table 198 Hours of Use by Crop Type

Crop Types	Annual Hours of Operation[308]
Flowering Crops (Tomatoes/Peppers)	4,255
Vegetative/Propagation Growth	6,498
Microgreens	6,300
Medical Cannabis – Flower Stage	4,255
Recreational Cannabis – Flowering Stage	4,255

3.43.4 DEMAND SAVINGS ESTIMATION

Summer coincidence peak demand savings can be calculated using the equation below:

$$\Delta\text{kW} = \left[\left(\frac{PPF_{Total,i}}{PPE_{BL,i} \times 1{,}000}\right) - kW_{ee,i}\right] \times CF \times WHF_d$$

Where:

WHF_d = *waste heat factor for demand to account for cooling savings from efficient lighting in cooled buildings.1.22*[309] *if cooling or 1.00 if none.*

CF = *0.89 for vegetative crops or 0.68 for flowering crops*[310]

3.43.5 NON-ENERGY BENEFITS

There are no non-energy benefits associated with the measure.

3.43.6 MEASURE LIFE

The expected measure life is 9.5 years (average rated life of 50,000 hours)[311].

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[307] Waste heat factor for cooling savings calculation as per Indoor agriculture loadshapes in IL TRM v12.0

[308] Historical custom grow lighting projects from 2020. 54 spaces and over 5500 proposed fixtures. SPS Workpaper NM Grow Lighting. Microgreens HOU calculated by multiplying 18 hours per day (Sole-Source Lighting of Plants. Technically Speaking by Erik Runkle. Michigan State University Extension. September 2017) by 350 operating days per year. Assuming 5 crop cycles with 3 days of downtime between each cycle

[309] Waste heat factor for cooling savings calculation as per Indoor agriculture load shapes in IL TRM v12.0

[310] Historical custom grow lighting projects from 2020. 54 spaces and over 5500 proposed fixtures. SPS Workpaper NM Grow Lighting.

[311] Based on 50,000 hours lifetime and 5,250 hours per year of use (average hours of use per year using flowering and vegetative rooms).

4 RESIDENTIAL MEASURES

4.1 CEILING INSULATION

This measure saves space heating and cooling energy by reducing heat transfer through the ceiling.

4.1.1 MEASURE OVERVIEW

Sector	Residential
End use	Space heating and cooling
Fuel	Electricity and Natural Gas
Measure category	Insulation
Delivery mechanism	Rebate (retrofit)
Baseline description	Retrofit: Existing insulation level New Construction312: ▸ Albuquerque: R-60 ▸ Santa Fe: R-60 ▸ Roswell: R-49 ▸ Las Cruces: R-49
Efficient case description	Insulation level higher than baseline level

4.1.2 SAVINGS

Savings are due to the reduction infiltration when installing more effective ceiling insulation, leading to a reduction in heating and cooling consumption during winter and summer months. A better R-value of the insulation being installed will achieve higher savings.

Projects may claim heating energy savings even if cooling energy savings are not claimed (e.g., in the case of homes with evaporative cooling).

4.1.3 ENERGY SAVINGS ESTIMATION

Savings are calculated based on the following formulas.

$$\Delta kWh = \Delta kWh_{Cooling} + \Delta kWh_{Heating}$$

[312] IECC 2021 Code Requirements for Climate Zones 3 (Las Cruces, Roswell), 4 (Albuquerque) and 5 (Santa Fe)

Cooling energy savings are calculated using:

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{Ceiling} * \left(1 - FF_{Ceiling}\right) * CDD * 24}{1000 * \eta_{Cooling}}$$

Where:

R_{Old} = *R-value of existing insulation*

(Default R-value of R-5 for uninsulated assemblies, assumed thermal resistance of roof materials, ft^2 °F.h/Btu; Lower R-value allowed if evidence provided, down to an allowable minimum of R-2)

R_{New} = *R-Value of new ceiling insulation (ft^2 - °F.h/Btu)*

$A_{Ceiling}$ = *Total area of insulated ceiling (ft^2)*

$FF_{Ceiling}$ = *Adjustment to account for area of framing, 7%*[313]

CDD = *Cooling Degree Days, as listed in* Table 200.

24 = *Converting Days to Hours*

1000 = *Converting Btu to kBtu*

$\eta_{Cooling}$ = *Seasonal Energy Efficiency Ratio of Cooling System (kBtu/kWh)*

= *Nameplate ratings wherever possible, if unavailable use the following efficiencies listed in* Table 199.

Table 199 provides cooling efficiencies based on the age of equipment.

Table 199: Cooling Efficiency (Federal Standards)

Age of Equipment	SEER Ratings
Before 2006	10.0
2006 - 2014	13.0
Central AC after 1/1/2015	13.0
Heat Pump after 1/1/2015	14.0

Heating energy savings for electric resistance and heat pump systems can be calculated using:

$$\Delta kWh_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{Ceiling} * \left(1 - FF_{Ceiling}\right) * HDD * 24}{1{,}000 * \eta_{Heating}}$$

[313] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1

Where:

HDD = *Heating Degree Days, as listed in Table 200.*

$\eta_{Heating}$ = *Efficiency of heating system (kBtu/kWh)*

= *Nameplate ratings wherever possible, if unavailable use the following efficiencies listed in Table 200.*

Table 200 provided cooling and heating degree day inputs for each climate zone.

Table 200: Cooling Degree Days and Heating Degree Days

City (Climate Zone)	CDD	HDD
Albuquerque	1,322	4,180
Santa Fe	645	5,417
Roswell	1,790	3,289
Las Cruces	1,899	2,816

Table 201 provides equipment heating efficiencies based on the age of the equipment.

Table 201: Heating Efficiency (Federal Standards)

Age of Equipment	HSPF Ratings
Heat Pump; Before 2006	6.8
Heat Pump; 2006 - 2014	7.7
Heat Pump; After 1/1/2015	8.2
Electric Resistance	3.412

Heating energy savings for gas heat systems can be calculated using:

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{Ceiling} * \left(1 - FF_{Ceiling}\right) * HDD * 24}{10^5 * \eta_{Heating}}$$

Where:

$\eta_{Heating}$ = *AFUE of gas heating system*

= *Nameplate ratings wherever possible, if unavailable use 0.8*

Example: A house in Las Cruces underwent a ceiling insulation retrofit i.e., from R-10 to R-32. The total area of the ceiling is 550 sq. ft. and is cooled using an air conditioner (installed June 2016) and heated using a gas furnace (installed June 2016). Savings generated from this measure can be calculated using:

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{Ceiling} * \left(1 - FF_{Ceiling}\right) * CDD * 24}{1000 * \eta_{Cooling}}$$

and

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{Ceiling} * \left(1 - FF_{Ceiling}\right) * HDD * 24}{10^5 * \eta_{Heating}}$$

i.e.,

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{10} - \frac{1}{32}\right) * 550 * (1 - 0.07) * 1{,}899 * 24}{1000 * 13.0} = 124\ kWh$$

and

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{10} - \frac{1}{32}\right) * 550 * (1 - 0.07) * 2{,}816 * 24}{10^5 * 0.8} = 30\ therms$$

4.1.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00-6:00 pm on the hottest summer weekdays. It is assumed that the time spent in the hottest temperature bin is likely during the peak time. Which bin is the hottest depends on the climate zone. Based on these assumptions, the demand savings for homes with standard DX cooling are derived with the following equation.[314]

$$Peak\ Demand\ Savings = \frac{\Delta kWh_{Cooling}}{EFLH_{Cool}} * CF$$

Where:

Peak Demand Savings = *Summer peak kW savings, kW*

$\Delta kWh_{Cooling}$ = *Cooling energy savings, kWh*

$EFLH_{Cool}$ = *Effective Full Load Cooling Hours,*

CF =*Coincidence Factor, 0.56*[315]

Table 202 provides the EFLH inputs for all climate zones.

[314] Based on ADM ceiling insulation calculator spreadsheet

[315] As per hourly AC metering data and thermostat runtime data

Table 202: Effective Full Load Cooling Hours

City	$EFLH_{Cool}$[316]
Albuquerque	852
Santa Fe	562
Roswell	1,008
Las Cruces	1,059

4.1.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.1.6 MEASURE LIFE

The lifetime for this measure is 30 years.[317]

4.2 LOW-FLOW SHOWERHEADS

This measure saves water heating energy by reducing consumption of hot water.

4.2.1 MEASURE OVERVIEW

Sector	Residential
End use	Water heating
Fuel	Electricity and Natural Gas
Measure category	Low-flow Showerheads
Delivery mechanism	Rebate, Direct install
Baseline description	2.0 gpm, 2.5 gpm or greater
Efficient case description	2.0, 1.75,1.5, 1.25 gpm

4.2.2 SAVINGS

The measure applies to both single and multifamily residences. For kit-based programs and programs for which the water heating fuel is unknown, multiply the savings listed below with the type of water-heating system fuel type percentage and the in-service rates provided in the

[316] Hourly AC metering data for a sample of 230 premises in PNM territory provided by Itron and thermostat runtime data for approximately 3,000 premises in EPE territory

[317] Guidehouse's 'EMV Group A, Deliverable 16 EUL Research – Residential Insulation,' prepared for the California Public Utilities Commission, June 2021

next section. The savings listed in Table 203 and Table 204 do not include the Fuel% or ISR parameters.

Table 203: Low Flow Showerheads Deemed Energy Savings in kWh

	Albuquerque		Las Cruces		Roswell		Santa Fe	
	SF	MF	SF	MF	SF	MF	SF	MF
Baseline Case: 2.0 gpm								
1.25 gpm	192.5	222.1	159.3	183.8	163.0	188.0	218.3	251.8
1.5 gpm	128.3	148.1	106.2	122.5	108.7	125.4	145.5	167.9
1.75 gpm	64.2	74.0	53.1	61.3	54.3	62.7	72.8	83.9
Baseline Case: 2.5 gpm								
1.25 gpm	320.8	370.1	265.5	306.3	271.6	313.4	363.8	419.7
1.5 gpm	256.6	296.1	212.4	245.1	217.3	250.7	291.0	335.8
1.75 gpm	192.5	222.1	159.3	183.8	163.0	188.0	218.3	251.8
2.0 gpm	128.3	148.1	106.2	122.5	108.7	125.4	145.5	167.9

Table 204: Low Flow Showerheads Deemed Energy Savings in Therms

	Albuquerque		Las Cruces		Roswell		Santa Fe	
	SF	MF	SF	MF	SF	MF	SF	MF
Baseline Case: 2.0 gpm								
1.25 gpm	8.6	9.9	7.1	8.2	7.3	8.4	9.7	11.2
1.5 gpm	5.7	6.6	4.7	5.5	4.8	5.6	6.5	7.5
1.75 gpm	2.9	3.3	2.4	2.7	2.4	2.8	3.2	3.7
Baseline Case: 2.5 gpm								
1.25 gpm	14.3	16.5	11.8	13.7	12.1	14.0	16.2	18.7
1.5 gpm	11.4	13.2	9.5	10.9	9.7	11.2	13.0	15.0
1.75 gpm	8.6	9.9	7.1	8.2	7.3	8.4	9.7	11.2
2.0 gpm	5.7	6.6	4.7	5.5	4.8	5.6	6.5	7.5

4.2.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula.[318]

[318] Derived based on the data provided in version 4.3 of the Residential: DHW – Showerheads UES Measures calculator created by the Regional Technical Forum (RTF), https://rtf.nwcouncil.org/measure/showerheads/

$$Svgs = (Pre_F - \ Post_F) \times (TempUsage - TempCold) \times Mins \times HtrEnergy\ x\ Fuel\%\ x\ ISR$$

Where:

Svgs	= *Annual energy savings, in therms*
PreF	= *Baseline flow rate, nominal flow rate adjusted by an in situ flow percentage (90%) in GPM,* see *Table 205*
PostF	= *Measure flow rate, nominal flow rate adjusted by an in situ flow percentage (90%) in GPM, see Table 206.*
$Temp_{Usage}$	= *Temperature of water coming out of showerhead, 101°F*[319]
$Temp_{Cold}$	= *Water heater inlet temperature in °F, refer to Table 205.*
Mins	= *Annual minutes showerhead is used; for single family: 2,979.8, for multifamily: 3,438.21. Calculated from data shown in Table 206*
$Heater_{Energy}$	= *Water heater heating energy, 0.0001112 therm per °F per gallon. Factor composed of thermal efficiency of water heater, 0.75 and therms per gallon degF, 0.0000834 (from heat capacity and density of water, and a conversion from Btu to therms). For electric it is .002493 kWh per °F per gallon. Factor composed of thermal efficiency of water heater, 0.98 and therms per gallon degF, 0.0000834 (from heat capacity and density of water, and conversion from Btu to therms) divided by the conversion factor of .03413 therm/kWh*
Fuel%	= *Percentage split between gas, electric, and propane water heating. When water heating fuel is known, used 100%. For kit-based and other program types for which the water heating fuel is not known, use territory-specific percentages. If territory-specific values are not known, use default values of 53% gas, 42% electricity, and 5% propane*[320]*.*
ISR	= *In-service rate, representing the proportion of distributed showerheads that are installed. For direct-install and downstream programs, use 1. For kit-based programs, use a territory-specific value. If a territory-specific value is not known, use a default value of 0.6*[321]

Varying parameters are shown in Table 205.

[319] Cadmus and Opinion Dynamics Evaluation Team. Showerhead and Faucet Aerator Meter Study. For Michigan Evaluation Working Group. June 2013. Temperature sensors provided the mixed water temperature readings resulting in an average of 101ºF

[320] US Energy Information Administration. https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.8.pdf The percentages shown are based on the West Mountain South Region.

[321] El Paso Electric New Mexico LivingWise® Program Summary Report Fall 2017

Table 205: Residential Low-flow Showerhead Flow Rate Dependent Parameters

Nominal Flow Rate (gpm)	Flow Rate (gpm)
Baseline Case	
2.0	1.8
2.5	2.25
Efficient Case	
1.25	1.13
1.50	1.35
1.75	1.58
2.00	1.80

The annual minutes value is calculated by taking the product of the four parameters listed in Table 206.

Table 206: Residential Low-flow Showerhead Minutes Parameters[322]

Parameter	Value	Source
Daily showers per Person, weighted average between primary and secondary showerheads (showers per person per day)	Single Family: 0.39 Multifamily: 0.45	Average of values from Arkansas TRM version 7 and Illinois TRM version 7
Annualized Occupancy (days per year)	365	All annual days
Persons per residence (people per housing unit)	2.57	U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, American Community Survey, Census of Population and Housing, State and County Housing Unit Estimates, County Business Patterns, Non-employer Statistics, Economic Census, Survey of Business Owners, Building Permits Last Assessed: 4 October, 2018
Average Shower Length (min per shower)	7.84	"Seattle Home Water Conservation Study"; Seattle Public Utilities and the U.S. E.P.A. (December 2000), Water and Energy Savings from High Efficiency Fixtures and Appliances in Single Family Homes, US EPA Combined Retrofit Report, 2005

Parameter values are based on the following sources.[323]

322As reported in ibid., except persons per residence, which uses data specific for New Mexico households.
[323] As reported in ibid318, except baseline flow rate.

Table 207: Residential Low-flow Showerhead Parameter Sources

Parameter	Source
Baseline Flow Rate	10 CFR 430.32(p)
Hot Water %	Percentage of hot water is calculated using the heat balance equation considering hot water temperature as 127.5^{0}F, cold water from Table 8, and the usage temperature as 101^{0}F.
Measure flow rate (With adjustment from nominal to actual)	RTF, informed by (1) "Seattle Home Water Conservation Study"; Seattle Public Utilities and the U.S. E.P.A. (December 2000) and (2) "Single Family 2007 Showerhead Kit Impact Evaluation". SBW Consulting; Seattle City Light. October 2008
Heater Energy	Heater efficiency is based on RTF decision informed by "Energy Efficient Showerhead and Faucet Aerator Metering Study" (PSE/BPA/SBW 1994) and "Single Family 2007 Showerhead Kit Impact Evaluation". Seattle City Light. October 2008

4.2.4 DEMAND SAVINGS ESTIMATION

There are no demand savings associated with this measure.

4.2.5 NON-ENERGY BENEFITS

Water savings are shown in Table 208. Local water and wastewater rates need to be applied to these values to monetize savings.

Table 208: Residential Low-Flow Showerhead Water Savings (in gallons)

Nominal Flow Rate	Single Family	Multi Family
Baseline Case: 2.0 gpm		
1.25 gpm	2,011	2,321
1.5 gpm	1,341	1,547
1.75 gpm	6,70	774
Baseline Case: 2.5 gpm		
1.25 gpm	3,352	3,868
1.5 gpm	2,682	3,094
1.75 gpm	2,011	2,321
2.0 gpm	1,341	1,547

4.2.6 MEASURE LIFE

The lifetime for this measure is 10 years.[324]

4.3 LOW-FLOW FAUCET AERATOR

This measure saves water heating energy by reducing consumption of hot water.

4.3.1 MEASURE OVERVIEW

Sector	Residential
End use	Water heating
Fuel	Electricity and Natural Gas
Measure category	Low-flow faucet aerators
Delivery mechanism	Direct Install
Baseline description	Federal standard 2.2 GPM or greater
Efficient case description	0.5 or 1.0 gpm (bathrooms) 1.5 gpm (kitchens)

4.3.2 SAVINGS

The measure applies to both single and multifamily residences. The deemed savings below are per aerator for different climate zones in New Mexico. For kit-based programs and programs for which the water heating fuel is unknown, multiply the savings listed below with the type of water-heating system fuel type percentage and the in-service rates provided in the next section. The savings listed in Table 209 do not include the Fuel% or ISR parameters.

Table 209: Residential Low-flow Faucet Aerator Deemed Annual Savings per Unit

Location	**Flow**	**Albuquerque**	**Las Cruces**	**Roswell**	**Santa Fe**
		Gas Savings (therms per unit)			
Bathroom	0.5 gpm	2.56	1.84	1.92	3.12
Bathroom	1.0 gpm	1.81	1.30	1.35	2.20
Kitchen	1.5 gpm	1.37	1.07	1.11	1.60
Location	**Flow**	**Electric Savings (kWh per unit)**			
Bathroom	0.5 gpm	57.51	41.29	43.01	70.04
Bathroom	1.0 gpm	40.60	29.15	30.36	49.44
Kitchen	1.5 gpm	30.76	24.09	24.79	35.93

[324] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

4.3.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following formula.[325]

$$Svgs = \frac{(FlowPre - FlowPost) \times (TempUsage - TempCold) \times Minutes \times Days \times HeatCapacity \times Density \times Const\ X\ Fuel\%\ X\ ISR}{EffDHW}$$

Where:

Svgs	= *Annual energy savings, in therms*
$Flow_{Pre}$	= *Baseline flow rate, 2.2 gpm*
$Flow_{Post}$	= *Measure flow rate, 0.5, 1.0, or 1.5 gpm*
$Temp_{Usage}$	= *Temperature of water coming out of aerator, °F, see Table 210.*
Minutes Of Use	= *Minutes per faucet per day faucet is used, 1.55 mins/faucet/day*[326]
Days	= *Days per year faucet is used, 365*
Heat Capacity	= *Heat capacity of water, 1 Btu per pound per °F*
Density	= *Density of water, 8.33 pounds per gallon*
Const	= *Constant, 1 therm/100,000 Btus, 1therm/0.03413 kWh*
EffDHW	= *Thermal efficiency of water heater. For Natural gas 0.75, for electric 0.98*
$Fuel_{\%}$	= *Percentage split between gas, electric, and propane water heating. When water heating fuel is known, used 100%. For kit-based and other program types for which the water heating fuel is not known, use territory-specific percentages. If territory-specific values are not known, use default values of 53% gas, 42% electricity, and 5% propane*[327].
ISR	= *In-service rate, representing the proportion of distributed aerators that are installed. For direct-install and downstream programs, use 1. For kit-based programs, use a territory-specific value. If a territory-specific value is not known, use a default value of 0.6*[328].

[325] ADM Associates, Evaluation of 2011 DSM Portfolio, New Mexico Gas Company, 2016, citing CLEAResult Workpaper, "Low Flow Aerators – 0.5[1.0] gpm" https://nmgco.com/userfiles/files/MeasurementVerificationReport.pdf

[326] Value derived using 2.57 persons/household, 2.34 minutes/person/day, 3.87 faucets/household. Persons/household derived from US Census Bureau https://www.census.gov/quickfacts/fact/table/US/PST045223 (persons/household): State and County QuickFacts. Minutes/person/day taken from TX TRM V10 Vol2 program year 2023, derived from Cadmus and Opinion Dynamics Evaluation Team, "Memorandum: Showerhead and Faucet Aerator Meter Study". Prepared for Michigan Evaluation Working Group. Faucets/household taken from TX TRM V10, based on the 2009 Residential Energy Consumption Survey (RECS), Table HC2.10.

[327] US Energy Information Administration. https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.8.pdf The percentages shown are based on the West Mountain South Region.

[328] El Paso Electric New Mexico LivingWise® Program Summary Report Fall 2017

Table 210 provides the typical usage temperature based on the faucet location.

Table 210: Residential Low-flow Faucet Aerator Usage Temperatures

Location	Usage Temperature (°F)[329]
Kitchen	93.0
Bathroom	86.0

Parameter values are based on the following sources.

Table 211: Residential Low-flow Faucet Aerator Parameter Sources

Parameter	Source
Baseline Flow Rate	Maximum flow rate federal standard for lavatories and aerators set in Federal Energy Policy Act of 1992 and codified at 2.2 gpm at 60 psi in 10CFR430.32.
Thermal Efficiency of Water Heater	Heater efficiency is based on RTF decision informed by "Energy Efficient Showerhead and Faucet Aerator Metering Study" (PSE/BPA/SBW 1994) and "Single Family 2007 Showerhead Kit Impact Evaluation". Seattle City Light. October 2008

4.3.4 DEMAND SAVINGS ESTIMATION

There are no demand savings associated with this measure.

4.3.5 NON-ENERGY BENEFITS

Water savings per faucet are shown in Table 212. Local water and wastewater rates need to be applied to these values to monetize savings.

Table 212: Residential Low-flow Faucet Aerator Water Savings (gallons)

Flow	Savings
0.5	986.6
1.0	696.4
1.5	406.2

[329] Cadmus and Opinion Dynamics Evaluation Team. Showerhead and Faucet Aerator Meter Study. For Michigan Evaluation Working Group. June 2013. The study finds that the average mixed water temperature flowing from the kitchen and bathroom faucets is 93ºF and 86ºF, respectively. The “Location Unknown” values are the average temperatures between all faucets in the household, assuming 2.83 bathrooms per single family residence, and 1.5 bathrooms per multifamily residence, based on findings from a 2009 ComEd residential survey of 140 sites provided by Cadmus

4.3.6 MEASURE LIFE

The lifetime for this measure is 10 years.[330]

4.4 RESIDENTIAL LIGHTING

This measure includes the replacement of pre-existing halogen lamps and fixtures with CFL or LED lamps and fixtures.

4.4.1 MEASURE OVERVIEW

Sector	Residential
End use	Lighting
Fuel	Electricity
Measure category	CFL and LED Lighting
Delivery mechanism	Upstream buy-down Give-away Direct Install Retail coupons
Baseline description	Federal minimum wattage
Efficient case description	Efficient lamp wattage

In 2012, the Energy Independence and Security Act of 2007 (EISA) requirements began to phase-in, which required all general-purpose light bulbs between 40 watts and 100 watts to have ~30% increased efficiency. The EISA legislation also contained a backstop provision, which required all lamps to have an efficacy of 45 lumens/watt by 1/1/2020. In December 2019, the DOE determined that this backstop efficiency was not economically justified. However, the DOE reversed course in May 2022 and issued a final rule331 for broadening the definition of General Service Lamps and implementing the 45 lumens/watt requirement.

The DOE indicated that there is a grace period for the remainder of 2022 to allow the import and manufacture of non-compliant lamps. The DOE also specified a sell through period of six months, ending in July 2023, by which date non-compliant lamps should not be available. The New Mexico TRM has not historically implemented code shifts midway through program years to avoid introducing market confusion, as well as allowing for additional sell through.

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[330] DEER 2014 EUL Table

[331] Energy Conservation Program: Definitions for General Service Lamps; Final rule. 10 CFR Part 430. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022

Therefore, the TRM assumes the 45 lumens/watt baselines are effective beginning January 1, 2024.

Additional considerations for applying lighting baselines depend on the type of program delivery, as well as the target participants.

- Market rate programs should use the existing EISA Tier 1 baselines for lamps incented through programs until January 1, 2024. After this date, the baseline for incented GSLs would need to be 45 lumens/watt. Lifetime savings calculations should shift the baseline to 45 lumens/watt starting January 1, 2027.
- Market rate direct install programs can use the EISA Tier 1 baseline after January 1, 2024, if it can be demonstrated that the program lamp is replacing an existing, fully functional halogen lamp. Lifetime savings calculations should shift the baseline to 45 lumens/watt two years after the installed program year.
- Income-eligible programs should use the existing EISA Tier 1 baselines for lamps incented through programs until January 1, 2026, to allow additional time to deplete existing stockpiles in the marketplace. After this date, the baseline for incented GSLs would need to be 45 lumens/watt. Lifetime savings calculations should shift the baseline to 45 lumens/watt starting January 1, 2029.
- Income-eligible direct install programs can use the EISA Tier 1 baseline after January 1, 2026, if it can be demonstrated that the program lamp is replacing an existing, fully functional halogen lamp. Lifetime savings calculations should shift the baseline to 45 lumens/watt two years after the installed program year.

4.4.2 SAVINGS

The savings depend on baseline wattage, as shown in Table 213. Tier 1 became effective on January 1st, 2014. The GSL backstop provision becomes effective in the TRM on January 1, 2024, following the guidance in the Measure Overview of this characterization.

Table 213: Residential Lighting Baseline – General Service

Lumen Range	EISA Status	EISA Baseline: 1st Tier (W)	DOE GSL Baseline: After 1/1/2024 (W)
250-309	Exempt	25	25
310-749	Non-exempt	29	11.8
750-1,049	Non-exempt	43	20.0
1,050-1,489	Non-exempt	53	28.2
1,490-2,600	Non-exempt	72	45.4
2,601-2,999	Exempt	150	150
3,000-5,279	Exempt	200	200
5,280-6,209	Exempt	300	300

Table 214 details wattage equivalence EISA specifications and expanded GSL baselines for reflector lamps. Program administrators should use model-specific wattages within these categorizations. The expanded definition of GSLs includes medium-sized directional lamps (BR30, BR40, and ER40).

Table 214: Baseline Wattage – Reflector Lamps

Lamp Type	Pre-EISA Incandescent Equivalent (W)	Baseline Wattage – Post-EISA (W)	DOE GSL Baseline: after 1/1/2024 (W)
PAR20	50	35	11.6
PAR30	50	35	11.6
R20	50	45	14.2
PAR38	60	45	17.2
BR30	65	Exempt	17.8
BR40	65	Exempt	17.8
ER40	65	Exempt	17.8
BR40	75	65	22.8
BR30	75	65	22.8
PAR30	75	55	21.7
PAR38	75	55	21.7
R30	75	65	21.7
R40	75	65	21.7
PAR38	90	70	25.0
PAR38	120	70	30.0
R20	≤ 45	Exempt	Exempt
BR30	≤ 50	Exempt	Exempt
BR40	≤ 50	Exempt	Exempt
ER30	≤ 50	Exempt	Exempt
ER40	≤ 50	Exempt	Exempt

There are 22 incandescent lamps exempt from EISA 2007. However, the expanded definition of GSLs includes many of these lamps. The new baselines become effective after January 1, 2024, in accordance with the guidance in the Measure Overview section of this characterization. Wattage for other specialty lamps is detailed in Table 215.

Table 215: Baseline Wattage – Other Specialty Lamps

Bulb Type	Lumen Range	Baseline Watts	DOE GSL Baseline: after 1/1/2024 (W)
3-Way	250-449	25	25
	450-799	40	13.9
	800-1,099	60	21.1
	1,100-1,599	75	30.0
	1,600-1,999	100	40.0
	2,000-2,549	125	50.5
	2,550-2,999	150	61.7
Globe (medium & intermediate base, ≤ 750 lumens)	90-179	10	10
	1810-249	15	15
	250-349	25	25
	350-749	40	12.2
Decorative (shapes B, BA, C, CA, DC, F, G, medium base, ≤ 750 lumens)	70-89	10	10
	90-149	15	15
	150-299	25	25
	300-499	40	8.9
	500-1,049	60	17.2
Globe (Candelabra base, ≤ 1,049 lumens)	90-179	10	10
	180-249	15	15
	250-349	25	25
	350-499	40	9.4
	500-1,049	60	17.2
Decorative (shapes B, BA, C, CA, DC, F, G, candelabra base, ≤ 1,050 lumens)	70-89	10	10
	90-149	15	15
	150-299	25	25
	300-499	40	8.9
	500-1,049	60	17.2

4.4.3 ENERGY SAVINGS ESTIMATION

Savings are calculated per lamp with the following formula.

$$Svgs = \frac{(Watts_{Baseline} - Watts_{Efficient})}{1{,}000} \times HoursOfUse \times HVACEnergy_{Factor}$$

Where:

Svgs	*= Annual energy savings, in kWh*
$Watts_{Baseline}$	*= Wattage of baseline incandescent lamp*
$Watts_{Efficient}$	*= Wattage of corresponding efficient lamp*
HoursOfUse	*= Annual average hours of use, see below*
HVAC_Energy Factor	*= Adjustment to lighting savings to account for the decreased heating and cooling load, see below*

Baseline and efficient lamp watts are determined using the wattages shown in Table 213, Table 214, and Table 215.

A method for deriving lifetime savings by implementing a Dual Baseline methodology to address a reduced useful life is presented below.

$$Lifetime\ Svgs = [\left(\frac{(Watts_{1^{st}Baseline} - Watts_{Efficient})}{1000} \times HoursOfUse \times HVAC_{Energy}Factor\right) \times 1^{st}Baseline_{NumberOfYears}] + \left(\frac{(Watts_{2^{nd}Baseline} - Watts_{Efficient})}{1000} \times HoursOfUse \times HVAC_{Energy}Factor\right) \times 2^{nd}Baseline_{NumberOfYears}]$$

Where:

Lifetime Svgs	*= Lifetime annual energy savings, in kWh*
$Watts_{1stBaseline}$	*= Wattage of baseline lamp consistent with EISA Tier 1.*
$Watts_{2ndBaseline}$	*= Wattage of baseline lamp*
$Watts_{Efficient}$	*= Wattage of corresponding efficient lamp*
Hours of Use	*= Annual average hours of use*
HVAC_Energy Factor	*= Adjustment to lighting savings to account for the decreased heating and cooling load, see below*
1st Baseline_#ofYears	*= Remaining useful life (years) prior to 1/1/2024*
2nd Baseline_#ofYears	*= Remaining useful life (years) post 1/1/2024*

Example:

Installation date:	1/1/2023
Installation location:	Albuquerque, NM
HVAC type:	Heat Pump
Hours of use:	817.6
HVAC Energy Factor:	0.76

Existing PAR 20 lamp wattage (1/1/2023 – 1st Baseline) = 45 W (310-749 Lumens)

Backstop PAR 20 lamp wattage (1/1/2024 – 2nd Baseline) = 11.8 W

Installed LED lamp wattage = 5 W (450 Lumens)

Full savings can be claimed until 1/1/2027, then need to change baseline to 45 lumens per watt for market rate programs. This would be different for Direct Install and Low-Income projects where the baseline shifts after 1/1/2029, the baseline changes to 45 lumen per watt for GSLs. Use Table 213 for GSLs.

$$Lifetime\ Svgs = [\left(\frac{(40-5)}{1000} \times 817.6 \times 0.76\right) \times 4] + \left(\frac{(11.8-5)}{1000} \times 817.6 \times 0.76\right) \times 20.5] = 173.6\ kWh$$

HVAC energy factors by type and region are listed in Table 216.

Table 216: HVAC Energy Factor[332]

HVAC Type	Albuquerque	Roswell	Santa Fe	Las Cruces
Gas heat with AC	1.05	1.10	1.03	1.12
Gas heat with no AC	1.00	1.00	1.00	1.00
Heat Pump	0.76	0.94	0.73	0.97
Electric Resistance Heat with AC	0.67	0.86	0.70	0.88
Electric Resistance Heat with no AC	0.57	0.70	0.66	0.70
No heat with AC	1.05	1.10	1.03	1.12
Unconditioned space	1.00	1.00	1.00	1.00
Heating cooling unknown	0.91	1.02	0.89	1.04
Upstream lighting	0.91	1.02	0.89	1.04

Hours of use were derived from the 2011 evaluations of New Mexico programs by ADM Associates.[333] Hours are shown in Table 217.

The weighted average hours are based on actual installations in 2011 in New Mexico.

[332] Values derived from TX TRM values, adjusted based on a comparison of CDD between Texas Cities and New Mexico cities.

[333] ADM based on the hours of use on KEMA, "CFL Metering Study", prepared for the California Public Utilities Commission, 2009, and US DOE, US Lighting Market Characterization, Navigant Consulting, 2002. Number of days per year is assumed to be 365 days.

Table 217: Residential Lighting Daily Hours of Use by Room Type

Room Type	Hours of Use
Kitchen	3.5
Living Room	3.3
Outdoor	3.1
Family Room	2.5
Garage	2.5
Utility Room	2.4
Dining Room	2.3
Office	1.9
Bedroom	1.6
Bathroom	1.5
Hall/Entry	1.5
Laundry Room	1.2
Closet	1.4
Other	1.2
Weighted Average	**2.24**

4.4.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00 to 6:00 pm on the hottest summer weekdays. Demand savings are derived with the following equation.[334]

$$Svgs = \frac{(Watts_{Baseline} - Watts_{Efficient})}{1{,}000} \times CoincidentFactor \times HVAC_{Demand}Factor$$

Where:

Svgs = *Summer peak kW savings*

$\mathrm{Watts}_{\mathrm{Baseline}}$ = *Baseline Wattage of lamp, as determined from table above*

$\mathrm{Watts}_{\mathrm{Efficient}}$ = *Installed Wattage of lamp*

CoincidentFactor = *0.1017 for residences, 0.18 for dormitories*

HVAC_Demand Factor = *Adjustment to lighting demand savings to account for the decreased heating and cooling load*

HVAC demand factors are listed in Table 218.

[334] Coincidence factors were derived from the ADM 2011 evaluations of the New Mexico utilities. ADM cited the KEMA 2009 study and DEER 2008.

Table 218: HVAC Demand Factor[335]

Room Type	Albuquerque	Roswell	Santa Fe	Las Cruces
Gas heat with AC	1.41	1.38	1.19	1.44
Gas heat with no AC	1.00	1.00	1.00	1.00
Heat Pump	1.24	1.32	1.12	1.37
Electric Resistance Heat with AC	1.00	1.17	1.00	1.36
Electric Resistance Heat with no AC	1.00	1.00	1.00	1.00
No heat with AC	1.41	1.38	1.19	1.44
Unconditioned space	1.00	1.00	1.00	1.00
Heating cooling unknown	1.28	1.32	1.13	1.41
Upstream lighting	1.28	1.32	1.13	1.41

4.4.5 NON-ENERGY BENEFITS

There is an added benefit from deferred replacement cost, as a CFL or LED lamp has a significantly longer rated life than an incandescent or halogen equivalent. Program staff may endeavor to quantify this.

4.4.6 MEASURE LIFE

The addition of the backstop requirement after January 1, 2024, requires that the useful life for LEDs reflect the time available for which a noncompliant lamp could be used as an alternative. Therefore, the measure life for LED lamps installed through the program depends on the type of target participant, in order to align with the baseline selection.

Market rate programs should claim halogen baselines until January 1, 2027[336], then shift the baseline to 45 lumens/watt for the remainder of the measure life values in Table 219.

Market rate direct install programs where it can be demonstrated that the program lamp is replacing an existing, fully functional halogen lamp, should claim halogen baselines for three

[335] Values derived from TX TRM values, adjusted based on a comparison of CDD between Texas Cities and New Mexico cities.

[336] Halogen lamps have 2000 hour lives, at 818 hours per year, is 2.4 years. This was rounded up to three years for lifetime savings calculations.

years after installation. The savings for the remainder of the measure life from Table 219 should be versus a 45 lumens/watt baseline.

Income-eligible should claim halogen baselines until January 1, 2029[337], then shift the baseline to 45 lumens/watt for the remainder of the measure life values in Table 219.

Income-eligible direct install programs where it can be demonstrated that the program lamp is replacing an existing, fully functional halogen lamp, should claim halogen baselines for three years after installation. The savings for the remainder of the measure life from Table 219 should be versus a 45 lumens/watt baseline.

Table 219: Residential Lighting Measure Lives

Measure	Rated Life	Expected Useful Life
CFL	8,000	5.1
	10,000	6.4
	12,000	7.7
LED	17,000	20.8[338]
	20,000	24.5[339]
	25,000	30.6[340]

4.5 DUCT SEALING

This measure saves energy by reducing the quantity of conditioned air that leaks from residential supply and return ducts.

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[337] Three years of remaining eligibility until 2026, plus three years of halogen life.

[338] The average rated life for Decorative lamps on the ENERGY STAR Qualified Products list (accessed 6/16/2020) is approximately 17,000 hours, the expected useful life calculated using the weighted average of 2.24 daily hours by room type.

[339] The average rated life for Omnidirectional lamps on the ENERGY STAR Qualified Products list (accessed 6/16/2020) is approximately 20,000 hours, the expected useful life calculated using the weighted average of 2.24 daily hours by room type.

[340] The average rated life for Directional lamps on the ENERGY STAR Qualified Products list (accessed 6/16/2020) is approximately 25,000 hours, the expected useful life calculated using the weighted average of 2.24 daily hours by room type.

4.5.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity and Natural Gas
Measure category	Duct Sealing
Delivery mechanism	Rebate
Baseline description	Ducts with a leakage factor assumed to be 35% or less of total fan flow[341]
Efficient case description	Final leakage rate, which must be less than 10% of fan CFM

4.5.2 SAVINGS

Savings depend on pre- and post-leakage rates, which must be measured with DuctBlaster™ or other pressurization equipment, and also on in-home HVAC equipment type. The baseline leakage rate cannot exceed 35% of the total fan flow of the system and should be capped at 35% of the total fan flow to use the algorithms presented in this measure.

4.5.3 ENERGY SAVINGS ESTIMATION

Total savings are the sum of cooling and heating savings. Cooling savings are derived with the following equation.[342]

$$Svgs = (DL_{Baseline} - DL_{Post}) \times 0.77 \times EFLH \times (h_{Out} \times \rho_{Out} - h_{In} \times \rho_{In}) \times \frac{60}{1000 \times SEER}$$

Where:

Svgs = *Annual cooling savings, kWh*

$DL_{baseline}$ = *Duct leakage, baseline, measured at 25 Pascals, CFM. Cannot exceed 35% of total fan flow.*

DL_{post} = *Duct leakage, after installation, measured at 25 Pascals, CFM*

0.77 = *Adjustment factor to account for the fact that people do not always operate their air conditioning systems when outside temperature is greater than 75° F*

EFLH = *Effective Full Load Hours for residential cooling, see below*

341 Texas Technical Reference Manual, Vol. 2 v10

342 Frontier Associates, Deemed Savings based on El Paso Specific Climate Data, Filing with TX Regulatory Commission, 2012.

h_{out} = *Outdoor air design specific enthalpy = 29 (Btu/lb)*[343]

ρ_{out} = *Density of outdoor air at 95°F = 0.0742 (Ib/ft3)*[344]

h_{in} = *Indoor air design specific enthalpy = 25 (Btu/lb)*[345]

ρ_{in} = *Density of conditioned air at 75°F = 0.0756 (Ib/ft3)*[346]

60 = *Conversion factor from minutes to hours*

1000 = *Conversion factor from Wh to kWh*

SEER = *Seasonal Energy Efficiency Ratio of Cooling System (kBtu/kWh)*

= *Nameplate ratings wherever* possible, if unavailable use the following efficiencies listed in *Table 220*.

Table 220 provides cooling efficiencies based on the equipment type and age.

Table 220: Cooling Efficiency (Federal Standards)

Equipment Type	Age of Equipment	SEER Ratings
Central AC and Heat Pump	Before 2006	10.0
Central AC and Heat Pump	2006 - 2014	13.0
Central AC	After 1/1/2015	13.0
Heat Pump	After 1/1/2015	14.0

Pre and post duct leakage parameters are provided on a per site basis. These values should be measured at a positive pressure of 25 Pascals with a DuctBlaster™ or similar equipment.

