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WATER HEATING
STORAGE WATER HEATER, COMMERCIAL
SWWH007-04

CONTENTS

Measure Name

Storage Water Heater, Commercial

Statewide Measure ID

SWWH007-04

Technology Summary

Commercial and industrial storage water heaters are used to produce hot water for a variety of applications. These units can be utilized for domestic purposes or could be used as process hot water. Storage water heaters heat and store water within the appliance at a thermostatically controlled temperature for delivery on-demand. Cold water supplied into the storage water heater via the supply line will be stored under pressure and heated by a natural gas burner placed at the bottom of the water heater. The natural gas burner will turn ON until the desired setpoint temperature inside the tank is reached. The high-temperature water is then supplied on-demand directly, or through a recirculation loop, depending on the application.

High efficiency units are characterized by a high thermal efficiency (TE), or uniform energy factor (UEF) rating. These ratings account for the amount of heat that is inputted into the system and the amount of heat that is successfully transferred into the water. Several factors determine the energy efficiency of a water heater, such as high-quality insulation and better heat transfer materials within the water heater.

Relative to a standard model, an energy efficient unit will typically have features such as larger heat exchange surfaces and/or additional tank insulation. The most efficient natural gas storage water heater is a *condensing* water heater. A condensing unit has more heat exchange surface between the hot exhaust gasses and the water being heated. This allows the water to absorb more of the exhaust gas heat, which in turn reduces the temperature of the exhaust gasses and condenses the exhaust by-products.

Measure Case Description

The measure case is defined as the replacement of a standard efficiency gas storage water heater with an energy efficient gas storage water heater. The minimum qualifying efficiency ratings of each measure offering equipment size are shown below. Energy is calculated by climate zone for each measure offering.

Measure Case Specification

Equipment Type	Measure Case Description
Large Storage Water heater with input rating > 75 kBtu/hr	TE ≥ 83%
	TE ≥ 90%
	TE ≥ 96%

Equipment Type	Measure Case Description
Small Storage Water heater with input rating ≤ 75 kBtu/hr	
30-gallon Medium Draw water heater	UEF ≥ 0.64 UES converted into Cap-kBtuh
40-gallon Medium Draw water heater	
50-gallon Medium Draw water heater	
30-gallon High Draw water heater	UEF ≥ 0.68; UES converted into Cap-kBtuh
40-gallon High Draw water heater	
50-gallon High Draw water heater	

Base Case Description

The base case technology is defined as a gas storage water heater that meets the efficiency ratings specified below. The measure offerings are offered for normal replacement installations. Therefore, the baseline for each measure is defined by either Code or standard practice. In this case, all measure offerings were evaluated against the code defined by the California Appliance Efficiency Regulations (Title 20, see Code Requirements). The table below provides the base case description for each measure offering.

Base Case Specification

Equipment Type	Base Case Description
Large Storage Water heater with input rating > 75 kBtu/hr	TE = 0.80 Standby Loss = 0.56%/hr
Small Storage Water heater with input rating ≤ 75 kBtu/hr	
30-gallon Medium Draw water heater	UEF ≥ 0.60
40-gallon Medium Draw water heater	UEF ≥ 0.58
50-gallon Medium Draw water heater	UEF ≥ 0.56
30-gallon High Draw water heater	UEF ≥ 0.65
40-gallon High Draw water heater	UEF ≥ 0.64
50-gallon High Draw water heater	UEF ≥ 0.63

Code Requirements

Applicable state and federal codes and standards for commercial storage water heaters are noted in the

tables below.[1] The standards for Federally Regulated Water Heaters were updated in late 2016, which are directly matched in the California Appliance Efficiency Regulations (Title 20).

Applicable State and Federal Codes and Standards for Commercial Water Heaters

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2019)	1605.1 (f) 1605.3(f)	January 1, 2019
CA Building Energy Efficiency Standards – Title 24 (2016)	110.3	January 1, 2017
Federal Standards – Code of Federal Regulations	10 CFR 430.32(d)	December 29, 2016
California Air Quality Management District (AQMD)/Air Pollution Control District Regulations		
South Coast AQMD (SCAQMD)	Rule 1121 Rule 1146.2	September 3, 2004 May 5, 2006
Bay Area AQMD (BAAQMD)	Regulation 9, Rule 6	November 7, 2007
San Joaquin Valley APCD (SJVAPCD)	Rule 4902	March 19, 2009
Sacramento Metropolitan AQMD (SMAQMD)	Rule 414	March 25, 2010
Yolo-Solano AQMD (YSAQMD)	Regulation II, Rule 2.37	April 8, 2009
Ventura County Air Pollution Control District (VCAPCD)	Rule 74.11	January 12, 2010