EFLH are shown in Table 221. Full-load hours for Albuquerque and Roswell were derived from the ENERGY STAR® Calculator for residential air conditioning.[347] EFLH for Las Cruces and Santa Fe were taken from eQuest simulations for the Community College building type performed by SBW Consulting as part of the development of the commercial air conditioning measure in this manual. The hours for this building type most closely matched the residential hours for the two New Mexico cities included in the ENERGY STAR® Calculator.

[343] ANSI/ASHRAE Standard 152-2004, Table 6.3b (El Paso)

[344] ASHRAE Fundamentals 2009, Chapter 1: Psychometrics, Equation 11, Equation 41, Table 2

[345] ANSI/ASHRAE Standard 152-2004, Table 6.3b (El Paso)

[346] ASHRAE Fundamentals 2009, Chapter 1: Psychometrics, Equation 11, Equation 41, Table 2

[347] https://www.energystar.gov/products/heating_cooling/guide/savings-calculator/standalone

Table 221: Residential Full Load Cooling Hours for New Mexico Climate Zones[348]

Location	$EFLH_C$
Albuquerque	852
Las Cruces	1,008
Roswell	1,059
Santa Fe	562

Cooling system SEER is entered on a per-household basis, if available. If this value is not available, a value of 10 should be used for cooling systems installed prior to 2006, and a value of 13 should be used for systems installed in 2006 or later.

Heating savings are derived with the following equation.[349]

$$Svgs = (DL_{Baseline} - DL_{Post}) \times 0.77 \times HDD \times 24 \times 60 \times \frac{0.018}{ConvFactor \times Efficiency}$$

Where:

Svgs	= *Annual heating savings, kWh or therms*
DLbaseline	= *Duct leakage, baseline, measured at 25 Pascals, CFM*
DLpost	= *Duct leakage, after installation, measured at 25 Pascals, CFM*
0.77	= *Adjustment factor to account for the fact that people do not always operate their heating systems when outside temperature is less than 65°F*
HDD	= *Heating Degree Days for New Mexico climate zones, see below, days-°F*
24	= *Conversion factor, days to hours*
0.018	= *Volumetric heat capacity of air* ($Btu/ft^3 °F$)
60	= *Conversion factor from minutes to hours*
ConvFactor	= *Conversion factor which yields either kWh or therms, see below*
Efficiency	= *Heating system efficiency, see* Table 222.

Table 222 heating system efficiencies are provided in the following table by equipment type and age.

[348] Based on hourly AC metering data for a sample of about 230 premises in the PNM territory provided by Itron and thermostat runtime data in the EPE territory.

[349] Frontier Associates, Deemed Savings based on El Paso Specific Climate Data, Filing with TX Regulatory Commission, 2012.

Table 222: Heating Efficiency (Federal Standards)

Age of Equipment	HSPF Ratings
Heat Pump; Before 2006	6.8
Heat Pump; 2006 - 2014	7.7
Heat Pump; After 1/1/2015	8.2
Electric Resistance	3.412

HDD are shown in Table 223[350] for each climate zone in New Mexico.

Table 223: Heating Degree Days for New Mexico Climate Zones

Location	HDD
Albuquerque	4,180
Las Cruces	2,816
Roswell	3,289
Santa Fe	5,417

Equipment and conversion factors depend on the type of heating system, as shown in Table 224.

Table 224: Heating System Type Conversion Factors and Efficiencies

Heating System Type	Description	Value
Heat Pump	Adjusted HSPF; Btu to kWh	1,000 x adjusted HSPF
Electric Resistance	100% efficiency; Btu/watt-hr to Btu/kWh	1,000
Gas furnace	78% efficiency; Btu to Therms	0.78 x 100,000

The adjusted HSPF is derived with the following formula.[351]

$$adjHSPF = HSPF \times \left(1 - \left(0.1392 + (-0.00846 * DTemp) + (-0.0001074 * (DTemp)^2) + (0.0228 * HSPF)\right)\right)$$

Where:

adjHSPF = *HSPF adjusted for location*

HSPF = *Nominal HSPF, taken to be 7.7*

DTemp = *Design temperature for the location*

350 http://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals

351 http://www.fsec.ucf.edu/en/publications/html/fsec-pf-413-04/

ASHRAE Design temperatures for New Mexico locations are shown in Table 225.

Table 225: Residential Heating Design Temperatures for New Mexico Locations

Location	Design Temperature (°F)
Albuquerque	18
Las Cruces	20
Roswell	20
Santa Fe	10

Example: Conditioned air leakage from the duct is reduced from 50 CFM to 10 CFM. This system is installed in Albuquerque and the efficiency of the cooling system installed is SEER 14.

Energy Savings = (50 CFM – 10 CFM) x 0.77 x 1,038 hours x (29 Btu/lb x 0.0742 lb/ft^3 - 25 Btu/lb x 0.0756 lb/ft^3) x 60/(1000 x 14)

= 35.87 kWh

Demand savings = (50 CFM – 10 CFM) x 0.77 x (29 Btu/lb x 0.0742 lb/ft^3 - 25 Btu/lb x 0.0756 lb/ft^3) x 60/(1000 x 14) x 0.87

= 0.03 kW

4.5.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00-6:00 pm on the hottest summer weekdays. Demand savings are derived with the following equation.

$$Svgs = (DL_{Baseline} - DL_{Post}) \times 0.77 \times (h_{Out} \times \rho_{Out} - h_{In} \times \rho_{In}) \times \frac{60}{1{,}000 \times SEER} \times CF$$

Where:

Svgs = *Peak cooling savings, kW*

CF = *Coincident Factor, 0.56*[352]

The Coincident Factor is derived as follows. For residential coincidence factors, Frontier Associates used the Air Conditioning Contractors of America (ACCA) Manual S, which recommends that residential HVAC systems be sized at 115% of the maximum cooling requirement of the house. Assuming that the house's maximum cooling occurs during the

[352] Based on hourly AC metering data and thermostat runtime data

peak period hours 1 to 7 pm, this sizing guideline leads to a coincidence factor for residential HVAC of 1.00/1.15 = 0.87.

4.5.5 NON-ENERGY BENEFITS

There is currently no non-energy benefits quantified for this measure. These benefits can be added during future TRM updates.

4.5.6 MEASURE LIFE

The lifetime for this measure is 18 years.[353]

4.6 HIGH EFFICIENCY AIR CONDITIONER

This measure involves residential HVAC high efficiency central air conditioning systems, including packaged systems, and split systems consisting of a remote condensing unit and one or more indoor units.

4.6.1 MEASURE OVERVIEW

Sector	Residential
End use	Air Conditioning
Fuel	Electricity
Measure category	High Efficiency Air Conditioner – retrofit and new construction
Delivery mechanism	Rebate
Baseline description	New Construction/Replace-on-Burnout: Federal Minimum Early Retirement: Existing Conditions
Efficient case description	More efficient than baseline

4.6.2 SAVINGS

Newly installed units must have a cooling capacity of less than 65,000 Btu/hour (5.4 tons) to be eligible for the measure. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system cooling capacity will be considered to be whichever is lower: the outdoor unit capacity, or the total capacity of the installed indoor

[353] DEER 2008, RTF

units. Federal minimum standard as defined by 42 U.S.C. 6291(16) are specified in the Code of Federal Regulations at CFR 430.32(c)(3):[354]

As per the Department of Energy (DOE) Docket: EERE-2014-BT-STD-0048[355], the new testing procedure M1 will be incorporated from January 1, 2023, in the Southwest Region. The M1 testing procedure is a new method of product testing designed to better reflect current field conditions. During this test, the systems' external static pressure is increased from the current SEER (0.1 in. of water) to SEER2 (0.5 in, of water). SEER2 stands for Seasonal Energy Efficiency Ratio 2. Specifically, SEER2 is the total heat removed from the conditioned space during the annual cooling season. The new M1 testing procedure will increase the systems' external static pressure by a factor of five to better reflect field conditions of installed equipment. With this change, new nomenclature will be used to denote M1 ratings (including EER2 and HSPF2)356. Baseline efficiencies as per the new standards and their respective unit conversions are provided below in Table 226 through Table 229.

Table 226: Baseline Efficiencies for Residential Central Air-Conditioners[357]

System Type	Manufactured After January 1, 2023			
	SEER	EER	SEER2	EER2
Split System AC (cooling capacity<45,000 Btu/h)	15.0	12.2*	14.3	11.7**
Split System AC (cooling capacity≥45,000 Btu/h)	14.5	11.7	13.8	11.2**
Packaged ACs	14		13.4	10.6

* 10.2 EER if SEER ≥ 16.0 SEER

** 9.8 EER2 if SEER2 ≥ 15.2 SEER2358

[354] Consumer Central Air Conditioner and Heat Pump Efficiency Standards (DOE): https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive#current_standards

[355] https://www.regulations.gov/document/EERE-2014-BT-STD-0048-0103

[356] https://www.energy.gov/sites/prod/files/2016/08/f33/Central%20Air%20Conditioners%20and%20Heat%20Pumps%20TP%20SNOPR_4.pdf

[357] https://www.energy.gov/sites/prod/files/2016/12/f34/CAC_HP_DFR_NOPR.pdf

[358] https://www.energy.gov/sites/prod/files/2016/12/f34/CAC_HP_DFR_NOPR.pdf

Table 227: Efficiency Unit Conversions[359]

Rating	Conversion
SEER2 to SEER	SEER = 1.2476 × SEER2 – 2.8674
EER2 to EER	EER = 1.0578 ×EER2 – 0.1769
HSPF2 to HSPF	HSPF = 1.1702 ×HSPF2 + 0.0700

Table 228: Baseline Efficiencies for Residential Central Air-Conditioners

System Type	Manufactured Before January 2006	Manufactured Between January 2015 and 2006	Manufactured After January 2015
	SEER	SEER	SEER
Split Air Conditioner	10.0	13.0	13.0
Packaged Air Conditioner	9.7	13.0	14.0

Table 229: Baseline Efficiencies for Residential Packaged Terminal Air-Conditioner and Heat Pump

System Type	Manufactured Before January 2006		Manufactured Between January 2015 and 2006	
	SEER	HSPF	SEER	HSPF
Packaged Terminal Air Conditioner (PTAC)	9.7	-	10.6	-

System Type	Manufactured After January 2015	
	SEER[360]	HSPF
Packaged Terminal Air Conditioner (PTAC)	12.5 - (0.213 * Capacity/1,000); New Construction 10.9 - (0.213 * Capacity/1,000); Replace on Burnout	-

Air conditioning equipment shall be properly sized to the dwelling, based on ASHRAE or ACCA Manual J standards. Manufacturer data sheets on installed air conditioning equipment or the AHRI reference number must be provided to the utility. The installed central air conditioning equipment must be AHRI certified.

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359 From PECO SWE Memo for TRM Measure 2.2.1 dated 08/12/2022. SWE conducted an analysis and modeled trendlines developed from equivalent values as stated in the Federal Code for Consumer Products (10 CFR 430.32(c) Energy and water conservation standards and their compliance dates. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C#p-430.32(c)) and ENERGY STAR criteria (ENERGY STAR Program Requirements for Central Air Source Heat Pumps and Central Air Conditioners)

360 Capacity is the rated cooling capacity of the product in Btu/hr. If the unit's capacity is less than 7,000 Btu/hr then use 7,000 Btu/hr and if more than 15,000 Btu/hr, use 15,000 Btu/hr in the calculation (IECC 2021).

4.6.3 ENERGY SAVINGS ESTIMATION

Savings can be determined using the following equations based on the measure event type:

New Construction and Replace-on-Burnout

$$kWh_{Savings} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{eff}}\right)$$

Where:

$kWh_{Savings}$	*= Annual energy savings*
$Capacity_{Cool}$	*= Cooling capacity of product in Btu/hr. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system capacity is whichever is lower: the capacity of the outdoor unit, or the total capacity of the installed indoor units* $EFLH_C$ *= Residential Effective Full Load Cooling Hours for New Mexico (Table 230)*
$SEER_{base}$	*= Seasonal Energy Efficiency Rating of the baseline cooling equipment (Table 228 & Table 229)*
$SEER_{eff}$	*= Seasonal Energy Efficiency Rating of the efficient cooling equipment (AHRI Certificate)*

Table 230 provides the cooling EFLH for each climate zone.

Table 230: Residential Full Load Cooling Hours for New Mexico Climate Zones[361]

Location	$EFLH_C$
Albuquerque	852
Las Cruces	1,008
Roswell	1,059
Santa Fe	562

Early Retirement

Annual kWh and kW savings should be calculated for two separate periods reflecting the remaining useful life (RUL) of the pre-existing equipment, and the effective useful life (EUL) of the installed equipment. Table 231 provides further information on the RUL based on the age of the equipment.

For Remaining Useful Life (RUL):

361 Based on hourly AC metering data for a sample of about 230 premises in the PNM territory provided by Itron and thermostat runtime data in the EPE territory.

$$kWh_{Savings,RUL} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{existing}} - \frac{1}{SEER_{eff}}\right)$$

Where:

$kWh_{Savings,RUL}$	*= Annual energy savings during RUL*
$SEER_{existing}$	*= Seasonal Energy Efficiency Rating of the existing cooling equipment. Use actual rated efficiency of existing unit. If existing efficiency cannot be obtained, select the federal minimum value corresponding to year of manufacture (Table 228)*
$SEER_{eff}$	*= Seasonal Energy Efficiency Rating of the efficient cooling equipment (from AHRI Certificate)*

For remaining time in the Estimated Useful period (EUL – RUL):

$$kWh_{Savings,EUL-RUL} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{eff}}\right)$$

Hence,

$$Lifetime\ Energy\ Savings = kWh_{Savings,RUL} * RUL + kWh_{Savings,EUL-RUL} * (EUL - RUL)$$

Where:

RUL	*= Remaining Useful Life (Table 231)*
EUL	*= Estimate Useful Life*
	= 18 Years

Table 231: Remaining Useful Life (Years) of Replaced Air Conditioner Unit[362]

Age of Equipment	Remaining Useful Life	Age of Equipment	Remaining Useful Life
1	16.8	14	8.6
2	15.8	15	8.2
3	14.9	16	7.9
4	14.1	17	7.6
5	13.3	18	7
6	12.6	19	6
Age of Equipment	**Remaining Useful Life**	**Age of Equipment**	**Remaining Useful Life**
7	11.9	20	5
8	11.3	21	4
9	10.8	22	3
10	10.3	23	2

[362] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. "Considerations for early replacement of residential equipment." Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. Use of the early retirement baseline is capped at 25 years, representing the age at which 75 percent of existing equipment is expected to have failed. Systems older than 25 years should use the ROB baseline.

Age of Equipment	Remaining Useful Life	Age of Equipment	Remaining Useful Life
11	9.8	24	1
12	9.4	25	0
13	9		

Example: A new packaged central air conditioner of 24,000 Btu/hour capacity (SEER = 16) will be installed for a newly constructed home in Albuquerque.

$kWh_{Savings}$ = 24,000 Btu/hr x 1/1,000 x 1,038 hours x (1/14 – 1/16)

= 222 kWh

EER_{base} = - 0.02 x $(14)^2$ + 1.12 x 14 = 11.76

EER_{eff} = - 0.02 x $(16)^2$ + 1.12 x 16 = 12.8

$kW_{Savings}$ = 240,00 Btu/hr x 1/1000 x (1/11.76 – 1/12.8) x 0.87

= 0.144 kW

4.6.4 DEMAND SAVINGS ESTIMATION

To calculate demand savings for this measure, the baseline SEER will need to be converted to EER (Energy Efficiency Rating) using the following formula.[363]

$$EER = -0.02 * SEER^2 + 1.12 * SEER$$

Peak demand savings are calculated with the following formula:

$$kW_{Savings} = Capacity_{Cool} * \frac{1}{1000} * \left(\frac{1}{EER_{base}} - \frac{1}{EER_{eff}}\right) * CF$$

Where:

$kW_{Savings}$ = *Peak Demand Savings*

$Capacity_{Cool}$ = *Cooling capacity of product in Btu/hr. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system capacity is whichever is lower: the capacity of the outdoor unit, or the total capacity of the installed indoor units*

CF = *Coincidence Factor for residential HVAC measures, 0.56364*

EER_{base} = *Full-Load Energy Efficiency Rating of the baseline cooling equipment*

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[363] Code specified SEER values converted to EER using EER = -0.02 x $SEER^2$ + 1.12 x SEER. National Renewable Energy Laboratory (NREL) 2010, "Building America House Simulation Protocols." U.S. DOE. Revised October 2010 www.nrel.gov/docs/fy11osti/49246.pdf

[364] Based on hourly AC metering data and thermostat runtime data.

EER_{eff} = *Full-load Energy Efficiency Rating of the efficient cooling equipment (from AHRI Certificate)*

4.6.5 NON-ENERGY BENEFITS

Well-designed HVAC systems increase occupant comfort and productivity.

4.6.6 MEASURE LIFE

The lifetime for this measure is 18 years.[365]

4.7 EVAPORATIVE COOLING

This measure involves the installation of a residential evaporative cooler. The cooler is a direct evaporative cooler, which is in place of a vapor-compression, split system air conditioner. Direct evaporative cooling (open circuit) is used to lower the temperature of air by using latent heat of evaporation, changing liquid water to water vapor. The heat of the outside air is used to evaporate water, and warm dry outside air is changed to cool moist air to directly cool the indoors. This measure does not include indirect evaporative cooling (i.e., closed circuit with a heat exchanger) or indirect-direct hybrid systems.

4.7.1 MEASURE OVERVIEW

Sector	Residential
End use	Air Conditioning
Fuel	Electricity
Measure category	Direct Evaporative Cooler
Delivery mechanism	Rebate
Baseline description	Federal Minimum: 13 SEER (11.09 EER) Split System Air Conditioner
Efficient case description	Direct evaporative cooling (no expansion cooling) with the following characteristics: cooling flow is three times the flow use for the code baseline buildings, effectiveness = 0.85.

[365] Texas TRM v12.0 Volume 2: Residential Measure

4.7.2 SAVINGS

The deemed annual energy and demand savings per residence are shown in Table 232 for the four New Mexico climate zones.

Table 232: Evaporative Cooling Energy and Demand Savings

Location	Energy Savings (kWh)	Demand Savings (kW)
Albuquerque	1,833	1.77
Roswell	2,604	2.38
Santa Fe	1,150	1.38
Las Cruces	3,465	2.46

4.7.3 ENERGY SAVINGS ESTIMATION

Savings are derived with the following assumptions:

- The baseline cooling load is met by DX A/C systems with the following capacities per climate zone:
  - Albuquerque: 2.5 tons
  - Roswell: 3 tons
  - Santa Fe: 2 tons
  - Las Cruces: 3 tons
- The baseline is equal to a 13 SEER (11.09 EER) Split System Air Conditioner
- The evaporative cooling system is two-speed, using 400 watts at low speed and 800 watts at high speed
- The evaporative cooler has runtime hours according to temperature bin shown in Table 233

Table 233: Evaporative Cooler Runtime Percentage

Temperature Range	Fan Speed	Runtime Percentage
70 – 75	Low	0%
75 – 80	Low	50%
80 – 85	50% low/50% high	75%
85 – 90	50% low/50% high	85%
90 – 95	High	95%
95 – 100	High	95%
100+	High	95%

- Baseline energy usage is derived similarly to the Residential High Efficiency A/C measure

4.7.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00 to 6:00 pm on the hottest summer weekdays. Demand savings are the difference in usage in the hottest TMY3 temperature bin with more than 9 hours.

4.7.5 NON-ENERGY BENEFITS

There are currently no non-energy benefits defined for this measure. These benefits may be added during future TRM updates.

4.7.6 MEASURE LIFE

The lifetime for this measure is 15 years.[366]

4.8 INFILTRATION REDUCTION

This measure reduces air infiltration into the residence, using pre- and post-treatment blower door air pressure readings to confirm air leakage reduction.

4.8.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity and Natural Gas
Measure category	Air Sealing - Reduce Infiltration
Delivery mechanism	Qualified professional installation
Baseline description	Upper limit of 4.00 CFM50 per square foot of house floor area
Efficient case description	A minimum air leakage reduction of 10% of the pre-installation reading is required

4.8.2 SAVINGS

A method for deriving savings is described in the following section. Savings are site specific, based on blower door test readings and HVAC system efficiencies.

[366] DEER 2008

4.8.3 ENERGY SAVINGS ESTIMATION

Savings are derived using the methodology in the State of Ohio Energy Efficiency Technical Reference Manual, 2020.

Annual cooling energy savings are derived with the following formula.

$$\Delta \text{kWh}_{Cooling} = \frac{\left(\frac{CFM50exist - CFM50new}{Nfactor}\right) \times 60 \times CDH \times 0.018}{(1000 \times \eta Cool)}$$

Where:

$\Delta kWh_{Cooling}$	= *Annual cooling energy savings, kWh*
CFM50exist	= *Existing Cubic Feet per Minute at 50 Pascal pressure differential as measured by the blower door before air sealing.*
CFM50new	= *New Cubic Feet per Minute at 50 Pascal pressure differential as measured by the blower door after air sealing.*
Nfactor	= *Conversion factor to convert 50-pascal air flows to natural airflow*
	= *21.5367*
60	= *Constant to convert cubic feet per minute to cubic feet per hour*
CDH	= *Cooling Degree Hours, see Table 234*
0.018	= *Volumetric heat capacity of air (Btu/ft^3°F)*
$\eta Cool$	= *Efficiency of Air Conditioning equipment (i.e., SEER rating), see Table 234 and Table 235*

Table 234 and Table 235 provide the cooling degree hours per climate zone, and the cooling efficiency based on equipment and age.

Table 234: Cooling Degree Hours for New Mexico Climate Zones

Region	Cooling Degree Hours[368] (65°F Reference Temp)
Albuquerque	31,728
Las Cruces	45,600
Roswell	42,936
Santa Fe	15,504

[367] Nfactor from methodology developed by the Lawrence Berkeley Laboratory (LBL) for Zone 3 (as defined by LBL), single story, normal exposure.

[368] www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals

Table 235: Cooling Efficiency (Federal Standards)

Type of Equipment	Age of Equipment	SEER Ratings
Central AC and Heat Pump	Before 2006	10.0
Central AC and Heat Pump	2006 - 2014	13.0
Central AC	after 1/1/2015	13.0
Heat Pump	after 1/1/2015	14.0

Annual space heating savings are derived with the following formulas.

$$Svgs\ Gas\ Heating = \frac{\left(\frac{CFM50exist - CFM50new}{Nfactor}\right) \times 60 \times 24 \times HDD \times 0.018}{(100{,}000 \times \eta Heat \times \eta Dist)}$$

$$Svgs\ Electric\ Heating = \frac{\left(\frac{CFM50exist - CFM50new}{Nfactor}\right) \times 60 \times 24 \times HDD \times 0.018 \times 29.31}{(100{,}000 \times \eta Heat \times \eta Dist)}$$

Where:

Svgs Gas Heating	= *Annual space heating energy savings, therms*
Svgs Electric Heating	= *Annual space heating energy savings, kWh*
CFM50exist	= *Existing Cubic Feet per Minute at 50 Pascal pressure differential as measured by the blower door before air-sealing.*
CFM50new	= *New Cubic Feet per Minute at 50 Pascal pressure differential as measured by the blower door after air-sealing.*
Nfactor	= *Conversion factor to convert 50-pascal air flows to natural airflow*
	= *21.5369*
60	= *Constant to convert cubic feet per minute to cubic feet per hour*
24	= *Constant to convert days to hours*
HDD	= *Heating Degree Days, see Table 236*
0.018	= *Volumetric heat capacity of air (Btu/ft^3°F)*
$\eta Heat$	= *Heating Equipment Efficiency (AFUE or COP; convert HSPF to COP using COP = HSPF/3.412)*
$\eta Dist$	= *Distribution Efficiency 370 (default = 80%)*
29.31	= *Constant to convert therms to kWh*

[369] Nfactor from methodology developed by the Lawrence Berkeley Laboratory (LBL) for Zone 3 (as defined by LBL), single story, normal exposure.

[370] The System Efficiency can be obtained either by recording the AFUE of the unit or performing a steady state efficiency test. The Distribution Efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute: (http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf) or by performing duct blaster testing. In the case of electric heat use 1.0 as the heating system efficiency, and for heat pumps use COP (HSPF/3.412).

Table 236 provides the heating degree days per climate zone.

Table 236: Heating Degree Days for New Mexico Climate Zones

Region	Heating Degree Days[371] (65°F Reference Temp)
Albuquerque	4,180
Las Cruces	2,816
Roswell	3,289
Santa Fe	5,417

Example:

Pre-treatment air infiltration = *4,000 CFM50*

Post treatment air infiltration = *2,000 CFM50*

SEER rating of the AC equipment = *13*

ΔkWh$_{Cooling}$ = *((4,000 CFM-2,000 CFM)/21.5) x 60 mins/hour x 31,728 hours x 0.018/(1000 x 13)*

= *245 kWh*

ΔkWh$_{Heating}$ = *((4,000 CFM-2,000 CFM)/21.5) x 60min/hour x 24 hour/day x 4180 days x 0.018/(100,000 x 1 x 0.80)*

= *126 kWh*

Total energy savings = *371 kWh*

Demand savings (Cooling only) = *245 kWh/1038 hours x 0.87 = 0.205 kW*

4.8.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00-6:00 pm on the hottest summer weekdays. Demand savings are derived with the following equation.

$$kW = \frac{\Delta kWh_{\ Cooling}}{EFLH_{\ Cooling}} \times CF$$

Where:

ΔkWh$_{\text{Cooling}}$ = Annual Cooling energy savings, kWh

$EFLH_{Cooling}$ = *Effective Full Load Hours for residential cooling*

CF = *Summer peak Coincidence Factor for measure = 0.56*[372]

[371] www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals

[372] Based on hourly AC metering data and thermostat runtime data for residential sites in NM utility territories

Full load cooling hours ($EFLH_{Cooling}$) are shown in Table 237.

Table 237: Full Load Cooling Hours for New Mexico Climate Zones[373]

	Full Load Cooling Hours ($EFLH_{Cooling}$)
Albuquerque	852
Las Cruces	1,008
Roswell	1,059
Santa Fe	562

4.8.5 NON-ENERGY BENEFITS

There are currently no non-energy benefits defined for this measure. These benefits may be added during future TRM updates.

4.8.6 MEASURE LIFE

The estimated useful life is 11 years for this measure.[374]

4.9 EFFICIENT WATER HEATERS

This measure saves water heating energy due to an increase in efficiency beyond federal standards.

4.9.1 MEASURE OVERVIEW

Sector	Residential
End use	Water Heating
Fuel	Electricity and Natural Gas
Measure category	Efficient water heaters
Delivery mechanism	Rebate
Baseline description	Federal standard minimum efficiencies for gas and electric storage and instantaneous water heaters
Efficient case description	Efficiencies meeting ENERGY STAR® standards

[373] Based on hourly AC metering data for a sample of about 230 premises in the PNM territory provided by Itron and thermostat runtime data in the EPE territory.

[374] DEER 2008 (low-income weatherization)

4.9.2 SAVINGS

Deemed savings values are provided for annual electric, deemed electric, and annual gas savings in Table 238, Table 239, Table 240 respectively for each climate zone.[375] Savings depend on the technology type (instantaneous vs storage units) when applicable, the number of bedrooms in the space, and the storage capacity of the unit if applicable.

Table 238: Electric Water Heater Deemed Annual Energy Savings (kWh)

Number of Bedrooms	1	2			3		4		5	6
Storage Capacity	**20**	**30**	**40**	**50**	**40**	**50**	**50**	**66**	**66**	**80**
Electric Storage Water Heater										
Albuquerque	1,845	1,742	2,339	2,944	2,494	3,140	2,842	272	273	327
Las Cruces	1,657	1,564	2,100	2,644	2,240	2,820	2,553	244	246	293
Roswell	1,677	1,584	2,127	2,677	2,268	2,855	2,585	248	249	297
Santa Fe	1,991	1,880	2,524	3,177	2,692	3,389	3,068	294	295	353

The baseline equipment for electric water heaters with storage tank capacity greater than 55 gallons is a heat pump water heater, which has a much higher efficiency. This explains the significant drop in energy savings for electric water heaters once storage tank capacities exceed 55 gallons, as shown in Table 239.

Table 239: Electric Water Heater Deemed Demand Savings (kW)

Number of Bedrooms	1	2			3		4		5	6
Storage Capacity	**20**	**30**	**40**	**50**	**40**	**50**	**50**	**66**	**66**	**80**
Electric Storage Water Heater										
Albuquerque	0.162	0.153	0.205	0.258	0.219	0.275	0.249	0.024	0.024	0.029
Las Cruces	0.145	0.137	0.184	0.232	0.196	0.247	0.224	0.021	0.022	0.026
Roswell	0.147	0.139	0.186	0.235	0.199	0.250	0.227	0.022	0.022	0.026
Santa Fe	0.175	0.165	0.221	0.279	0.236	0.297	0.269	0.026	0.026	0.031

Gas-fired water heater savings is shown in Table 240.

[375] The deemed savings provided are derived using the average Uniform Energy Factors across the draw patterns.

Table 240: Gas-fired Water Heater Deemed Annual Energy Savings (Therms)

Number of Bedrooms	1	2		3			4		5	6
Storage capacity	**20**	**30**	**40**	**30**	**40**	**50**	**40**	**50**	**50**	**50**
Gas-fired Storage Water Heater										
Albuquerque	35.2	44.7	69.6	47.0	73.1	105.3	75.8	109.2	112.3	126.4
Las Cruces	31.6	46.9	62.5	42.2	65.6	94.6	68.0	98.1	100.9	113.5
Roswell	32.0	47.4	63.3	42.7	66.4	95.8	68.9	99.3	102.1	114.9
Santa Fe	38.0	56.3	75.1	50.7	78.8	113.6	81.8	117.9	121.2	136.4
Instantaneous Gas-Fired Water Heater[376]										
Albuquerque	9.4	11.7		14.0			16.4		18.7	21.1
Las Cruces	8.4	10.5		12.6			14.7		16.8	18.9
Roswell	8.5	10.6		12.8			14.9		17.0	19.2
Santa Fe	10.1	12.6		15.2			17.7		20.2	22.7
Gas-fired Storage Water Heater to Instantaneous Gas-Fired Water Heater[377]										
Albuquerque	75.2	87.5	126.6	91.9	133.0	180.2	137.9	186.9	192.2	216.2
Las Cruces	67.5	78.6	113.7	82.5	119.4	161.8	123.8	167.8	172.6	194.2
Roswell	68.4	79.6	115.2	83.6	120.9	163.9	125.4	169.9	174.8	196.6
Santa Fe	81.1	94.5	136.7	99.2	143.5	194.5	148.8	201.7	207.4	233.4

4.9.3 ENERGY SAVINGS ESTIMATION

Savings are determined with the following equations.

$$Savings = EnergyInWater * \left(\frac{1}{UEF_{Base}} - \frac{1}{UEF_{Measure}}\right)$$

Where:

Savings = *Annual energy savings, kWh or therms*

EnergyInWater = *Derived with the equation below*

UEF_{Base} = *Baseline uniform energy factor, see below*

$UEF_{Measure}$ = *Efficient uniform energy factor, see below*

= *Rated efficiency of the incented unit, if unknown use values in Table 243.*

$$EnergyInWater = GallonsPerDay * 365 * Density * C_p * (Temp_{Hot} - Temp_{Cold}) * ConversionConstant$$

[376] These savings are for replacing a baseline instantaneous gas-fired water heater with a high-efficiency instantaneous gas-fired water heater.

[377] These savings are for replacing a baseline storage gas-fired water heater with a high-efficiency instantaneous gas-fired water heater.

Where:

EnergyUse	= *Annual energy use due to changes in water temperature, kWh, or therms*
GallonsPerDay	= *Daily hot water usage in gallons, see below*
Density	= *Density of water, 8.33 lbs/gallon*
C_p	= *Heat capacity of water, 1.0 Btu/lb/°F*
$Temp_{Hot}$	= *Temperature of water in tank, 127.5 °F*
$Temp_{Cold}$	= *Temperature of inlet water, °F, see*Table 241[378]
ConversionConstant	= *Converts Btus into kWh or therms: 0.0002932972 kWh/Btu, 0.00001 therms/Btu*

Table 241 provides values for the daily hot water usage input in gallons according to end usage based on the number of bedrooms.

Table 241:Domestic Hot Water Consumption by End Use [379]

Number of bedrooms	**1**	**2**	**3**	**4**	**5**	**6**
Clothes Washer	10.0	12.5	15.0	17.5	20.0	22.5
Dishwasher	3.3	4.2	5.0	5.8	6.7	7.5
Shower	18.7	23.3	28.0	32.7	37.4	42.0
Bath	4.7	5.8	7.0	8.2	9.4	10.5
Sinks	16.7	20.8	25.0	29.1	33.3	37.5
Total	**53.3**	**66.7**	**80.0**	**93.3**	**106.7**	**120.0**

Baseline case UEF's are shown in Table 242. The value for UEF is derived from the equation provided in the table, which uses the unit's volume (Vr - in gallons).

[378] Inlet water temperature is calculated using NREL report "Building America Performance Analysis Procedures for Existing Homes". Ambient temperature for Albuquerque, Las Cruces, Roswell and Santa Fe are taken from the TMY data.

[379] Hot water consumption is calculated based on different uses of water in a house as given in the Building America Research Benchmark report. https://www.nrel.gov/docs/fy10osti/47246.pdf

Table 242: Baseline UEF for Electric and Gas-fired Water Heaters[380]

Product Class	Rated Storage Volume	Draw pattern[381]	Uniform Energy Factor*
Electric storage	≥20 gal and ≤55 gal	Very Small	0.8808 – (0.0008 × Vr)
		Low	0.9254 – (0.0003 × Vr)
		Medium	0.9307 – (0.0002 × Vr)
		High	0.9349 – (0.0001 × Vr)
	>55 gal and ≤100 gal	Very Small	1.9236 – (0.0011 × Vr)
		Low	2.0440 – (0.0011 × Vr)
		Medium	2.1171 – (0.0011 × Vr)
		High	2.2418 – (0.0011 × Vr)
Gas-fired storage	≥20 gal and ≤55 gal	Very Small	0.3456 – (0.0020 × Vr)
		Low	0.5982 – (0.0019 × Vr)
		Medium	0.6483 – (0.0017 × Vr)
		High	0.6920 – (0.0013 × Vr)
	>55 gal and ≤100 gal	Very Small	0.6470 – (0.0006 × Vr)
		Low	0.7689 – (0.0005 × Vr)
		Medium	0.7897 – (0.0004 × Vr)
		High	0.8072 – (0.0003 × Vr)
Instantaneous Gas-fired	<2 gal & >50,000 Btu/h	Very Small	0.8
		Low	0.81
		Medium	0.81
		High	0.81
Instantaneous Electric	<2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92

Efficient case UEF's are shown in Table 243.

[380] Water heater uniform energy factors are taken from the Code of Federal Regulation 10 CFR 430.32 Energy and water conservation standards. https://www.ecfr.gov/cgi-bin/text-idx?SID=80dfa785ea350ebeee184bb0ae03e7f0&mc=true&node=se10.3.430_132&rgn=div8

[381] The draw pattern is governed by 10 CFR 429.17- Water Heaters. Maximum gallons per minute for different draw patterns are as follows: Very Small- 1.7 gal/min, Low- 2.8 gal/min, Medium-4 gal/min, High-No upper limit.

Table 243: Measure UEF for Electric and Gas-fired Water Heaters[382]

Product Class	Rated Storage Volume	Uniform Energy Factor
Electric	≤ 55 gallons	3.50[383]
	> 55 gallons	3.57[384]
Gas-fired storage	≤ 55 gallons, Medium Draw Pattern	0.64
	≤ 55 gallons, High Draw Pattern	0.68
	> 55 gallons, Medium Draw Pattern	0.78
	> 55 gallons, High Draw Pattern	0.80
Gas-fired instantaneous	-	0.87

4.9.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using:

$$kW_{savings} = kWh_{savings} \text{ X } Ratio_{Annual\ kWh}^{Peak\ kW}$$

Where:

$kW_{savings}$ = *Annual demand savings, in kW*

$kWh_{savings}$ = *Annual energy savings as calculated above*

$Ratio_{Annual\ kWh}^{Peak\ kW}$ = *Peak kW to annual energy kWh ratio, 0.0000877*[385]

4.9.5 NON-ENERGY BENEFITS

Higher efficiency water heaters generally have a longer lifespan.

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[382] Measure efficiency of water heaters based on the ENERGY STAR requirements. https://www.energystar.gov/sites/default/files/Water%20Heaters%20Final%20Version%203.2_Program%20Requirements.pdf

[383] Average efficiency of listed electric ENERGY STAR water heaters with rated storage volume. https://www.energystar.gov/productfinder/product/certified-water-heaters/

[384] Average efficiency of listed electric ENERGY STAR water heaters with rated storage volume. https://www.energystar.gov/productfinder/product/certified-water-heaters/

[385] 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).

4.9.6 MEASURE LIFE

The measure life for this equipment is shown in Table 244.[386]

Table 244: Residential Water Heater Measure Life (years)

Measure	Measure Life
Gas storage	11
Gas Instantaneous	20
Electric (HPWH)	13

4.10 HIGH EFFICIENCY GAS FURNACE (CONDENSING)

This measure involves the installation of a new high efficiency, gas-fired condensing furnace for residential space heating, instead of a new baseline gas furnace with a federal standard efficiency. The measure could be installed in either an existing or new home.

4.10.1 MEASURE OVERVIEW

Sector	Residential
End use	Space Heating
Fuel	Natural Gas
Measure category	High Efficiency Gas Furnaces
Delivery mechanism	Rebate
Baseline description	Federal standard minimum efficiency for gas furnace, effective May 1, 2013. AFUE = 0.80
Efficient case description	AFUE ≥ 0.90

4.10.2 SAVINGS

Savings are a function of the baseline and as-installed furnace efficiency (AFUE), input capacity (CAP_{Input}), and effective full load hours (EFLH) of operation. The efficiency and the CAP_{Input} values are application-specific, whereas the EFLH is deemed according to weather zone. A de-

[386] IL TRM, DEER, NW Power Council, NREL National Database of Energy Efficiency measures - http://www.nrel.gov/ap/retrofits/measures.cfm?gId=6&ctId=270&scId=4142&acId=4142

rating factor is also applied to account for research indicating a nominal discrepancy between rated efficiency and actual operating efficiency for both the baseline and efficient cases.

4.10.3 ENERGY SAVINGS ESTIMATION

The savings for the installation of a high efficiency furnace are calculated using the formula shown below.

$$Therm_{Savings} = \frac{\frac{EFLH_H \times CAP_{Input}}{(1 - Derating_{eff})} \times \left(\frac{AFUE_{eff} \times (1 - Derating_{eff})}{AFUE_{base} \times (1 - Derating_{base})} - 1\right)}{100{,}000}$$

Where:

$Therm_{Savings}$ = *Annual gas savings*

CAP_{Input} = *Gas Furnace input capacity, Btu/hr*

$EFLH_H$ = *Effective Full Load Hours of the furnace for the climate region, Table 245*

$AFUE_{base}$ = *Baseline Furnace Annual Fuel Utilization Efficiency rating, 0.80*

$AFUE_{eff}$ = *Efficient Furnace Annual Fuel Utilization Efficiency rating, actual*

$Derating_{base}$ = *Baseline furnace AFUE derating, 0.064387*

$Derating_{eff}$ = *Efficient furnace AFUE derating*

= *0.000 if verified quality installation is performed*

= *0.064388 if verified quality installation is not performed or unknown*

Table 245 provides values for effective full load hours for each climate zone.

Table 245: Residential Full Load Heating Hours for New Mexico Climate Zones

Location	$EFLH_H$
Albuquerque	1,358
Las Cruces	899
Roswell	921
Santa Fe	1,447

[387] Brand, L., Yee, S., and Baker, J. "Improving Gas Furnace Performance: A Field and Laboratory Study at End of Life." Building Technologies Office. National Renewable Energy Laboratory. 2015

[388] Ibid

4.10.4 DEMAND SAVINGS ESTIMATION

There are no demand savings for this measure.

4.10.5 NON-ENERGY BENEFITS

Higher efficiency furnaces generally have a longer lifespan.