In December 2016 the U.S. Department of Energy (DOE) issued a Final Ruling in Docket No. EERE-2015-BT-TP-0007 that established a new efficiency rating for all residential and some commercial water heating technologies are rated.[2] All water heaters within the scope of the ruling will no longer be rated with the energy Factor (EF), thermal efficiency (TE), or standby loss ratings; the Uniform Energy Factor (UEF) is the new metric for the energy efficiency of water heaters. A UEF rating is determined by assigning a water heater into one of four different categories of hot water usage and then evaluating its performance based on that usage.[3] The four categories are based on *draw pattern – very small, low, medium,* and *high*. This allows water heaters to be compared more easily between different types (i.e., storage and tankless), as long as units are compared within the same bin.

With this final ruling, the DOE established a mathematical conversion between the values determined using the ER, TE, and SL test procedures and the values determined using the uniform efficiency descriptor test procedure. The DOE used the conversion factors to derive minimum energy performance

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[1] California Energy Commission (CEC). 2019. 2019 Appliance Efficiency Regulations. CEC-400-2019-002. Section 1605.3(f).

California Energy Commission. 2015. 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. CEC-400-2015-037-CMF. Section 110.3.

Code of Federal Regulations at 10 CFR 430.32(d).

[2] U.S. Department of Energy (DOE). 2016. "Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters." *Federal Register: The Daily Journal of the United States.* 81 Fed. Reg. 250. December 29, 2016.

[3] A.O. Smith. (n.d.) "What Does UEF Mean To You?*"*

standards based on UEF. The standards denominated in UEF are neither more nor less stringent than the EF-denominated standards for consumer water heaters and for commercial water-heating equipment based on the TE and SL metrics.

Table II.1 – Consumer Water Heater Energy Conservation Standards Denominated in UEF

Product Class	Rated Storage Volume and Input Rating (if applicable)	Draw Pattern	Minimum Uniform Energy Factor*
Gas-fired Storage Water Heater	≥ 20 gallons and ≤ 55 gallons	Very small	$0.3456 - (0.0020 \times V_r)$
		Low	$0.5982 - (0.0019 \times V_r)$
		Medium	$0.6483 - (0.0017 \times V_r)$
		High	$0.6920 - (0.0013 \times V_r)$
	> 55 gallons and ≤ 100 gallons	Very small	$0.6470 - (0.0006 \times V_r)$
		Low	$0.7689 - (0.0005 \times V_r)$
		Medium	$0.7897 - (0.0004 \times V_r)$
		High	$0.8072 - (0.0003 \times V_r)$
Oil-fired Storage Water Heater	≤ 50 gallons	Very small	$0.2509 - (0.0012 \times V_r)$
		Low	$0.5330 - (0.0016 \times V_r)$
		Medium	$0.6078 - (0.0016 \times V_r)$
		High	$0.6815 - (0.0014 \times V_r)$
Electric Storage Water Heaters	≥ 20 gallons and ≤ 55 gallons	Very small	$0.8808 - (0.0008 \times V_r)$
		Low	$0.9254 - (0.0003 \times V_r)$
		Medium	$0.9307 - (0.0002 \times V_r)$
		High	$0.9349 - (0.0001 \times V_r)$
	> 55 gallons and ≤ 120 gallons	Very small	$1.9236 - (0.0011 \times V_r)$
		Low	$2.0440 - (0.0011 \times V_r)$
		Medium	$2.1171 - (0.0011 \times V_r)$
		High	$2.2418 - (0.0011 \times V_r)$
Tabletop Water Heater	≥ 20 gallons and ≤ 120 gallons	Very small	$0.6323 - (0.0058 \times V_r)$
		Low	$0.9188 - (0.0031 \times V_r)$
		Medium	$0.9577 - (0.0023 \times V_r)$
		High	$0.9884 - (0.0016 \times V_r)$
Instantaneous Gas-fired Water Heater	< 2 gallons and >50,000 Btu/h	Very small	0.80
		Low	0.81
		Medium	0.81
		High	0.81
Instantaneous Electric Water Heater	< 2 gallons	Very small	0.91
		Low	0.91
		Medium	0.91
		High	0.92
Grid-Enabled Water Heater	> 75 gallons	Very small	$1.0136 - (0.0028 \times V_r)$
		Low	$0.9984 - (0.0014 \times V_r)$
		Medium	$0.9853 - (0.0010 \times V_r)$
		High	$0.9720 - (0.0007 \times V_r)$

* V_r = Rated Storage Volume in gallons.