4.10.6 MEASURE LIFE

The measure life for this equipment is 20 years.[389]

4.11 HIGH EFFICIENCY GAS BOILER (CONDENSING)

This measure involves the installation of a new residential sized ENERGY STAR® qualified high efficiency gas-fired condensing boiler for residential space heating, instead of a new baseline gas boiler. The measure could be installed in either an existing or new home or multifamily building.

4.11.1 MEASURE OVERVIEW

Sector	Residential
End use	Space Heating
Fuel	Natural Gas
Measure category	High Efficiency Gas Boilers
Delivery mechanism	Rebate
Baseline description	For single-family: Federal standard minimum efficiency for gas boiler, effective May 1, 2013. AFUE = 0.82 For multifamily: Hot water boiler (300 - 2500 kBtuh, 80.0 Et) Hot water boiler (> 2,500 kBtuh, 80.0 Et, 82.0Ec) Hot water boiler (< 300 kBtuh, 82.0 AFUE) Steam boiler (300 – 2,500 kBtuh, 79.0 Et) Steam boiler (> 2,500 kBtuh, 79.0 Et, 82.0Ec) Steam boiler (< 300 kBtuh, 80.0 AFUE)
Efficient case description	For single-family: ENERGY STAR® qualified, AFUE > or = 0.90 For multifamily: Greater efficiency than baseline boiler

[389] US Department of Energy, WPN 19-4: Revised Energy Audit Approval Procedures, Related Audit, and Material Approvals, Attachment 9, January 17, 2019.

Et: Thermal Efficiency, Ec: Combustion Efficiency, AFUE: Annual Fuel Utilization Efficiency

4.11.2 SAVINGS

Savings are a function of the baseline and as-installed boiler efficiency (EF), output capacity (CAP), and effective full load hours (EFLH) of operation. The efficiency and the CAP values are application-specific, whereas the EFLH is deemed according to weather zone. A de-rating factor is also applied to take into account research indicating a nominal discrepancy between rated efficiency and actual operating efficiency for both the baseline and efficient cases.

4.11.3 ENERGY SAVINGS ESTIMATION

Savings are determined with the following equation.

$$Savings = CAP * \left(\frac{1}{C_B * 0.82} - \frac{1}{C_E * EF_{AE}}\right) * EFLH_{CR} * 0.01$$

Where:

Savings	*= Annual energy savings, therms*
CAP	*= Efficient boiler rated output capacity, MBH*
EF_E	*=Efficient boiler rated efficiency*
C_B	*=De-rating factor for baseline boiler, 0.967*[390]
C_E	*=De-rating factor for efficient boiler, 0.941*[391]
$EFLH_{CR}$	*= Effective full load hours of boiler operation for the climate region*
0.01	*= Conversion factor from kBtu to therms, 0.01 therms/kBtu*
0.82	*= Federal standard minimum efficiency for gas boiler, effective May 1, 2013.*

CAP and EF_E are variable according to the application. $EFLH_{CR}$ is determined with the following equation.

$$EFLH_{CR} = \left(24 * \left(\frac{1}{Sizing\ Factor}\right) * HDD_{CR}\right) / (55 - T_{CR})$$

Where:

Sizing Factor	*= Sizing factor to account for the difference between net and gross output, given piping losses and initial pickup, 1.15*[392]
HDD_{CR}	*= Heating Degree Days at base 55°F for the climate zone*[393]

[390] High Efficiency Heating Equipment Impact Evaluation (Cadmus, 2015)

[391] Ibid.

[392] 2016 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 32 Section 5.

[393] An Analysis of Representative Heating Load Lines for Residential HSPF Ratings (ORNL, July 2015)

T_{CR} = *99% Heating Design Outdoor Air Temperature for the climate zone*[394]

Table 246 shows the HDD_{CR}, T_{CR}, and $EFLH_{CR}$ for each of the four New Mexico climate regions.

Table 246: Climate Region Parameters

Parameter	Albuquerque	Las Cruces	Roswell	Santa Fe
HDD_{CR}	2,213	1,508	1,588	3,121
T_{CR}	21	20	19	10
$EFLH_{CR}$	1,358	899	921	1,447

Example: An Energy star® qualified boiler is installed in place of existing minimum efficiency boiler. The rated capacity of the boiler is 200 kBtuh with 90% boiler efficiency.

$$Savings = 200\ kBtuh\ x\ \left[\left(\frac{1}{0.967 \times 0.82}\right) - \left(\frac{1}{0.941 \times 0.90}\right)\right] x\ 1250\ hours\ x\ 0.01$$

$$= 200.88\ therms$$

4.11.4 DEMAND SAVINGS ESTIMATION

No demand savings are associated with this measure.

4.11.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.11.6 MEASURE LIFE

The measure life for this equipment is 20 years.[395]

4.12 ADVANCED POWER STRIPS

Advanced power strips (APSs) help reduce phantom loads in home entertainment and office setups, where devices consume electricity even when turned off. APSs detect when the main device, typically a TV or computer, is turned off or enters low-power mode, and they automatically cut power to connected peripheral devices, saving energy.

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394 Energy-Star Certified Homes Design Temperatures by County.

395 US Department of Energy, WPN 19-4: Revised Energy Audit Approval Procedures, Related Audit, and Material Approvals, Attachment 9, January 17, 2019.

Tier 1 APSs operate using a master control socket system. When the device connected to the master socket is turned off, the APS shuts off power to the peripherals plugged into the controlled power-saver sockets. To power the peripherals, the device in the master socket must be turned on and remain on.

4.12.1 MEASURE OVERVIEW

Sector	Residential
End use	Plug Load
Fuel	Electricity
Measure category	Advanced Power Strips
Delivery mechanism	Rebate/Direct Install/Leave-behind/Mail-by-request
Baseline description	Standard power strip, or no power strip
Efficient case description	Load sensing Advanced Power Strip (APS) - power to peripheral devices is shut off when the controlling device is turned off or enters low power mode - in one of the following applications 1. Home Entertainment 2. Home Office 3. Unspecified application

4.12.2 SAVINGS

Deemed energy and demand savings for the measure are shown in Table 247 per appliance connected to the APS by application.

Table 247: Advanced Power Strip Electric Energy and Demand Savings

Application	Energy Savings (kWh)	Demand Savings (kW)
Home Entertainment	62	0.0068
Home Office	36	0.0039
Unspecified	52	0.0057

4.12.3 ENERGY SAVINGS ESTIMATION

Savings are based on the following equation, which is general for all appliances.[396]

[396] Pennsylvania Technical Reference Manual (PA TRM) as the source of savings, and equations from the 2021 PA TRM are used as the basis of savings here

$$kWh_{Savings} = IdlePower_{App} \times DailyIdleHours_{App} \times 365 \times ISR$$

Parameters are described in Table 248 based on different appliance types. Note, the values presented are based on the assumption that the device is connected to a 5-outlet APS rather than the 7-outlet APS, based on program evaluation findings that the number of connected peripheral devices was not high enough to justify the higher savings.[397]

Table 248: Advanced Power Strip Inputs & Sources

Variable	Definition	Value
$IdlePower_{TV}$	Idle power draw of home entertainment peripheral devices, kW	0.0085[398,399]
$DailyIdleHours_{TV}$	Number of hours per day the home entertainment system is not in use	20[398]
$IdlePower_{Comp}$	Idle power draw of home office peripheral devices, kW	0.0049[398,399,400]
$DailyIdleHours_{Comp}$	Number of hours per day the home office system is not in use	20[398]
ISR	In-service-rate	Provided by implementer, according to delivery mechanism

The energy savings and demand reduction are calculated for both home office and home entertainment use for Tier 1 strips. For Tier 1 strips, if the intended use of the power strip is not specified, or if multiple power strips are purchased, the values for "unspecified use" should be applied. If it is known that the power strip is intended to be used for an entertainment center, the "entertainment center" values should be applied, while the "home office" values should be applied if it is being used in a home office setting. Where the installed application is unknown, the probabilities of installation application are shown in Table 249.[401] These weightings are used to derive the "Unspecified" measure application.

397 PNM/Ecova Savings Brief, citing ADM evaluation

398 PNM/Ecova Savings Brief, citing "Electricity Savings Opportunities for Home Electronics and Other Plug-In Devices in Minnesota Homes", Energy Center of Wisconsin, May 2010.

399 PNM/Ecova Savings Brief, citing "Advanced Power Strip Research Report", NYSERDA, August 2011

400 PNM/Ecova Savings Brief, citing "Smart Plug Strips", ECOS, July 2009.

401 Northwest Power & Conservation Council, Regional Technical Forum, https://rtf.nwcouncil.org/measure/residential-advanced-power-strips/(The PA TRM just uses a 50/50 installation split with no source cited.)

Table 249: Advanced Power Strip Installation Weightings

Application	Weighting
Home Entertainment	61%
Home Office	39%

The in-service-rate (ISR) is a combination of the installation rate and the removal rate. This value will vary according to delivery mechanism and should be determined by the program implementer according to evaluation results of this or similar measures.

4.12.4 DEMAND SAVINGS ESTIMATION

Savings are derived with the following equation.

$$Demand\ kW_{Savings} = kWSavings_{App} \times CoincidenceFactor$$

Parameters in this equation are described in Table 250.

Table 250: Advanced Power Strips Peak Demand Savings Inputs and Sources

Variable	Definition	Value and Source
$kWSavings_{TV}$	The power savings when the home entertainment peripheral devices are shut off	$IdlePower_{TV}$, above
$kWSavings_{Comp}$	The power savings when the home office peripheral devices are shut off	$IdlePower_{Comp}$, above
Coincidence Factor	Fraction which describes the overlap between the measure and peak hours	0.8[402]

4.12.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.12.6 MEASURE LIFE

The measure life for this equipment is 5 years.[403]

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[402] PNM/Ecova Savings Brief, citing “Efficiency Vermont coincidence factor for smart strip measure – in the absence of empirical evaluation data, this was based on the assumptions of the typical run pattern for televisions and computers in homes.”

[403] Northwest Power & Conservation Council, Regional Technical Forum, https://rtf.nwcouncil.org/measure/residential-advanced-power-strips/

4.13 HEAT PUMPS

This measure involves residential HVAC high efficiency central heat pump systems, including packaged systems, and split systems consisting of a remote condensing unit and one or more indoor units.

4.13.1 MEASURE OVERVIEW

Sector	Residential
End use	Heating and Cooling
Fuel	Electricity
Measure category	Residential heat pumps – Electric only
Delivery mechanism	Rebate
Baseline description	New Construction/Replace-on-Burnout: Federal Minimum Early Retirement: Existing Conditions
Efficient case description	More efficient than baseline

4.13.2 SAVINGS

Newly installed units must have a cooling capacity of less than 65,000 Btu/hour (5.4 tons) to be eligible for the measure. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the total cooling capacity should be determined by choosing the lower of outdoor unit or the sum of all indoor units. Federal minimum standards as defined by 42 U.S.C. 6291(16) are specified in the Code of Federal Regulations at 10 CFR 430.32(c)(3):[404]

As per the Department of Energy (DOE) Docket: EERE-2014-BT-STD-0048[405], the new testing procedure M1 will be incorporated from January 1, 2023, in the Southwest Region. The M1 testing procedure is a new method of product testing designed to better reflect current field conditions. During this test, the systems' external static pressure is increased from the current SEER (0.1 in. of water) to SEER2 (0.5 in, of water). SEER2 stands for Seasonal Energy Efficiency Ratio 2. Specifically, SEER2 is the total heat removed from the conditioned space during the annual cooling season. The new M1 testing procedure will increase systems' external static pressure by a factor of five to better reflect field conditions of installed equipment. With this

[404] Consumer Central Air Conditioner and Heat Pump Efficiency Standards (DOE): https://www.energy.gov/eere/buildings/consumer-central-air-conditioners-and-heat-pumps

[405] https://www.regulations.gov/document/EERE-2014-BT-STD-0048-0103

change, new nomenclature will be used to denote M1 ratings (including EER2 and HSPF2)[406]. Baseline efficiencies as per the new standards and their respective unit conversions are listed in Table 251. Efficiency unit Conversions are shown in Table 252.

Table 251 Baseline Efficiencies for Residential Heat Pumps Manufactured After January 1, 2023[407]

System Type	SEER	HSPF	SEER2	HSPF2
Split Heat Pump	**15**	**8.8**	**14.3**	**7.5**
Packaged Heat Pump	**14**	**8**	**13.4**	**6.7**

Table 252 Efficiency Unit Conversions[408]

Rating	Conversion
SEER2 to SEER	SEER = 1.2476 × SEER2 – 2.8674
EER2 to EER	EER = 1.0578 ×EER2 – 0.1769
HSPF2 to HSPF	HSPF = 1.1702 ×HSPF2 + 0.0700

Baseline efficiencies for residential heat pumps are shown in Table 253 for equipment manufactured prior to January 1, 2023.

406 https://www.energy.gov/sites/prod/files/2016/08/f33/Central%20Air%20Conditioners%20and%20Heat%20Pumps%20TP%20SNOPR_4.pdf

407 The 2023 federal standards (10 CFR 430.32(c)(5)) are in terms of an updated metric, depicted as SEER2, EER2, and HSPF2 and manufacturers must certify their products meet the standard according to the new test procedure and new metrics. The updated test method as well as the updated energy conservation standards were negotiated under the appliance standards and rulemaking federal advisory committee (ASRAC) in accordance with the Federal Advisory Committee Act (FACA) and the negotiated rulemaking act. An equivalent stringency of these new standards for split system heat pumps are 15 SEER and 8.8 HSPF and for single-package heat pumps are 14 SEER and 8 HSPF, as detailed in: Federal Code of Regulations, Energy Conservation Program: Energy Conservations Standards for residential Central Air Conditioners and Heat Pumps; Confirmation of effective date and compliance date for direct final rule, May 26, 2017, Docket: EERE-2014-BT-STD-0048 (https://www.regulations.gov/document/EERE-2014-BT-STD-0048-0200)

408 From PECO SWE Memo for TRM Measure 2.2.1 dated 08/12/2022. SWE conducted an analysis and modeled trendlines developed from equivalent values as stated in the Federal Code for Consumer Products (10 CFR 430.32(c) Energy and water conservation standards and their compliance dates. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C#p-430.32(c)) and ENERGY STAR criteria (ENERGY STAR Program Requirements for Central Air Source Heat Pumps and Central Air Conditioners)

Table 253: Baseline Efficiencies for Residential Heat Pumps

System Type	Manufactured Before January 2006		Manufactured Between January 2006 and January 2015		Manufactured After January 2015	
	SEER	HSPF	SEER	HSPF	SEER[409]	HSPF
Split Heat Pump	10.0	6.8	13.0	7.7	14.0	8.2
Packaged Heat Pump	9.7	6.6	13.0	7.7	14.0	8.0
Split Air Conditioner with Electric Furnace	10.0	3.41	13.0	3.41	13.0	3.41
Packaged Air Conditioner with Electric Furnace	9.7	3.41	13.0	3.41	14.0	3.41
Packaged Terminal Heat Pump (PTHP)	9.7	6.6	10.6	7.0	New Construction: 12.3 - (0.213 * Capacity/1000) Replace on Burnout: 10.8 - (0.213 * Capacity/1000)	New Construction: 3.2 - (0.026 * Capacity/1000) Replace on Burnout: 2.9 - (0.026 * Capacity/1000)

Air conditioning equipment shall be properly sized to the dwelling, based on ASHRAE or ACCA Manual J standards. Manufacturer data sheets on installed air conditioning equipment or the AHRI reference number must be provided to the utility. The installed central air conditioning equipment must be AHRI certified.

4.13.3 ENERGY SAVINGS ESTIMATION

Energy Savings can be determined using the following equations based on the measure event type of the project:

409 Capacity is the rated cooling capacity of the product in Btu/hr. If the unit's capacity is less than 7,000 Btu/hr then use 7,000 Btu/hr and if more than 15,000 Btu/hr, use 15,000 Btu/hr in the calculation (IECC 2021, Table C403.3.2(4))

New Construction and Replace-on-Burnout

$$kWh_{Savings} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{eff}}\right) +$$
$$Capacity_{Heat} * \frac{1}{1000} * EFLH_H * \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{eff}}\right)$$

Where:

$kWh_{Savings}$ = *Annual energy savings*

$Capacity_{Cool}$ = *Cooling capacity of product in Btu/hr. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system capacity is whichever is lower: the capacity of the outdoor unit, or the total capacity of the installed indoor units*

$EFLH_C$ = *Residential Effective Full Load Cooling Hours for New Mexico (Table 253)*

$SEER_{base}$ = *Seasonal Energy Efficiency Rating of the baseline cooling equipment, use "Manufactured after January 2015" column of Table 229)*

$SEER_{eff}$ = *Seasonal Energy Efficiency Rating of the efficient cooling equipment (AHRI Certificate)*

$Capacity_{Heat}$ = *Heating capacity of product in Btu/hr. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system capacity is whichever is lower: the capacity of the outdoor unit, or the total capacity of the installed indoor units*

$EFLH_H$ = *Residential Effective Full Load Heating Hours for New Mexico (Table 253)*

$HSPF_{base}$ = *Heating System Performance Factor of the baseline cooling equipment, use "Manufactured after January 2015" column of Table 253*

$HSPF_{eff}$ = *Heating System Performance Factor of the efficient cooling equipment (AHRI Certificate)*

Table 254 provides inputs for cooling and heating effective full load hours based on the climate zone.

Table 254: Residential Full Load Cooling and Heating Hours for New Mexico Climate Zones[410]

Climate Zone	$EFLH_C$	$EFLH_H$
Albuquerque	852	2,162
Las Cruces	1,008	1,909
Roswell	1,059	1,596
Santa Fe	562	2,490

410 EFLH Cooling values determined using hourly AC metering data for a sample of 230 premises in the PNM territory provided by Itron and thermostat runtime data for 3,000 premises in the EPE territory. Derived from ENERGY STAR® Air-Source Heat Pump Calculator. Las Cruces and Santa Fe values derived from El Paso and Amarillo values, respectively, with a comparison of degree-days.

Early Retirement

Annual kWh and kW should be calculated for two different time periods:

1. The estimated remaining life of the equipment that is being removed, designated the Remaining Useful Life (RUL; Table 254).
2. The remaining time in the EUL period, i.e. (EUL-RUL)

For Remaining Useful Life (RUL):

$$kWh_{Savings,RUL} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{existing}} - \frac{1}{SEER_{eff}}\right) + Capacity_{Heat} * \frac{1}{1000} * EFLH_H * \left(\frac{1}{HSPF_{existing}} - \frac{1}{HSPF_{eff}}\right)$$

Where:

$kWh_{Savings,RUL}$ = *Annual energy savings during RUL*

$SEER_{existing}$ = *Seasonal Energy Efficiency Rating of the existing cooling equipment. Use actual rated efficiency of existing unit. If existing efficiency cannot be obtained, select the federal minimum value corresponding to year of manufacture Table 253)*

$SEER_{eff}$ = *Seasonal Energy Efficiency Rating of the efficient cooling equipment (AHRI Certificate)*

$HSPF_{existing}$ = *Heating System Performance Factor of the existing cooling equipment. Use actual rated efficiency of existing unit. If existing efficiency cannot be obtained, select the federal minimum value corresponding to year of manufacture (Table 253)*

$HSPF_{eff}$ = *Heating System Performance Factor of the efficient cooling equipment (AHRI Certificate; Heat Pump only)*

For remaining time in the Estimated Useful period (EUL – RUL):

$$kWh_{Savings,EUL-RUL} = Capacity_{Cool} * \frac{1}{1000} * EFLH_C * \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{eff}}\right) + Capacity_{Heat} * \frac{1}{1,000} * EFLH_H * \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{eff}}\right)$$

Hence,

$$Lifetime\ Energy\ Savings = kWh_{Savings,RUL} * RUL + kWh_{Savings,EUL-RUL} * (EUL - RUL)$$

Where:

RUL = *Remaining Useful Life (Table 255)*

EUL = *Estimate Useful Life*

= *15 Years*

Table 255 provides the expected remaining useful life of the heat pump based on the age of the equipment.

Table 255: Remaining Useful Life (Years) of Replaced Central Heat Pump Unit[411]

Age of Equipment	Remaining Useful Life	Age of Equipment	Remaining Useful Life
1	13.7	12	7.9
2	12.7	13	7.6
3	12	14	7
4	11.3	15	6
5	10.7	16	5
6	10.2	17	4
7	9.7	18	3
8	9.3	19	2
9	8.9	20	1
10	8.5	21	0
11	8.2		

4.13.4 DEMAND SAVINGS ESTIMATION

To calculate demand savings for this measure, the baseline SEER will need to be converted to EER (Energy Efficiency Rating) using the formula:[412]

$$EER = -0.02 * SEER^2 + 1.12 * SEER$$

Peak demand savings:

$$kW_{Savings} = Capacity_{Cool} * \frac{1}{1000} * \left(\frac{1}{EER_{base}} - \frac{1}{EER_{eff}}\right) * CF$$

Where:

$kW_{Savings}$ = *Peak Demand Savings*

[411] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. "Considerations for early replacement of residential equipment." Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. RULs are capped at the 75th percentile of equipment age, 21 years, as determined based on DOE survival curves. Systems older than 21 years should use the ROB baseline.

[412] Code specified SEER values converted to EER using EER = -0.02 x $SEER^2$ + 1.12 x SEER. National Renewable Energy Laboratory (NREL) 2010, "Building America House Simulation Protocols." U.S. DOE. Revised October www.nrel.gov/docs/fy11osti/49246.pdf

$Capacity_{Cool}$	= *Cooling capacity of product in Btu/hr. For multi-split systems which have multiple indoor units connected to a single outdoor unit, the system capacity is whichever is lower: the capacity of the outdoor unit, or the total capacity of the installed indoor units*
CF	= *Coincidence Factor for residential HVAC measures, 0.564*[413]
EER_{base}	= *Full-Load Energy Efficiency Rating of the baseline cooling equipment*
EER_{eff}	= *Full-load Energy Efficiency Rating of the efficient cooling equipment (AHRI Certificate)*

4.13.5 NON-ENERGY BENEFITS

Well-designed HVAC systems increase occupant comfort and productivity.

4.13.6 MEASURE LIFE

This measure life is 15 Years.[414]

4.14 ENERGY STAR® CLOTHES DRYER

This measure involves the installation of a residential ENERGY STAR® clothes dryer in new construction or replacement-on-burnout scenarios. This measure applies to all residential applications.

4.14.1 MEASURE OVERVIEW

Sector	Residential
End use	Efficient Laundry
Fuel	Electricity and Natural Gas
Measure category	Efficient Laundry Appliances
Delivery mechanism	Prescriptive
Baseline description	Non-Energy Star® Clothes Dryer
Efficient case description	Energy Star® Clothes Dryer

4.14.2 SAVINGS

ENERGY STAR® qualified clothes dryers save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through

[413] Based on hourly AC metering data and thermostat runtime data.

[414] Texas TRM v10.0 Volume 2: Residential Measures

increased insulation, modifying operating conditions such as air flow and/or heat input rate, improving air circulation through better drum design or booster fans, and improving efficiency of motors. Reducing the runtime of dryers through automatic termination by temperature and moisture sensors is believed to have the greatest potential for reducing energy use in clothes dryers. ENERGY STAR® provides criteria for both electric and gas clothes dryers.

The baseline condition is a clothes dryer meeting the minimum federal requirements for units manufactured on or after January 1, 2015. As per federal regulations, dryers should comply with these efficiency standards as shown in Table 256.

Table 256: Federal Standards for Clothes Dryers (Manufactured After January 1, 2015)[415]

Product Class	Combined Energy Factor (lbs/kWh)
Vented Electric, Standard (4.4 cu. ft. or greater capacity)	3.73
Vented Electric, Compact (120V) (less than 4.4 cu. ft. capacity)	3.61
Vented Electric, Compact (240V) (less than 4.4 cu. ft. capacity)	3.27
Ventless Electric, Compact (240V) (less than 4.4 cu. ft capacity)	2.55
Ventless Electric, Combination Washer-Dryer	2.08
Vented Gas	3.30

In the efficient case, the clothes dryer must meet ENERGY STAR® criteria, as stated in Table 257.

[415] Code of Federal Regulations 10 CFR 430.32(h) https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

Table 257: ENERGY STAR® Clothes Dryer Efficiency Standards[416]

Product Class	Combined Energy Factor (lbs/kWh)
Vented Electric, Standard (4.4 cu. ft. or greater capacity)	3.93
Vented Electric, Compact (120V) (less than 4.4 cu. ft. capacity)	3.80
Vented Electric, Compact (240V) (less than 4.4 cu. ft. capacity)	3.45
Ventless Electric, Compact (240V) (less than 4.4 cu. ft capacity)	2.68
Ventless Electric, Combination Washer-Dryer	3.93
Vented Gas	3.48

The maximum test cycle time for a clothes dryer is typically 80 minutes.[417]

4.14.3 ENERGY SAVINGS ESTIMATION

Electric savings can be determined using the formula below.

$$kWh_{savings} = \left(\frac{Load}{CEF_{Baseline}} - \frac{Load}{CEF_{ES}}\right) * N_{Cycles} * \%Electric$$

Where:

$Load$ = *The average total weight (lbs) of clothes per drying cycle. If dryer size is unknown, assume Standard dryer size.*

$CEF_{Baseline}$ = *Combined Energy Factor in lbs/kWh of the baseline unit. If dryer is electric but product class is unknown, assume vented electric standard.*

CEF_{ES} = *Combined Energy Factor in lbs/kWh of the ENERGY STAR® unit. If dryer is electric but product class is unknown, assume vented electric standard.*

N_{Cycles} = *Number of dryer cycles per year. Use actual data if available. If unknown, use 283 cycles per year*[418]

[416] ENERGY STAR® Clothes Dryer Key Product Criteria https://www.energystar.gov/products/appliances/clothes_dryers/key_product_criteria

[417] ENERGY STAR® Clothes Dryer Key Product Criteria https://www.energystar.gov/products/appliances/clothes_dryers/key_product_criteria

[418] 10 CFR Chapter II, Subchapter D, Part 430, Subpart B, Appendix D1– Uniform Test Method for Measuring the Energy Consumption of Clothes Dryers.

$\%Electric$ = *Percent of overall savings coming from electricity (100% for Electric, 16% for Gas)*[419]

Table 258 provides the average load per drying cycle for a clothes dryer.

Table 258: Average Load of Clothes Per Drying Cycle

Dryer Size	Load (lbs)[420]
Standard	8.45
Compact	3

Natural Gas Savings can be determined using the formula below.

$$Therm_{savings} = \left(\frac{Load}{CEF_{Baseline}} - \frac{Load}{CEF_{ES}}\right) * N_{Cycles} * Conversion\ Factor * \%Gas$$

Where:

$Conversion\ Factor$ = *Conversion Factor from kWh to Therms*
= *0.03413 therm/kWh*

$\%Gas$ = *Percent of overall savings coming from natural gas (0% for Electric, 84% for Gas)*

Example: A standard vented electric dryer is replaced with ENERGY STAR® vented electric dryer.

$kWh_{savings}$ = *(8.45 lbs/ 3.73 lbs/kWh – 8.45 lbs/3.93 lbs/kWh) x 283 cycles/year x 100%*

= *32.62 kWh*

$kW_{savings}$ = *32.62/ (283 x 80) x 0.07 = 0.0001 kW*

4.14.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following equation.

$$kW_{savings} = \frac{kWh_{savings}}{Hours} * CF$$

Where:

$Hours$ = *Annual Operating Hours*

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[419] %Electric accounts for the fact that some of the savings on gas dryers come from electricity (motors, controls, etc.). 16% was determined using a ratio of the electric to total savings from gas dryers given by ENERGY STAR® Draft 2 Version 1.0 Clothes Dryers Data and Analysis.

[420] Based on ENERGY STAR® Dryer Test Criteria https://www.energystar.gov/products/appliances/clothes_dryers/key_product_criteria

$= N_{Cycles} * \frac{d}{60\ min/hr}$ *(where d is the Average Duration of a Drying cycle, 80 minutes)*

CF = *Coincidence Factor = 0.07*[421]

4.14.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.14.6 MEASURE LIFE

The average lifetime of this measure is 14 years according to the US DOE.[422]

4.15 ENERGYSTAR® CLOTHES WASHER

This measure involves the installation of a residential ENERGYSTAR® clothes washer in new construction or replacement-on-burnout scenarios. This measure applies to all residential applications.

4.15.1 MEASURE OVERVIEW

Sector	Residential
End use	Efficient Laundry
Fuel	Electricity and Natural Gas
Measure category	Efficient Laundry Appliances
Delivery mechanism	Prescriptive
Baseline description	Non-ENERGY STAR® Clothes Washer
Efficient case description	ENERGY STAR® Clothes Washer

[421] Value from Clothes Washer Measure, Mid Atlantic TRM 2014. Metered data from Navigant Consulting "EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Appliance Rebate Program." March 21, 2014, p. 36.

[422] Based on an average estimated range of 12-16 years. ENERGY STAR® Market & Industry Scoping Report. Residential Clothes Dryers. November 2011 http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf

4.15.2 SAVINGS

The baseline for this measure is equal to the current federal minimum efficiency levels, as shown in Table 259 for all new construction and replace on burnout scenarios.[423] For the replacement of a washer prior to the end of its useful life, the baseline efficiency levels may correspond to the configuration of the pre-existing washer, even if it does not match that of the new washer.

Table 259: Baseline Efficiency for Clothes Washer Configurations

Clothes Washer Configuration	Baseline Efficiency (Federal)
Top Loading (Standard, 1.6 cu. ft. or greater)	IMEF ≥ 1.57 WF ≤ 6.5
Top Loading (Compact, 1.6 cu. ft. or less)	IMEF ≥ 1.15 WF ≤ 12.0
Front Loading (Standard, 1.6 cu. ft. or greater)	IMEF ≥ 1.84 WF ≤ 4.7
Front Loading (Compact, 1.6 cu. ft. or less)	IMEF ≥ 1.13 WF ≤ 8.3

Efficiency performance for clothes washers is characterized by Integrated Modified Energy Factor (IMEF) and Integrated Water Factor (IWF). The units for IMEF are cu. ft./kWh/cycle. Units with higher IMEF values are more efficient. The units for IWF are gallons/cycle/cu. ft. Units with lower IWF values will use less water and are therefore more efficient.

The efficiency standard is the ENERGY STAR® requirements for clothes washers, as shown in Table 260.[424]

Table 260: ENERGY STAR® Efficiency for Clothes Washer Configurations

Clothes Washer Configuration	ENERGY STAR Efficiency
Top Loading (Greater than 2.5 cu. ft.)	IMEF ≥ 2.06 WF ≤ 4.3
Washer 2.5 cu. ft. or less	IMEF ≥ 2.07 WF ≤ 4.2
Front Loading (Greater than 2.5 cu. ft.)	IMEF ≥ 2.76 WF ≤ 3.2

423 Current federal standards for clothes washers can be found on the DOE website at: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=68&action=viewlive

424 Current ENERGY STAR® criteria for clothes washers can be found on the ENERGY STAR® website at: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

4.15.3 ENERGY SAVINGS ESTIMATION

Energy Savings for this measure were derived using the ENERGY STAR® Clothes Washer Savings Calculator.[425] Unless otherwise specified, all savings assumptions are extracted from the ENERGY STAR® calculator. The baseline and ENERGY STAR® efficiency levels are set to match Table 259 and Table 260. The ENERGY STAR® calculator determines savings based on whether an electric or gas water heater is used. Calculations are also conducted based on whether the dryer is electric or gas.

For applications using an electric water heater and an electric dryer, the savings are calculated as follows:

$$kWh_{savings} = (E_{conv,machine} + E_{conv,WH} + E_{conv,dryer}) - (E_{ES,machine} + E_{ES,WH} + E_{ES,dryer})$$

Where:

$E_{conv,machine}$	= *Conventional Machine Energy (kWh)*
$E_{conv,WH}$	= *Conventional Water Heater Energy (kWh)*
$E_{conv,dryer}$	= *Dryer Energy needed in combination with a conventional washer (kWh)*
$E_{ES,machine}$	= *ENERGY STAR® Machine Energy (kWh)*
$E_{ES,WH}$	= *ENERGY STAR® Water Heater Energy (kWh)*
$E_{ES,dryer}$	= *Dryer Energy needed in combination with an ENERGY STAR® washer (kWh)*

Energy consumption for the above factors can be determined using the following algorithms.

$$E_{conv,machine} = \frac{MCF * RUEC_{conv} * LPY}{RLPY}$$

$$E_{conv,WH} = \frac{WHCF * RUEC_{conv} * LPY}{RLPY}$$

$$E_{conv,dryer} = \left[\left(\frac{CAP * LPY}{IMEF_{FS}} - \frac{RUEC_{conv} * LPY}{RLPY}\right)\right] * \frac{DU_{DW}}{DUF}$$

$$E_{ES,machine} = \frac{MCF * RUEC_{ES} * LPY}{RLPY}$$

$$E_{ES,WH} = \frac{WHCF * RUEC_{ES} * LPY}{RLPY}$$

[425] The ENERGY STAR® Clothes Washer Savings Calculator can be found on the ENERGY STAR® website https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

$$E_{ES,dryer} = \left[\left(\frac{CAP * LPY}{IMEF_{ES}} - \frac{RUEC_{ES} \ * LPY}{RLPY}\right)\right] * \frac{DU_{DW}}{DUF}$$

If the water heater is gas, the following equation is used to determine therms savings from water heating:

$$therms_{savings,WH} = \frac{WHCF * LPY}{RLPY * \eta_{gas\,WH}} * \frac{0.03412\ therms}{kWh} * (RUEC_{conv} - \ RUEC_{ES})$$

If the dryer is gas, the following equation is used to determine therms savings from reduced time for drying:

$$therm_{savings,dryer} =$$

$$\left[\left[\left(\frac{CAP * LPY}{IMEF_{FS}} - \frac{RUEC_{conv} \ * LPY}{RLPY}\right)\right] - \left[\left(\frac{CAP * LPY}{IMEF_{ES}} - \frac{RUEC_{ES} \ * LPY}{RLPY}\right)\right]\right]$$

$$* \frac{0.03412\ therms}{kWh} * \frac{DU_{DW}}{DUF}$$

Where:

MCF	= *Machine Electricity Consumption Factor = 20%*	
$WHCF$	= *Water Heater Electricity Consumption Factor = 80%*	
$RUEC_{conv}$	= *Rated Unit Electricity Consumption (kWh/year) =*	
		381 (Top Loading, > 2.5 cu. ft.);
		169 (Front Loading, > 2.5 cu. ft.);
		163 (≤ 2.5 cu. ft.)
$RUEC_{ES}$	= *Rated Unit Electricity Consumption (kWh/year) =*	
		230 (Top Loading, > 2.5 cu. ft.);
		127 (Front Loading, > 2.5 cu. ft.);
		108 (≤ 2.5 cu. ft.)
CAP	= *Clothes Washer Capacity, cu. ft.*	
$IMEF_{FS}$	= *Federal Standard Integrated Modified Energy Factor (cu. ft./kWh/cycle)*	
$IMEF_{ES}$	= *ENERGY STAR® Integrated Modified Energy Factor (cu. ft./kWh/cycle)*	
LPY	= *Loads per year = 295*	
$RLPY$	= *Reference Loads per year = 392*	
DU_{DW}	= *Dryer Use in households with both a washer and dryer = 95%*	
DUF	= *Dryer Use Factor = 91%*	
$\eta_{gas\,WH}$	= *Gas water heater efficiency = 75%*	

All the assumed factors and utilization factors in the measure have been sourced from the ENERGY STAR® Appliance Calculator[426].

4.15.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following equation:

$$kW_{savings} = \frac{kWh_{savings}}{AOH} * CF$$

Where:

AOH = *Annual Operating Hours* = $LPY * d$, *where d is the Average wash cycle duration (1 hour)*

CF = *Coincidence Factor = 0.07*[427]

4.15.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.15.6 MEASURE LIFE

The estimated useful life (EUL) of an ENERGY STAR® clothes washer is established at 11 years based on the Technical Support Document for the current DOE Final Rule standards for residential clothes washers.[428]

4.16 FLOOR INSULATION

Floor insulation is installed on the underside of floor areas sitting below conditioned space. Typically, it is installed in ventilated crawlspaces. Savings are presented per square foot of treated floor area.

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[426] The ENERGY STAR® Clothes Washer Savings Calculator can be found on the ENERGY STAR® website https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

[427] Value from Clothes Washer Measure, Mid Atlantic TRM 2014. Metered data from Navigant Consulting "EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Appliance Rebate Program." March 21, 2014, p. 36.

[428] The median lifetime was calculated using the survival function outlined in the DOE Technical Support Document. Final Rule: Standards, Federal Register, 77 FR 32308 (May 31, 2012) and associated Technical Support Document. Accessed 10/07/2014.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39
Download TSD at: http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0019-0047

4.16.1 MEASURE OVERVIEW

Sector	Residential
End use	Insulation
Fuel	Electricity and Gas
Measure category	Building Envelope
Delivery mechanism	Prescriptive, Retrofit
Baseline description	No Floor Insulation
Efficient case description	R-19 or Greater Floor Insulation*

**A minimum of 24-inch clearance from bottom of the insulation to the ground is required by Occupational Safety and Health Association (OSHA).*

4.16.2 SAVINGS

Calibrated simulation modeling for Texas climate zones 1-5 was used to develop these deemed savings values as listed in the Texas Technical Reference Manual.[429]

Deemed savings estimates were calculated using BEopt 2.6, running Energy Plus 8.1 for the Texas climate zones, and adjusted for weather for New Mexico climate zones. The deemed cooling and heating savings from Texas Climate Zone 5 were adjusted as per the cooling degree days and heating degree days for all the New Mexico climate zones.

The baseline for this measure is an existing floor space with no insulation. This measure is not eligible for new construction homes.

4.16.3 ENERGY SAVINGS ESTIMATION

Table 261 through Table 264 present deemed energy savings on a kWh per square foot of insulation installed basis for all four New Mexico climate zones. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

Table 261: Albuquerque - Residential Floor Insulation Deemed Annual Energy Saving (kWh/sq.ft.)

Home Type	Cooling Savings		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Electric Resistance	Heat Pump	Natural Gas (Therms)
Site-Built Home	-0.16	-0.07	1.35	0.53	0.0577
Manufactured Home	-0.13	-0.06	1.19	0.47	0.0509

[429] Texas Technical Reference Manual, Version 10.0, Volume 2: Residential Measures, Program Year 2023)

Table 262: Roswell - Residential Floor Insulation Deemed Annual Energy Saving (kWh/sq.ft.)

Home Type	Cooling Savings		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Electric Resistance	Heat Pump	Natural Gas (Therms)
Site-Built Home	-0.14	-0.06	1.34	0.52	0.0572
Manufactured Home	-0.12	-0.05	1.18	0.46	0.0504

Table 263: Las Cruces - Residential Floor Insulation Deemed Annual Energy Saving (kWh/sq.ft.)

Home Type	Cooling Savings		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Electric Resistance	Heat Pump	Natural Gas (Therms)
Site-Built Home	-0.16	-0.07	1.35	0.53	0.0575
Manufactured Home	-0.13	-0.06	1.19	0.47	0.0507

Table 264: Santa Fe - Residential Floor Insulation Deemed Annual Energy Saving (kWh/sq.ft.)

Home Type	Cooling Savings		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Electric Resistance	Heat Pump	Natural Gas (Therms)
Site-Built Home	-0.06	-0.03	2.91	1.14	0.1241
Manufactured Home	-0.05	-0.02	2.57	1.01	0.1095

4.16.4 DEMAND SAVINGS ESTIMATION

Table 265 to Table 268 present deemed peak demand savings on a kW per square foot for all four New Mexico climate zones.

Table 265: Albuquerque - Residential Floor Insulation Deemed Peak Demand Saving (kW/sq.ft.)

Home Type	Refrigerated Air	Evaporated Cooling
Site-Built Home	6.32E-05	-1.35E-06
Manufactured Home	8.34E-07	1.86E-07

Table 266: Roswell - Residential Floor Insulation Deemed Peak Demand Saving (kW/sq.ft.)

Home Type	Refrigerated Air	Evaporated Cooling
Site-Built Home	5.65E-05	-1.20E-06
Manufactured Home	7.46E-07	1.66E-07

Table 267: Las Cruces - Residential Floor Insulation Deemed Peak Demand Saving (kW/sq.ft.)

Home Type	Refrigerated Air	Evaporated Cooling
Site-Built Home	6.19E-05	-1.32E-06
Manufactured Home	8.17E-07	1.82E-07

Table 268: Santa Fe - Residential Floor Insulation Deemed Peak Demand Saving (kW/sq.ft.)

Home Type	Refrigerated Air	Evaporated Cooling
Site-Built Home	2.32E-05	-4.95E-07
Manufactured Home	3.06E-07	6.83E-08

4.16.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.16.6 MEASURE LIFE

The EUL for this measure is 30 years.[430]

4.17 WATER HEATER PIPE INSULATION

This measure involves the installation of pipe insulation on un-insulated domestic water heater pipes.

4.17.1 MEASURE OVERVIEW

Sector	Residential (DHW only)
End use	Insulation
Fuel	Electric, Natural Gas
Measure category	Water Heater
Delivery mechanism	Prescriptive
Baseline description	Uninsulated Hot Water Pipe
Efficient case description	Insulated Hot Water Pipe

4.17.2 SAVINGS

The baseline is assumed to be a typical electric/gas/heat pump water heater with no heat traps and no insulation on water heater pipes.

New construction and retrofits involving the installation of new water heaters are not eligible for this new measure.

[430] US Department of Energy, WPN 19-4: Revised Energy Audit Approval Procedures, Related Audit, and Material Approvals, Attachment 9, January 17, 2019.

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. All visible hot water piping must be insulated. Savings are based on a maximum allowable insulation length of 6 feet of piping.

4.17.3 ENERGY SAVINGS ESTIMATION

Hot water pipe insulation energy savings are calculated using the formula:

$$Energy\ Savings\ per\ Year{:}Annual\ Energy\ Savings = (U_{Pre} - U_{Post}) * A * (T_{Pipe} - T_{Ambient}) * \left(\frac{1}{Eff}\right) * Hours_{otal} * \frac{1}{Conversion\ Factor}$$

Where:

U_{Pre}431 = *1/(2.03 + R_{Pipe}) Btu/hr sq. ft. °F (R_{Pipe} is considered to be 0 given the high conductivity of bare metal pipe)= 0.4926 Btu/hr sq. ft. °F*

U_{Post} = *1/(2.03+$R_{insulation}$) Btu/hr sq. ft. °F*

$R_{insulation}$ = *R-value of 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 not known, use Table 269*

T_{Pipe} = Average temperature of the pipe, use 127.5 °F[432]

$T_{Ambient}$ = Average annual temperature, use table below

Eff = System Efficiency (in the case of heat pump water heaters, COP; AFUE for gas water heater) of installed water heater. If unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters433 or 0.80 for natural gas storage water heaters and 0.82 for natural gas tankless water heaters434

$Hours_{Total}$ = 8,760 hours per year

$Conversion\ Factor$ = 3,412 Btu/kWh, for Electric Water Heater
= 100,000 BTU/Therm, for Gas Water Heater

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[431] 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.

[432] Preliminary visits to schools in New Mexico have shown water heater temperatures set at 125 – 130°F, within typical range for domestic hot water. Average of 127.5°F used.

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

[434] ENERGY STAR® Residential Water Heaters: Final Criteria Analysis https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterAnalysis_Final.pdf

Table 269 provides pipe surface area values based on pipe diameter and length.

Table 269: Pipe Diameter and Pipe Surface Area

Pipe Diameter (inches)	Pipe Surface Area (sq. ft.)
0.5	0.13 * Pipe Length Insulated (in feet)
0.75	0.20 * Pipe Length Insulated (in feet)
1.0	0.26 * Pipe Length Insulated (in feet)
1.25	0.33 * Pipe Length Insulated (in feet)
1.5	0.39 * Pipe Length Insulated (in feet)
2.0	0.52 * Pipe Length Insulated (in feet)

Table 270 provides the temperature values for unconditioned and conditioned areas for each climate zone.

Table 270: Temperature of Unconditioned and Conditioned Areas

Climate Zone	$T_{Ambient}$ (Unconditioned)[435]	$T_{Ambient}$ (Conditioned)
Albuquerque	61.6°F	72.7 °F[436]
Roswell	67.5°F	
Santa Fe	56.5°F	
Las Cruces	68.2 °F	

Example: Insulation (R-3) added to an uninsulated natural gas storage water heater pipe with diameter 0.5 inches and 20 feet total length.

Annual Energy Savings = *[(1/(2.03 + 0) – 1/(2.03 + 0 + 3)] Btu/hr sq. ft. °F x (0.13 x 20) sq. ft. x (127.5 – 61.6) °F x 1/0.80 x 8760 hours x 1/(100,000 BTU/Therm)*

= *5.5 Therms*

4.17.4 DEMAND SAVINGS ESTIMATION

Tank insulation demand savings can be calculated using the equation below (kW, only for electric and heat pump water heater):

$$Demand\ Savings = \frac{Annual\ Energy\ Savings}{8{,}760}$$

[435] Average ambient temperatures were taken from TMY3 data (adjusted for interior unconditioned spaces)

[436] 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

4.17.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.17.6 MEASURE LIFE

As per the 2014 California Database for Energy Efficiency Resources (DEER), the EUL for this measure is listed as 13 years.[437]

4.18 PROGRAMMABLE THERMOSTAT

This measure characterizes the household energy savings from the installation of a new programmable thermostat, or for the reprogramming of an existing unit. This allows for reduced heating and cooling energy consumption through temperature setback during unoccupied or reduced demand times.

4.18.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity, Natural Gas
Measure category	Programmable Thermostat
Delivery mechanism	Prescriptive
Baseline description	Manual Thermostat, Programmable Thermostat verified to be operated as a manual thermostat, or No Thermostat
Efficient case description	Appropriately Programmed Programmable Thermostat

4.18.2 SAVINGS

Savings for this measure are achieved by installing a programmable thermostat capable of temperature setback during unoccupied periods (Table 271). The baseline can be a manual thermostat which requires manual intervention to change temperature, a programmable thermostat operating in override mode, or no thermostat at all.

[437] 2014 California Database for Energy Efficiency Resources.

As per ENERGY STAR® guidelines, the following control scheme is ideal for a residential programmable thermostat:[438]

Table 271: Temperature Setpoint for Different Time Settings

Setting	Time	Temperature Setpoint (Heat)	Temperature Setpoint (Cool)
Wake	6:00 AM	< 70 °F	> 78 °F
Day	8:00 AM	Setback at least 8 °F	Setup at least 7 °F
Evening	6:00 PM	< 70 °F	> 78 °F
Sleep	10:00 PM	Setback at least 8 °F	Setup at least 4 °F

4.18.3 ENERGY SAVINGS ESTIMATION

Savings can be determined using the following equations:

$$\Delta kWh = \Delta kWh_{Heating} + \Delta kWh_{Cooling}$$

$$\Delta kWh_{cooling} = \frac{Capacity_{cool}}{1000\frac{W}{kW}} \times \frac{1}{SEER \times Eff_{duct}} \times EFLH_{Cool} \times Reduction_{Cool}$$

The following equations are used to determine heating savings dependent on the type of heating equipment available:

$$\Delta kWh_{heat.heatpump} = \frac{Capacity_{heat}}{1000\frac{W}{kW}} \times \frac{1}{HSPF_{heat\ pump} \times Eff_{duct}} \times EFLH_{Heat} \times Reduction_{Heat} \times \%HeatPump$$

$$\Delta kWh_{heat.electricfurn} = \frac{Capacity_{heat}}{1000\frac{W}{kW}} \times \frac{1}{HSPF_{elec\ furn} \times Eff_{duct}} \times EFLH_{Heat} \times Reduction_{Heat} \times \%ElecFurn$$

$$\Delta kWh_{heat.gasfurn} = \frac{HP_{motor} \times \left(746\frac{W}{HP}\right) \times EFLH_{Heat}}{\eta_{motor} \times 1000\frac{W}{kW}} \times Reduction_{Heat} \times \%GasFurn$$

Where:

$Capacity_{Cool}$ = *Cooling equipment's rated cooling capacity, Btu/h (36,000 Btu/h, if unknown)*[439]

$Capacity_{Heat}$ = *Heating equipment's rated heating capacity, Btu/h (34,560 Btu/h, if unknown)*[440]

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[438] A Guide to Energy-Efficient Heating and Cooling https://www.energystar.gov/ia/partners/publications/pubdocs/HeatingCoolingGuide%20FINAL_9-4-09.pdf

[439] Conservative estimate based on program data from Texas IOUs showing average cooling capacity

[440] Based on Frontier assumptions that heating capacity is 96% of cooling capacity, based on an analysis of AHRI-rated systems

$EFLH_{Cool}$ = *Estimate of annual residential cooling hours for air conditioning equipment, see Table 272*

$EFLH_{Heat}$ = *Estimate of annual residential heating hours, see Table 272.*

$1{,}000$ = *Conversion between W and kW*

$SEER$ = *Cooling equipment's Seasonal Energy Efficiency Ratio Rating, Btu/Wh (Nameplate Data; default = 13.0)*

$Reduction_{Cool}$ = *Assumed percentage reduction in total household cooling energy consumption due to installation of a programmable thermostat, 5.6%441*

$Reduction_{Heat}$ = *Assumed percentage reduction in total household heating energy consumption due to installation of a programmable thermostat, 6.2%442*

$HSPF$ = *Heating equipment's Heating Seasonal Performance Factor, Btu/Wh (Nameplate Data; default Heat Pump = 7.7, Electric Furnace = 3.412)*

Eff_{duct} = *Duct System Efficiency, 0.8443*

$\Delta kWh_{heat.gasfurn}$ = *Fan energy savings in a gas heat furnace, kWh*

HP_{motor} = *Gas furnace blower motor horsepower, HP (default = 0.5 HP)*

η_{motor} = *Efficiency of furnace blower motor horsepower (default = 50%)*

%HeatPump = *% of homes using heat pump heat. For upstream programs, default = 20%444. If heating type is known to be heat pump, use 100%.*

%ElecFurn = *% of homes using electric resistance heat. For upstream programs, default = 23%445. If heating type is known to be electric resistance, use 100%.*

%GasFurn = *% of homes using gas heat. For upstream programs, default = 57%446. If heating type is known to be gas, use 100%.*

Table 272 provides the effective full load hour inputs per climate zone for both heating and cooling equipment.

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[441] Cooling reduction estimated based on multiplying smart thermostat cooling reduction by ratio of programmable thermostat heating reduction to smart thermostat heating reduction (manual thermostat baseline); 8% x (6.2% / 8.8%) = 5.6%

[442] Value published in Illinois Technical Resource Manual v7.0, Volume 3: Residential Measures, a conservative estimate based on studies done in various regions

[443] 2014 Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation

[444] US Energy Information Administration. https://www.eia.gov/consumption/residential/data/2015/hc/php/hc6.8.php. The heating type split is considered for West Mountain South Region.

[445] Ibid.

[446] Ibid.

Table 272: Residential Full Load Cooling and Heating Hours for New Mexico Climate Zones[447]

Climate Zones	EFLHCool	EFLHHeat
Albuquerque	852	1,358
Las Cruces	1,008	899
Roswell	1,059	921
Santa Fe	562	1,447

Natural Gas Energy Savings:

$$\Delta Therms = \frac{Capacity_{Heat} \times EFLH_{Heat}}{AFUE \times Eff_{duct}} \times Reduction_{Heat} \times \%GasFurn$$

Where:

$AFUE$ = *Heating equipment's Annual Fuel Utilization Efficiency, (Nameplate Data; default = 80%)*

Example: If a house in Las Cruces installed a new programmable thermostat that has an electric heat furnace, the savings can be determined using the formula:

$$\Delta kWh_{cooling} = \frac{36{,}000\frac{Btu}{h}}{1000\frac{W}{kW}} \times \frac{1}{13.0 \times 0.8} \times 1{,}290 \times 5.6\% = 250\,kWh$$

$$\Delta kWh_{heat} = \frac{34{,}560\frac{Btu}{h}(default)}{1000\frac{W}{kW}} \times \frac{1}{3.412(default) \times 0.8} \times 1{,}909 \times 6.2\% = 1{,}498\,kWh$$

$$\Delta kWh = 250 + 1{,}498 = 1{,}748\,kWh$$

4.18.4 DEMAND SAVINGS ESTIMATION

Demand savings can be calculated using the following equation:

$$Demand\ Savings = \frac{Annual\ Energy\ Savings}{Hours_{Thermostat}} * CF$$

Where:

$Hours_{Thermostat}$ = *the annual hours the HVAC is controlled by the thermostat (listed in Table 273).*

CF = *Coincidence Factor, 100%*

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[447] EFLH Cooling values determined using metered data and thermostat data collected from residential sites located in NM utility territories. Derived from ENERGY STAR® Air-Source Heat Pump Calculator. Las Cruces and Santa Fe values derived from El Paso and Amarillo values, respectively, with a comparison of degree-days.

Table 273 provides the annual hours of operation the underlying HVAC system is controlled by the thermostat.

Table 273: Programmable Thermostat Operational Hours for Demand Savings

Climate Zone	$Hours_{Thermostat}$
Roswell	5,424
Las Cruces	5,035
Santa Fe	6,474
Albuquerque	5,876

4.18.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.18.6 MEASURE LIFE

The expected measure life of a programmable thermostat is assumed to be 10 years[448] based upon equipment life only.[449]

4.19 SMART THERMOSTATS

This measure estimates the annual energy savings from the installation of a new smart thermostat(s). This equipment allows for reduced heating and cooling consumption through a configurable schedule of temperature setpoints and automatic variations to that schedule, which provides a better match between HVAC system runtimes and occupant comfort needs.

These schedules may be defaults, established through user interaction, and changed manually at the device or remotely through a web or mobile app. Automatic variations to that schedule could be driven by local sensors and software algorithms, and/or through connectivity to an internet software service. Data triggers to automatic schedule changes might include, for example: occupancy/activity detection, arrival & departure of conditioned

[448] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007

[449] Future evaluation is strongly encouraged to inform the persistence of savings to further refine measure life assumption. As this characterization depends heavily upon a large scale but only 2-year study of the energy impacts of programmable thermostats, the longer-term impacts should be assessed.

spaces, optimization based on historical or population-specific trends, weather data, and forecasts.

4.19.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity, Natural Gas
Measure category	Smart Thermostat
Delivery mechanism	Prescriptive, Mail-in, Online
Baseline description	Manual or Programmable Thermostat
Efficient case description	Smart Thermostat

4.19.2 SAVINGS

The savings for this measure are based on studies as summarized in the Illinois Statewide Technical Reference Manual for Energy Efficiency (Version 12.0, 5.3.16). The document analyzed consumption for residences which underwent a retrofit from a manual or programmable thermostat to a smart thermostat. The study was conducted by Navigant Energy for the Illinois Stakeholder Advisor Group.[450]

4.19.3 ENERGY SAVINGS ESTIMATION

Energy Savings for this measure can be calculated using the following equations:

$$\Delta kWh = \Delta kWh_{Heating} + \Delta kWh_{Cooling}$$

$$\Delta kWh_{cooling} = \frac{Capacity_{cool}}{1000\frac{W}{kW}} \times \frac{1}{SEER \times Eff_{duct}} \times EFLH_{Cool} \times Reduction_{Cool}$$

Heating savings can be calculated using the following equations dependent on the underlying heating system:

$$\Delta kWh_{heat.heatpump} = \frac{Capacity_{heat}}{1000\frac{W}{kW}} \times \frac{1}{HSPF_{heat\ pump} \times Eff_{duct}} \times EFLH_{Heat} \times Reduction_{Heat} \times \%HeatPump$$

[450] 'Residential Smart Thermostats: Impact Analysis – Gas Preliminary Findings', December 2015

$$\Delta kWh_{heat.electricfurn} = \frac{Capacity_{heat}}{1000\frac{W}{kW}} \times \frac{1}{HSPF_{elec\ furn} \times Eff_{duct}} \times EFLH_{Heat} \times Reduction_{Heat} \times \%ElecFurn$$

$$\Delta kWh_{heat.gasfurn} = \frac{HP_{motor} \times \left(746\frac{W}{HP}\right) \times EFLH_{Heat}}{\eta_{motor} \times 1000\frac{W}{kW}} \times Reduction_{Heat} \times \%GasFurn$$

Where:

$Capacity_{Cool}$	*= Cooling equipment's rated cooling capacity, Btu/h (36,000 Btu/h, if unknown)451*
$Capacity_{Heat}$	*= Heating equipment's rated heating capacity, Btu/h (34,560 Btu/h, if unknown)*[452]
$EFLH_{Cool}$	*= Estimate of annual residential cooling hours for air conditioning equipment, see Table 274.*
$EFLH_{Heat}$	*= Estimate of annual residential heating hours, see Table 274.*
1,000	*= Conversion between W and kW*
$SEER$	*= Cooling equipment's Seasonal Energy Efficiency Ratio Rating, Btu/Wh (Nameplate Data; default = 13.0)*
$Reduction_{Cool}$	*= Assumed percentage reduction in total household cooling energy consumption due to installation of a smart thermostat, 8.4%*[453]
$Reduction_{Heat}$	*= Assumed percentage reduction in total household heating energy consumption due to installation of a smart thermostat* *Manual to Smart Thermostat: 10.2%* *Programmable to Smart Thermostat: 7.1%* *Unknown (default) to Smart Thermostat: 8.5%*[454]
$HSPF$	*= Heating equipment's Heating Seasonal Performance Factor, Btu/Wh (Nameplate Data; default Heat Pump = 7.7, Electric Furnace = 3.412)*
Eff_{duct}	*= Duct System Efficiency, 0.8*[455]
HP_{motor}	*= Gas furnace blower motor horsepower, 0.5 HP*

[451] Conservative estimate based on program data from Texas IOUs showing average cooling capacity

[452] Based on Frontier assumptions that heating capacity is 96% of cooling capacity, based on an analysis of AHRI-rated systems

[453] Value published in Illinois Technical Resource Manual v12.0, Volume 3: Residential Measures, a conservative estimate based on studies done in various regions

[454] Value published in Illinois Technical Resource Manual v12.0, Volume 3: Residential Measures, a conservative estimate based on studies done in various regions

[455] 2014 Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation

η_{motor}	= *Efficiency of furnace blower motor horsepower, 50%*
%HeatPump	= *% of homes using heat pump heat. For upstream programs, default = 20%*[456]*. If heating type is known to be heat pump, use 100%.*
%ElecFurn	= *% of homes using electric resistance heat. For upstream programs, default = 23%*[457]*. If heating type is known to be electric resistance, use 100%.*
%GasFurn	= *% of homes using gas heat. For upstream programs, default = 57%*[458]*. If heating type is known to be gas, use 100%.*

Table 274 provides the cooling and heating effective full load hours inputs for each climate zone.

Table 274: Residential Full Load Cooling and Heating Hours for New Mexico Climate Zones[459]

City	EFLHCool	EFLHHeat
Albuquerque	852	1,358
Las Cruces	1,008	899
Roswell	1,059	921
Santa Fe	562	1,447

Natural Gas Energy Savings:

$$\Delta Therms = \frac{Capacity_{Heat} \times EFLH_{Heat}}{AFUE \times Eff_{duct} \times 100{,}000 \frac{BTU}{Therm}} \times Reduction_{Heat} \times \%GasFurn$$

Where:

$AFUE$	= *Heating equipment's Annual Fuel Utilization Efficiency, (Nameplate Data; default = 80%)*
$100{,}000$	= *Conversion between BTU and Therms*

Example: If a house (packaged air conditioning, natural gas furnace) in Santa Fe retrofits a programmable thermostat with a smart thermostat the estimated savings can be calculated using these:

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456 US Energy Information Administration. https://www.eia.gov/consumption/residential/data/2015/hc/php/hc6.8.php. The heating type split is considered for West Mountain South Region.

457 Ibid.

458 Ibid.

459 EFLH Cooling values determined using metered data and thermostat data collected from residential sites located in NM utility territories. Derived from ENERGY STAR® Air-Source Heat Pump Calculator. Las Cruces and Santa Fe values derived from El Paso and Amarillo values, respectively, with a comparison of degree-days.

$$\Delta kWh_{cooling} = \frac{36{,}000\frac{Btu}{h}}{1000\frac{W}{kW}} \times \frac{1}{13.0 \times 0.8} \times 629 \times 8\% = 174\ kWh$$

$$\Delta kWh_{heat.gasfurn} = \frac{0.5\ HP \times \left(746\frac{W}{HP}\right) \times 2{,}490}{50\% \times 1000\frac{W}{kW}} \times 5.6\% = 105\ kWh$$

$$Therms = \frac{34{,}560\frac{Btu}{h} \times 2{,}490}{80\% \times 0.8} \times 10^{-5} \times 5.6\% = 75\ therms$$

4.19.4 DEMAND SAVINGS ESTIMATION

Conventional programmable thermostats likely do not lead to coincident demand savings because most of the savings occur during off-peak hours. There is no strong evidence that smart thermostats save coincident demand any differently than programmable thermostats.

4.19.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.19.6 MEASURE LIFE

The expected measure life for advanced thermostats is assumed to be like that of a programmable thermostat, i.e., 10 years.[460]

4.20 WATER HEATER TANK INSULATION

This measure saves electric consumption by insulating an uninsulated water heater tank located within a conditioned or unconditioned space.

4.20.1 MEASURE OVERVIEW

Sector	Residential
End use	Insulation
Fuel	Electric, Natural Gas
Measure category	Water Heater
Delivery mechanism	Prescriptive
Baseline description	Uninsulated Water Heater Tank
Efficient case description	Insulated Water Heater Tank

[460] Table 1, HVAC Controls, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, 2007 (https://www.caetrm.com/media/reference-documents/HVAC_Ltg_measure_life_GDS_2007.pdf#:~:text=Nearly%20all%20of%20the%20commercial%20and%20industrial%20lighting%20and)

4.20.2 SAVINGS

The baseline condition is assumed to be a typical electric or gas water heater with no insulation. There is no minimum insulation requirement to be eligible for this measure. Manufacturer's instructions on the water heater jacket and water heater itself should be followed. Thermostat and heating element access panels must be left uncovered.

Example: Water tank insulation of $R_{insulation}$ = 5 is added to a natural gas water heater of 50 gallons capacity in Albuquerque. The variables are as follows:

Savings	*= [1/5 – 1/(5+(5 x 1.4))] Btu/hr sq. ft. °F x 22.63 sq. ft. x [127.5 – 61.6] °F x (1/0.8) x 8760 hours x (1/100,000 BTU/Therm)*
	= 19 therms

4.20.3 ENERGY SAVINGS ESTIMATION

Hot water tank insulation energy savings are calculated using the formula below.

$$Annual\ Energy\ Savings = (U_{Pre} - U_{Post}) * A * (T_{Tank} - T_{Ambient}) * \left(\frac{1}{Eff}\right) * Hours_{Total} * \frac{1}{Conversion\ Factor}$$

Where:

U_{Pre}	*= 1/(5) Btu/hr sq. ft. °F*[461]
U_{Post}	*= 1/(5+$R_{insulation}$) Btu/hr sq. ft. °F*
$R_{insulation}$	*= R-value of insulation (Multiplied by a factor of 1.4 to adjust for increase in perceived tank radius; determined using estimated average tank diameter of 22" and insulation thickness of 1.5")*[462]
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 275*
T_{Tank}	*= Average temperature of the tank, use 127.5 °F*[463]
$T_{Ambient}$	*= Average annual temperature, °F, use Table 275*

461 Baseline R-value as per Texas Technical Reference Manual v10.0, Volume 2: Residential Measures

462 True R-Values of Round Residential Ductwork, https://aceee.org/files/proceedings/2006/data/papers/SS06_Panel1_Paper18.pdf

463 Preliminary visits to schools in New Mexico have shown water heater temperatures set at 125 – 130°F, within typical range for domestic hot water. Average of 127.5°F used.

Eff = *System Efficiency (in the case of heat pump water heaters, COP; AFUE for gas water heater) of installed water heater. If unknown, use 0.98 as a default for electric resistance water heaters or 2.2 for heat pump water heaters*[464] *or 0.80 for natural gas water heaters*

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

$Conversion\ Factor$ = *3,412 Btu/kWh, for Electric Water Heater*
= *100,000 Btu/Therm, for Gas Water Heater*

Table 275 provides the input for surface area based on the volume of the hot water heater.

Table 275: Hot Water Heater Surface Area by Volume

Volume (gallons)	Area (sq. ft.)[465]
30	17.45
40	21.81
50	22.63
60	26.94
80	30.36
120	38.73

Table 276 provides inputs for unconditioned and conditioned temperatures, as well as typical temperatures for mobile homes for each climate zone.

Table 276: Temperature Inputs for Unconditioned and Conditioned Spaces

Climate Zone	Tambient (Unconditioned)[466]	Tambient (Conditioned)[467]	Tambient (Mobile home)[468]
Albuquerque	61.6°F	72.7 °F	56.6°F
Roswell	67.5°F		62.5°F
Santa Fe	56.5°F		51.5°F
Las Cruces	68.2 °F		63.2°F

[464] Default values based on median recovery efficiency of residential water heaters by fuel type in the AHRI database, at

[465] Texas Technical Reference Manual v10.0, Volume 2: Residential Measures

[466] Average ambient temperatures were taken from TMY3 data. 5-F was added to each average to approximate the difference between outdoor temperature and unconditioned interior temperature.

[467] 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

[468] Average ambient temperatures were taken from TMY3 data. Decreased unconditioned temp by 5 F to adjust for interaction with outside air to each average to approximate the difference between outdoor temperature and unconditioned interior temperature.

4.20.4 DEMAND SAVINGS ESTIMATION

Tank insulation demand savings can be calculated using the equation below. Note only electric demand savings can be calculated for heat pump water heaters.

$$Demand\ Savings = \frac{Annual\ Energy\ Savings}{8{,}760}$$

4.20.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.20.6 MEASURE LIFE

As per 2014 California Database for Energy Efficiency Resources (DEER), the EUL for this measure is listed as 7 years.[469]

4.21 ENERGY STAR® WINDOWS

This measure achieves energy and demand savings by installing ENERGY STAR® windows which are more energy efficient. ENERGY STAR® window savings are calculated per square foot of the installed unit, inclusive of frame and sash.

4.21.1 MEASURE OVERVIEW

Sector	Residential
End use	Single-family, duplex, and triplex; Multifamily; Manufactured
Fuel	Electricity and Natural Gas
Measure category	Building Envelope
Delivery mechanism	Retrofit, Prescriptive
Baseline description	Single-Pane/Double-Pane Windows
Efficient case description	ENERGY STAR® rated Windows

4.21.2 SAVINGS

Cooling savings for this measure apply to customers with central or mini-split electric refrigerated air conditioning, or for customers who have evaporated cooling systems. Homes

[469] 2014 California Database for Energy Efficiency Resources.

must be heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings.

For the baseline condition, the U-Values and SHGCs stated in Table 277 should be assumed:[470]

Table 277: U-Factor and SHGC for Baseline Windows

Number of Panes	U-Factor Btu/(h sq.ft.°F)	Solar Heat Gain Coefficient (SHGC)
1 (Single)	1.16	0.76
2 (Double)	0.76	0.67

For the efficient condition, windows must satisfy ENERGY STAR® criteria as outlined in

Table 278 for each climate zone.[471]

Table 278: U-Factor and SHGC for ENERGY STAR® Windows[472]

Climate Zone	U-Factor Btu/(h sq.ft.°F)	Solar Heat Gain Coefficient (SHGC)
Albuquerque	≤ 0.30	≤ 0.40
Santa Fe	U-factor ≤ 0.27 and Any SHGC U-factor ≤ 0.28 and SHGC ≥ 0.32 U-factor ≤ 0.29 and SHGC ≥ 0.37 U-factor ≤ 0.30 and SHGC ≥ 0.42	
Roswell	≤ 0.30	≤ 0.25
Las Cruces	≤ 0.30	≤ 0.25

470 Baseline value for U-Factor and SHGC as per Texas Technical Resource Manual v10.0, Volume 2: Residential Measures

471 ENERGY STAR® criteria for U.S. South-Central Region effective January 2015

472 Windows, Doors, and Skylights Climate Zone Finder: https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/climate_zone/search

4.21.3 ENERGY SAVINGS ESTIMATION

Deemed savings values have been estimated using calibrated simulation models for the El Paso region of Texas and then adjusted for New Mexico climate zones based on weather.[473]

In the base case, homes were fitted with single-pane and double-pane windows, and in the retrofit case, homes were equipped with windows meeting ENERGY STAR® criteria. A weighted single- and double-pane baseline is also provided, assuming a standard distribution of 46 percent single-pane and 54 percent double-pane based on 2020 RECS survey data.[474] This baseline may be used exclusively if applied consistently for all projects.

Based on the cooling and heating equipment utilized in a particular residence, total deemed savings per square foot can be calculated using the formula below.

$$Total\ Deemed\ Savings\ \left(\frac{kWh}{sq}.ft.\right) = Deemed\ Heating\ Svgs. + Deemed\ Cooling\ Svgs.$$

Therefore,

$$Annual\ Energy\ Svgs\ (kWh) = Total\ Deemed\ Svgs\ \left(\frac{kWh}{sq}.ft.\right) \times Area\ of\ Windows\ (sq.ft.)$$

Deemed heating and cooling savings for ENERGY STAR® single pane windows are listed in Table 279.

Table 279: ENERGY STAR® Windows Replacing Single Pane Windows, Deemed Annual Energy Savings

Climate Zone	Cooling Savings (kWh/sq.ft.)		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Gas Heat (therms/sq.ft.)	Electric Resistance (kWh/sq.ft.)	Heat Pump (kWh/sq.ft.)
Albuquerque	5.69	1.91	0.05	1.22	0.85
Santa Fe	2.09	0.70	0.11	2.62	1.83
Roswell	5.10	1.71	0.05	1.21	0.84
Las Cruces	5.58	1.87	0.05	1.21	0.84

[473] Deemed Savings for El Paso (Texas Climate Zone 5) from the ENERGY STAR® Windows Measure provided in Texas Technical Reference Manual v10.0, Volume 2: Residential Measures. The savings were adjusted by comparing the Heating Degree Days and Cooling Degree Days of New Mexico climate zones with that of Texas Climate Zone 5.

[474] 2020 Residential Energy Consumption Survey (RECS). Structural and geographic characteristics in the South and West regions (HC2.8). Analysis based on West South-Central census region. https://www.eia.gov/consumption/residential/data/2020/

Deemed heating and cooling savings for ENERGY STAR® double pane windows are listed in Table 280.

Table 280: ENERGY STAR® Windows Replacing Double Pane Windows, Deemed Annual Energy Savings

Climate Zone	Cooling Savings (kWh/sq.ft.)		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Gas Heat (therms/sq.ft.)	Electric Resistance (kWh/sq.ft.)	Heat Pump (kWh/sq.ft.)
Albuquerque	4.26	1.47	-0.01	-0.22	0.20
Santa Fe	1.56	0.54	-0.02	-0.48	0.42
Roswell	3.81	1.31	-0.01	-0.22	0.20
Las Cruces	4.18	1.44	-0.01	-0.22	0.20

Deemed heating and cooling savings for ENERGY STAR® weighted single and double pane windows are listed in Table 281.

Table 281: ENERGY STAR® Windows Replacing Weighted Single and Double Pane Windows, Deemed Annual Energy Savings

Climate Zone	Cooling Savings (kWh/sq.ft.)		Heating Savings		
	Refrigerated Air	Evaporated Cooling	Gas Heat (therms/sq.ft.)	Electric Resistance (kWh/sq.ft.)	Heat Pump (kWh/sq.ft.)
Albuquerque	4.92	1.67	0.02	0.44	0.50
Santa Fe	1.80	0.61	0.04	0.95	1.07
Roswell	4.40	1.49	0.02	0.44	0.49
Las Cruces	4.82	1.64	0.02	0.44	0.49

4.21.4 DEMAND SAVINGS ESTIMATION

Deemed peak demand savings for installing ENERGY STAR® single pane windows are listed in Table 282.

Table 282: ENERGY STAR® Windows Replacing Single Pane Windows, Deemed Peak Demand Savings

Climate Zone	Cooling Savings (kW/sq.ft.)	
	Refrigerated Air	Evaporated Cooling
Albuquerque	0.00549	0.00184
Santa Fe	0.00333	0.00111
Roswell	0.00376	0.00126
Las Cruces	0.00433	0.00145

Deemed peak demand savings for installing ENERGY STAR® double pane windows are listed in Table 283.

Table 283: ENERGY STAR® Windows Replacing Double Pane Windows, Deemed Peak Demand Savings (kW/sq.ft.)

Climate Zone	Cooling Savings (kW/sq.ft.)	
	Refrigerated Air	Evaporated Cooling
Albuquerque	0.00410	0.00432
Santa Fe	0.00249	0.00262
Roswell	0.00281	0.00296
Las Cruces	0.00324	0.00340

Deemed peak demand savings for installing ENERGY STAR® double pane windows are listed in Table 284.

Table 284: ENERGY STAR® Windows Replacing Weighted Single and Double Pane Windows, Deemed Peak Demand Savings (kW/sq.ft.)

Climate Zone	Cooling Savings (kW/sq.ft.)	
	Refrigerated Air	Evaporated Cooling
Albuquerque	0.00474	0.00318
Santa Fe	0.00288	0.00193
Roswell	0.00325	0.00218
Las Cruces	0.00374	0.00250

Therefore,

$$Peak\ Demand\ Savings\ (kW) = Deemed\ Cooling\ Savings\ \left(\frac{kW}{sq}.ft.\right) \times Area\ of\ Vertical\ Windows\ (sq.ft.)$$

4.21.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.21.6 MEASURE LIFE

The Estimated Useful Life is 25 years for ENERGY STAR® windows[475].

4.22 SOLAR SCREENS

This measure involves the installation of solar screens on west and/or south-facing windows or glass doors. Deemed savings are calculated per square foot of treated window or door opening.

4.22.1 MEASURE OVERVIEW

Sector	Residential
End use	Building Envelope
Fuel	Electricity
Measure category	Solar Screens
Delivery mechanism	Direct Install, Rebate
Baseline description	Single pane, clear, unshaded glass on fenestration
Efficient case description	Solar screens reducing solar heat gain by at least 80%

4.22.2 SAVINGS

Cooling savings for this measure apply to customers with central or mini-split electric refrigerated air conditioning or evaporative cooling in their homes. The heating savings penalty applies to homes that are centrally heated with either a furnace (gas or electric resistance) or a heat pump.

The baseline is a single pane, clear glass, unshaded, west-, or south-facing window. Double-paned windows are not eligible for this measure. Baseline window area is assumed to be 7.5 percent of the total wall area.

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[475] According to the GDS Associates Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures (2007).

Solar screens must be installed on windows or glass doors that face west or south and receive significant direct sun exposure. Solar screens must block at least 80 percent of the solar heat gain and are not recommended for homes with electric resistance heat.

Deemed savings values were derived using the savings values from the Texas TRM, version 10. The Texas savings values were adjusted based on a comparison of annual solar radiation for the Texas representative cities and the New Mexico representative cities. Solar radiation values were taken from NREL's PVWatts tool, with inputs representing a vertical surface (i.e., tilt = 90 degrees) and south and west orientations (i.e., azimuth = 180 degrees, 270 degrees). Cooling energy savings were adjusted using radiation for the months of April through October, and heating energy savings were adjusted using radiation for the months of January through March and November through December. Peak demand savings were adjusted using radiation for the months of June through August.

The savings values in the Texas TRM version 10 were estimated using calibrated simulation models. Specifically, the deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. A single modification was made to the prototype models for the various climate zone-HVAC type combinations to create the base case models for estimating savings for the solar screens measure. Windows facing all directions are assumed to be single-pane windows with U-Values of 1.16 BTU/h-ft2-R and Solar Heat Gain Coefficients (SHGC) of 0.76.[476]

For the change case models, an 80 percent reduction was applied to the solar heat gain coefficient for the south and west-facing windows.

Summer peak demand savings are estimated by taking the difference in demand for the 20 hours identified from the TMY3 datasets in which the summer and winter peaks are most likely to occur as described in Texas TRM Volume 1 Section 4.

The model assumes the average solar screen installed blocks 80 percent of the solar heat gain attributed to the south and west facing windows based on performance data from solar screens analyzed at sun angles of 30, 45, and 75 degrees to the window.[477]

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[476] BEopt default values for single-paned windows with metal frames.

[477] Performance data from Matrix, Inc., Mesa, Arizona testing facility for Phifer Wire Products' SunTex screen, blocks 80 percent of solar heat gain.

While it is recommended that solar screens be removed during winter to allow the advantage of free heat from the sun, they are not often removed seasonally. This may be due to solar screens serving as an insect screen in addition to blocking the sun or simply that they're installed in difficult-to-reach areas such as second floor windows. The savings estimates presented herein assume that the installed solar screens remain in place year-round.

Thermal Performance Improvement

Manual J and other studies researched indicate a thermal improvement to a window with a solar screen due to reduced air infiltration. The National Certified Testing Laboratories provided a report stating a 15 percent reduction in the thermal transmittance of a single pane, ¼" clear glass window with a solar screen added to the exterior.

Another study that was conducted for NFRC indicated between a 22 percent and 4 percent improvement to the U-value of a window with a solar screen. A single pane, clear window has a 22 percent improvement with the addition of a solar screen, whereas a double pane, spectrally selective low-E window may only have a 4 percent improvement. The deemed savings models assume an average 10 percent improvement in thermal performance with the addition of a solar screen.

Window Frame

The window frame accounts for 10-30 percent[478] of the window area and since it is opaque and blocks sunlight from entering the home, it is factored into the model. An average of 15 percent frame area was incorporated into the performance of the window.

4.22.3 ENERGY SAVINGS ESTIMATION

Table 285 presents the deemed energy savings value per square foot of solar screen installed. Annual energy savings are the sum of cooling and heating savings for the appropriate equipment types.

$$\text{Deemed Energy Savings (kWh)} = \text{Deemed Value (kWh/Sq.Ft)} \times \text{Area (Sq.Ft)}$$

478 Residential Windows – A Guide to New Technologies and Energy Performance, 2000.

Table 285: Deemed Energy (kWh) Savings per Square Foot of Solar Screen

Climate Zone	Cooling Savings (kWh/sq. ft.)		Heating Savings		
	Refrigerated Air	Evaporative Cooling	Gas Heat (therms/sq. ft.)	Electric Resistance (kWh/sq. ft.)	Heat Pump (kWh/sq. ft.)
Albuquerque	3.77	1.38	(0.65)	(13.51)	(4.79)
Las Cruces	5.74	2.03	(0.45)	(10.81)	(3.93)
Roswell	5.73	2.03	(0.43)	(10.26)	(3.73)
Santa Fe	3.64	1.33	(0.64)	(13.32)	(4.72)

4.22.4 DEMAND SAVINGS ESTIMATION

Table 286 presents the deemed summer peak demand savings value per square foot of solar screen installed.

Table 286: Deemed Summer Peak Demand (kW) Savings per Square Foot of Solar Screen

Climate Zone	Cooling Savings (kW/sq. ft.)	
	Refrigerated Air	Evaporative Cooling
Albuquerque	0.00277	0.00130
Las Cruces	0.00322	0.00110
Roswell	0.00327	0.00112
Santa Fe	0.00264	0.00123

4.22.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.22.6 MEASURE LIFE

The estimated useful life (EUL) for solar screens is 10 years. This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[479]

4.23 COOL ROOFS

This section presents the deemed savings methodology for the installation of an ENERGY STAR® certified roof. The installation of an ENERGY STAR® roof decreases the roofing heat transfer coefficient and reduces the solar heat transmitted to the building space. This measure decreases the cooling energy use during hours when cooling is required in the

[479] 2014 California Database for Energy Efficiency Resources.

building. During hours when heating is required in the building, this measure increases the heating energy use.

4.23.1 MEASURE OVERVIEW

Sector	Residential
End use	Building Envelope
Fuel	Electricity and Natural Gas
Measure category	Cool Roofs
Delivery mechanism	Direct Install, Rebate
Baseline description	Existing home with a standard medium- or dark-colored roof
Efficient case description	Roof products that have been rated by the Cool Roof Rating Council and compliance with ENERGY STAR® certified roof product performance specifications for the relevant roof application

4.23.2 SAVINGS

Cooling savings in this measure apply to customers with central or mini-split electric refrigerated air conditioning, or evaporative cooling in their homes. Homes must be centrally heated with either a furnace (gas or electric resistance) or a heat pump to claim heating savings.