The final ruling also includes tables that define each of the draw patterns categories, as follows:

Section 429.17 (B) Determine the applicable draw pattern as follows:

(1) For consumer gas-fired water heaters, consumer oil-fired water heaters, consumer electric water heaters, tabletop water heaters, grid enabled water heaters, residential-duty commercial gas water heaters, residential-duty commercial oil filed water heaters: Use the New FHR [First Hour Rating] … to select the applicable draw pattern from the table in this paragraph:

Storage Water Heater Draw Patterns

New FHR greater than or equal to:	New FHR rating less than:	Draw Pattern
0 gallons	18 gallons	Very Small
18 gallons	51 gallons	Low
51 gallons	75 gallons	Medium
75 gallons	No upper limit	High

In addition to the aforementioned federal standards, commercial storage and tankless water heaters are covered by ENERGY STAR.[4] *Note that while all small units (<75,000btu/hr) meet residential ENERGY STAR criteria, only Tier 3 large units meet commercial ENERGY STAR requirements.*

ENERGY STAR Commercial Water Heaters – Product Type Requirements

Product Type	ENERGY STAR Requirement
Gas Storage	> 75,000 Btu/hr input
	≤ 140 gallons storage capacity
Gas Tankless	≥ 4,000 Btu/hr per gallon of stored water

ENERGY STAR Commercial Water Heaters – Minimum Efficiency Requirements

Product Type	Criteria	ENERGY STAR Requirement
Storage	Thermal Efficiency (TE)	TE ≥ 0.94
Instantaneous		
Storage	Maximum Standby Loss	≤ 0.84 * [(Input Rate / 800) +110(Volume)1/2] (Btu/hr)
Instantaneous		
Storage	Minimum Manufacturer	3 years on tank and/or heat exchanger
Instantaneous	Limited Warranty	1 year on parts

ENERGY STAR Residential Gas Fired Storage Water Heaters – Product Type Requirements

Product Type	ENERGY STAR Requirement
Gas Storage	≤ 75,000 Btu/hr input
	≤ 55 gallons storage capacity

ENERGY STAR Residential Gas Fired Storage Water Heaters – Minimum Efficiency Requirements

Product Type	Criteria	ENERGY STAR Requirement
Storage (Medium Draw)	Uniform Energy Factor (UEF)	UEF ≥ 0.64
Storage (High Draw)	Uniform Energy Factor (UEF)	UEF ≥ 0.68

Normalizing Unit

kBtu per hour of rated input capacity (Cap-kBtuh).

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[4] ENERGY STAR. 2018. "ENERGY STAR Program Requirements for Commercial Water Heaters. Eligibility Criteria Version 2.0." Effective on October 1, 2018.

Program Requirements

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Normal replacement	DnDeemDI	Com
Normal replacement	DnDeemed	Com
Normal replacement	UpDeemed	Com
New construction	DnDeemDI	Com
New construction	DnDeemed	Com
New construction	UpDeemed	Com
Accelerated replacement	DnDeemDI	Com

For accelerated replacement application types, this measure adopts the program-level "Preponderance of Evidence Assessment" described in Version 2.0 of the Accelerated Replacement Using Preponderance of Evidence report developed by the utilities and stakeholders to provide guidance for the California programs ("POEV 2.0", see Section 7).[5] "Continued viability" and "program influence" must be demonstrated as the evidence of accelerated replacement.

To demonstrate the viability of the pre-existing system or to show that the program is replacing equipment that is "installed and operating," the customer must be approached by a direct install implementer. Additionally, the program must obtain and provide additional documentation, including (but not limited to) the following:

- Targeted segment of the market or customers
- Customer/site information
- Make/model of pre-existing equipment and/or
- Performance/flowrate measurements of pre-existing equipment, and/or
- Photograph of pre-existing equipment in place and operating

Program influence evidence can be demonstrated through one of the three alternatives listed in Section 7.3 of POEV 2.0. This measure establishes the program-level evidence of program influence by adopting the net-to-gross (NTG) ratio from prior program evaluation results.