The ENERGY STAR® program classifies roofs with a slope greater than 2/12 as having a steep slope, and roofs with a slope less than or equal to 2/12 as low slope roofs. ENERGY STAR® performance specifications for cool roof products for use on roofs with steep slopes and low slopes are provided in Table 287.

Table 287: ENERGY STAR® Solar Reflectance Specification for Cool Roof Products

Roof Slope	Characteristic	Performance Specification
Low Slope ≤ 2/12	Initial Solar Reflectance	≥ 0.65
	3-Year Solar Reflectance	≥ 0.50
High Slope > 2/12	Initial Solar Reflectance	≥ 0.25
	3-Year Solar Reflectance	≥ 0.15

If a cool roof is installed concurrent with changes to attic insulation levels, savings should be claimed for the reflective roof according to the post-retrofit (ceiling or roof deck) insulation levels. Savings for changes in insulation levels should be claimed separately according to the ceiling insulation or attic encapsulation measures, assuming the retrofit performed meets the requirements of those measures.

Deemed savings values were derived from the Texas TRM, version 10. The Texas savings values were adjusted based on a comparison of annual solar radiation for the Texas representative cities and the New Mexico representative cities. Solar radiation values were taken from NREL's PVWatts tool, with inputs representing a horizontal surface (i.e., tilt = 0 degrees). Cooling energy savings were adjusted using radiation for the months of April through October, and heating energy savings were adjusted using radiation for the months of January through March and November through December. Peak demand savings were adjusted using radiation for the months of June through August.

Calibrated simulation modeling was used to develop the deemed savings values in the Texas TRM. Specifically, the deemed savings estimates were developed using BEopt 2.6, running EnergyPlus 8.4 as the underlying simulation engine. To model this measure, the prototype home models for each climate zone were modified as follows. Roof slopes were modified to reflect representative levels for the low slope and steep slope roofs. A 1/12 slope was selected for modeling low slope roofs (defined as having slope less than or equal to 2/12), and a 4/12 slope was selected for modeling steep slope roofs (slope > 2/12). Based on the performance criteria and review of the rated 3-year reflectance of rated products listed in the CRRC database, four reflectance levels were selected for modeling: 0.2, 0.4, 0.6, and 0.8, representing 20 to 80 percent reflectance.

Because of the interplay between the performance of insulation and attic/roof deck temperatures, which are directly affected by the installation of a cool roof, savings were estimated for a range of different attic insulation scenarios: a range of ceiling insulation levels from no insulation (R-0) to R-30, and two roof deck insulation levels, R-19 and R-38, were modeled. The model runs calculated energy use for the prototypical home prior to encapsulating the attic. Next, change-case models were run to calculate energy use with the floor insulation measure in place with either R-30 or R-38 insulation. Modeled prototypical home characteristics are shown in Table 288.

Table 288: Prototypical Home Characteristics

Shell Characteristic	Value	Source
Base Case Roof Material	Medium Asphalt Shingle, Reflectance = 0.15	Prototype home default
Change Case Roof Material	Medium Asphalt Shingle, Reflectance = 0.2 Reflectance = 0.4 Reflectance = 0.6 Reflectance = 0.8	Lower reflectance levels are only relevant for steep slope roofs. Modeled reflectance levels reflect midpoints of ranges: 0.15 ≤ R < 0.3 0.3 ≤ R < 0.5 0.5 ≤ R < 0.7 0.7 ≤ R
Roof Slope: Low-Slope Roof	1/12	Not modified between base and change cases
Roof Slope: Steep-Slope Roof	4/12	Not modified between base and change cases
Ceiling (attic floor) Insulation Levels	R-0 R1-R4 R5-R8 R9-R14 R-15-R22 R-30	Not modified between base and change cases
Roof Deck (underside) Insulation Levels	R-19 R-38	Not modified between base and change cases

The following tables (Table 289 to Table 304) list energy and demand savings for cool roofs according to the rated 3-year reflectance of the installed cool roof product and the type of roof (low-slope, high-slope) on which it is installed. Separate tables of energy and demand savings are provided for each climate zone, and for insulation types (ceiling or roof deck). Savings are per square foot of installed roofing.

Table 289: Energy Savings for Homes with Ceiling Insulation, Albuquerque

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-0	0.15 - 0.29	0.05	0.02	-0.01	-0.08	-0.03
R-0	0.3 – 0.49	0.26	0.09	-0.02	-0.45	-0.17
R-0	0.5 – 0.69	0.47	0.18	-0.05	-0.84	-0.32
R-0	≥ 0.7	0.68	0.25	-0.08	-1.28	-0.47

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
R-1 to R-4	0.15 - 0.29	0.04	0.02	0.00	-0.07	-0.03
R-1 to R-4	0.3 – 0.49	0.22	0.08	-0.02	-0.37	-0.14
R-1 to R-4	0.5 – 0.69	0.40	0.15	-0.04	-0.70	-0.26
R-1 to R-4	≥ 0.7	0.58	0.21	-0.07	-1.05	-0.39
R-5 to R-8	0.15 - 0.29	0.02	0.01	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.13	0.04	-0.02	-0.21	-0.07
R-5 to R-8	0.5 – 0.69	0.22	0.08	-0.03	-0.38	-0.15
R-5 to R-8	≥ 0.7	0.32	0.13	-0.05	-0.57	-0.21
R-9 to R-14	0.15 - 0.29	0.02	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.08	0.03	-0.01	-0.14	-0.05
R-9 to R-14	0.5 – 0.69	0.16	0.06	-0.03	-0.26	-0.09
R-9 to R-14	≥ 0.7	0.23	0.08	-0.04	-0.39	-0.15
R-15 to R-22	0.15 - 0.29	0.01	0.00	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.06	0.02	-0.01	-0.09	-0.04
R-15 to R-22	0.5 – 0.69	0.10	0.04	-0.02	-0.18	-0.06
R-15 to R-22	≥ 0.7	0.16	0.06	-0.03	-0.26	-0.11
R-30	0.15 - 0.29	0.01	0.00	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.04	0.01	-0.01	-0.06	-0.02
R-30	0.5 – 0.69	0.07	0.02	-0.02	-0.12	-0.04
R-30	≥ 0.7	0.10	0.04	-0.03	-0.17	-0.06
Low Slope						
R-0	0.5 – 0.69	0.50	0.19	-0.05	-0.91	-0.35
R-0	≥ 0.7	0.72	0.26	-0.08	-1.37	-0.52
R-1 to R-4	0.5 – 0.69	0.43	0.16	-0.05	-0.75	-0.28
R-1 to R-4	≥ 0.7	0.62	0.23	-0.07	-1.14	-0.42
R-5 to R-8	0.5 – 0.69	0.24	0.09	-0.03	-0.42	-0.16
R-5 to R-8	≥ 0.7	0.36	0.14	-0.05	-0.62	-0.23
R-9 to R-14	0.5 – 0.69	0.17	0.06	-0.03	-0.28	-0.11
R-9 to R-14	≥ 0.7	0.24	0.09	-0.04	-0.43	-0.16
R-15 to R-22	0.5 – 0.69	0.12	0.04	-0.02	-0.20	-0.07
R-15 to R-22	≥ 0.7	0.18	0.07	-0.03	-0.30	-0.12
R-30	0.5 – 0.69	0.08	0.03	-0.02	-0.14	-0.05
R-30	≥ 0.7	0.13	0.05	-0.03	-0.20	-0.07

Table 290: Energy Savings for Homes with Roof Deck Insulation, Albuquerque

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-19	0.15 - 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.06	0.02	-0.01	-0.14	-0.05
R-19	0.5 – 0.69	0.14	0.04	-0.01	-0.30	-0.12
R-19	≥ 0.7	0.21	0.07	-0.02	-0.44	-0.17
R-38	0.15 - 0.29	0.01	0.00	0.00	-0.02	-0.01
R-38	0.3 – 0.49	0.05	0.02	-0.01	-0.12	-0.04
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.14	0.04	-0.02	-0.32	-0.13
Low Slope						
R-19	0.5 – 0.69	0.14	0.04	-0.01	-0.28	-0.12
R-19	≥ 0.7	0.21	0.07	-0.02	-0.44	-0.17
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.14	0.04	-0.02	-0.31	-0.12

Table 291: Energy Savings for Homes with Ceiling Insulation, Las Cruces

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-0	0.15 - 0.29	0.09	0.03	0.00	-0.08	-0.03
R-0	0.3 – 0.49	0.44	0.17	-0.02	-0.43	-0.16
R-0	0.5 – 0.69	0.80	0.30	-0.03	-0.84	-0.32
R-0	≥ 0.7	1.19	0.44	-0.05	-1.32	-0.49
R-1 to R-4	0.15 - 0.29	0.07	0.03	0.00	-0.07	-0.03
R-1 to R-4	0.3 – 0.49	0.37	0.14	-0.01	-0.35	-0.13
R-1 to R-4	0.5 – 0.69	0.68	0.26	-0.03	-0.68	-0.26
R-1 to R-4	≥ 0.7	1.01	0.38	-0.05	-1.07	-0.40
R-5 to R-8	0.15 - 0.29	0.04	0.02	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.21	0.08	-0.01	-0.20	-0.07
R-5 to R-8	0.5 – 0.69	0.39	0.15	-0.02	-0.38	-0.14
R-5 to R-8	≥ 0.7	0.58	0.23	-0.03	-0.59	-0.22
R-9 to R-14	0.15 - 0.29	0.03	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.15	0.06	-0.01	-0.14	-0.05

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
R-9 to R-14	0.5 – 0.69	0.27	0.11	-0.01	-0.27	-0.10
R-9 to R-14	≥ 0.7	0.41	0.16	-0.02	-0.41	-0.15
R-15 to R-22	0.15 - 0.29	0.02	0.01	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.10	0.04	-0.01	-0.10	-0.04
R-15 to R-22	0.5 – 0.69	0.19	0.08	-0.01	-0.18	-0.07
R-15 to R-22	≥ 0.7	0.29	0.12	-0.02	-0.28	-0.10
R-30	0.15 - 0.29	0.01	0.01	0.00	-0.01	-0.01
R-30	0.3 – 0.49	0.07	0.03	0.00	-0.06	-0.02
R-30	0.5 – 0.69	0.13	0.05	-0.01	-0.12	-0.04
R-30	≥ 0.7	0.20	0.08	-0.01	-0.18	-0.07
Low Slope						
R-0	0.5 – 0.69	0.90	0.34	-0.04	-0.94	-0.36
R-0	≥ 0.7	1.32	0.49	-0.06	-1.49	-0.56
R-1 to R-4	0.5 – 0.69	0.77	0.29	-0.03	-0.77	-0.29
R-1 to R-4	≥ 0.7	1.13	0.43	-0.05	-1.23	-0.45
R-5 to R-8	0.5 – 0.69	0.45	0.18	-0.02	-0.44	-0.16
R-5 to R-8	≥ 0.7	0.66	0.26	-0.03	-0.68	-0.25
R-9 to R-14	0.5 – 0.69	0.32	0.13	-0.02	-0.31	-0.12
R-9 to R-14	≥ 0.7	0.47	0.19	-0.03	-0.47	-0.18
R-15 to R-22	0.5 – 0.69	0.23	0.09	-0.01	-0.21	-0.08
R-15 to R-22	≥ 0.7	0.34	0.14	-0.02	-0.32	-0.12
R-30	0.5 – 0.69	0.17	0.07	-0.01	-0.14	-0.06
R-30	≥ 0.7	0.25	0.10	-0.02	-0.22	-0.08

Table 292: Energy Savings for Homes with Roof Deck Insulation, Las Cruces

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-19	0.15 - 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.11	0.04	-0.01	-0.14	-0.05
R-19	0.5 – 0.69	0.22	0.08	-0.01	-0.28	-0.11
R-19	≥ 0.7	0.35	0.12	-0.02	-0.45	-0.17
R-38	0.15 - 0.29	0.02	0.01	0.00	-0.02	-0.01

R-38	0.3 – 0.49	0.09	0.03	0.00	-0.11	-0.04
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.20	-0.08
R-38	≥ 0.7	0.23	0.08	-0.01	-0.31	-0.12
Low Slope						
R-19	0.5 – 0.69	0.23	0.08	-0.01	-0.29	-0.11
R-19	≥ 0.7	0.36	0.12	-0.02	-0.46	-0.18
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.24	0.08	-0.01	-0.32	-0.12

Table 293: Energy Savings for Homes with Ceiling Insulation, Roswell

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-0	0.15 - 0.29	0.09	0.03	0.00	-0.07	-0.03
R-0	0.3 – 0.49	0.43	0.17	-0.02	-0.40	-0.15
R-0	0.5 – 0.69	0.78	0.29	-0.03	-0.78	-0.30
R-0	≥ 0.7	1.15	0.43	-0.05	-1.22	-0.46
R-1 to R-4	0.15 - 0.29	0.07	0.03	0.00	-0.07	-0.03
R-1 to R-4	0.3 – 0.49	0.36	0.14	-0.01	-0.33	-0.12
R-1 to R-4	0.5 – 0.69	0.66	0.25	-0.03	-0.63	-0.24
R-1 to R-4	≥ 0.7	0.98	0.37	-0.05	-1.00	-0.37
R-5 to R-8	0.15 - 0.29	0.04	0.02	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.20	0.08	-0.01	-0.19	-0.07
R-5 to R-8	0.5 – 0.69	0.38	0.15	-0.02	-0.35	-0.13
R-5 to R-8	≥ 0.7	0.56	0.22	-0.03	-0.55	-0.21
R-9 to R-14	0.15 - 0.29	0.03	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.15	0.06	-0.01	-0.13	-0.05
R-9 to R-14	0.5 – 0.69	0.26	0.11	-0.01	-0.25	-0.09
R-9 to R-14	≥ 0.7	0.40	0.16	-0.02	-0.38	-0.14
R-15 to R-22	0.15 - 0.29	0.02	0.01	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.10	0.04	-0.01	-0.09	-0.04
R-15 to R-22	0.5 – 0.69	0.18	0.08	-0.01	-0.17	-0.07
R-15 to R-22	≥ 0.7	0.28	0.12	-0.02	-0.26	-0.09
R-30	0.15 - 0.29	0.01	0.01	0.00	-0.01	-0.01
R-30	0.3 – 0.49	0.07	0.03	0.00	-0.06	-0.02
R-30	0.5 – 0.69	0.13	0.05	-0.01	-0.11	-0.04
R-30	≥ 0.7	0.19	0.08	-0.01	-0.17	-0.07
Low Slope						
R-0	0.5 – 0.69	0.87	0.33	-0.04	-0.88	-0.34
R-0	≥ 0.7	1.27	0.48	-0.06	-1.38	-0.52

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
R-1 to R-4	0.5 – 0.69	0.75	0.28	-0.03	-0.72	-0.27
R-1 to R-4	≥ 0.7	1.10	0.42	-0.05	-1.14	-0.42
R-5 to R-8	0.5 – 0.69	0.44	0.17	-0.02	-0.41	-0.15
R-5 to R-8	≥ 0.7	0.64	0.25	-0.03	-0.63	-0.23
R-9 to R-14	0.5 – 0.69	0.31	0.13	-0.02	-0.29	-0.11
R-9 to R-14	≥ 0.7	0.46	0.18	-0.03	-0.44	-0.17
R-15 to R-22	0.5 – 0.69	0.22	0.09	-0.01	-0.20	-0.07
R-15 to R-22	≥ 0.7	0.33	0.14	-0.02	-0.30	-0.11
R-30	0.5 – 0.69	0.17	0.07	-0.01	-0.13	-0.06
R-30	≥ 0.7	0.24	0.10	-0.02	-0.21	-0.07

Table 294: Energy Savings for Homes with Roof Deck Insulation, Roswell

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-19	0.15 - 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.11	0.04	-0.01	-0.13	-0.05
R-19	0.5 – 0.69	0.21	0.08	-0.01	-0.26	-0.10
R-19	≥ 0.7	0.34	0.12	-0.02	-0.42	-0.16
R-38	0.15 - 0.29	0.02	0.01	0.00	-0.02	-0.01
R-38	0.3 – 0.49	0.09	0.03	0.00	-0.10	-0.04
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.19	-0.07
R-38	≥ 0.7	0.22	0.08	-0.01	-0.29	-0.11
Low Slope						
R-19	0.5 – 0.69	0.22	0.08	-0.01	-0.27	-0.10
R-19	≥ 0.7	0.35	0.12	-0.02	-0.43	-0.17
R-38	0.5 – 0.69	0.16	0.05	-0.01	-0.20	-0.07
R-38	≥ 0.7	0.23	0.08	-0.01	-0.30	-0.11

Table 295: Energy Savings for Homes with Ceiling Insulation, Santa Fe

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-0	0.15 - 0.29	0.05	0.02	-0.01	-0.08	-0.03
R-0	0.3 – 0.49	0.25	0.09	-0.02	-0.44	-0.16
R-0	0.5 – 0.69	0.45	0.17	-0.05	-0.82	-0.31
R-0	≥ 0.7	0.65	0.24	-0.08	-1.25	-0.46
R-1 to R-4	0.15 - 0.29	0.04	0.02	0.00	-0.07	-0.03
R-1 to R-4	0.3 – 0.49	0.21	0.08	-0.02	-0.36	-0.13
R-1 to R-4	0.5 – 0.69	0.38	0.14	-0.04	-0.68	-0.26
R-1 to R-4	≥ 0.7	0.55	0.20	-0.07	-1.03	-0.38
R-5 to R-8	0.15 - 0.29	0.02	0.01	0.00	-0.04	-0.01
R-5 to R-8	0.3 – 0.49	0.12	0.04	-0.02	-0.21	-0.07
R-5 to R-8	0.5 – 0.69	0.21	0.08	-0.03	-0.37	-0.14
R-5 to R-8	≥ 0.7	0.31	0.12	-0.05	-0.56	-0.21
R-9 to R-14	0.15 - 0.29	0.02	0.01	0.00	-0.03	-0.01
R-9 to R-14	0.3 – 0.49	0.08	0.03	-0.01	-0.13	-0.05
R-9 to R-14	0.5 – 0.69	0.15	0.06	-0.03	-0.26	-0.09
R-9 to R-14	≥ 0.7	0.22	0.08	-0.04	-0.38	-0.14
R-15 to R-22	0.15 - 0.29	0.01	0.00	0.00	-0.02	-0.01
R-15 to R-22	0.3 – 0.49	0.06	0.02	-0.01	-0.09	-0.04
R-15 to R-22	0.5 – 0.69	0.10	0.04	-0.02	-0.17	-0.06
R-15 to R-22	≥ 0.7	0.15	0.06	-0.03	-0.26	-0.10
R-30	0.15 - 0.29	0.01	0.00	0.00	-0.01	0.00
R-30	0.3 – 0.49	0.04	0.01	-0.01	-0.06	-0.02
R-30	0.5 – 0.69	0.07	0.02	-0.02	-0.11	-0.04
R-30	≥ 0.7	0.10	0.04	-0.03	-0.16	-0.06
Low Slope						
R-0	0.5 – 0.69	0.48	0.18	-0.05	-0.89	-0.34
R-0	≥ 0.7	0.69	0.25	-0.08	-1.34	-0.50
R-1 to R-4	0.5 – 0.69	0.41	0.15	-0.05	-0.73	-0.28
R-1 to R-4	≥ 0.7	0.59	0.22	-0.07	-1.11	-0.41

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
R-5 to R-8	0.5 – 0.69	0.23	0.09	-0.03	-0.41	-0.15
R-5 to R-8	≥ 0.7	0.34	0.13	-0.05	-0.61	-0.23
R-9 to R-14	0.5 – 0.69	0.16	0.06	-0.03	-0.28	-0.10
R-9 to R-14	≥ 0.7	0.23	0.09	-0.04	-0.42	-0.15
R-15 to R-22	0.5 – 0.69	0.11	0.04	-0.02	-0.20	-0.07
R-15 to R-22	≥ 0.7	0.17	0.07	-0.03	-0.29	-0.11
R-30	0.5 – 0.69	0.08	0.03	-0.02	-0.13	-0.05
R-30	≥ 0.7	0.12	0.05	-0.03	-0.20	-0.07

Table 296: Energy Savings for Homes with Roof Deck Insulation, Santa Fe

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Cooling Savings		Heating Savings		
		Refrigerated Air (kWh/SF)	Evaporative Cooling (kWh/SF)	Gas Heat (Therms/SF)	Electric Resistance (kWh/SF)	Heat Pump (kWh/SF)
Steep Slope						
R-19	0.15 - 0.29	0.00	0.00	0.00	0.00	0.00
R-19	0.3 – 0.49	0.06	0.02	-0.01	-0.13	-0.05
R-19	0.5 – 0.69	0.13	0.04	-0.01	-0.29	-0.11
R-19	≥ 0.7	0.20	0.07	-0.02	-0.43	-0.16
R-38	0.15 - 0.29	0.01	0.00	0.00	-0.02	-0.01
R-38	0.3 – 0.49	0.05	0.02	-0.01	-0.11	-0.04
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.13	0.04	-0.02	-0.31	-0.12
Low Slope						
R-19	0.5 – 0.69	0.13	0.04	-0.01	-0.28	-0.11
R-19	≥ 0.7	0.20	0.07	-0.02	-0.43	-0.16
R-38	0.5 – 0.69	0.09	0.03	-0.01	-0.21	-0.08
R-38	≥ 0.7	0.13	0.04	-0.02	-0.30	-0.11

Table 297: Demand Savings for Homes with Ceiling Insulation, Albuquerque

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-0	0.15 - 0.29	n/a	n/a	0.0000456	0.0000189
R-0	0.3 – 0.49	n/a	n/a	0.0002357	0.0000950
R-0	0.5 – 0.69	0.0004694	0.0002069	0.0004477	0.0001853
R-0	≥ 0.7	0.0007102	0.0003006	0.0006845	0.0002872
R-1 to R-4	0.15 - 0.29	n/a	n/a	0.0000387	0.0000175
R-1 to R-4	0.3 – 0.49	n/a	n/a	0.0001935	0.0000892
R-1 to R-4	0.5 – 0.69	0.0003819	0.0001657	0.0003644	0.0001616
R-1 to R-4	≥ 0.7	0.0006011	0.0002666	0.0005908	0.0002686
R-5 to R-8	0.15 - 0.29	n/a	n/a	0.0000152	0.0000069
R-5 to R-8	0.3 – 0.49	n/a	n/a	0.0000833	0.0000460
R-5 to R-8	0.5 – 0.69	0.0001832	0.0000948	0.0001678	0.0000773
R-5 to R-8	≥ 0.7	0.0002933	0.0001595	0.0002944	0.0001441
R-9 to R-14	0.15 - 0.29	n/a	n/a	0.0000062	0.0000082
R-9 to R-14	0.3 – 0.49	n/a	n/a	0.0000581	0.0000224
R-9 to R-14	0.5 – 0.69	0.0001204	0.0000617	0.0001112	0.0000465
R-9 to R-14	≥ 0.7	0.0001976	0.0000937	0.0001956	0.0000965
R-15 to R-22	0.15 - 0.29	n/a	n/a	0.0000024	-0.0000009
R-15 to R-22	0.3 – 0.49	n/a	n/a	0.0000365	0.0000157
R-15 to R-22	0.5 – 0.69	0.0000813	0.0000384	0.0000755	0.0000282
R-15 to R-22	≥ 0.7	0.0001348	0.0000646	0.0001410	0.0000772
R-30	0.15 - 0.29	n/a	n/a	-0.0000007	0.0000035
R-30	0.3 – 0.49	n/a	n/a	0.0000243	0.0000188
R-30	0.5 – 0.69	0.0000555	0.0000181	0.0000514	0.0000278
R-30	≥ 0.7	0.0000952	0.0000444	0.0000984	0.0000617

Table 298: Demand Savings for Homes with Roof Deck Insulation, Albuquerque

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-19	0.15 - 0.29	n/a	n/a	0.0000000	0.0000000
R-19	0.3 – 0.49	n/a	n/a	0.0000275	0.0000078
R-19	0.5 – 0.69	0.0000572	0.0000189	0.0000551	0.0000160
R-19	≥ 0.7	0.0001017	0.0000078	0.0000907	0.0000156
R-38	0.15 - 0.29	n/a	n/a	0.0000060	0.0000061
R-38	0.3 – 0.49	n/a	n/a	0.0000150	0.0000074
R-38	0.5 – 0.69	0.0000154	0.0000024	0.0000144	0.0000107
R-38	≥ 0.7	0.0000489	0.0000094	0.0000396	0.0000171

Table 299: Demand Savings for Homes with Ceiling Insulation, Las Cruces

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-0	0.15 - 0.29	n/a	n/a	0.0000567	0.0000212
R-0	0.3 – 0.49	n/a	n/a	0.0002883	0.0001246
R-0	0.5 – 0.69	0.0006408	0.0002300	0.0005705	0.0002561
R-0	≥ 0.7	0.0009482	0.0003385	0.0008347	0.0003134
R-1 to R-4	0.15 - 0.29	n/a	n/a	0.0000503	0.0000192
R-1 to R-4	0.3 – 0.49	n/a	n/a	0.0002491	0.0001000
R-1 to R-4	0.5 – 0.69	0.0005444	0.0001868	0.0004882	0.0002119
R-1 to R-4	≥ 0.7	0.0008498	0.0003054	0.0007262	0.0002913
R-5 to R-8	0.15 - 0.29	n/a	n/a	0.0000273	0.0000090
R-5 to R-8	0.3 – 0.49	n/a	n/a	0.0001276	0.0000603
R-5 to R-8	0.5 – 0.69	0.0003074	0.0001346	0.0002602	0.0001386
R-5 to R-8	≥ 0.7	0.0004791	0.0002059	0.0003988	0.0001788
R-9 to R-14	0.15 - 0.29	n/a	n/a	0.0000126	0.0000093
R-9 to R-14	0.3 – 0.49	n/a	n/a	0.0000828	0.0000532
R-9 to R-14	0.5 – 0.69	0.0002079	0.0001004	0.0001738	0.0000890
R-9 to R-14	≥ 0.7	0.0003285	0.0001446	0.0002612	0.0001225
R-15 to R-22	0.15 - 0.29	n/a	n/a	0.0000062	0.0000037

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-15 to R-22	0.3 – 0.49	n/a	n/a	0.0000621	0.0000442
R-15 to R-22	0.5 – 0.69	0.0001507	0.0000766	0.0001246	0.0000652
R-15 to R-22	≥ 0.7	0.0002431	0.0001115	0.0001888	0.0000890
R-30	0.15 - 0.29	n/a	n/a	0.0000067	0.0000006
R-30	0.3 – 0.49	n/a	n/a	0.0000479	0.0000288
R-30	0.5 – 0.69	0.0001014	0.0000594	0.0000885	0.0000509
R-30	≥ 0.7	0.0001808	0.0000854	0.0001326	0.0000678

Table 300: Demand Savings for Homes with Roof Deck Insulation, Las Cruces

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-19	0.15 - 0.29	n/a	n/a	0.0000000	0.0000000
R-19	0.3 – 0.49	n/a	n/a	0.0000366	0.0000225
R-19	0.5 – 0.69	0.0000815	0.0000277	0.0000899	0.0000444
R-19	≥ 0.7	0.0001336	0.0000231	0.0001356	0.0000446
R-38	0.15 - 0.29	n/a	n/a	0.0000116	0.0000019
R-38	0.3 – 0.49	n/a	n/a	0.0000256	-0.0000072
R-38	0.5 – 0.69	0.0000381	-0.0000012	0.0000497	-0.0000005
R-38	≥ 0.7	0.0000996	0.0000056	0.0000844	0.0000063

Table 301: Demand Savings for Homes with Ceiling Insulation, Roswell

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-0	0.15 - 0.29	n/a	n/a	0.0000560	0.0000209
R-0	0.3 – 0.49	n/a	n/a	0.0002850	0.0001231
R-0	0.5 – 0.69	0.0006335	0.0002274	0.0005640	0.0002532
R-0	≥ 0.7	0.0009373	0.0003346	0.0008251	0.0003098
R-1 to R-4	0.15 - 0.29	n/a	n/a	0.0000497	0.0000190
R-1 to R-4	0.3 – 0.49	n/a	n/a	0.0002462	0.0000989

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-1 to R-4	0.5 – 0.69	0.0005381	0.0001847	0.0004825	0.0002095
R-1 to R-4	≥ 0.7	0.0008400	0.0003018	0.0007178	0.0002879
R-5 to R-8	0.15 - 0.29	n/a	n/a	0.0000270	0.0000089
R-5 to R-8	0.3 – 0.49	n/a	n/a	0.0001261	0.0000596
R-5 to R-8	0.5 – 0.69	0.0003038	0.0001330	0.0002572	0.0001370
R-5 to R-8	≥ 0.7	0.0004736	0.0002035	0.0003942	0.0001767
R-9 to R-14	0.15 - 0.29	n/a	n/a	0.0000124	0.0000092
R-9 to R-14	0.3 – 0.49	n/a	n/a	0.0000818	0.0000526
R-9 to R-14	0.5 – 0.69	0.0002055	0.0000993	0.0001718	0.0000880
R-9 to R-14	≥ 0.7	0.0003247	0.0001430	0.0002581	0.0001211
R-15 to R-22	0.15 - 0.29	n/a	n/a	0.0000061	0.0000037
R-15 to R-22	0.3 – 0.49	n/a	n/a	0.0000614	0.0000437
R-15 to R-22	0.5 – 0.69	0.0001489	0.0000758	0.0001231	0.0000644
R-15 to R-22	≥ 0.7	0.0002403	0.0001102	0.0001867	0.0000880
R-30	0.15 - 0.29	n/a	n/a	0.0000066	0.0000006
R-30	0.3 – 0.49	n/a	n/a	0.0000474	0.0000285
R-30	0.5 – 0.69	0.0001003	0.0000587	0.0000875	0.0000503
R-30	≥ 0.7	0.0001787	0.0000844	0.0001311	0.0000670

Table 302: Demand Savings for Homes with Roof Deck Insulation, Roswell

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-19	0.15 - 0.29	n/a	n/a	0.0000000	0.0000000
R-19	0.3 – 0.49	n/a	n/a	0.0000361	0.0000222
R-19	0.5 – 0.69	0.0000805	0.0000274	0.0000889	0.0000439
R-19	≥ 0.7	0.0001321	0.0000228	0.0001340	0.0000441
R-38	0.15 - 0.29	n/a	n/a	0.0000114	0.0000019
R-38	0.3 – 0.49	n/a	n/a	0.0000253	-0.0000071
R-38	0.5 – 0.69	0.0000376	-0.0000012	0.0000491	-0.0000005
R-38	≥ 0.7	0.0000985	0.0000056	0.0000834	0.0000062

Table 303: Demand Savings for Homes with Ceiling Insulation, Santa Fe

Ceiling Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-0	0.15 - 0.29	n/a	n/a	0.0000433	0.0000180
R-0	0.3 – 0.49	n/a	n/a	0.0002238	0.0000902
R-0	0.5 – 0.69	0.0004456	0.0001964	0.0004250	0.0001759
R-0	≥ 0.7	0.0006742	0.0002853	0.0006498	0.0002726
R-1 to R-4	0.15 - 0.29	n/a	n/a	0.0000367	0.0000166
R-1 to R-4	0.3 – 0.49	n/a	n/a	0.0001837	0.0000847
R-1 to R-4	0.5 – 0.69	0.0003625	0.0001573	0.0003459	0.0001534
R-1 to R-4	≥ 0.7	0.0005706	0.0002531	0.0005609	0.0002550
R-5 to R-8	0.15 - 0.29	n/a	n/a	0.0000145	0.0000065
R-5 to R-8	0.3 – 0.49	n/a	n/a	0.0000790	0.0000437
R-5 to R-8	0.5 – 0.69	0.0001739	0.0000900	0.0001593	0.0000734
R-5 to R-8	≥ 0.7	0.0002785	0.0001515	0.0002795	0.0001368
R-9 to R-14	0.15 - 0.29	n/a	n/a	0.0000059	0.0000077
R-9 to R-14	0.3 – 0.49	n/a	n/a	0.0000551	0.0000213
R-9 to R-14	0.5 – 0.69	0.0001143	0.0000585	0.0001055	0.0000442
R-9 to R-14	≥ 0.7	0.0001876	0.0000889	0.0001857	0.0000917
R-15 to R-22	0.15 - 0.29	n/a	n/a	0.0000022	-0.0000009
R-15 to R-22	0.3 – 0.49	n/a	n/a	0.0000347	0.0000149
R-15 to R-22	0.5 – 0.69	0.0000772	0.0000364	0.0000717	0.0000268
R-15 to R-22	≥ 0.7	0.0001280	0.0000614	0.0001339	0.0000733
R-30	0.15 - 0.29	n/a	n/a	-0.0000007	0.0000033
R-30	0.3 – 0.49	n/a	n/a	0.0000231	0.0000179
R-30	0.5 – 0.69	0.0000527	0.0000172	0.0000488	0.0000264
R-30	≥ 0.7	0.0000904	0.0000421	0.0000934	0.0000585

Table 304: Demand Savings for Homes with Roof Deck Insulation, Santa Fe

Roof Deck Insulation R-value	Installed Roof Material 3-Year Reflectance	Low Slope		Steep Slope	
		Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)	Refrigerated Air (kW/SF)	Evaporative Cooling (kW/SF)
R-19	0.15 - 0.29	n/a	n/a	0.0000000	0.0000000
R-19	0.3 – 0.49	n/a	n/a	0.0000261	0.0000074
R-19	0.5 – 0.69	0.0000543	0.0000180	0.0000523	0.0000151
R-19	≥ 0.7	0.0000965	0.0000074	0.0000861	0.0000149
R-38	0.15 - 0.29	n/a	n/a	0.0000057	0.0000058
R-38	0.3 – 0.49	n/a	n/a	0.0000143	0.0000070
R-38	0.5 – 0.69	0.0000147	0.0000023	0.0000137	0.0000102
R-38	≥ 0.7	0.0000464	0.0000089	0.0000376	0.0000162

4.23.3 ENERGY SAVINGS ESTIMATION

The deemed energy and demand savings values are used in the following formulas to calculate savings:

$$Cooling\ Energy\ Savings = Roof\ \ Area \times Deemed\ Cooling\ Savings$$

$$Heating\ Energy\ Savings = Roof\ \ Area \times Deemed\ Heating\ Savings$$

Where:

Roof Area	*= Total area of ENERGY STAR®roof in square feet*
Deemed Cooling Savings	*= Per-SF cooling savings from tables above by climate zone, insulation type roof slope, insulation R-value, roof reflectance, and cooling system type*
Deemed Heating Savings	*= Per-SF heating savings from tables above by climate zone, insulation type, roof slope, insulation R-value, roof reflectance, and heating system type*

4.23.4 DEMAND SAVINGS ESTIMATION

The deemed demand savings factors are used in the following formulas to calculate savings:

$$Peak\ Summer\ Demand\ Savings = Roof\ \ Area \times Deemed\ Demand\ Savings$$

Where:

Deemed Demand Savings	*= Per-SF demand savings from tables above by climate zone, insulation type, roof slope, insulation R-value, roof reflectance, and cooling system type*

4.23.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.23.6 MEASURE LIFE

The estimated useful life (EUL) for cool roofs is 15 years. This value is consistent with the EUL reported in the 2014 California Database for Energy Efficiency Resources (DEER).[480]

[480] 2014 California Database for Energy Efficiency Resources.

4.24 WALL INSULATION

This measure saves space heating and cooling energy by reducing heat transfer through the walls from the installation of wall insulation.

4.24.1 MEASURE OVERVIEW

Sector	Residential
End use	Space heating and cooling
Fuel	Electricity and Natural Gas
Measure category	Insulation
Delivery mechanism	Rebate (retrofit)
Baseline description	Retrofit: Existing insulation level New Construction[481]: ECC 2021
Efficient case description	Insulation level higher than baseline level

4.24.2 SAVINGS

The installation of improved wall insulation will lead to reduced consumption of heating and cooling during winter and summer months. A better R-value of the insulation being installed will achieve higher savings.

Baseline R-value for new construction projects are listed in Table 305.

Table 305: IECC 2021 Wall Insulation Baseline R-value

	R-value			
Cities	**Wood Frame Wall**	**Mass Wall**	**Basement Wall**	**Crawl Space Wall**
Albuquerque	30 or 20+5 or 13+10 or 0+20**	8/13*	10/13*	10/13*
Santa Fe	30 or 20+5 or 13+10 or 0+20**	13/17*	15/19*	15/19*
Roswell	20 or 13+5**	8/13*	5/13*	5/13*
Las Cruces	20 or 13+5**	8/13*	5/13*	5/13*

*13/17 means R-13 continuous insulated sheathing and R-17 on the interior or exterior of the wall or R-17 cavity insulation at the interior of the basement wall
**13+5 means R-13 cavity insulation plus R-5 insulated sheathing

[481] IECC 2021 Code Table R402.1.3 Requirements for Climate Zones 3 (Las Cruces, Roswell), 4 (Albuquerque) and 5 (Santa Fe)

4.24.3 ENERGY SAVINGS ESTIMATION

Savings are calculated based on the following formulas.

$$\Delta kWh = \Delta kWh_{Cooling} + \Delta kWh_{Heating}$$

Cooling energy savings are calculated using:

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{wall} * (1 - FF_{Wall}) * CDD * 24}{1000 * \eta_{Cooling}}$$

Where:

R_{Old} = *R-Value of existing insulation or baseline in case of new construction*

R_{New} = *R-Value of new wall insulation (ft^2 - °F.h/Btu)*

A_{wall} = *Total area of insulated wall (ft^2)*

FF_{wall} = *Adjustment to account for area of framing, 25%*[482]

CDD = *Cooling Degree Days, as listed in Table* 306,

24 = *Converting Days to Hours*

1000 = *Converting Btu to kBtu*

$\eta_{Cooling}$ = *Seasonal Energy Efficiency Ratio of Cooling System (kBtu/kWh)*

= *Nameplate ratings wherever possible, if unavailable use the following efficiencies listed in Table* 306

Table 306 provides the efficiencies based on federal standard for different equipment types by age.

Table 306: Cooling Efficiency (Federal Standards)

Equipment Type	Age of Equipment	SEER Ratings
Central AC and Heat Pump	Before 2006	10.0
Central AC and Heat Pump	2006 - 2014	13.0
Central AC	After 1/1/2015	13.0
Heat Pump	After 1/1/2015	14.0

Heating energy savings for electric resistance and heat pump systems can be calculated using:

$$\Delta kWh_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{wall} * (1 - FF_{wall}) * HDD * 24}{3412 * \eta_{Heating}}$$

[482] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1

Where:

HDD	*= Heating Degree Days, as listed in Table 307.*
3,412	*=Converting Btu to kWh*
$\eta_{Heating}$	*=Efficiency of heating system (kBtu/kWh)*
	=Nameplate ratings wherever possible, if unavailable use the following efficiencies listed in Table 307.

Table 307 provides the cooling and heating degree day inputs for each climate zone.

Table 307: Cooling Degree Days and Heating Degree Days

Climate Zone	CDD	HDD
Albuquerque	1,322	4,180
Santa Fe	645	5,417
Roswell	1,790	3,289
Las Cruces	1,899	2,816

Table 308 provides the heating efficiencies based on federal standards by equipment and age.

Table 308: Heating Efficiency (Federal Standards)

Age of Equipment	HSPF Ratings
Heat Pump; Before 2006	6.8
Heat Pump; 2006 - 2014	7.7
Heat Pump; After 1/1/2015	8.2
Electric Resistance	1.0 (COP)

Heating energy savings for gas heat systems can be calculated using:

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * \ A_{wall} * (1 - FF_{wall}) * HDD * 24}{100{,}000 * \eta_{Heating}}$$

Where:

$\eta_{Heating}$	*=AFUE of gas heating system. Use nameplate ratings wherever possible, if unavailable use 0.8*

Example: A house in Las Cruces underwent a wall insulation retrofit i.e., from R-10 to R-32. The total area of the wall is 2500 sq. ft. and is cooled using an air conditioner (installed June 2016) and heated using a gas furnace (installed June 2016). Savings generated from this measure can be calculated using:

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{wall} * (1 - FF_{wall}) * CDD * 24 * DUA}{1{,}000 * \eta_{Cooling}}$$

and

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{New}}\right) * A_{wall} * \left(1 - FF_{Ceiling}\right) * HDD * 24}{100{,}000 * \eta_{Heating}}$$

i.e.,

$$\Delta kWh_{Cooling} = \frac{\left(\frac{1}{10} - \frac{1}{32}\right) * 2{,}500 * (1 - 0.07) * 1{,}899 * 24 * 0.75}{1000 * 13.0} = 339\ kWh$$

and

$$\Delta therms_{Heating} = \frac{\left(\frac{1}{10} - \frac{1}{32}\right) * 2{,}500 * (1 - 0.07) * 2{,}816 * 24}{100{,}000 * 0.8} = 109\ therms$$

4.24.4 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure during 3:00-6:00 pm on the hottest summer weekdays. It is assumed that the time spent in the hottest temperature bin is likely during the peak time. Which bin is the hottest depends on the climate zone. Based on these assumptions, the demand savings for homes with standard DX cooling are derived with the following equation.[483]

$$Peak\ Demand\ Savings = \frac{\Delta kWh_{Cooling}}{EFLH_{Cool}} * CF$$

Where:

$Peak\ Demand\ Savings$ = *Summer peak kW savings, kW*

$\Delta kWh_{Cooling}$ = Cooling energy savings, kWh

$EFLH_{Cool}$ = Effective Full Load Cooling Hours, *Table* 309.

CF = *Coincidence Factor, 0.56*[484]

Table 309 provides the effective full load cooling hours inputs for the deemed savings calculation based on climate zone.

[483] Based on ADM ceiling insulation calculator spreadsheet

[484] Based on hourly metering data and thermostat runtime data for residences in NM utility territories.

Table 309: Effective Full Load Cooling Hours[485]

Climate Zone	$EFLH_{Cool}$
Albuquerque	852
Santa Fe	562
Roswell	1,008
Las Cruces	1,059

4.24.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.24.6 MEASURE LIFE

The lifetime for this measure is 30 years.[486]

4.25 LOW-E WINDOW FILM

This measure consists of adding solar film to east and west facing windows. This measure applies to all residential applications.

4.25.1 MEASURE OVERVIEW

Sector	Residential
End use	Building Envelope
Fuel	Electricity
Measure category	Window Treatments
Delivery mechanism	Prescriptive
Baseline description	Clear glass without existing window treatments
Efficient case description	Eligible window treatments installed on eligible windows

485 EFLH Cooling values determined using metered data and thermostat data collected from residential sites located in NM utility territories.

486 Guidehouse's 'EMV Group A, Deliverable 16 EUL Research – Residential Insulation,' prepared for the California Public Utilities Commission, June 2021

4.25.2 BASELINE AND EFFICIENCY STANDARDS

This measure is applicable to existing homes only. Low-E windows and tinted windows are not applicable for this measure. In order to qualify for deemed savings, solar film should be applied to east and west facing glass. Table 310 provides the baseline condition for this measure.

Table 310: Window Film – Baseline and Efficiency Standards

Baseline	Efficiency Standard
Single- or double-pane window with no existing solar films, solar screens, or low-e coating	Solar Film with SHGC <0.50

4.25.3 DEEMED ENERGY AND DEMAND SAVINGS

Deemed savings are provided in Table 311 through Table 314 on a per square foot basis. Savings are equal to the product of the deemed values and the square footage of the window area to which the films are being added. Gas Heat (no AC) kWh applies to forced air furnace systems only. Deemed savings value for single-pane, double-pane, and weighted single- and double-pane windows are provided. The weighted single- and double-pane window assumes a standard distribution of 46% single-pane and 54% double-pane based on 2020 RECS survey data.[487]

Deemed savings values have been calculated for each of the four weather zones. The deemed savings are dependent on the SHGC of pre- and post-retrofit glazing. BEopt™ was used to estimate energy savings for a series of models using the DOE EnergyPlus simulation engine. Since window film savings are sensitive to weather, available TMY3 weather data specific to each of the four Arkansas weather regions were used for the analysis. The prototype home characteristics used in the BEopt building model are outlined in Appendix A.

Table 311: Window Film – Deemed Savings Values – Albuquerque

Existing Window Pane Type	AC/Gas Heat kWh/Sq.ft	Gas Heat (no AC) kWh/Sq.ft	Gas Heat Therms/Sq. ft	AC/Electric Resistance kWh/Sq.ft	Heat Pump kWh/Sq.ft	AC Peak Savings kW/Sq.ft	Peak Gas Savings Therms/Sq.ft
Single Pane	2.452	-0.275	-0.409	-5.663	-1.298	0.0021	-0.0018

[487] 2020 Residential Energy Consumption Survey (RECS). Structural and geographic characteristics in the South and West regions (HC2.8). Analysis based on West South-Central census region. https://www.eia.gov/consumption/residential/data/2020/

Existing Window Pane Type	AC/Gas Heat kWh/Sq.ft	Gas Heat (no AC) kWh/Sq.ft	Gas Heat Therms/Sq. ft	AC/Electric Resistance kWh/Sq.ft	Heat Pump kWh/Sq.ft	AC Peak Savings kW/Sq.ft	Peak Gas Savings Therms/Sq.ft
Double Pane	0.800	-0.089	-0.133	-2.061	-0.516	0.0000	-0.0018
Weighted	1.560	-0.175	-0.260	-3.718	-0.876	0.001	-0.002

Table 312: Window Film – Deemed Savings Values - Santa Fe

Existing Window Pane Type	AC/Gas Heat kWh/Sq.ft	Gas Heat (no AC) kWh/Sq.ft	Gas Heat Therms/Sq.ft	AC/Electric Resistance kWh/Sq.ft	Heat Pump kWh/Sq.ft	AC Peak Savings kW/Sq.ft	Peak Gas Savings Therms/Sq.ft
Single Pane	1.843	-0.343	-0.476	-8.304	-2.720	0.0025	-0.0016
Double Pane	0.597	-0.116	-0.160	-2.941	-0.990	-0.0004	-0.0025
Weighted	1.170	-0.220	-0.305	-5.408	-1.786	0.001	-0.002

Table 313: Window Film – Deemed Savings Values – Roswell

Existing Window Pane Type	AC/Gas Heat kWh/Sq.ft	Gas Heat (no AC) kWh/Sq.ft	Gas Heat Therms/Sq.ft	AC/Electric Resistance kWh/Sq.ft	Heat Pump kWh/Sq.ft	AC Peak Savings kW/Sq.ft	Peak Gas Savings Therms/Sq.ft
Single Pane	2.873	-0.229	-0.362	-3.838	-0.315	0.0018	-0.0020
Double Pane	0.941	-0.070	-0.114	-1.452	-0.188	0.0003	-0.0013
Weighted	1.830	-0.143	-0.228	-2.550	-0.246	0.001	-0.002

Table 314: Window Film – Deemed Savings Values - Las Cruces

Existing Window Pane Type	AC/Gas Heat kWh/Sq.ft	Gas Heat (no AC) kWh/Sq.ft	Gas Heat Therms/Sq.ft	AC/Electric Resistance kWh/Sq.ft	Heat Pump kWh/Sq.ft	AC Peak Savings kW/Sq.ft	Peak Gas Savings Therms/Sq.ft
Single Pane	2.971	-0.218	-0.351	-3.413	-0.086	0.0018	-0.0021
Double Pane	0.974	-0.066	-0.110	-1.311	-0.112	0.0003	-0.0012
Weighted	1.893	-0.136	-0.221	-2.278	-0.100	0.001	-0.002

4.25.4 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.25.5 MEASURE LIFE

The average lifetime of this measure is 10 years.[488]

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[488] DEER 2008

4.26 ENERGY STAR® ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)

This measure involves the installation of an ENERGY STAR® certified Level 2 electric vehicle supply equipment (EVSE) at a residential site. EVSE is the infrastructure that enables plug-in electric vehicles (PEV) to charge onboard batteries. Level 2 EVSE requires 240-volt electrical service. This measure provides deemed savings for the energy efficiency improvement of an ENERGY STAR® EVSE over a standard or non-ENERGY STAR® EVSE.

4.26.1 MEASURE OVERVIEW

Sector	Residential
End use	Electric Vehicle Charging Equipment
Fuel	Electricity
Measure category	Appliance
Delivery mechanism	Prescriptive
Baseline description	Non-ENERGY STAR® certified Level 2 EVSE
Efficient case description	ENERGY STAR® certified Level 2 EVSE

4.26.2 ENERGY SAVINGS ESTIMATION

Energy Savings for the measure are realized due to the improved operating efficiency of the ENERGY STAR® EVSE when the vehicle is plugged in but not being charged, and when the vehicle is not plugged in.

Savings are calculated according to the following algorithm:

$$ENERGY\ STAR\ Idle\ Consumption\ [kWh] = \frac{\left(hrs_{plug} *\ W_{plug} + hrs_{unplug_C} * W_{unplug}\right) * days_C + hrs_{unplug_{NC}} * W_{unplug} * days_{NC}}{1000}$$

$$Baseline\ Idle\ Consumption\ [kWh] = \frac{ENERGY\ STAR\ Idle\ Consumption}{0.6}$$

$$Annual\ Energy\ Savings\ [kWh] = Baseline\ Idle\ Consumption\ -\ ENERGY\ STAR\ Idle\ Consumption$$

Where:

hrs_{plug} = *Hours per day the vehicle is plugged into the EVSE and not charging, 9.3 hrs.*[489]

[489] Idaho National Lab (INL) EV Project, June 2015, "Characterize the Demand and Energy Characteristics of Residential Electric Vehicle Supply Equipment," page 5. A vehicle plugged in for 11.7 hours and charging for 2.4 hours leaves 9.3 hours when it is plugged in and not charging.

W_{plug} = Wattage of the EVSE when the vehicle is plugged into the EVSE but not charging, 7.0 W.[490]

hrs_{unplug} = Hours per day the vehicle is not plugged into the EVSE on a charging day, 12.3 hrs.[491]

hrs_{unplug_NC} = Hours per day the vehicle is not plugged into the EVSE on a non-charge day, 24 hrs.

W_{unplug} = Wattage of the EVSE when the vehicle is not plugged into the EVSE, 2.9 W.[492]

$days_C$ = Number of charging days per year, 321.[493]

$days_{NC}$ = Number of non-charging days per year, 44.

1000 = Conversion from Wh to kWh

0.6 = Efficiency adjustment factor[494]

4.26.3 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following formula:

$$Demand\ Savings\ [kW] = Annual\ Energy\ Savings * PLS$$

Where:

PLS = Probability-weighted peak load share, Table 315

Table 315 presents the deemed annual energy savings per EVSE.

Table 315: EVSE Peak Load Share[495]

Summer PLS	Winter PLS
0.00011	0.00016

4.26.4 DEEMED ENERGY AND DEMAND SAVINGS

Table 316 presents the deemed annual energy savings per EVSE.

490 Average Idle Mode Input Power from ENERGY STAR® certified EVSE product list as of August 27, 2019.

491 INL, page 5. 24 hours per day minus 11.7 hours plugged in leaves 12.3 hours unplugged.

492 Average No Vehicle Mode Input Power from ENERGY STAR® certified EVSE product list.

493 INL, page 6. 88% of PEV owners charge every day. 365 x .88 = 321.2.

494 ENERGY STAR® EVSE overview: "ENERGY STAR certified EV charger… on average use 40% less energy than a standard EV charger when the charger is in standby mode (i.e., not actively charging a vehicle)." https://www.energystar.gov/products/other/evse. Accessed August 2022.

495 Probability weighted peak load factors are calculated according to the method in Section 4 of the Texas TRM Vol 1 using data from 3 studies: CCET Wind Integration in ERCOT, Avista Utilities Semi Annual Report on Electric Vehicle Supply, and Xcel CO EVCS Pilot.

Table 316: EVSE Annual Energy Savings

Annual Energy Savings (kWh)
23.6

Table 317 presents the deemed summer and winter peak kW savings per EVSE.

Table 317: EVSE Peak Demand Savings

Summer Peak kW	Winter Peak kW
0.002597	0.003777

4.26.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.26.6 MEASURE LIFE

The estimated useful life (EUL) for an EVSE is assumed to be 10 years.[496]

4.27 SOLAR ATTIC FANS

Solar attic fans increase the extraction rate of accumulated hot air in attics during the cooling season. Solar attic fans introduce no new electrical load to the home since they are powered by an attached photovoltaic panel. They save energy by reducing the load on air conditioning equipment, cooling the conditioned space directly underlying the attic, and reducing heat exchange with supply ducts located in the attic when present. Deemed savings are provided for reduced air conditioning load.

Note: This is a new measure originally sourced from the Texas TRM with limited savings information; therefore, solar attic fans should be implemented with the expectation of a savings methodology update in future TRMs as Texas-specific field information becomes available.

[496] U.S. Department of Energy Vehicle Technologies Office, November 2015, "Costs Associated with Non-Residential Electric Vehicle Supply Equipment" p. 21. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf, Accessed August 2022.

4.27.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity
Measure category	Building Envelope
Delivery mechanism	Direct Install
Baseline description	Attic with no solar attic fan
Efficient case description	Solar attic fans capable of removing a minimum of 400 cfm for every thousand square feet of attic floorspace

4.27.2 DEFINITION OF BASELINE EQUIPMENT

The baseline condition is an existing home with refrigerated air conditioning, and a vented attic without solar attic fans.

4.27.3 DEFINITION OF EFFICIENT EQUIPMENT

The high-efficiency condition is the installation of sufficient solar attic fans to remove 400 cfm for every thousand square feet of attic floor space. A solar attic fan consists of an electric fan powered by an integrated photovoltaic panel installed for the exclusive purpose of powering the fan.

4.27.4 ENERGY SAVINGS ESTIMATION

Savings have been estimated by performing energy balances on the roof surface and on the attic airspace on an hourly time step. The energy balances account for heat flux from the roof into the attic and between the attic and the underlying conditioned space. Solar attic fans are assumed to operate in the cooling season in the hours of the day when there is incident solar irradiation on the panel. Deemed savings are based on replacing hot attic air with outside air using solar attic fans with a capacity of 400 cfm per thousand square feet of attic floor. Estimated savings are a function of the difference in heat transfer to conditioned space with and without solar attic fans, considering that the heat transferred to conditioned space must be removed by the air conditioning system. For homes with ducts in the attic, additional savings are estimated considering heat transfer to supply ducts.

Hourly data for the ambient conditions is from TMY3 files for the Texas TRM climate zones.

Annual energy savings are simply the sum of the hourly energy savings:

$$Annual\ Energy\ Savings\ (kWh) = \sum_{hr=1}^{8760} Hourly\ Energy\ Savings * CAF$$

Attic temperature for each hour is estimated according to the following equation for both the baseline and high-efficiency conditions.[497]

$$T_a = \frac{A_r * U_r * \frac{\alpha * I_S + h_O * T_O}{h_O + U_r} + Q * \rho * c_p * T_o + (A_c * U_c + A_d * U_d) * T_i}{\frac{A_r * U_r * h_O}{h_O + U_r}} + Q * \rho * c_p + (A_c * U_c + A_d * U_d)$$

Once hourly attic temperatures are estimated for the baseline and high-efficiency conditions, hourly energy savings are estimated as follows:

$$Hourly\ Energy\ Savings\ (kWh) = \frac{(A_c * U_c + A_d * U_d)}{1000 * EER} * (T_{a,b} - T_{a,he}) * 1\ hr$$

Where:

CAF	= *Cooling savings adjustment factor: set to 1.0 for homes with central refrigerated air; for homes with one or more room air conditioners set to 0.6.*
A_r	= *Roof surface area* (ft^2)
U_r	= *U-factor of the roof between the unconditioned attic and the exterior* (Btu/ft^2*-hr-°F)*
a	= *Absorption coefficient of the roof (dimensionless)*
I_s	= *Solar irradiance* (Btu/ft^2*-hr)*
h_o	= *Convective heat transfer coefficient for air* (Btu/ft^2*-hr-°F)*
T_o	= *Exterior temperature (°F)*
T_r	= *Temperature of the roof (°F)*
T_a	= *Temperature of the attic (°F)*
Q	= *Ventilation airflow rate (CFM)*
r	= *Density of air* (lb/ft^3)
c_p	= *Specific heat of air (Btu/lb-°F)*
A_c	= *Ceiling surface area* (ft^2)

497 This equation results from solving the energy balance on the roof for Tr and inserting this value into the energy balance for the attic airspace, while solving for Ta. The equations are drawn from ASHRAE Fundamentals, Chapter 17, Residential Heat Load Guidebook. Approach originally derived by TetraTech, Inc. (see references section).

U_c = *U-factor of the ceiling between the conditioned space and the unconditioned attic (Btu/ft² -hr-°F)*

A_d = *Surface area of supply ducts in the attic (ft²); set to zero if there are no supply ducts in the attic*

U_d = *U-factor of the insulation on the ducts, (Btu/ft²-hr-°F)*

Ti = *Temperature of the conditioned space (°F)*

EER = *Efficiency of the air conditioner (Btu/W-h)*

$T_{a,b}$ = *Temperature of the baseline attic, without solar powered attic fan (°F)*

$T_{a,he}$ = *Temperature of the attic in the high-efficiency condition, with solar powered attic fan (°F)*

4.27.5 DEMAND SAVINGS ESTIMATION

The cooling adjustment factor is also applied to the demand savings:

$$Peak\ Demand\ Savings\ (kW) = Summer\ Peak\ Demand\ Savings\ \times\ CAF$$

The Summer Peak Demand Savings are summarized in Table 319.

Winter peak demand savings are not estimated. Solar attic fans that operate in the winter would likely require more space heating and produce negative savings by increasing the temperature gradient between conditioned space and the cooler attic air, while potentially creating condensation issues.

4.27.6 DEEMED ENERGY AND DEMAND SAVINGS

Table 318 and Table 319 present the Deemed Energy and Demand Savings respectively for homes with ducts in the attic and for homes with no ductwork in their attics.

Table 318: Solar Attic Fans Deemed Annual Energy Savings (kWh)

Climate Zone	No Ducts in Attic	Ducts in Attic
Albuquerque	169	281
Santa Fe	137	229
Roswell	191	317
Las Cruces	196	325

Table 319: Solar Attic Fans Deemed Summer Peak Demand Savings (kW)

Climate Zone	No Ducts in Attic	Ducts in Attic
Albuquerque	0.15	0.25
Santa Fe	0.16	0.27
Roswell	0.14	0.24
Las Cruces	0.14	0.24

4.27.7 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.27.8 MEASURE LIFE

The EUL for solar attic fans in Texas is estimated to be 15 years.[498]

4.28 WINDOW AIR CONDITIONER REPLACEMENT AND RECYCLING

This measure involves replacement of an existing window air conditioner with a new high efficient window air conditioner. The characterization also includes an option for Window AC recycling. Window AC recycling is only eligible for fully functional units which are removed from the grid and not replaced with a new unit. This measure applies to all residential applications.

4.28.1 MEASURE OVERVIEW

Sector	Residential
End use	HVAC
Fuel	Electricity
Measure category	ENERGY STAR® Window AC
Delivery mechanism	Rebate
Baseline description	IECC 2021 efficiency
Efficient case description	Efficiency must meet current ENERGY STAR® specification

4.28.2 DEFINITION OF BASELINE EQUIPMENT

The baseline is assumed to be a new air conditioning unit with a combined energy efficiency ratio (CEER) rating that meets the current federal standard, which became effective on June 1, 2014.[499]

498 The EUL of a solar attic fan is closely related to its motor. The US DOE Advanced Manufacturing Office's Motor Systems Tip Sheet #3 suggests motors should last approximately 35,000 hours. The average annual hours of operation for solar attic fans across the Texas TRM zones is about 2,300 hours.

499 10 CFR 430.32(b). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

4.28.3 DEFINITION OF EFFICIENT EQUIPMENT

Installed units must meet the current ENERGY STAR® specification of 19 to 36 percent more efficient than the federal standard for all categories. The baseline and efficiency standards are summarized in Table 320 and Table 321.

Table 320: Window AC Replacement – Baseline and Efficiency Standard[500]

Reverse Cycle (Yes/No)	Louvered Sides (Yes/No)	Capacity (Btu/hr)	Baseline Efficiency (CEER)	Efficiency Standard (CEER)
No	Yes	< 6,000	11.0	13.1
		6,000 to 7,999	11.0	13.7
		8,000 and 10,999	10.9	14.7
		11,000 to 13,999	10.9	14.7
		14,000 to 19,999	10.7	14.4
		20,000 to 27,999	9.4	12.7
		= 28,000	9.0	12.2
No	No	< 6,000	10.0	12.8
		6,000 to 7,999	10.0	12.8
		8,000 and 10,999	9.6	13
		11,000 to 13,999	9.5	12.8
		14,000 to 19,999	9.3	12.6
		20,000 to 27,999	9.4	12.7
		= 28,000	9.4	12.7
Yes	Yes	< 20,000	9.3	13.2
		= 20,000	9.3	12.6
Yes	No	< 14,000	9.3	12.6
		=14,000	8.7	11.7

Table 321: Window AC Replacement – Casement Type – Baseline and Efficient Standards[501]

Casement Type	Baseline Efficiency (CEER)	Efficiency Standard (CEER)
Casement-Only	9.5	12.8
Casement-Slider	10.4	14.0

4.28.4 ENERGY SAVINGS ESTIMATION

Savings can be calculated using the following equations:

[500] https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32
501 ibid

$$kWh_{Savings} = CAP * \left(\frac{1\ kW}{1000\ W}\right) * RAF * [(EFLH_C)] \quad * \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{post}}\right)$$

CAP = *Rated equipment cooling capacity of the new or recycled unit (Btu/hr)*

η_{base} = *Energy efficiency rating (EER) of the baseline cooling equipment. Use Table 320 for replacements and recycling when known. For recycling where efficiency is unknown, assume 9.8 CEER*[502]*.*

η_{post} = *Energy efficiency rating (EER) of the installed cooling equipment (at least equal to value from Table 320). For recycling, remove this term from the equation.*

CF = *Coincidence factor = 0.87 (default)*

RAF = *Room AC adjustment factor = 0.49 (default); derivation described in (Table 323)*

$EFLH_C$ = *Equivalent full-load cooling hours (Table 323)*

The EFLHs from the ENERGY STAR® Room AC savings are the same as those used for the ENERGY STAR® Central AC savings calculator and are provided in Table 322.

Table 322: Room AC Replacement – Equivalent Full-Load Cooling Hours[503]

Location	$EFLH_C$
Albuquerque	1,081
Las Cruces	1,375
Roswell	1,319
Santa Fe	736

The values provided are not appropriate for the application of savings for room AC units as they typically do not run as many hours as central systems. To correct for this issue, an adjustment factor of 51 percent is applied to the ENERGY STAR® EFLHs. This adjustment factor is derived by taking the ratio of the average run hours from two sources to the ENERGY STAR® EFLHs. The derivation of this factor is described in Table 323.

The values in the RLW Adj Hours column were calculated by multiplying the ES EFLHC values by a 0.33 factor. The 0.33 factor was derived by taking the ratio of EFLHc specified in a study performed by RLW Analytics for the Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group to the EFLHc values from the ENERGY STAR® Room AC savings calculator for the same reference cities. The values in the AHAM Hours

[502] Federal efficiency standard for most window AC units (less than 20,000 btu/hr with louvered sides).

[503] EFLH values are derived from the values in the Arkansas TRM version 8.1

column are taken directly from the Association of Home Manufacturers (AHAM) Room Air Conditioner calculator.

Table 323: Room AC Adjustment Factor (RAF) Derivation[504]

Location	ES $EFLH_C$	RLW Adj Hours[505]	AHAM (Association of Home Manufacturers) Hours	Avg. Hours	RAF
Albuquerque	1,081	357	749	553	0.51
Las Cruces	1,375	454	899	676	0.49
Roswell	1,319	435	871	653	0.49
Santa Fe	736	245	573	409	0.55
				Average:	**0.51**

4.28.5 DEMAND SAVINGS ESTIMATION

Demand savings are derived with the following equation. When calculating demand savings from recycling, do not include the η_{post} term to determine the peak demand of only the baseline unit which was recycled.

$$Demand\ Savings\ (kW) = CAP * \left(\frac{1\ kW}{1000\ W}\right) * \left(\frac{1}{\eta_{base}} - \frac{1}{\eta_{post}}\right) * CF$$

4.28.6 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.28.7 MEASURE LIFE

The estimated measure life for window air conditioners is 10.5 years.[506]

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504 Values in table are derived from the values in the Arkansas TRM version 8.1

505 RLW Analytics: Final Report Coincidence Factor Study Residential Room Air Conditioners, https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf. Derived by taking the average ratio of EFLH for Room ACs (from the RLW Analytics report) to EFLHs for Central ACs for the same location (from the ENERGY STAR® Central AC Calculator).

506 According to the DOE's Technical Support Document, Chapter 8: Life Cycle Cost and Payback Period Analyses 2011

4.29 GAS FURNACE TUNE-UP (NEW)

This measure is for a natural gas Residential furnace that provides space heating. The tune-up will improve furnace performance by inspecting, cleaning, and adjusting the furnace and appurtenances for correct and efficient operation. Additional savings may be realized through a complete system tune-up.

4.29.1 MEASURE OVERVIEW

Sector	Residential
End use	Space Heating
Fuel	Natural Gas
Measure category	High Efficiency Gas Furnaces
Delivery mechanism	Rebate
Baseline description	Steady state furnace efficiency before tune-up
Efficient case description	Steady state furnace efficiency after tune-up

4.29.2 SAVINGS

The baseline equipment is equal to a furnace, or a gas-fired rooftop unit assumed not to have had a tune-up in the past 3 years.

To qualify for this measure an approved technician must complete the tune-up requirements listed below:[507]

- Measure the combustion efficiency using an electronic flue gas analyzer
- Check and clean the blower assembly and components per manufacturer's recommendations
- Where applicable, lubricate the motor, and inspect and replace fan belt if required
- Inspect for gas leaks
- Clean the burner per manufacturer's recommendations and adjust as needed
- Check the ignition system and safety systems, and clean and adjust as needed

[507] American Standard Maintenance for Indoor Units (see 'HVAC Maintenance American Standard')

- Check and clean the heat exchanger per manufacturer's recommendations
- Inspect the exhaust/flue for proper attachment and operation
- Inspect the control box, wiring, and controls for proper connections and performance
- Check the air filter and clean or replace per manufacturer's
- Inspect the duct work connected to furnace for leaks or blockages
- Measure the temperature rise and adjust flow as needed
- Check for correct line and load volts/amps
- Check the thermostat operation is per manufacturer's recommendations (if adjustments are made, refer to 'Small Commercial Programmable Thermostat Adjustment' measure for savings estimate)
- Perform carbon monoxide tests and adjust the heating system until results are within standard industry acceptable limits

4.29.3 ENERGY SAVINGS ESTIMATION

Electric savings are calculated based on the following formula:

$$\Delta kWh = \Delta Therms \times F_e \times 29.3$$

Where:

$\Delta Therms$ = *annual gas savings in therms*

F_e = *Furnace Fan energy consumption as a percentage of annual fuel consumption*

= *3.14%*[508]

29.3 = *kWh per Therm*

Therm savings are calculated based on the following formulas:

$$\Delta Therms = \frac{(CAP_{InputPre} \times EFLH \times (\frac{\frac{1}{Eff_{Before} - 1}}{Eff_{Before} + E_i})}{100{,}000 \frac{BTU}{therm}}$$

[508] Fe is not one of the AHRI certified ratings provided for residential furnaces but can be reasonably estimated from a calculation based on the certified values for fuel energy (Ef in MMBtu/yr) and Eae (kWh/yr). An average of a 300 record sample (non-random) out of 1495 was 3.14%. This is, appropriately, ~50% greater than the ENERGY STAR version 3 criteria for 2% Fe. See "Programmable Thermostats Furnace Fan Analysis.xlsx" for reference.

$$Peak\ Day\ Therm\ Savings = \frac{\Delta Therms}{yr} \times GM$$

Where:

$CAP_{InputPre}$ = *Measured gas Furnace input capacity pre tune-up (Btuh)*

EFLH = *heating equivalent full load hours for the appropriate weather zone (from Table* 324*)*

Eff_{Before} = *Actual efficiency of the furnace before the tune-up*

Note: Contractors should select a mid-level firing rate that appropriately represents the average building operating condition over the course of the heating season and take readings at a consistent firing rate for pre and post tune-up.

E_i = *Actual efficiency improvement of the furnace tune-up measure*

Table 324 provides values for the equivalent full load heating hours for each climate zone.

Table 324: Heating Equivalent Full Load Operating

City	EFLHHeat
Albuquerque	1,358
Las Cruces	899
Roswell	921
Santa Fe	1,447

4.29.4 DEMAND SAVINGS ESTIMATION

There are no demand savings for this measure.

4.29.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

4.29.6 MEASURE LIFE

The measure life for the clean and check tune up is 3 years.[509]

[509] Assumed consistent with other tune-up measures.

4.30 HIGH EFFICIENCY POOL PUMPS (NEW/REPLACEMENT)

This measure involves the installation of a new ENERGY STAR® or CEE T1 variable speed residential pool pump motor in place of a pump meeting the federal standard for Time of Sale and New Construction scenarios, or the early replacement of a standard single speed motor of equivalent horsepower.

4.30.1 MEASURE OVERVIEW

Sector	Residential
End use	Pool Water Pumping
Fuel	Electricity
Measure category	Water Pumping
Delivery mechanism	Rebate
Baseline description	Two speed residential pool pump meeting the Federal Standard
Efficient case description	0.5-3 HP ENERGY STAR® or CEE T1 qualified multi-speed or variable-speed pool pump

4.30.2 SAVINGS

Residential outdoor pool pumps can be single speed, two/multi speed, or variable speed. The federal standard 82 FR 5650 (effective July 19, 2021) effectively requires new pumps to be at least two speeds.

Single speed pumps are often oversized and run frequently at constant flow regardless of load. Single speed pool pumps require that the motor be sized for the task that requires the highest speed. As such, energy is wasted performing low speed tasks at high speed. Two-speed and variable speed pool pumps reduce speed when less flow is required, such as when filtering is needed but not cleaning, and have timers that encourage programming for fewer operating hours. Variable speed pool pumps use advanced motor technologies to achieve efficiency ratings of 90% while the average single speed pump will have efficiency ratings between 30% and 70%.

The high efficiency equipment is an ENERGY STAR or CEE Tier residential pool pump meeting the ENERGY STAR minimum qualifications outlined in Table 325 for either in-ground or above-ground pools. The table provides information for weighted energy factor (WEF) and hydraulic horsepower (HHP). ENERGY STAR version 3.0 specification takes effect on July 19, 2021. Note that for in-ground pools, the CEE Tier 1 is the same as the new Federal Standard, and Tier 2 is the same as ENERGY STAR® V3 for the standard size pumps, so savings for CEE Tier 1 is only provided for above ground pools where there is an increment in efficiency.

Table 325: Minimum Qualifications for High Efficiency Pool Pumps

Pump Sub-Type	Size Class	ENERGY STAR® Version 3.0 Energy Efficiency Level (Effective 7/19/2021)	CEE Tier 1	CEE Tier 2
Self-Priming (Inground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 13.40	N/A	N/A
	Small (hhp > 0.13 and < 0.711)	WEF ≥ -2.45 x ln (hhp) + 8.40	WEF ≥ -1.30 x ln (hhp) + 4.95	WEF ≥ -2.83 x ln (hhp) + 8.84
	Standard Size (hhp ≥ 0.711)	WEF ≥ -2.45 x ln (hhp) + 8.40	WEF ≥ -2.3 x ln (hhp) + 6.59	WEF ≥ -2.45 x ln (hhp) + 8.4
Non-Self Priming (Aboveground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 4.92	N/A	N/A
	Standard Size (hhp > 0.13)	WEF ≥ -1.00 x ln (hhp) + 3.85	WEF ≥ -1.60 x ln (hhp) + 9.10	N/A

Baseline equipment is equivalent to a two-speed residential pool pump meeting the Federal Standard, effective July 19, 2021, provided in Table 326.

Table 326: Federal Standard for Baseline Pool Pumps

Pump Sub-Type	Size Class	Baseline (Effective 7/19/2021)
Self-Priming (Inground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 5.55
	Small (hhp > 0.13 and < 0.711)	WEF ≥ -1.30 x ln (hhp) + 2.90
	Standard Size (hhp ≥ 0.711)	WEF ≥ -2.30 x ln (hhp) + 6.59
Non-Self Priming (Aboveground) Pool Pumps	Extra Small (hhp ≤ 0.13)	WEF ≥ 4.60
	Standard Size (hhp > 0.13)	WEF ≥ -0.85 x ln (hhp) + 2.87

*hhp = Hudraulic Horsepower, WEF - Weighted Energy Factor

For early replacement scenarios, the baseline equipment is the existing single speed residential pool pump.

4.30.3 ENERGY SAVINGS ESTIMATION[510]

Savings are provided below based on the measure event type:

For Time of Sale and New Construction:

$$\Delta kWh = \frac{\left(Gallons * Turnovers * \left(\frac{1}{WEF_{base}} - \frac{1}{WEF_{ESTAR}}\right) * Days\right)}{1{,}000}$$

For Early Replacement:

$$\Delta kWh = \frac{\left(Gallons * Turnovers * \left(\frac{1}{EF_{Exist}} - \frac{1}{WEF_{ESTAR}}\right) * Days\right)}{1{,}000}$$

Where:

$Gallons$ = *Actual capacity of the pool. If unknown refer to Table 327*

$Turnovers$ = *Desired number of pool water turnovers per day = 2*[511]

WEF_{base} = *Weighted Energy Factor of baseline pump (gal/Wh)*[512]

WEF_{ESTAR} = *Weighted Energy Factor of ENERGY STAR® pump (gal/Wh)*[513]

EF_{Exist} = *Energy Factor of existing single speed pump (gal/Wh)= 2.3*[514]

Days = *Number of days per year that the swimming pool is operational = 122*[515]

1,000 = *Conversion factor from Wh to kWh*

Table 327 provides input values for the capacity of the pool.

[510] The methodology followed is consistent with the most recent version of the 2020 ENERGY STAR calculator (Pool_Pump_Calculator_2020.05.05_FINAL.xls), however, this has not been updated to account for the new federal standard.

[511] Consistent with assumption in the 2020 ENERGY STAR calculator.

[512] Based on applying the federal standard specifications to the average Curve-C rated hydraulic horsepower (hhp) from the ENERGY STAR Qualified Products List, accessed 3/31/2021.

[513] Based on applying the ENERGY STAR and CEE Tier 1 specifications to the average Curve-C rated hydraulic horsepower (hhp) from the ENERGY STAR Qualified Products List, accessed 3/31/2021.

[514] Consistent with assumption in the 2020 ENERGY STAR calculator, assuming 1.5 HP pump.

[515] Consistent with assumption in the 2020 ENERGY STAR calculator.

Table 327: Input Values for Capacity of the Pool (Gallons)

Pool Type	Capacity of the Pool (Gallons)
In ground	22,000[516]
Above ground	7,540[517]

Table 328 Table 329 provide the weighted energy factors for baseline and EnergyStar pumps, respectively.

Table 328: Weighted Energy Factor for Baseline Pump

Pool Type	WEF_{Base}
In ground	4.63
Above ground	2.57

Table 329: Weighted Energy Factor for EnergyStar Pump

Pool Type	WEF_{ESTAR}	
	ENERGY STAR®	CEE Tier 1
In ground	6.31	N/A
Above ground	3.49	8.53

Based on the defaults provided above, the electric annual energy savings are detailed in

Table 330 based on the pool type.

Table 330: High Efficiency Pool Pumps Deemed Annual energy savings

Pool Type	TOS/NC		Retrofit	
	ENERGY STAR®	CEE T1	ENERGY STAR®	CEE T1
In ground	307.7	N/A	1512.1	N/A
Above ground	189.5	499.5	283.7	593.6

4.30.4 DEMAND SAVINGS ESTIMATION

Demand savings can be calculated using the following equations based on the measure event type:

[516] Consistent with assumption in the 2020 ENERGY STAR calculator.

[517] Based on typical pool sizes from "Evaluation of Potential Best Management Practices - Pools, Spas, and Fountains, The California Urban Water Conservation Council", 2010.

For Time of Sale and New Construction:

$$\Delta kW = \left(\frac{\frac{kWh}{day_{base}}}{\frac{Hrs}{day_{base}}}\right) - \left(\frac{\frac{kWh}{day_{ESTAR}}}{\frac{Hr}{day_{ESTAR}}}\right) x\ CF$$

For Early Replacement:

$$\Delta kW = \left(\frac{\frac{kWh}{day_{Exist}}}{\frac{Hrs}{day_{Exist}}}\right) - \left(\frac{\frac{kWh}{day_{ESTAR}}}{\frac{Hr}{day_{ESTAR}}}\right) *\ CF$$

Where:

kWh/day = *daily energy consumption of pool pump, as defined above.*

= *Actual, defaults provided below (Table 331and Table 332)*

Hrs/day_{base} = *daily run hours of pool pump*

= *(Gallons * Turnover) / GPM*

CF = *Summer Peak Coincidence Factor for measure*

= *0.831*[518]

Table 331 provides input values for the daily energy consumption per pool type.

Table 331: Daily Energy consumption of pool pump (kW)

Pool Type	Standard Baseline	ENERGY STAR®	CEE T1	Existing
In ground	9.5	7	N/A	19.4
Above ground	5.9	4.3	1.8	6.6

Table 332 provides input values for the expected daily runtime of the pool pump by pool type.

Table 332: Daily Run Hours of Pool Pump

Pool Type	Condition	Weighted Average GPM	Hours/Day
In ground	Standard Baseline	43.6	16.8
	Efficient	32.2	22.8
	Existing	78	9.4
Above ground	Standard Baseline	44.7	5.6
	Efficient	27.3	9.2
	Existing	78.1	3.2

[518] Based on assumptions of daily load pattern through pool season. Assumption was developed for Efficiency Vermont but is considered a reasonable estimate for New Mexico.

Based on the defaults provided above, savings for each measure event type are provided in Table 333.

Table 333: Energy Demand Savings for Pool Pump (kW)

Pool Type	Demand Savings (kW)			
	TOS/NC		Retrofit	
	ENERGY STAR®	CEE T1	ENERGY STAR®	CEE T1
In ground	0.2152	N/A	1.4641	N/A
Above ground	0.4793	0.7094	1.3285	1.5586

4.30.5 NON-ENERGY BENEFITS

There are no non-energy benefits for this measure.

4.30.6 MEASURE LIFE

The estimated useful life for a two-speed or variable-speed pool pump is 7 years.[519]

4.31 RESIDENTIAL INDUCTION COOKING (NEW)

Residential cooking appliances include ovens, cooktops, and full ranges. A full range consists of an oven with a built-in cooktop.

An induction range is an electric oven with a built-in induction cooktop. Induction technology works on the principle of magnetic induction, where excited eddy currents in ferromagnetic cookware within the presence of an oscillating magnetic field dissipate heat through the Joule effect. This heat is directly generated by the cookware and is transmitted to the food within it, lessening thermal condition heat loss between the heating element and the cookware. Induction cooktops include a switching-power electronics circuit that delivers high-frequency current to a planar coil of wire embedded in the cooking surface. The cookware is magnetically coupled to the coil by the oscillating magnetic field. Current flows in the cooking vessel due to the low resistance of the metal. Resistance is a function of the permeability and resistivity of the cookware as well as the frequency of excitation. Typical induction cooktops

[519] As recommended in Navigant 'ComEd Effective Useful Life Research Report', May 2018.

operate at switching frequencies between 25 kHz and 50 kHz, which restricts coupling to ferromagnetic cookware such as cast iron, and some alloys of stainless steel.[520]

According to manufacturers, induction cooktops heat food faster, are easier to clean, are less likely to burn those using them, and have a higher cooking efficiency than electric resistance cooktops.

4.31.1 MEASURE OVERVIEW

Sector	Residential
End use	Appliance or Plug Load
Fuel	Electricity
Measure category	Appliances
Delivery mechanism	Prescriptive
Baseline description	Electric Resistance Cooktop
Efficient case description	Induction Cooktop

4.31.2 SAVINGS

Energy Savings are calculated as the difference between the baseline and high-efficiency condition unit energy consumption (UEC). These exclude HVAC interactive effects or savings due to reduced kitchen hood consumption. Range oven cooking efficiency varies by cooktop type. Ranges with electric resistance and induction cooktops both have electric resistance oven components. Therefore, baseline and high-efficiency condition oven cooking efficiencies are equivalent and are excluded from the savings calculation.

This measure requires the installation of an electric range with an induction cooktop or a standalone induction cooktop in a residential application. This measure assumes the use of small cookware typical of residential applications.