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[5] Track 1 Working Group. 2016. Accelerated Replacement Using Preponderance of Evidence. Version 2.0. December 7.

Specific documentation requirements will be determined by the program administrator and will be specified in the program implementation plan.

Eligible Products

Eligible commercial storage water heaters must meet the following requirements:

- Meet minimum qualifying efficiency ratings in the Measure Case Description.
- For *normal replacement installations*, only gas-for-gas replacements are eligible.
- Meet the definition of a storage water heater, as defined by the California Energy Commission:
    - Be used primarily for domestic hot water.
    - Have an input rating of less than 4,000 Btu per hour per gallon of stored water.

Eligible Building Types

This measure is applicable for any commercial domestic (or "service") hot water application in a nonresidential facility of any existing building type or vintage.

Eligible Climate Zones

The measure is applicable in all California climate zones.

Program Exclusions

Water heaters or hot water boilers used for space conditioning, industrial (process) end-use applications, pools, or spas are not eligible.

Data Collection Requirements

Data collection requirements are to be determined.

Use Category

Service & Domestic Hot Water

Electric Savings (kWh)

Not applicable.

Peak Electric Demand Reduction (kW)

Not applicable.

Gas Savings (Therms)

The unit energy savings (UES) for this measure were estimated using the Database of Energy Efficient Resources (DEER) water heater calculator tool, a macro-enabled Excel workbook developed by consultants of the California Public Utilities Commission (CPUC) Energy Division to standardize the inputs and savings calculations for water heating measures. The DEER water heater calculator utilizes hourly output from the DOE2 building prototypes for hot water loads and ambient conditions to estimate hourly gas consumption. Version v4.2 was used for the gas energy savings analysis for this measure.[6]

The following table indicates the measures taken directly from or created with the *DEER-WaterHeater-Calculator-v4.2.x*lsm tool.

DEER Measure Codes

Statewide Measure Offering ID	Energy Impact ID	Measure Description	DEER Version
SWWH007B	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-0p64UEF*	30 Gallon Medium Draw Gas Storage Water Heater with ≥ 0.64 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007D	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-MD-0p64UEF*	40 Gallon Medium Draw Gas Storage Water Heater with ≥ 0.64 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007F	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-MD-0p64UEF*	50 Gallon Medium Draw Gas Storage Water Heater with ≥ 0.64 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007A	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-HI-0p68UEF*	30 Gallon High Draw Gas Storage Water Heater with ≥ 0.68 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007C	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-0p68UEF*	40 Gallon High Draw Gas Storage Water Heater with ≥0.68 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007E	*NG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-0p68UEF*	50 Gallon High Draw Gas Storage Water Heater with ≥ 0.68 UEF	DEER-WaterHeater-Calculator-v4.2
SWWH007G	NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p83Et	Large Gas Storage Water Heater, Et = 0.83, Stdby Loss = 0.56%/hr	DEER-WaterHeater-Calculator-v4.2
SWWH007H	NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p90Et	Large Gas Storage Water Heater, Et = 0.90, Stdby Loss = 0.56%/hr	DEER-WaterHeater-Calculator-v4.2
SWWH007I	NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p96Et	Large Gas Storage Water Heater, Et = 0.96, Stdby Loss = 0.56%/hr	DEER-WaterHeater-Calculator-v4.2

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[6] California Public Utilities Commission (CPUC), Energy Division. 2020. DEER2021"DEER-WaterHeater-Calculator-v4.2.xlsm." Updated September 17, 2020.

Annual Unit Energy Consumption

The water heater calculator was used to estimate the baseline and measure case unit energy consumption (UEC); the UES was calculated as the difference.

The annual UEC is estimated with the expression below.

$$WH_{annual\ Therm} = \left[\sum_{hour=}^{8760} \left(\frac{(HW_{load} + UA_{load} - Aux_{load} + Btu_{Aux})}{RE * 100,000} \right)_{hour} \right]$$

For each hour:

$$HW_{load} = Volume \times (T_{tank} - T_{main}) \times \frac{Btu}{Gal \times F}$$

$$UA_{load} = Tank_{UA} \times (T_{tank} - T_{ambient})$$

$$Tank_{UA} = \left(\frac{\frac{RE}{UEF} - 1}{\left(\left(\frac{24\frac{hr}{day}}{41092\frac{Btu}{day}} \right) - \frac{1}{UEF \times P \times 1000} \right)} \right) \div (67.5)$$

$$Aux_{load} = -(Btuh_{Aux} * Eff_{Aux})$$

$$Btu_{Aux} = (pilot\ light \left(\frac{Btu}{hr} \right) \times 1hr \times \frac{1\ Therm}{100,000\ Btu})$$