4.31.3 ENERGY SAVINGS ESTIMATION

Energy Savings are derived as follows:

[520] Sweeney, M., J. Dols, B. Fortenbery, and F. Sharp (EPRI), "Induction Cooking Technology Design and Assessment." Proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings, p. 9370. https://www.aceee.org/files/proceedings/2014/data/papers/9-702.pdf

$$Energy\ Savings\ [\Delta kWh] = UEC_{base} - UEC_{IC}$$

$$UEC_{IC} = UEC_{base} \times \frac{CE_{base}}{CE_{IC}}$$

Where:

UEC_{base} = *Baseline annual unit energy consumption [kWh]; See Table 334.*

UEC_{IC} = *Induction cooking annual unit energy consumption [kWh]*

CE_{base} = *Baseline cooking efficiency = 75%*[521]

CE_{IC} = *Induction cooking efficiency = 85%*[522]

Based on the provided inputs, the deemed energy savings for this measure is 12[523] kWh.

Table 334 provides the unit energy consumption values based on the number of burners on the induction cooktop.

Table 334: Induction Cooking—Baseline Electric Resistance Cooktop Unit Energy Consumption[524]

Number of Burners	Electric Cooktop Baseline, kWh
0	84
1	89
2	95
3	101
4	106
5	112
6	118
7+	124

4.31.4 DEMAND SAVINGS ESTIMATION

$$Peak\ Demand\ Savings\ [\Delta kW] = \frac{kWh_{savings}}{8{,}760} \times CF_{s/w}$$

[521] "2021-2022 Residential Induction Cooking Tops," ENERGY STAR® https://www.energystar.gov/about/2021_residential_induction_cooking_tops#:~:text=The%20per%20unit%20efficiency%20of,times%20more%20efficient%20than%20gas

[522] Ibid.

[523] For all applications, this measure assumes a default value of four burners. Savings for 0-7+ burners only vary from 10-15 kWh

[524] "Plug Loads and Lighting Modeling," Codes and Standards Enhancement Initiative (CASE). 2016 California Building Energy Efficiency Standards. June 2016. Table 35. https://www.caetrm.com/media/reference-documents/2016_T24CASE_Report__Plug_Load_and_Ltg_Modeling_-_June_2016.pdf

Where,

8,760 = Total hours per year

CF_{summer} *= Summer peak coincidence factor = 0.002*

CF_{winter} *= Winter peak coincidence factor = 0.010*

Based on the provided inputs, the deemed summer peak demand savings is 0.000003 kW, and the deemed winter peak demand savings is 0.000014[525] kW.

4.31.5 NON-ENERGY BENEFITS

Induction cooktops have a positive impact on the power quality of the grid. They exhibit relatively lower current harmonics for all load levels and a high power factor. However, there are no quantifiable benefits at this time.

4.31.6 MEASURE LIFE

The estimated useful life (EUL) of an induction cooktop is 16 years based on the average lifetime specified for electric cooktops in the 2016 DOE life-cycle cost tool for residential cooking products.[526]

4.32 RESIDENTIAL AC TUNE-UP (NEW)

This measure applies to central air conditioners and heat pumps. An AC tune-up, in general terms, involves checking, adjusting, and resetting the equipment to factory conditions, such that it operates closer to the performance level of a new unit. This measure applies to all residential applications.

For this measure, the service technician must complete the following tasks according to industry best practices:

Air Conditioner Inspection and Tune-Up Checklist[527]

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[525] CF and deemed demand savings values are referenced from TX – PY2023 TRM 10.0 Vol 2 Residential for Climate Zone 5: El Paso

[526] U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy Office (EERE). 2016. 2016 SNOPR Analytical Tools: Life-Cycle Cost and Payback Period Analysis Spreadsheet. https://www.caetrm.com/media/reference-documents/Cooking_Pds_LCC_SNOPR_DOE_2016_publication.xlsm

[527] Based on ENERGY STAR® HVAC Maintenance Checklist. https://www.energystar.gov/saveathome/heating-cooling/maintenance-checklist

- Inspect and clean the condenser, evaporator coils, and blower.
- Inspect the refrigerant level and adjust to manufacturer specifications.
- Measure the static pressure across the cooling coil to verify adequate system airflow and adjust to manufacturer specifications.
- Inspect, clean, or change air filters.
- Calibrate the thermostat on and off set points based on building occupancy.
- Tighten all electrical connections, and measure voltage and current on motors.
- Lubricate all moving parts, including motor and fan bearings.
- Inspect and clean the condensate drain.
- Inspect controls of the system to ensure proper and safe operation. Check the starting cycle of the equipment to assure the system starts, operates, and shuts off properly.
- Provide documentation showing completion of the above checklist to the utility or the utility's representative.

4.32.1 MEASURE OVERVIEW

Sector	Residential
End use	Space Cooling
Fuel	Electric
Measure category	High Efficiency Air Conditioners and Heat Pumps
Delivery mechanism	Rebate
Baseline description	Pre-tune-up measured efficiency
Efficient case description	Post tune-up measured/nameplate efficiency

4.32.2 SAVINGS

Savings for this measure are based on direct site measurements of EER pre- and post-tune-up. Pre and post EER measurements should be conducted, and the measurements should be taken on the same site visit and under similar operating conditions using reliable, industry accepted techniques.

4.32.3 ENERGY SAVINGS ESTIMATION

Annual energy savings for unitary AC/HP tune-up should be calculated using the following formulas:

$$kWh_{savings,C} = CAP_C \times \frac{1}{1{,}000} \times EFLH_C \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right)$$

$$kWh_{savings,H} = CAP_H \times \frac{1}{1{,}000} \times EFLH_H \times \left(\frac{1}{HSPF_{pre}} - \frac{1}{HSPF_{post}}\right)$$

$$kWh_{savings,AC} = kWh_{savings,C}$$

$$kWh_{savings,HP} = kWh_{savings,C} + kWh_{savings,H}$$

Where:

CAP_C	*= Rated or calculated equipment cooling capacity (Btu/hr)*
CAP_H	*= Rated or calculated equipment heating capacity (Btu/hr)*
1000	*= Conversion constant for watts to kilowatts*
EER_{pre}	*= Measured efficiency of the equipment for cooling before tune-up*
EER_{post}	*= Nameplate or Measured efficiency of the existing equipment for cooling; if unknown, use 11.2 EER (default)*[528]
$HSPF_{pre}$	*= Measured efficiency of the equipment for heating before tune-up*
$HSPF_{post}$	*= Nameplate or Measured efficiency of the existing equipment for heating; if unknown, use 7.7 HSPF (default)*[529]
$EFLH_C$	*= Residential Effective Full Load Cooling Hours for New Mexico climate zones, see Table 335*
$EFLH_H$	*= Residential Effective Full Load Heating Hours for New Mexico climate zones, see Table 335*

Table 335 provides the effective full load cooling and heating hours per climate zone.

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528 Code specified SEER value (13 SEER from federal standard effective January 23, 2006 through January 1, 2015) converted to EER using EER = -0.02 x SEER2 + 1.12 x SEER. National Renewable Energy Laboratory (NREL). "Building America House Simulation Protocols." U.S. DOE. Revised October 2010. www.nrel.gov/docs/fy11osti/49246.pdf

529 Consumer Central Air Conditioner and Heat Pump Efficiency Standards (DOE): https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive#current_standards

Table 335 Residential Full Load Cooling and Heating Hours for New Mexico Climate Zones[530]

Climate Zone	$EFLH_C$	$EFLH_H$
Albuquerque	1,038	2,162
Las Cruces	1,290	1,909
Roswell	1,355	1,596
Santa Fe	629	2,490

The system capacity (CAP_C) is adjusted using the following equation:

$$CAP_C = CAP_{nameplate} \times \frac{EER_{post}}{EER_{nameplate}}$$

In cases where only a pre-tune up efficiency can be measured; the post tune-up efficiency may be estimated using the lesser of the nameplate efficiency or the results of the following equation:

$$EER_{post} = \frac{EER_{pre}}{(1 - M)^{Age}}$$

The above equation estimates the efficiency of the unit based on the age as well as typical maintenance practices of the customer.

Where:

M = *Maintenance factor[531], use 0.01 if annual maintenance is conducted or 0.03 if maintenance is seldom; use default value of 0.03 if maintenance history is unknown*

Age = *Age of equipment in years, up to a maximum of 20 years, use a default of 10 years if unknown*

530 Derived from ENERGY STAR® Air-Source Heat Pump Calculator. Las Cruces and Santa Fe values derived from El Paso and Amarillo values, respectively, with a comparison of degree-days.

531 "Building America House Simulation Protocols." U.S. DOE. Revised October 2010. Table 32. Page 40. http://www.nrel.gov/docs/fy11osti/49246.pdf

For heat pump systems, an additional savings credit may be calculated as follows:

$$HSPF_{pre} = HSPF_{post} \times (1 - M)^{Age}$$

4.32.4 DEMAND SAVINGS ESTIMATION

Peak demand savings for unitary AC/HP tune-up should be calculated using the following formula:

$$kW_{savings} = CAP_C \times \frac{1}{1000} \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right) \times CF$$

Where:

CF = Coincidence Factor for residential HVAC measures, 0.87[532]

4.32.5 NON-ENERGY BENEFITS

Well-tuned HVAC systems increase occupant comfort and productivity.

4.32.6 MEASURE LIFE

The measure life is assumed to be 3 years[533].

4.33 HEAT PUMP WATER HEATER (NEW)

This measure involves the installation of an ENERGY STAR® -compliant heat pump water heater (HPWH) in place of a standard electric water heater in a home. Savings are presented dependent on the heating system installed in the home due to the impact of the heat pump water heater on the heating loads.

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[532] For residential coincidence factors, Frontier used the Air Conditioning Contractors of America (ACCA) Manual S, which recommends that residential HVAC systems be sized at 115% of the maximum cooling requirement of the house. Assuming that the house's maximum cooling occurs during the hours 3 to 6 pm, this sizing guideline leads to a coincidence factor for residential HVAC of 1.0/1.15 = 0.87

[533] Based on DEER 2014 EUL Table for "Clean Condenser Coils – Residential" and "Refrigerant Charge – Residential".

4.33.1 MEASURE OVERVIEW

Sector	Residential
End use	Water Heating
Fuel	Electricity and Natural Gas
Measure category	Heat Pump Water Heaters
Delivery mechanism	Rebate
Baseline description	Federal standard minimum efficiencies for gas and electric storage water heaters
Efficient case description	ENERGY STAR® -Compliant Heat Pump Water Heater

4.33.2 SAVINGS

The baseline condition is an electric/gas storage water heater. The baseline efficiency, defined as the uniform energy factor (UEF) is determined by tank size and draw pattern, according to the amended federal energy efficiency standards for residential water heaters with tank sizes 20 to 120 gallons, as published in 10 CFR Part 430.32 of the Federal Register[534]. HPWH - federal standard for residential water heaters is shown in Table 336.

Table 336 HPWH—Federal Standard for Residential Water Heaters

Product Class	Rated Storage Volume	Draw Pattern[535]	Uniform Energy Factor*
Electric storage	≥20 gal and ≤55 gal	Very Small	0.8808 – (0.0008 × Vr)
		Low	0.9254 – (0.0003 × Vr)
		Medium	0.9307 – (0.0002 × Vr)
		High	0.9349 – (0.0001 × Vr)
	>55 gal and ≤100 gal	Very Small	1.9236 – (0.0011 × Vr)
		Low	2.0440 – (0.0011 × Vr)
		Medium	2.1171 – (0.0011 × Vr)
		High	2.2418 – (0.0011 × Vr)
Gas-fired storage	≥20 gal and ≤55 gal	Very Small	0.3456 – (0.0020 × Vr)

[534] Code of Federal Regulation 10 CFR 430.32 Energy and water conservation standards. https://www.ecfr.gov/cgi-bin/text-idx?SID=80dfa785ea350ebeee184bb0ae03e7f0&mc=true&node=se10.3.430_132&rgn=div8

[535] The draw pattern is governed by 10 CFR 429.17- Water Heaters. Maximum gallons per minute for different draw patterns are as follows: Very Small- 1.7 gal/min, Low- 2.8 gal/min, Medium-4 gal/min, High-No upper limit.

Product Class	Rated Storage Volume	Draw Pattern[535]	Uniform Energy Factor*
		Low	0.5982 – (0.0019 × Vr)
		Medium	0.6483 – (0.0017 × Vr)
		High	0.6920 – (0.0013 × Vr)
	>55 gal and ≤100 gal	Very Small	0.6470 – (0.0006 × Vr)
		Low	0.7689 – (0.0005 × Vr)
		Medium	0.7897 – (0.0004 × Vr)
		High	0.8072 – (0.0003 × Vr)

Where Vr is Rated Storage Volume in Gallons

The same draw pattern as defined in the AHRI certificate (very small, low, medium, or high draw) should be used for both baseline and efficient units. If using a deemed approach, for units less than or equal to 55 gallons, the baseline is assumed to be a resistance storage unit with efficiency represented by the equation below, assuming medium draw.

*Baseline efficiency = 0.9307 – (0.0002 * rated volume in gallons)*

For units greater than 55 gallons, assume a 50-gallon resistance tank baseline[536], (i.e., 0.9299 UEF, assuming high draw). If unknown, assume a 50-gallon resistance tank baseline, at medium draw, therefore 0.9207 UEF.

The efficient condition is a HPWH certified by ENERGY STAR[537]. Heat pump water heaters depend on adequate ventilation to properly function, including adequate space for both inlet and outlet airflow, and should be installed in spaces where the temperature does not drop below a certain level. The Department of Energy recommends installation in locations that

[536] A 50-gallon volume tank for the baseline is assumed to capture market practice of using larger heat pump water heaters to achieve greater efficiency of the heat pump cycle and preventing the unit from going in electric resistance mode

[537] ENERGY STAR® Requirements (as of March 2022). HPWH must have a maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Water%20Heaters%20Final%20Specification%20and%20Partner%20Commitments-March2022_5.pdf

remain above 40°F year-round and provide a minimum of 1,000 cubic feet of air space around the water heater[538].

4.33.3 ENERGY SAVINGS ESTIMATION

HPWH savings are calculated on a per-unit basis. Annual electric energy savings are calculated utilizing the standard algorithms outlined below:

$$kWh_{savings} = \left[\frac{\rho \times C_p \times GPD \times 365.25 \times (Temp_{Hot} - Temp_{Cold}) \times \left(\frac{1}{UEF_{Base}} - \frac{1}{UEF_{Eff}}\right)}{3{,}412}\right] + kWh_{Cooling} - kWh_{heating} + Deh_{Reduction}$$

Where:

$kWh_{savings}$ = *Annual energy savings, kWh*

ρ = *Density of water, 8.33 lbs/gal*

Cp = *Specific heat of water, 1 Btu/lb*°F*

GPD = *Daily hot water usage, see Table 336.*

365.25 = *Days per year*

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

$Temp_{Hot}$ = *Tank temperature, 127.5 °F*

$Temp_{Cold}$ = *Inlet water temperature, see Table 336*

UEF_{Base} = *Baseline uniform energy factor calculated as per Table 336 using the same draw pattern as the efficient equipment.*

UEF_{Eff} = *Actual uniform energy factor of HPWH*

$kWh_{Cooling}$ = *Cooling savings from conversion of heat in home to water heat*

$$kWh_{Cooling} = \left[\frac{\left(1 - \frac{1}{UEF_{Eff}}\right) * \rho \times C_p \times GPD \times 365.25 \times (Temp_{Hot} - Temp_{Cold})}{3{,}412}\right] * \frac{1}{COP_{Cool}} * LF * 27\% * LM$$

LF = *Location Factor*

= *1.0 for HPWH installation in a conditioned space*

[538] Heat Pump Water Heaters. Department of Energy, May 2012. http://energy.gov/energysaver/articles/heat-pump-water-heaters

= *0.22 for HPWH installation in an unknown location*[539]

= *0.0 for installation in an unconditioned space*

27% = *Portion of reduced waste heat that results in cooling savings*[540]

COP_{Cool} = *COP of central air conditioning*

= *Actual, if unknown, assume 2.8*[541]

LM = *Latent multiplier to account for latent cooling demand*

= *1.33*[542]

$kWh_{Heating}$ = *Heating cost from conversion of heat in home to water heat (Dependent on heating fuel)*

$$kWh_{Heating} = \left[\frac{\left(1 - \frac{1}{UEF_{Eff}}\right) * \rho \times C_p \times GPD \times 365.25 \times (Temp_{Hot} - Temp_{Cold})}{3{,}412}\right] * \frac{1}{COP_{Heat}} * LF * 5\% * (1 - \%NaturalGas)$$

5% = *Portion of reduced waste heat that results in increased heating load*[543]

COP_{Heat} = *COP of electric heating system*

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539 West Hills Energy and Computing (2019) found 78% of HPWHs "are installed in basements that are not intentionally heated."

540 REMRate determined percentage (27%) of lighting savings that result in reduced cooling loads (lighting is used as a proxy for hot water heating since load shapes suggest their seasonal usage patterns are similar).

541 Starting from standard assumption of SEER 10.5 central AC unit, converted to 9.5 EER using algorithm (-0.02 * SEER2) + (1.12 * SEER) (from Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Master's Thesis, University of Colorado at Boulder), converted to COP = EER/3.412 = 2.8COP

542 A sensible heat ratio (SHR) of 0.75 corresponds to a latent multiplier of 4/3 or 1.33. SHR of 0.75 for typical split system from page 10 of "Controlling Indoor Humidity Using Variable-Speed Compressors and Blowers" by M. A. Andrade and C. W. Bullard, 1999

543 The operation of a HPWH causes both sensible and latent heat transfer with the surrounding air(and water vapor). The amount of sensible heat transfer is governed by the specific heat capacity of water: 4,186 J/kg·°C (which is 4x larger than that of dry air) and the temperature change. The latent heat transfer is governed by the latent heat of vaporation for water: 22.6x105 J/kg. Only the sensible heat transfer increases the heating load, and because of the relative sizes of these parameters, the latent heat transfer is several orders of magnitude greater than the sensible heat transfer. See HPWH_CalculationSheet.xlsx for the specific example used to derive the 5% portion for sensible heat.

= *actual. If not available, use Table 337*[544]

$\%NaturalGas$ = *Factor dependent on heating fuel:*

= *100 % for Natural Gas*

= *0 % for Electric Resistance or Heat Pump*

$Deh\_Reduction$ = *Savings resulting from reduced dehumidification*

= *values based Table 337*[545]

Table 337 provides values for the daily water usage input in gallons, based on the number of bedrooms.

Table 337 Daily Hot Water Usage[546]

Number of bedrooms	1	2	3	4	5	6
Clothes Washer	10.0	12.5	15.0	17.5	20.0	22.5
Dishwasher	3.3	4.2	5.0	5.8	6.7	7.5
Shower	18.7	23.3	28.0	32.7	37.4	42.0
Bath	4.7	5.8	7.0	8.2	9.4	10.5
Sinks	16.7	20.8	25.0	29.1	33.3	37.5
Total	**53.3**	**66.7**	**80.0**	**93.3**	**106.7**	**120.0**

Table 338 provides values for the inlet water temperature input based on climate zone.

[544] These default system efficiencies are based on the applicable minimum Federal Standards. In 2006 the Federal Standard for Heat Pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate. Note efficiency should include duct losses. Defaults provided assume 15% duct loss for heat pumps.

[545] West Hills Energy and Computing (2019) found that 20% of homes had dehumidifiers in use and in interviews with homeowners found the following reductions in dehumidifier usage: 46% reported “1 month or more reduction”, 32% reported “3 months or more reduction”, and 15% reported removal of a dehumidifier. kWh savings assumptions are based on an average of: Federal Standard, ENERGY STAR, and ENERGY STAR Most Efficient annual energy usage. See HPWH_CalculationSheet.xlsx for calculations

[546] Hot water consumption is calculated based on different uses of water in a house as given in the Building America Research Benchmark report. https://www.nrel.gov/docs/fy10osti/47246.pdf

Table 338 Inlet Water Temperature[547]

Climate Zone	Temperature Cold (°F)
Albuquerque	62.6
Las Cruces	69.2
Roswell	68.5
Santa Fe	57.5

Table 339 provides efficiency in terms of HSPF and COP based on equipment type and age. Please note:

$$COP = \frac{HSPF}{3.413} \times 0.85$$

Table 339 HPWHs—HSPF and COP_{heat}

System Type	Age of Equipment	HSPF	COP
Heat Pump	Before 2006	6.8	1.70
	After 2006 - 2014	7.7	1.92
	2015 on	8.2	2.04
Resistance	N/A	N/A	1.00
Unknown[548]	N/A	N/A	1.28

Table 340 provides values for the dehumidification reduction inputs based on the status of dehumidification.

Table 340 HPWHs— Dehumidification Reduction

Dehumidifcation Status	Dehuminidifcation Reduction (kWh)
If Dehumidifier is in use	359
If unknown	72

Annual Therms savings are calculated utilizing the standard algorithms outlined below:

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547 Average annual cold-water temperatures for each city were calculated using Equation 4 in the Department of Energy's "Building America Performance Analysis Procedures for Existing Homes" (https://www.nrel.gov/docs/fy06osti/38238.pdf). Ambient temperature for Albuquerque, Las Cruces, Roswell and Santa Fe were taken from the TMY3 data.

548 Calculation assumes 35% Heat Pump and 65% Resistance, which is based upon data from Energy Information Administration, 2009 Residential Energy Consumption Survey, see "HC6.9 Space Heating in Midwest Region.xls", using average for East North Central Region. Average efficiency of heat pump is based on assumption that 50% are units from before 2006 and 50% from 2006- 2014. Program or evaluation data should be used to improve this assumption if available.

$$Therms_{savings} = \left[\frac{\rho \times C_p \times GPD \times 365.25 \times (Temp_{Hot} - Temp_{Cold}) \times \left(\frac{1}{UEF_{Base}} - \frac{1}{UEF_{Eff}}\right)}{100{,}000}\right] - Therms_{heating}$$

$Therms_{heating}$ = *Heating cost from conversion of heat in home to water heat for homes with Natural Gas heat*[549]

$$Therms_{heating} = \left[\frac{\left(1 - \frac{1}{UEF_{Eff}}\right) * \rho \times C_p \times GPD \times 365.25 \times (Temp_{Hot} - Temp_{Cold})}{3{,}412}\right] * \frac{1}{\eta Heat} * LF * 5\% * 0.03412 * \%NaturalGas$$

0.03412 = *conversion factor (therms per kWh)*

ηHeat = *AFUE of gas heating system. Use nameplate ratings wherever possible, if unavailable use 0.8*

Other factors as defined above.

4.33.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated by using:

$$kW_{savings} = \frac{kWh_{savings}}{Hours} \times CF$$

Where:

kW savings = *Peak demand savings, kW*

Hours = *Full load hours of water heater, 2,533*[550]

CF = *Summer Peak Coincidence Factor for measure, 0.12*[551]

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[549] This is the additional energy consumption required to replace the heat removed from the home during the heating season by the heat pump water heater. kWh_heating (electric resistance) is that additional heating energy for a home with electric resistance heat (COP 1.0). This formula converts the additional heating kWh for an electric resistance home to the MMBtu required in a Natural Gas heated home, applying the relative efficiencies.

[550] Full load hours assumption based on Efficiency Vermont analysis of Itron eShapes.

[551] Calculated from Figure 8 "Combined six-unit summer weekday average electrical demand" in FEMP study; 'Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters' as (average kW usage during peak period * hours in peak period) / [(annual kWh savings / FLH) * hours in peak period] = (0.1 kW * 5 hours) / [(2100 kWh / 2533 hours) * 5 hours] = 0.12

4.33.5 NON-ENERGY BENEFITS

Heat pump water heaters have a longer lifespan compared to other types of baseline water heaters.

4.33.6 MEASURE LIFE

The measure life for HPWH is 13 years[552].

4.34 LED NIGHTLIGHTS (NEW)

This measure describes savings associated with the installation of LED nightlights installed for residential applications.

4.34.1 MEASURE OVERVIEW

Sector	Residential
End use	Lighting
Fuel	Electricity
Measure category	LED Nightlights
Delivery mechanism	Rebate
Baseline description	The baseline condition is assumed to be an incandescent/halogen nightlight.
Efficient case description	LED nightlight

4.34.2 SAVINGS

Savings can be calculated using the following equations:

Electric Energy Savings

$$\Delta kWh = ((Watts_{Base} - Watts_{EE}) / 1000) * ISR * Hours * WHF_e$$

Where:

$Watts_{base}$ = *Actual wattage if known, if unknown, assume 7W*[553].

$Watts_{EE}$ = *Actual wattage of LED purchased/installed.*

[552] 2010 ACEEE Summer Study on Energy Efficiency in Buildings, LBNL, "Heat Pump Water Heaters and American Homes: A Good Fit?" p 9-74. https://www.aceee.org/files/proceedings/2010/data/papers/2205.pdf.

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

ISR = In Service Rate or the percentage of nightlights rebated that get installed

Hours = Average hours of use per year= 4,380[554]

WHFe = Waste heat factor for energy to account for cooling savings from efficient lighting

Table 341 presents the ISRs by program delivery method.

Table 341 In Service Rate by program delivery method

Program	In Service Rate (ISR)
Retail (Time of Sale)	98.0% [555]
Direct Install	96.9% [556]
School Kits	84% [557]

Table 342 presents the Waste Heat Factor for Energy Savings.

Table 342 Waste Heat Factor for Energy Savings Lookup Table

Space Conditioning Equipment	Climate Zone			
	Albuquerque	Roswell	Santa Fe	Las Cruces
Gas heat with AC	1.05	1.10	1.03	1.12
Gas heat with no AC	1.00	1.00	1.00	1.00
Heat Pump	0.76	0.94	0.73	0.97
Electric Resistance Heat with AC	0.67	0.86	0.70	0.88
Electric Resistance Heat with no AC	0.57	0.70	0.66	0.70
No heat with AC	1.05	1.10	1.03	1.12
Unconditioned space	1.00	1.00	1.00	1.00
Heating cooling unknown	0.91	1.02	0.89	1.04
Upstream lighting	0.91	1.02	0.89	1.04

[554] Assumes nightlight is operating 12 hours per day, consistent with the 2016 Pennsylvania TRM.

[555] 1st year in service rate is based upon analysis of ComEd PY7, PY8, and PY9 intercept data (see 'Res Lighting ISR_2018.xlsx' for more information).

[556] Consistent with assumption for standard CFLs (in the absence of evidence that it should be different for this bulb type). Based upon review of the PY2 and PY3 ComEd Direct Install program surveys. This value includes bulb failures in the 1st year to be consistent with the Commission approval of annualization of savings for first year savings claims. ComEd PY2 All Electric Single Family Home Energy Performance Tune-Up Program Evaluation, Navigant Consulting, December 21, 2010

[557] 1st year ISR for school kits based on ComEd PY9 data for the Elementary Energy Education program

4.34.3 DEMAND SAVINGS ESTIMATION

Demand savings are defined as the reduction in average kW attributable to the measure between 3:00-6:00 pm on the hottest summer weekdays. Demand savings are assumed to be zero for this measure.

Demand savings are derived from the following equation:

$$\Delta kW = ((WattsBase - WattsEE) / 1000) * ISR * (1\text{-}Leakage) * WHFd * CF$$

Where:

WHF_d = *Waste heat factor for demand to account for cooling savings from efficient lighting.*

CF = Summer Peak Coincidence Factor for measure, 0 since nightlights used during off-peak period.

Table 343 presents options to determine the Waste Heat Factor for Demand Savings.

Table 343 Waste Heat Factor for Demand Savings Lookup Table

Space Conditioning Equipment	Climate Zone			
	Albuquerque	**Roswell**	**Santa Fe**	**Las Cruces**
Gas heat with AC	1.41	1.38	1.19	1.44
Gas heat with no AC	1.00	1.00	1.00	1.00
Heat Pump	1.24	1.32	1.12	1.37
Electric Resistance Heat with AC	1.00	1.17	1.00	1.36
Electric Resistance Heat with no AC	1.00	1.00	1.00	1.00
No heat with AC	1.41	1.38	1.19	1.44
Unconditioned space	1.00	1.00	1.00	1.00
Heating cooling unknown	1.28	1.32	1.13	1.41
Upstream lighting	1.28	1.32	1.13	1.41

4.34.4 NON-ENERGY BENEFITS

Non-energy benefits are not associated with this measure.

4.34.5 MEASURE LIFE

The estimated useful life of the is estimated is 8 years [558]

[558] The value is estimated at 1.11 (calculated as 1 + (0.66 * 0.466 / 2.8)). See footnote relating to WHFe for details. Note the 46.6% factor represents the average Residential cooling coincidence factor calculated by dividing average load during the peak hours divided by the maximum cooling load

4.35 TIER 2 ADVANCED POWER STRIPS

This measure is applicable to the installation of a Tier 2 Advanced Power Strip for household audio-visual environments (Tier 2 AV APS). Tier 2 AV APS are multi-plug power strips that remove power from audio-visual equipment through intelligent control and monitoring strategies.[559]

4.35.1 MEASURE OVERVIEW

Sector	Residential
End use	Plug Load
Fuel	Electricity
Measure category	Tier 2 Advanced Power Strips – Audio Visual
Delivery mechanism	Direct Install
Baseline description	Standard power strip, or no power strip
Efficient case description	Use of a Tier 2 AV APS in a residential AV environment that includes control of at least 2 AV devices, with one being the television.[560]

4.35.2 SAVINGS

A Tier 2 APS uses an external sensor paired with a configurable countdown timer to manage both active and standby power loads for controlled devices in a complete system. A Tier 2 APS may operate either with or without a master control socket. Those without a master control socket sense power of all devices connected to the controlled sockets, while those with a master control socket sense power for the device connected to the master control socket. The external sensor of a Tier 2 APS may use an infrared-only sensor, or it may use a "multi-sensor," which detects both infrared (IR) remote control signals and motion to determine device inactivity and deliver additional savings as compared to a Tier 1 APS. Both versions of external sensors use IR filtering to prevent inappropriate switching events that may have otherwise resulted from natural interference, such as sunlight or CFL light bulbs.

Energy and demand deemed savings are shown in Table 344.

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[559] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

[560] Given this requirement, an AV environment consisting of a television and DVD player or a TV and home theater would be eligible for a Tier 2 AV APS installation.

Table 344: Tier 2 Advanced Power Strips Deemed Savings[561]

Product Type	Annual Savings kWh	Demand Savings kW
Infrared Only	136.1	0.0249
Infrared and Occupancy Sensor	96.7	0.0177

4.35.3 ENERGY SAVINGS ESTIMATION

Energy Savings for a Tier 2 APS are calculated using the following equation.[562]

$$\Delta kWh = ERP * BaselineEnergy_{AV} * ISR$$

Where:

ERP = *Energy Reduction Percentage of qualifying Tier 2 AV APS product range (see | Table 345)*

$BaselineEnergy_{AV}$ = *466 kWh*[563]

ISR = *In Service Rate (Table 345 and Table 346)*

Table 345 and Table 346 provide values for the energy reduction percentage and in service rate inputs, respectively.

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[561] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

[562] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

[563] Average of baseline energy in Regional Technical Form survey of Tier 2 APS pre-post methodology studies, see ‘RTF_T2_APS.ppt’.

Table 345: Energy Reduction Percentage

Product Type	ERP
Infrared Only	40%[564]
Infrared and Occupancy Sensor	25%[565]

Table 346: In Service Rate

Product Type	ISR566
Infrared Only	73%
Infrared and Occupancy Sensor	83%

4.35.4 DEMAND SAVINGS ESTIMATION

Demand savings for a Tier 2 APS are calculated using the following equation.[567]

$$\Delta kW = \Delta kWh / Hours * CF$$

Where:

ΔkWh = *Annual kWh energy savings calculated as defined above*

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[564] Representative savings assumption based on the following independent field tests on Embertec's IR-only product. This includes both simulated saving results (based on recording what action the APS would have taken, but where equipment is not actually switched off allowing evaluation of the expected length of savings), and pre/post metering studies.
• AESC (page 30) - Valmiki, MM., Corradini, Antonio PE. 2015. Tier 2 Advanced Power Strips in Residential and Commercial Applications. Prepared for San Diego Gas & Electric by Alternative Energy Systems Consulting, Inc. (Simulated 50%, pre/post 32%).
• AESC- Valmiki, MM., Corradini, Antonio PE., Feb 2016. Energy Savings of Tier 2 Advanced Power Strips in Residential AV Systems. (Simulated 50%, pre/post 29%)
• CalPlug research (Page 12) - Wang, M. e. 2014. "Tier 2 Advanced Power Strip Evaluation for Energy Saving Incentive". California Plug Load Research Center (CalPlug), UC Irvine. (Simulated 51%)
• NMR Group Inc., RLPNC 17-3: Advanced Power Strip Metering Study, Revised March 18, 2019, submitted to Massachusetts Program Administrators and EEAC. (Pre/post with regression 50%, Pre/post only 20%).

[565] Representative savings assumption based on the following independent field tests on TrickleStar IR-OS product and reflect both simulated and pre/post meter study results.
• AESC- Valmiki, MM., Corradini, Antonio PE., Feb 2016. Energy Savings of Tier 2 Advanced Power Strips in Residential AV Systems. (Simulated 27%, pre/post 25%)
• NMR Group Inc., RLPNC 17-3: Advanced Power Strip Metering Study, Revised March 18, 2019, submitted to Massachusetts Program Administrators and EEAC. (Pre/post with regression 37%, Pre/post only 11%)

[566] Weighted average of evaluation results from AESC, Inc, "Energy Savings of Tier 2 Advanced Power Strips in Residential AC Systems", p35. These assumptions include "adjustments in weighting based on the persistence sensitivity to demographics" and NMR Group Inc., RLPNC 17-3: Advanced Power Strip Metering Study, Revised March 18, 2019.

[567] State of Illinois Energy Efficiency Technical Reference Manual, version 12.0

Hours	= *Annual hours per year controlled by APS* = *4,380*[568]
CF	= *Coincidence Factor* = 0.8[569]

4.35.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.35.6 MEASURE LIFE

The measure life for this equipment is 7 years.[570]

4.36 REFRIGERATOR AND FREEZER RECYLING (NEW)

This measure describes savings from the retirement and recycling of inefficient but operational refrigerators and freezers. This measure applies to residential grade appliances, regardless of if they are installed in a residential or commercial building. Savings are provided based on a 2013 workpaper provided by Cadmus that used data from a 2012 ComEd metering study, and metering data from a Michigan study, to develop a regression equation that uses key inputs describing the retired unit. The savings are equivalent to the Unit Energy Consumption of the retired unit and should be claimed for the assumed remaining useful life of that unit. A part use factor is applied to account for those secondary units that are not in use throughout the entire year. Please note that the regression algorithm is designed to provide an accurate portrayal of savings for the population as a whole and includes those parameters that have a significant effect on the consumption of savings for individual units will vary.

568This is estimate based on assumption that approximately half of savings are during active hours (supported by AESC study) (assumed to be 5.3 hrs/day, 1936 per year (NYSERDA 2011. "Advanced Power Strip Research Report")) and half during standby hours (8760-1936 = 6824 hours). The weighted average is 4380.

[569] PNM/Ecova Savings Brief, citing "Efficiency Vermont coincidence factor for smart strip measure – in the absence of empirical evaluation data, this was based on the assumptions of the typical run pattern for televisions and computers in homes."

[570] There is little evaluation to base a lifetime estimate upon. Based on review of assumptions from other jurisdictions and the relative treatment of In Service Rates and persistence, an estimate of 7 years was agreed by the Technical Advisory Committee, but further evaluation is recommended.

4.36.1 MEASURE OVERVIEW

Sector	Residential/Commercial
End use	Food Service
Fuel	Electricity
Measure category	Food Service Equipment
Delivery mechanism	ERET
Baseline description	Existing inefficient unit (10-30 ft^3)
Efficient case description	N/A

4.36.2 ENERGY SAVINGS ESTIMATION

4.36.2.1 ENERGY SAVINGS[571]

Refrigerators:

Energy Savings for refrigerators are based upon a linear regression model using the following coefficients[572].

Table 347: Coefficient Estimates for Input Variables for Refrigerators

Independent Variable Description	Coefficient Estimate
Intercept	83.324
Age (years)	3.678
Pre-1990 (=1 if manufactured pre-1990)	485.037
Size (cubic feet)	27.149
Dummy: Side-by-Side (= 1 if side-by-side)	406.779
Dummy: Primary Usage Type (in absence of the program) (= 1 if primary unit)	161.857
Interaction: Located in Unconditioned Space x CDD/365.25	15.366
Interaction: Located in Unconditioned Space x HDD/365.25	-11.067

571 Based on the specified regression, a small number of units may have negative energy and demand consumption. These are a function of the unit size and age and should comprise a very small fraction of the population. While on an individual basis this result is counterintuitive it is important that these negative results remain such that as a population the average savings is appropriate.

572 Energy Savings are based on an average 30-year TMY temperature of 51.1 degrees. Coefficients provided in July 30, 2014 memo from Cadmus: "Appliance Recycling Update no single door July 30, 2014".

$$\Delta kWh = [83.32 + (Age * 3.68) + (Pre\_1990 * 485.04) + (Size * 27.15) + (Side\_by\_side * 406.78) + (Proportion\ of\ Primary\ Appliances * 161.86) + (CDD/365.25 * unconditioned * 15.37) + (HDD/365.25 * unconditioned * -11.07)] * Part\ Use\ Factor$$

Where:

Age	*= Age of retired unit.*
Pre_1990	*= Pre-1990 dummy (1 if manufactured pre-1990, else 0).*
Size	*= Capacity (cubic feet) of retired unit.*
Side_by_side	*= Side-by-side dummy (1 if side-by-side, else 0).*
Primary Usage	*= Primary Usage Type (in absence of the program) dummy (1 if Primary, else 0).*
Interaction:	*Located in Unconditioned Space x CDD/365.25.*

*(=1 * CDD/365.25 if in unconditioned space)*

CDD	*= Cooling Degree Days (Table* 348*)*
	= Dependent on location.

Interaction: Located in Unconditioned Space x HDD/365.25.

*(=1 * HDD/365.25 if in unconditioned space)*

HDD	*= Heating Degree Days*
	= Dependent on location.
Part Use Factor	= To account for those units that are not running throughout the entire year. The most recent part-use factor participant survey results available at the start of the current program year shall be used.[573]

Table 348 provides the cooling and heating degree days per climate zone.

Table 348 Cooling Degree Days and Heating Degree Days[574]

Climate Zone	CDD	HDD
Albuquerque	1,322	4,180
Santa Fe	645	5,417
Roswell	1,790	3,289
Las Cruces	1,899	2,816

[573] For example, the part-use factor that shall be applied to the current program year t (PYt) for savings verification purposes should be determined through the PYt-2 participant surveys conducted in the respective utility's service territory, if available. If an evaluation was not performed in PYt-2 the latest available evaluation should be used.

[574] https://www.nm-prc.org/wp-content/uploads/2021/07/New-Mexico-TRM-2021-Final-03-09-2021.pdf

Freezers:

Energy Savings for freezers are based upon a linear regression model using the following coefficients:[575]

Table 349: Coefficient Estimates for Input Variables for Freezers

Independent Variable Description	Estimate Coefficient
Intercept	132.122
Age (years)	12.130
Pre-1990 (=1 if manufactured pre-1990)	156.181
Size (cubic feet)	31.839
Chest Freezer Configuration (=1 if chest freezer)	-19.709
Interaction: Located in Unconditioned Space x CDD/365.25	9.778
Interaction: Located in Unconditioned Space x HDD/365.25	-12.755

$$\Delta kWh = [132.12 + (Age * 12.13) + (Pre\_1990 * 156.18) + (Size * 31.84) + (Chest\ Freezer * -19.71) + (CDDs * unconditioned * 9.78) + (HDDs * unconditioned * -12.75)] * Part\ Use\ Factor$$

Where:

Age	*= Age of retired unit.*
Pre_1990	*= Pre_1990 dummy (=1 if manufactured pre-1990, else 0)*
Size	*= Capacity (cubic feet) of retired unit.*
Chest Freezer	*= Chest Freezer dummy (= 1 if chest freezer, else 0).*
Interaction:	*Located in Unconditioned Space x CDD/365.25.*
	*(=1 * CDD/365.25 if in unconditioned space)*
CDD	*= Cooling Degree Days (see table above).*
Interaction:	*Located in Unconditioned Space x HDD/365.25*
	*(=1 * HDD/365.25 if in unconditioned space)*
HDD	*= Heating Degree Days (see table above).*
Part Use Factor	*= To account for those units that are not running throughout the entire year. The most recent part-use factor participant survey results available at the start of the current program year shall be used.*[576]

575 Energy Savings are based on an average 30-year TMY temperature of 51.1 degrees. Coefficients provided in January 31, 2013 memo from Cadmus: "Appliance Recycling Update".

576 Most recent freezer part-use factor from Ameren Illinois Company PY5 evaluation.

4.36.3 DEMAND SAVINGS ESTIMATION

$$\Delta kW = \frac{\Delta kWh * CF}{8{,}760}$$

Where:

kWh = *Savings provided in the algorithm above*

CF = *Coincident factor defined as summer kW/average kW*

= *1.081 for Refrigerators*

= *1.028 for Freezers*[577]

4.36.4 MEASURE LIFE

The estimated remaining useful life of the recycling units is 6.5 years.[578]

4.37 ENERGYSTAR® WATER COOLERS

This measure involves the installation of a residential ENERGYSTAR® water cooler in place of a conventional water cooler in new construction or Time-Of-Sale projects. This measure applies to all residential applications.

4.37.1 MEASURE OVERVIEW

Sector	Residential
End use	Efficient Appliances
Fuel	Electricity
Measure category	Efficient Appliances
Delivery mechanism	Prescriptive
Baseline description	Non-ENERGY STAR® Water Coolers
Efficient case description	ENERGY STAR® Water Coolers

577 Cadmus memo, February 12, 2013; “Appliance Recycling Update”

578 DOE refrigerator and freezer survival curves are used to calculate RUL for each equipment age and develop a RUL schedule. The RUL of each unit in the ARCA database is calculated and the average RUL of the dataset serves as the final measure RUL. Refrigerator recycling data from ComEd (PY7-PY9) and Ameren (PY6-PY8) were used to determine EUL with the DOE survival curves from the 2009 TSD. A weighted average of the retailer ComEd data and the Ameren data results in an average of 6.5 years. See Navigant ‘ComEd Effective Useful Life Research Report’, May 2018.

4.37.2 SAVINGS

The baseline equipment for this measure is a standard or conventional non-ENERGYSTAR certified water cooler. The efficient equipment is an ENERGYSTAR certified water cooler meeting the ENERGYSTAR 3.0 efficiency criteria as listed below in Table 350.

Table 350: Energy Efficiency Criteria for Certified Water Coolers

Product Type	**On Mode with No Water Draw (kWh/Day)**
Cold Only & Cook and Cold units (Conditioned Storage)	≤ 0.16
Hot & Cold & Hot, Cook and Cold units (Conditioned Storage; Low Capacity)	≤ 0.68
Hot & Cold & Hot, Cook and Cold units (Conditioned Storage; High Capacity)	≤ 0.80
Hot & Cold & Hot, Cook and Cold units (On Demand Heating)	≤ 0.18

4.37.3 ENERGY SAVINGS ESTIMATION

Energy Savings for this measure were derived using the product list of ENERGY STAR® Water Coolers. Unless otherwise specified, all savings assumptions are extracted from the ENERGY STAR® calculator.

For applications using an efficient water cooler, the savings are calculated as follows:

$$kWh_{savings} = (kWh_{base} - kWh_{ee}) * Days$$

Where:

kWh_{base} = *Daily energy use (kWh/Day) for baseline water cooler*[579]*(Table 351)*

kWh_{ee} = *Daily energy use (kWh/Day) for efficient water cooler*[580] *(Table 352)*

Day = Number of days the water cooler will be in use; 365 Days

Table 351 and Table 352 provide the baseline and efficient daily energy use values, respectively.

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[579] CEC Product list accessed April 2023. Water Coolers Final Version 3.0 Data Package

[580] Energy Star QPL accessed July 2023. Water Coolers Final Version 3.0 Data Package

Table 351: Baseline Daily Energy Use for Water Cooler

Product Type	Baseline Daily Energy Use (kWh/day)
Hot and Cold Water (Storage)	0.875
Hot and Cold Water (On Demand)	0.811
Cold Water Only	0.826

Table 352: Efficient Daily Energy Use for Water Cooler

Product Type	Baseline Daily Energy Use (kWh/day)
Hot and Cold Water (Storage)	0.689
Hot and Cold Water (On Demand)	0.138
Cold Water Only	0.139

4.37.4 DEMAND SAVINGS ESTIMATION

Demand savings are calculated using the following equation:

$$kW_{savings} = \frac{kWh_{savings}}{Hours} * CF$$

Where:

$Hours$ = *Annual Operating Hours; 8,760 Hrs per year*

CF = *Coincidence Factor = 1.0*

4.37.5 NON-ENERGY BENEFITS

There are no non-energy benefits.

4.37.6 MEASURE LIFE

The estimated useful life (EUL) of an ENERGY STAR® water cooler is established at 10 years.[581]

[581] Savings Calculator for ENERGY STAR Certified Water Coolers, last updated 2009.

5 INDUSTRIAL MEASURES

5.1 PUMP OFF CONTROLS (POC)

This measure category applies to pumps used to extract oil from the earth. The measure saves energy by reducing the runtime of the pump. This measure is only eligible for retrofit applications.

5.1.1 MEASURE OVERVIEW

Sector	Industrial
End use	Oil Production
Fuel	Electricity
Measure category	Motor controls
Delivery mechanism	Rebate
Baseline description	Pump motor with clock timer operating 80% of the time
Efficient case description	Pump motor controlled by sensor (strain gauges or other)

5.1.2 SAVINGS

Allowable methods of deriving savings are described in the following sections. The methods are derived from a calculator that was developed as a joint venture between ADM Associates and SPS, which was developed from extensive monitoring performed by ADM.

5.1.3 ENERGY SAVINGS ESTIMATION

Savings are determined with the following equation:

$$kWh_{Savings} = \left(\frac{HP * LF * .746}{Eff_{Motor} * Eff_{SurfMech}}\right) * \left(TC - \left(\frac{Run_{Const} + Run_{Coeff} * Eff_{VolPump} * TC * 100}{100}\right)\right) * 8{,}760$$

The parameters in this equation are derived from a combination of user defined, prescriptive, and empirically derived methods, and are provided in Table 353.

Table 353: Pump Off Controls Energy Savings Parameters and Sources

Variable	Definition	Value and Source
$kWh_{Savings}$	Annual kWh Savings for the installation of a POC	Calculated
HP	Motor Horsepower	Provided by customer
LF	Motor Load Factor	Ratio of average demand to maximum demand = 25%. From NYSERDA (New York State Energy Research and Development Authority), Energy $mart Programs Deemed Savings Database and adjusted based on Field measurements provided by ADM, based on 2010 custom projects.
0.746	HP to Watt conversion	Standard conversion from horsepower to kW or Horsepower to watts. 1 HP = 0.746 kW = 746 watts
Eff_{Motor}	Motor Efficiency	NEMA Standard Efficient Motor based on Deemed Plan B table from motor HP, enclosure, and RPM
$Eff_{SurfMech}$	Surface Mechanical Efficiency	Mechanical efficiency of sucker rod pump = 95%
TC	Time Clock setting observed during the site visit	Deemed Clock Timer setting based on ADM field monitoring of 2010-2013 custom projects = 70%
Run_{Const}	Run Constant	8.366: Empirically derived coefficient for run time calculation from J.E Bullock, Society of Petroleum Engineers Paper SPE 16363, "Electric Savings in Oil Production"
Run_{Coeff}	Run Coefficient	.956: Empirically derived coefficient for run time calculation from J.E Bullock, Society of Petroleum Engineers Paper SPE 16363, "Electric Savings in Oil Production"
$Eff_{VolPump}$	Volumetric pump efficiency	Average Fill level of pump cylinder at clock time percentage, provided by the customer
8760	Annual Hours	Total hours in a year

The motor efficiency in the POC calculator is pulled from the lookup Table 354 based on motor horsepower and RPM.

Table 354: Motor Efficiency

Motor HP	EPACT Efficiency			
	900 RPM	1200 RPM	1800 RPM	3600 RPM
1	74.0%	80.0%	82.5%	75.5%
1.5	75.5%	85.5%	84.0%	82.5%
2	85.5%	86.5%	84.0%	84.0%
3	86.5%	87.5%	87.5%	85.5%
5	87.5%	87.5%	87.5%	87.5%
7.5	88.5%	89.5%	89.5%	88.5%
10	89.5%	89.5%	89.5%	89.5%
15	89.5%	90.2%	91.0%	90.2%
20	90.2%	90.2%	91.0%	90.2%
25	90.2%	91.7%	92.4%	91.0%
30	91.0%	91.7%	92.4%	91.0%
40	91.0%	93.0%	93.0%	91.7%
50	91.7%	93.0%	93.0%	92.4%
60	92.4%	93.6%	93.6%	93.0%
75	93.6%	93.6%	94.1%	93.0%
100	93.6%	94.1%	94.5%	93.6%
125	93.6%	94.1%	94.5%	94.5%
150	93.6%	94.1%	95.0%	94.5%
200	93.6%	95.0%	95.0%	95.0%
250	94.5%	95.0%	95.0%	95.4%
300	94.5%	95.0%	95.4%	95.4%
350	94.5%	95.0%	95.4%	95.4%
400	94.9%	95.0%	95.4%	95.4%
450	95.3%	95.0%	95.4%	95.4%
500	95.3%	95.9%	95.8%	95.4%

5.1.4 *DEMAND SAVINGS ESTIMATION*

Savings are derived with the following equation,

$$Demand\ kW_{Savings} = \left(\frac{HP * LF * 0.746}{Eff_{Motor} * Eff_{SurfMech}}\right) * CoincidentFactor$$

The Coincident Factor is determined by subtracting the percent of annual hours the controlled pump operates from the baseline time clock setting. This assumes that the controller is equally likely to turn off the pump at all hours of the year. Subtracting the proposed case operating hours from the baseline time clock setting accounts for the probability that the pump would have been turned off by the time clock in the baseline case, thus resulting in no demand savings in the proposed case. The Coincident Factor is derived with the following equation,

$$CoincidentFactor = TC - \left(\frac{Run_{Const} + Run_{Coeff} * Eff_{VolPump} * TC * 100}{100}\right)$$

The parameters in this equation are derived from a combination of user defined, prescriptive, and empirically derived methods, and are provided in Table 355.

Table 355: Pump Off Controls Peak Demand Savings Variable & Sources

Variable	Definition	Value and Source
$kW_{Savings}$	Annual kW Savings for the installation of a POC	Calculated
HP	Motor Horsepower	Provided by customer
LF	Motor Load Factor	Ratio of average demand to maximum demand = 25%. From NYSERDA (New York State Energy Research and Development Authority), Energy $mart Programs Deemed Savings Database and adjusted based on Field measurements provided by ADM, based on 2010 custom projects.
0.746	HP to Watt conversion	Standard conversion from horsepower to kW or Horsepower to watts. 1 HP = 0.746 kW = 746 watts
Eff_{Motor}	Motor Efficiency	NEMA Standard Efficient Motor based on Deemed Plan B table from motor HP, enclosure, and RPM
$Eff_{SurfMech}$	Surface Mechanical Efficiency	Mechanical efficiency of sucker rod pump = 95%
Coincident Factor	Adjusts the gross kW savings to account for overlap with the peak period	Derived per above equation.
TC	Time Clock setting observed during the site visit	Deemed Clock Timer setting based on ADM field monitoring of 2010-2013 custom projects = 70%
Run_{Const}	Run Constant	8.366: Empirically derived coefficient for run time calculation from J.E Bullock, Society of Petroleum Engineers Paper SPE 16363, "Electric Savings in Oil Production"
Run_{Coeff}	Run Coefficient	.956: Empirically derived coefficient for run time calculation from J.E Bullock, Society of Petroleum Engineers Paper SPE 16363, "Electric Savings in Oil Production"
$Eff_{VolPump}$	Volumetric pump efficiency	Average Fill level of pump cylinder at clock time percentage, provided by the customer

5.1.5 NON-ENERGY BENEFITS

The non-energy benefits of this measure work to decrease energy costs but also extend the life of the equipment. The controls reduce the operating hours of the equipment, thus reducing energy consumption. However, they also allow the pumps to run only during optimal operating conditions, thus increasing the efficiency during the operating periods. This also reduces the wear and tear on the pumps and stress on the beams, thus extending the life of the equipment.

5.1.6 MEASURE LIFE

The measure life for this equipment is 13 years.[582]

5.2 VFD ON ROD BEAM PUMPS

Rod beam pumps are a type of artificial lift system in oil production that adds energy to the fluid column in an oil well (wellbore) with the objective to increase fluid production from the well. Rod beam pumps combine a barrel and piston with valves to transfer well fluids into the tubing and displace them to the surface. These pumps are connected to the surface by a metal rod string inside the tubing and are operated by reciprocating surface beam units or pumping jacks that are powered by an electric motor.

Rod beam pumps typically have a greater capacity than the natural ingress of oil flow from the formation to the pump especially when the reservoir has been in service for an extended period of time. This imbalance leads to inefficient operations and maintenance issues related to stresses on the sucker rod due to impact on the low reservoir surface during the return stroke.

Installing a VFD to control the speed of a rod beam pump will allow the pumping rate to be in sync with the ingress of oil from the reservoir. A higher efficiency will be achieved by not having to turn the pump ON and OFF, which keeps the barrel of the pump full and reduces the downtime associated with sucker rod stress. This measure involves the addition of adding a VFD to a rod beam pump without existing controls (i.e., without a POC controller).

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[582] SPS Motor and Drive Efficiency Workpaper citing: Efficiency Vermont: Technical Reference User Manual (TRM) No. 2004-31. There is no listed measure life for POCs, but the pump motors have a rated life of 20 years, and controllers have a rated life between 10 and 15 years, based on the type and application.

5.2.1 MEASURE OVERVIEW

Sector	Industrial
End use	Oil Production
Fuel	Electricity
Measure category	VFD
Delivery mechanism	Rebate
Baseline description	Rod Beam Pump powered by a 10 HP – 150 HP Motor without POC or existing VFD controls
Efficient case description	Rod Beam Pump powered by a 10 HP – 150 HP Motor with VFD controls

5.2.2 SAVINGS

The input power of the pump varies depending upon the pump load, which changes as a function of fluid lift requirements in the underground rod beam pump. The VFD adjusts the pump motor speed (and fluid displacement) with a reduction in load, whereas absent the VFD, the motor continues to upstroke and downstroke at a constant speed regardless of the fluid level in the rod beam pump. When pumping at the correct speed, fluid level is maintained through the downstroke and upstroke cycle of the rod beam, allowing for optimum energy efficiency and fluid production. The reduction in power input for the VFD is seen under part-load conditions when compared with no controls. This leads directly to the savings achieved by the VFD when deployed in oil extraction road beam pump applications.

5.2.3 ENERGY SAVINGS ESTIMATION

Savings are determined with the following equation:

$$kWh_{Savings} = \left(\frac{HP * LF * .746}{Eff_{Motor}}\right) * \left(1 - \frac{VFD_{Speed}}{VFD_{Eff}}\right) * HOU$$

The parameters in this equation are derived from a combination of user defined, prescriptive, and empirically derived methods, and are provided in Table 356.

Table 356: Rod Beam VFD Energy Savings Variable and Sources

Variable	Definition	Value and Source
$kWh_{Savings}$	Annual kWh Savings for the installation of a POC	Calculated
HP	Motor Horsepower	Provided by customer
LF	Motor Load Factor	Baseline Motor Load % was determined based on previous rod beam pump VFD retrofit projects in the PG&E and SCE territory.[583] = 34.50%
0.746	HP to Watt conversion	Standard conversion from horsepower to kW or Horsepower to watts. 1 HP = 0.746 kW = 746 watts
Eff_{Motor}	Motor Efficiency	NEMA Standard Efficient Motor based on Deemed Plan B table from motor HP, enclosure, and RPM
VFD_{Speed}	VFD Speed (%)	Post VFD Motor Speed based on previous rod beam pump VFD retrofit projects in the PG&E and SCE territory.[584] = 59%
VFD_{Eff}	VFD Efficiency (%)	Post VFD Motor Speed based on previous rod beam pump VFD retrofit projects in the PG&E and SCE territory.[585] = 96.36%
HOU	Annual Hours Of Use	Total hours in a year when the motor is operational

The motor efficiency in the POC calculator is pulled from the lookup Table 357, based on motor horsepower and RPM.

Table 357: Motor Efficiency

Motor HP	EPACT Efficiency			
	900 RPM	1,200 RPM	1,800 RPM	3,600 RPM
1	74.0%	80.0%	82.5%	75.5%
1.5	75.5%	85.5%	84.0%	82.5%
2	85.5%	86.5%	84.0%	84.0%
3	86.5%	87.5%	87.5%	85.5%
5	87.5%	87.5%	87.5%	87.5%
7.5	88.5%	89.5%	89.5%	88.5%

[583] Measure Characterization: VFD on Rod Beam Pump, CA eTRM

[584] Ibid

[585] Ibid

Motor HP	EPACT Efficiency			
	900 RPM	1,200 RPM	1,800 RPM	3,600 RPM
10	89.5%	89.5%	89.5%	89.5%
15	89.5%	90.2%	91.0%	90.2%
20	90.2%	90.2%	91.0%	90.2%
25	90.2%	91.7%	92.4%	91.0%
30	91.0%	91.7%	92.4%	91.0%
40	91.0%	93.0%	93.0%	91.7%
50	91.7%	93.0%	93.0%	92.4%
60	92.4%	93.6%	93.6%	93.0%
75	93.6%	93.6%	94.1%	93.0%
100	93.6%	94.1%	94.5%	93.6%
125	93.6%	94.1%	94.5%	94.5%
150	93.6%	94.1%	95.0%	94.5%

5.2.4 DEMAND SAVINGS ESTIMATION

Savings are derived with the following equation:

$$Demand\ kW_{Savings} = \left(\frac{kWh_{Savings}}{HOU}\right)$$

It is assumed that this measure operates within the peak period on weekdays at a constant load throughout the day. The average demand savings is therefore equal to the annual energy savings divided by the assumed annual hours of operation.

5.2.5 NON-ENERGY BENEFITS

The non-energy benefits of this measure have not been quantified.

5.2.6 MEASURE LIFE

The measure life for this equipment is 15 years.[586]

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[586] DEER 2014

6 PROTOCOLS

6.1 HOME ENERGY REPORTS (NEW)

This measure involves randomly assigning residential customers into treatment and control groups and then having the treatment group receive regular (e.g., monthly) energy reports that show how their energy use compared with a group of peer households. If the treatment household energy consumption is higher than the peer average, then this information encourages the household to reduce their energy use. Helpful tips for reducing energy use are also included with the energy reports.

Savings are calculated by comparing the average energy use between the treatment and control groups in the post-participation period once the home energy reports are sent out. Prior to sending out the reports, the control group is set during the design phase to match the treatment group based on key parameters; at a minimum the groups must be matched based on average energy consumption. Additional matching can occur based on participation rates in utility rebate programs if this information is being tracked.

6.1.1 MEASURE OVERVIEW

Sector	Residential
End use	Multiple
Fuel	Electricity
Measure category	Cross Cutting
Delivery mechanism	Email or paper energy reports on household electricity use compared with a matched peer group
Baseline description	Average electricity consumption from a randomly selected matched control group
Efficient case description	Average electricity consumption from the participating treatment group that receives the home energy reports

6.1.2 ENERGY SAVINGS ESTIMATION

Savings are determined using a fixed effects regression model and a sample that contains monthly billing data for both treatment and control group customers. The model dataset should include a minimum of 12 months of pre-participation billing data and 12 months of post-participation billing data.

The fixed effects billing regression model is specified as follows:

$$kWh_{i,t} = \alpha_i + \beta_1 Post_t + \beta_2 Treatment + \beta_3 CDD_{i,t} + \beta_4 HDD_{i,t} + \beta_5 Post_t * Treatment + \varepsilon_{i,t}$$

$Where$:

$kWh_{i,t}$	= *daily electricity usage of customer* i *on day* t
α_i	= *customer-specific fixed effect*
$Post_t$	= *indicator for post-program for year t*
$Treatment$	= *indicator for treatment group participants*
CDD_t, HDD_t	= *cooling and heating degree days (base of 65°F) for customer* i *on day t*
$\beta_1, \beta_2, \ldots$	= *coefficients to be estimated by the regression*
ε	= *random error term*

The coefficient estimate on the $\mathrm{Post} * \mathrm{Treatment}$ interaction variable (β_5) can be interpreted as the change in daily energy consumption (i.e., savings) for a participating household in the treatment group.

Since the model includes data from both participants and non-participants, the regression results can be interpreted as net impacts.

6.1.3 NON-ENERGY BENEFITS

None.

6.1.4 MEASURE LIFE

The measure life for this equipment is 1 year.

6.2 RESIDENTIAL LIGHTING GUIDANCE ON EISA BACKSTOP (NEW)

6.2.1 MEASURE OVERVIEW

Sector	Residential
End use	Lighting
Fuel	Electricity
Measure category	CFL and LED Lighting
Delivery mechanism	Upstream buy-down Give-away Direct Install Retail coupons
Baseline description	Federal minimum wattage
Efficient case description	Efficient lamp wattage

6.2.2 SAVINGS

In 2012, Federal legislation stemming from the Energy Independence and Security Act of 2007 (EISA) will require all general-purpose light bulbs between 40 watts and 100 watts to have ~30% increased efficiency, essentially phasing out standard incandescent technology. In 2012, the 100 w lamp standards apply; in 2013 the 75 w lamp standards will apply, followed by restrictions on the 60 w and 40 w lamps in 2014. Since measures installed under this TRM all occur after 2014, baseline equipment are the values after EISA.

Additionally, an EISA backstop provision was included that would require replacement baseline lamps to meet an efficacy requirement of 45 lumens/watt or higher beginning on 1/1/2020. In December 2019, DOE issued a final determination for General Service Incandescent Lamps (GSILs), finding that this more stringent standard was not economically justified. However, in May 2022 DOE reversed this decision by issuing a final rule for both the broadened General Service Lamp definition as well as the implementation of the 45 lumen per watt backstop. DOE stated that it will use its enforcement discretion to minimize impacts on the supply chain and effectively allow companies to continue the manufacture and import of noncompliant bulbs through the remainder of 2022 and allow retailers to continue selling them with limited enforcement until July 2023.

6.2.2.1 Non-Income Qualified Programs

This TRM assumes that non-income qualified participants would continue to have access to baseline / noncompliant bulbs through retail until 6/30/2023. The New Mexico TRM has not historically implemented code shifts midway through program years to avoid introducing market confusion, as well as allowing for additional sell through. Therefore, the TRM assumes the 45 lumens/watt baselines are effective beginning January 1, 2024. The lifetime savings for non-income qualified participants should shift the baseline to 45 lumens/watt lamps starting January 1, 2027. This accounts for the three-year measure life of an installed halogen lamp.

Direct Install programs where it can be shown that the LED is replacing working inefficient lighting should continue to use the existing inefficient lighting as baseline. The program can claim full savings from halogen to LED for three years, after which the baseline should shift to 45 lumens /watt for the remaining lamp life.

6.2.2.2 Income Qualified Programs

This TRM assumes that income qualified participants would continue to have access to baseline / noncompliant bulbs through retail and existing stocks until June 2025 (two years past market rate participants). The New Mexico TRM has not historically implemented code shifts midway through program years to avoid introducing market confusion, as well as allowing for additional sell through. Therefore, the TRM assumes the 45 lumens/watt baselines are effective beginning January 1, 2026. The lifetime savings for income qualified participants should shift the baseline to 45 lumen/watt lamps starting January 1, 2029. This accounts for the three year measure life of an installed halogen lamp.

Direct Install programs where it can be shown that the LED is replacing working inefficient lighting should continue to use the existing inefficient lighting as baseline. The program can claim full savings from halogen to LED for three years, after which the baseline should shift to 45 lumens /watt for the remaining lamp life.

6.2.2.3 New Construction Programs

Since IECC 2015 energy code, there has been mandatory requirements for lighting in New Construction: "Not less than 75 percent (90 percent in IECC 2018 and 100 percent in IECC 2021) of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 75 percent (90 percent in IECC 2018 and 100 percent in IECC 2021) of the permanently installed lighting fixtures shall contain only high-efficacy lamps". To meet the 'high efficacy' requirements, lamps need to be CFL or LED, however since CFLs are no longer commonly purchased (only 1% baseline forecast) it is assumed that 75% (IECC 2015) or 90% (IECC 2018) or 100% (IECC 2021) of the New Construction baseline is an LED and therefore savings are reduced by that percentage for bulbs provided in New Construction projects. Any

New Construction project utilizing IECC 2021 code should therefore not include savings from this measure.

The baseline and efficient measure assumptions are shown in Table 358. New lamps must be ENERGY STAR labeled or equivalent to the most recent version of ENERGY STAR specifications. Note a new ENERGY STAR specification v2.1 became effective on 1/2/2017. As of December 31, 2024, ENERGY STAR has sunset their qualified product list for general service LED lamps. In absence of this list, equivalent certifications for new lamps may include:

- Legacy ENERGY STAR qualified product list if available
- The Federal Trade Commission's Lighting Facts label, which communicates performance to consumers including bulb brightness, expected energy cost, lifetime, and energy usage
- Lab testing reports such as LM-79 or LM-80

Table 358: Residential Lighting Baseline and Efficiency Wattage – General Service

<table>
<tr><th rowspan="3">Minimum Lumens</th><th rowspan="3">Maximum Lumens</th><th rowspan="3">LED Wattage $(Watts)_{EE}$</th><th rowspan="3">Baseline $(Watts)_{Base}$</th><th colspan="2">Baseline for New Construction</th><th>Delta Watts</th><th colspan="2">Delta Watts for New Construction</th></tr>
<tr><th colspan="2">$(Watts)_{Base}$</th><th rowspan="2">(WattsEE)</th><th colspan="2">(WattsEE)</th></tr>
<tr><th>IECC 2015</th><th>IECC 2018</th><th>IECC 2015</th><th>IECC 2018</th></tr>
<tr><td>120</td><td>399</td><td>4</td><td>25</td><td>9.3</td><td>6.1</td><td>21</td><td>5.3</td><td>2.1</td></tr>
<tr><td>400</td><td>749</td><td>6.6</td><td>29</td><td>12.2</td><td>8.8</td><td>22.4</td><td>5.6</td><td>2.2</td></tr>
<tr><td>750</td><td>899</td><td>9.6</td><td>43</td><td>18</td><td>12.9</td><td>33.4</td><td>8.4</td><td>3.3</td></tr>
<tr><td>900</td><td>1399</td><td>13.1</td><td>53</td><td>23.1</td><td>17.1</td><td>39.9</td><td>10</td><td>4</td></tr>
<tr><td>1400</td><td>1999</td><td>16</td><td>72</td><td>30</td><td>21.6</td><td>56</td><td>14</td><td>5.6</td></tr>
<tr><td>2000</td><td>2999</td><td>21.8</td><td>150</td><td>53.9</td><td>34.6</td><td>128.2</td><td>32.1</td><td>12.8</td></tr>
<tr><td>3000</td><td>3999</td><td>28.9</td><td>200</td><td>71.7</td><td>46</td><td>171.1</td><td>42.8</td><td>17.1</td></tr>
<tr><td>4000</td><td>5000</td><td>35.7</td><td>300</td><td>101.8</td><td>62.1</td><td>264.3</td><td>66.1</td><td>26.4</td></tr>
</table>

Table 359 details wattage ENERGY STAR specifications for reflector lamps. Program administrators should use model-specific wattages within these categorizations.

Table 359: Baseline and Efficiency Wattage – Reflector Lamps

Bulb Type	Minimum Lumens	Maximum Lumens	LED Wattage ($(Watts)_{EE}$)	Baseline ($(Watts)_{Base}$)	Baseline for New Construction ($(Watts)_{Base}$) IECC 2015	Baseline for New Construction ($(Watts)_{Base}$) IECC 2018	Delta Watts (WattsEE)	Delta Watts for New Construction (WattsEE) IECC 2015	Delta Watts for New Construction (WattsEE) IECC 2018
Reflector lamp types with medium screw bases (PAR20, PAR30(S,L), PAR38, R40, etc.) w/ diameter >2.25" (*see exceptions below)	400	649	7	50	17.8	11.3	43	10.8	4.3
	650	899	10.7	75	26.8	17.1	64.3	16.1	6.4
	900	1049	13.9	90	32.9	21.5	76.1	19	7.6
	1050	1199	13.8	100	35.4	22.4	86.2	21.6	8.6
	1200	1499	15.9	120	41.9	26.3	104.1	26	10.4
	1500	1999	18.9	150	51.7	32	131.1	32.8	13.1
	2000	4200	27.3	250	83	49.6	222.7	55.7	22.3
Reflector lamp types with medium screw bases (PAR16, R14, R16, etc.) w/ diameter <2.25" (*see exceptions below)	280	374	4.6	35	12.2	7.6	30.4	7.6	3
	375	600	6.4	50	17.3	10.8	43.6	10.9	4.4
*BR30, BR40, or ER40	650	949	9.3	65	23.2	14.9	55.7	13.9	5.6
	950	1099	12.7	75	28.3	18.9	62.3	15.6	6.2
	1100	1399	14.4	85	32.1	21.5	70.6	17.7	7.1
	1400	1600	16.6	100	37.5	24.9	83.4	20.9	8.3
	1601	1800	22.2	120	46.7	32	97.8	24.5	9.8
*R20	450	524	6	40	14.5	9.4	34	8.5	3.4
	525	750	7.1	45	16.6	10.9	37.9	9.5	3.8
*MR16	250	324	3.8	20	7.9	5.4	16.2	4.1	1.6
	325	369	4.8	25	9.9	6.8	20.2	5.1	2
	370	400	4.9	25	9.9	6.9	20.1	5	2

For PAR, MR, and MRX Lamps (highly focused directional lamp types), it is necessary to have Center Beam Candle Power (CBCP) and beam angle measurements to accurately estimate the equivalent baseline wattage. The formula below is based on the ENERGY STAR Center Beam Candle Power tool.[587] If CBCP and beam angle information are not available or if the equation below returns a negative value (or undefined), use the manufacturer's recommended baseline wattage equivalent.[588]

$$Watts_{base} = 375.1 - 4.355(D) - \sqrt{(227{,}800 - 937.9(D) - 0.9903(D^2) - 1479(BA) - 12.02(D * BA) + 14.69(BA^2) - 16{,}720 * ln\,(CBCP))}$$ *;other specialty lamps are detailed in Table* 360.

where:

D = Bulb diameter (e.g. for PAR20 D = 20)

BA = Beam angle

CBCP = Center beam candle power

The result of the equation above should be rounded DOWN to the nearest wattage.

Table 360: Specialty Lamp Permitted Wattage Details Based on Diameter

Diameter	Permitted Wattages
16	20, 35, 40, 45, 50, 60, 75
20	50
30S	40, 45, 50, 60, 75
30L	50, 75
38	40, 45, 50, 55, 60, 65, 75, 85, 90 100, 120, 150, 250

Table 361 provides baseline and efficient wattages for other specialty lamps.

[587] See 'ESLampCenterBeamTool.xls'.

[588] The ENERGY STAR Center Beam Candle Power tool does not accurately model baseline wattages for lamps with certain bulb characteristic combinations – specifically for lamps with very high CBCP.

Table 361: Baseline and Efficiency Wattage – Specialty Lamps

Bulb Type	Minimum Lumens	Maximum Lumens	LED Wattage (Watts)	Baseline (Watts)	Baseline for New Construction (Watts)		Delta Watts (WattsEE)	Delta Watts for New Construction (WattsEE)	
					IECC 2015	IECC 2018		IECC 2015	IECC 2018
Omni-Directional 3-Way	1100	1999	14.7	100	36	23.2	85.3	21.3	8.5
	2000	2700	22.6	150	54.5	35.3	127.4	31.9	12.7
Globe (medium and intermediate bases less than 750 lumens)	150	349	3	25	8.5	5.2	22	5.5	2.2
	350	499	4.7	40	13.5	8.2	35.3	8.8	3.5
	500	574	5.7	60	19.3	11.1	54.3	13.6	5.4
	575	649	6.5	75	23.6	13.4	68.5	17.1	6.9
	650	1000	8.2	100	31.2	17.4	91.8	23	9.2
Globe (candelabra bases less than 1050 lumens)	150	349	3.5	25	8.9	5.7	21.5	5.4	2.2
	350	499	4.4	40	13.3	8	35.6	8.9	3.6
	500	574	5.5	60	19.1	11	54.5	13.6	5.5
Decorative (Shapes B, BA, C, CA, DC, F, G, medium and intermediate bases less than 750 lumens)	160	299	2.6	25	8.2	4.8	22.4	5.6	2.2
	300	499	4.3	40	13.2	7.9	35.7	8.9	3.6
	500	800	5.8	60	19.4	11.2	54.2	13.6	5.4
Decorative (Shapes B, BA, C, CA, DC, F, G, candelabra bases less than 1050 lumens)	120	159	1.5	15	4.9	2.9	13.5	3.4	1.4
	160	299	2.7	25	8.3	4.9	22.3	5.6	2.2
	300	499	4.2	40	13.2	7.8	35.8	9	3.6
	500	650	5.5	60	19.1	11	54.5	13.6	5.5
Decorative (Shape ST)	250	499	6.5	40	14.9	9.9	33.5	8.4	3.4
	500	999	8.8	60	21.6	13.9	51.2	12.8	5.1
	1000	1500	10	100	32.5	19	90	22.5	9
Decorative (Shape S)	50	75	1	11	3.5	2	10	2.5	1
	100	120	1.2	15	4.7	2.6	13.8	3.5	1.4
	120	340	2.25	25	7.9	4.5	22.8	5.7	2.3

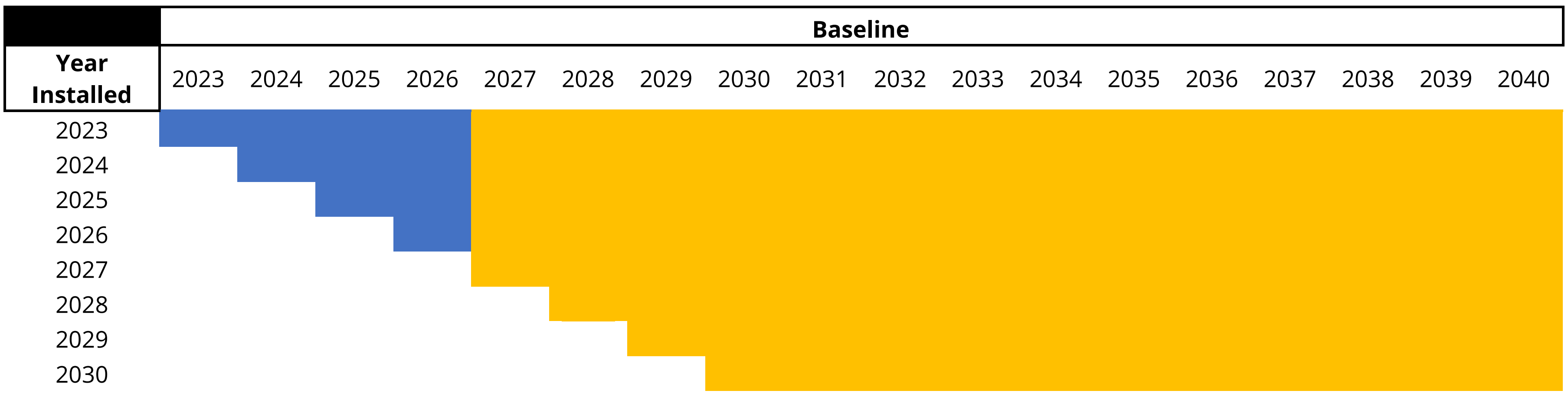
6.2.3 EXAMPLE

6.2.3.1 EISA Example

halogen baseline

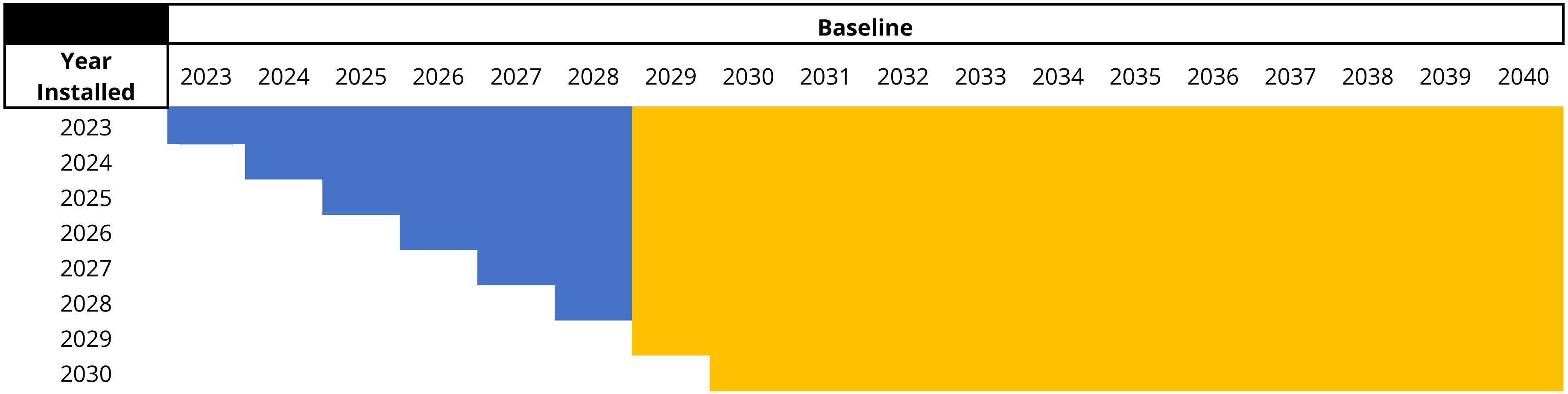
45 lum/watt

Non-Income Qualified (Non-IQ)



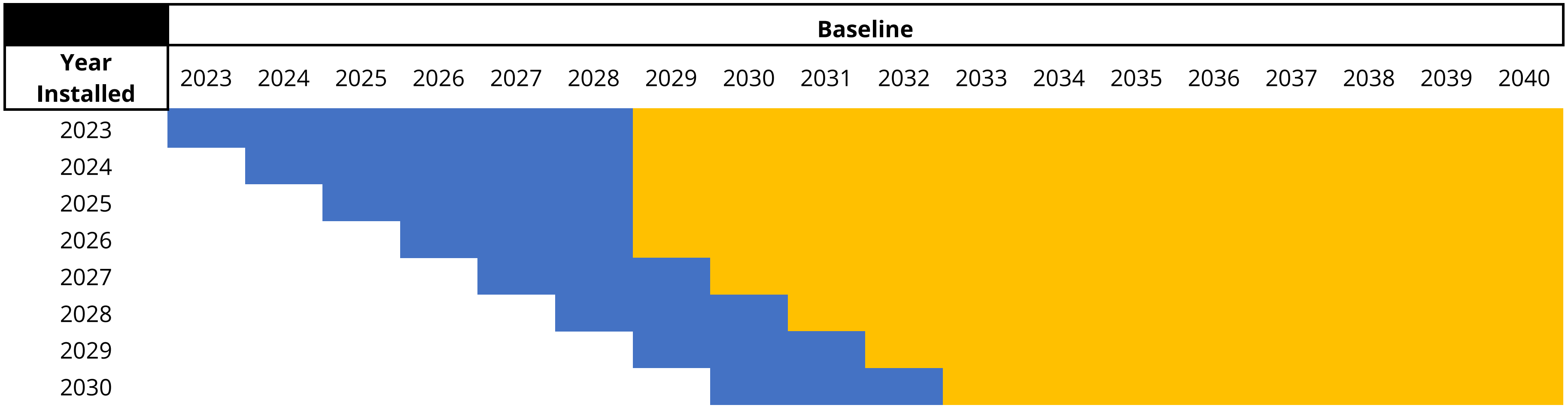
If an efficient fixture was installed in 2025, the halogen baseline applies to 2025 and 2026. Starting in the year 2027, the remaining baseline shall use 45 lum/watt.

Income Qualified (IQ)



If an efficient fixture was installed in 2025, the halogen baseline applies to 2025 through 2028. Starting in the year 2029, the remaining baseline shall use 45 lum/watt.

Direct Install - Visually verified replacing a halogen bulb



If an efficient fixture was installed in 2025, the halogen baseline applies to 2025 through 2028. Starting in the year 2029, the remaining baseline shall use 45 lum/watt.