$WH_{load\ annual} = annual\ water\ heater\ energy\ consumption$

$HW_{load} = hourly\ water\ heater\ load\ due\ to\ water\ use$

$UA_{load} = hourly\ load\ due\ to\ tank\ shell\ loss$

$Aux_{load} = pilot\ light\ heat\ rate$

$RE = recovery\ efficiency$

$UEF = uniform\ energy\ factor$

Conversion from Energy Factor to Uniform Energy Factor

It is important to note that while EF values were based on a single draw pattern, the UEF value is based on four different draw patterns.

Storage Water Heater EF to UEF Conversion

The DOE process to convert a gas-fired storage water heater from EF value to UEF is as follows:

First, the draw pattern for a given storage water heater must be determined. The UEF has four potential draw patterns. One out of those four, will provide the correct conversion from EF to UEF. The EUF draw pattern is determined by the new first hour rating (FHR) per the DOE test procedure. The following defines the conversion to the new FHR.

$$FHR = 25.0680 + 0.6535 * FHR_p$$

$$FHR_p = prior\ first\ hour\ rating\ of\ the\ EF\ rated\ water\ heater$$

Using the FHR, the appropriate draw pattern can be selected in the table below.

New FHR greater than or equal to:	New FHR rating less than:	Draw Pattern
0 gallons	18 gallons	Very Small
18 gallons	51 gallons	Low
51 gallons	75 gallons	Medium
75 gallons	No upper limit	High

The draw pattern can then be used to select the constant coefficients in the below table.

Draw Pattern	a	b	c	d
Very small	0.250266	57.5	0.039864	67.5
Low	0.065860	57.5	0.039864	67.5
Medium	0.045503	57.5	0.039864	67.5
High	0.029794	57.5	0.039864	67.5

Along with the water heater specifications listed below, the constant coefficients are used to determine the UEF$_{WHAM}$.

$$UEF_{WHAM} = \left[\frac{1}{\eta_r} + \left(\frac{1}{EF} - \frac{1}{\eta_r}\right)\left(\frac{aP\eta_r - b}{cP\eta_r - d}\right)\right]^{-1}$$

$$\eta_r = recovey\ efficiency$$

$$EF = energy\ factor$$

$$a, b, c, d = constant\ coefficients\ dependant\ on\ draw\ pattern$$

$$P = water\ heater\ input\ rate\ (Btu/hr)$$

Finally, the UEF for a storage water heater can then be determined with the following formula.

$$UEF = 0.0746 + 0.8653 \times UEF_{WHAM}$$

Sample Calculation

The calculation of the consumption for one hour of the year per the water heating schedule was adopted from the "DEER-WaterHeater-Calculator-v4.2" for measure "RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-0p64UEF". Considering hour 8, which heats 0.6 gallons of water in climate zone 9 for a single-family dwelling.

$$HW_{load} = 0.6\ gal \times (135\ F - 60.23\ F) \times 8.2\frac{Btu}{gal \times F} = 386\ Btu$$

$$Tank_{UA} = \left(\frac{\frac{0.76}{0.64} - 1}{\left(\left(\frac{24 \frac{hr}{day}}{41092 \frac{Btu}{day}} \right) - \frac{1}{0.64 * 32{,}600 \frac{Btu}{hr}} \right)} \right) \div (67.5) = \frac{5.18 \ Btu}{hr \times F}$$

$$UA_{load} = \frac{5.18 \ Btu}{hr \times F} \times (135 \ F - 44 \ F) \times 1hr = 471 \ Btu$$

$$Aux_{load} = -\left(350 \frac{Btu}{hr} \times .67 \right) \times 1 \ hr = -235 \ Btu$$

$$Btu_{Aux-for \ 1 \ hour} = (350) \left(\frac{Btu}{hr} \right) \times 1hr = 350 \ Btu$$

$$WH_{1 \ hour \ load} = \left[\sum_{hour=1}^{1} \left(\frac{(386 \ Btu + \ 471 \ Btu - 235 \ Btu + 350 \ Btu)}{0.760 \times 100{,}000} \right)_{hour \ 8} \right] = 0.0125 \ Therm$$

The above result is for one hour of the year; the process was repeated for all annual hours and summed to yield the annual water heater load. The savings were then computed as the difference between the measure annual UEC and the baseline annual UEC.

Life Cycle

Effective Useful Life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. EUL is often, but not always, derived from measure persistence or retention studies. Remaining Useful Life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for this measure are specified below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	15.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs)	5.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."

Base Case Material Cost ($/unit)

When the customer replaces equipment on burnout (normal replacement), they must buy a new water heater to continue operating, so the base case cost is equal to the cost of a base case (standard) boiler/tankless water heater.

The base case material costs for this measure were derived from the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc.[7] A linear regression analysis using the data from the Itron study was conducted to conform costs to UEF ratings.[8] The cost analysis assumes that unit costs will remain consistent with the past units.

Measure Case Material Cost ($/unit)

The measure case material costs for this measure were derived from the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc.[9] A linear regression analysis using the data from the Itron study was conducted to conform costs to UEF ratings.[10] The cost analysis assumes that labor costs will remain consistent with the past units.

Base Case Labor Cost ($/unit)

Labor costs were derived using the same methodology to develop base case and measure case material costs.

Measure Case Labor Cost ($/unit)

Labor costs were derived using the same methodology to develop base case and measure case material costs.

Net-to-Gross (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG ("default NTG") is applicable to all energy efficiency measures that have been offered through commercial sector programs for more than two years and for which impact evaluation results are not available.

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[7] Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report.* Prepared for the California Public Utilities Commission.

[8] Southern California Gas Company (SCG). 2018. "WPSCGNRWH120206A-Rev10_Att. C - Cost Regression.xlsx"

[9] Itron, Inc. 2014. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Prepared for the California Public Utilities Commission.

[10] Southern California Gas Company (SCG). 2018. "WPSCGNRWH120206A-Rev10_Att. C - Cost Regression.xlsx"

Net-to-Gross Ratios

Parameter	Value	Source
NTG – commercial	0.60	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission Page 15-4 Table 15-3.

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current "default" rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

Parameter	Value	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

Non-Energy Impacts

Non-energy impacts for this measure have not been quantified.

DEER Differences Analysis

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	Yes
DEER Measure Case	Yes
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	n/a
DEER Version	DEER-WaterHeater-Calculator-v4.2
Reason for Deviation from DEER	n/a
DEER Run and Measure IDs Used	NG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-0p64UEF NG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-MD-0p64UEF NG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-MD-0p64UEF NG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-HI-0p68UEF NG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-0p68UEF NG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-0p68UEF NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p83Et NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p90Et

DEER Item	Comment
	NG-WtrHt-LrgStrg-Gas-gt75kBtuh-0p96Et
NTG	Source: DEER2015. NTG of 0.60 is associate with NTG ID: *Com-Default>2yrs,*
GSIA	GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER 2015. The EUL of 15 years is associated with EUL ID: *WtrHt--Com*

Revision History

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	03/14/2018	Jennifer Holmes, Cal TF Staff	The draft of the text fields for this statewide measure is based upon: WPSCGNRWH120206A Revision 9 (July 26, 2016) Consensus reached among Cal TF members
	01/04/2019	Jennifer Holmes, Cal TF Staff	Updated draft based upon: WPSCGNRW120206A, Revision 10 (October 1, 2018)
	2/15/2019	Matthew Mendoza, SoCalGas	Minor Edits to references and text document language
	02/27/2019	Jennifer Holmes, Cal TF Staff	Revisions for submission of version 01.
	07/02/2019	Ayad Al-Shaikh, Cal TF Staff	Update DEER IDs.
02	06/15/2020	Anders Danryd, Engineer, SoCalGas	Update savings using DEER 2021 Water Heater Calculator v4.1, add new "Tier 3" Large Unit
	07/07/2020	Anders Danryd, Engineer, SoCalGas	Per CPUC comment: Fixed formatting issues, updated Title 20 references, added RUL to the workpaper.
03	07/21/2020	Anders Danryd, Engineer, SoCalGas	Updated EAD table to include "New" vintage in addition to "Ex"
	08/27/2020	Anders Danryd, Engineer, SoCalGas	Updated workpaper and EAD tables to reflect new version number per CPUC direction
	09/23/2020	Anders Danryd, Engineer SoCalGas	Updated energy savings using DEER 2021 Water Heater Calculator v4.2
04	11/30/2020	Anders Danryd, Engineer SoCalGas	Added savings for all Commercial building types per E-5082 (in addition to Com weighted savings)