



**WATER HEATING**  
**STORAGE WATER HEATER, RESIDENTIAL**  
SWWH012-02

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**MEASURE NAME**

Storage Water Heater, Residential

**STATEWIDE MEASURE ID**

SWWH012-02

**TECHNOLOGY SUMMARY**

Conventional electric-resistance and natural gas water heaters consist of a glass-lined steel tank with foam insulation. An electric or natural gas burner is located at the base end of the tank where cold water enters and is heated by the burner. The heated water rises to the top portion of the tank where the hot water is drawn for consumption.

Relative to a standard model, a high-efficiency storage water heater is characterized by having superior insulating material and more effective heat transfer surfaces. These features reduce the water heater envelope losses and the energy required to maintain the water at the desired setpoint temperature. These attributes improve the energy performance of the water heater and provide an opportunity for energy savings.

**MEASURE CASE DESCRIPTION**

This measure is defined as the installation of an electric or gas storage water heater with 30, 40, or 50-gallon storage capacity. The measure case specifications by storage capacity are specified below. The minimum qualifying measure efficiencies exceed the California Appliance Efficiency Regulations (Title 20) and the Code of Federal Regulations. Energy savings are calculated by climate zone for each of the measure offering.

**Measure Case Specification**

Storage Capacity (gal)	Draw Pattern	Min. Qualifying Efficiency (UEF)
30	Medium	0.64
	High	0.68
40	Medium	0.64
	High, (Tier 1)	0.68
	High, (Tier 2)	0.83
50	Medium	0.64
	High, (Tier 1)	0.68
	High, (Tier 2)	0.88

**BASE CASE DESCRIPTION**

The base case is defined a gas standard efficiency storage water heater with 30, 40, or 50-gallon storage capacity. The minimum base case efficiencies are consistent with the federal U.S. Department of Energy (DOE) standards (see Code Requirements).

**Base Case Specification**

Storage Capacity (gal)	Draw Pattern	Efficiency (UEF)
30	Med	0.60
	High	0.65
40	Med	0.58
	High	0.64
50	Med	0.56
	High	0.63

**CODE REQUIREMENTS**

Applicable state and federal code and standards are detailed below.<sup>1</sup> Additionally, water heating equipment must comply with emissions limits set forth by air quality management districts (AQMDs) or air pollution control districts (APCDs) throughout the State.

**Applicable State and Federal Codes and Standards**

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2019)	Sections 1605.1(f)(2)	January 1, 2019
CA Building Energy Efficiency Standards – Title 24 (2016)	Section 110.3	January 21, 2016
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.<sup>2</sup> 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

<sup>1</sup> California Energy Commission (CEC). 2019. 2019 Appliance Efficiency Regulations. CEC-400-2019-002. Section 1605.1(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).

<sup>2</sup> 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.

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.<sup>3</sup> 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 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.			

<sup>3</sup> A.O. Smith. (n.d.) “What Does UEF Mean To You?”

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 fired 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.<sup>4</sup>

#### 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

Each.

## 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

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<sup>4</sup> ENERGY STAR. 2018. "ENERGY STAR Program Requirements for Commercial Water Heaters. Eligibility Criteria Version 2.0." Effective on October 1, 2018.

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	Res
Normal replacement	DnDeemed	Res
Normal replacement	UpDeemed	Res
New construction	DnDeemDI	Res
New construction	DnDeemed	Res
New construction	UpDeemed	Res
Accelerated replacement	DnDeemDI	Res

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).<sup>5</sup> “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.

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

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<sup>5</sup> Track 1 Working Group. 2016. Accelerated Replacement Using Preponderance of Evidence. Version 2.0. December 7.

*Eligible Products*

Eligible water heaters must comply with the measure case specification (see Measure Case Description).

Only storage water heaters as defined by the California Energy Commission qualify, and they must:

- Be used primarily for domestic hot water
- “Storage water heater” means a water heater that heats and stores water within the appliance at a thermostatically-controlled temperature for delivery on demand, and that has an input less than 4,000 Btu per hour per gallon of stored water.

Equipment must comply with the test methods referenced in the California Building Energy Efficiency Standards (Title 24) and the California Appliance Efficiency Regulations (Title 20). Additionally, the equipment must meet minimum emissions requirements as defined by local air quality management districts. See Code Requirements.

Only gas-for-gas normal replacements or for new construction installations are eligible.

Normal replacements must replace a storage water heater with another storage water heater.

The manufacturer and equipment model number must be provided.

If necessary, customer must provide proof of unit efficiency (e.g., manufacturer’s equipment specification sheet).

*Eligible Building Types*

This measure is applicable to any single-family, multi-family, and double-wide mobile home residential building of any vintage.

*Eligible Climate Zones*

The measure is applicable in all California climate zones.

**PROGRAM EXCLUSIONS**

Fuel switching is not allowed.

Water heaters used for space conditioning, process end use applications, pools or spas are not eligible.

Water heaters for nonresidential applications 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 4.1 of the DEER water heater calculator was used for the gas energy savings analysis for this measure.<sup>6</sup>

The following table indicates the measures taken directly from or created with the *DEER-WaterHeater-Calculator-v4.1.xlsm* tool. While most of the technologies were in the calculator, new technology was added in for the 40 and 50 gallon Condensing type water heater to add higher tiers for those sizes.

## DEER Measure Codes

Statewide Measure Offering ID	Energy Impact ID	Measure Description	DEER Version
SWWH012E	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-Op64UEF	Efficient water heater: 30 gallon Medium Draw gas water heater (UEF ≥ 0.64)	WaterHeater-Calculator-v4.1
SWWE012J	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-HI-Op68UEF	Efficient water heater: 30 gallon High Draw gas water heater (UEF ≥ 0.68)	WaterHeater-Calculator-v4.1
SWWH012F	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-MD-Op64UEF	Efficient water heater: 40 gallon Medium Draw gas water heater (UEF ≥ 0.64)	WaterHeater-Calculator-v4.1
SWWH012G	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-Op68UEF	Efficient water heater: 40 gallon High Draw gas water heater (UEF ≥ 0.68)	WaterHeater-Calculator-v4.1
SWWH012H	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-MD-Op64UEF	Efficient water heater: 50 gallon Medium Draw gas water heater (UEF ≥ 0.64)	WaterHeater-Calculator-v4.1

<sup>6</sup> California Public Utilities Commission (CPUC), Energy Division. 2020. "DEER-WaterHeater-Calculator-v4.1.xlsm." Updated June 1, 2020.



Statewide Measure Offering ID	Energy Impact ID	Measure Description	DEER Version
SWWH012I	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-Op68UEF	Efficient water heater: 50 gallon High Draw gas water heater (UEF ≥ 0.68)	WaterHeater-Calculator-v4.1
SWWH012K	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-Op83UEF	Condensing water heater: 40 gallon High Draw gas water heater (UEF ≥ 0.83)	WaterHeater-Calculator-v4.1
SWWH012L	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-Op88UEF	Condensing water heater: 50 gallon High Draw gas water heater (UEF=0.88)	WaterHeater-Calculator-v4.1

### 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.

$$WH_{annual\ Therm} = \left[ \sum_{hour=1}^{8760} \left( \frac{(HW_{load} + UA_{load} - Aux_{load} + Btu_{Aux})}{RE * 100,000} \right)_{hour} \right]$$

For each hour:

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

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

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

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

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

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

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

$UA_{load}$  = hourly load due to tank shell loss(Btu)

$Aux_{load}$  = pilot light heat rate(Btu/hr) contribution to water heater

$RE$  = recovery efficiency

$UEF$  = uniform energy factor

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

### 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  $UEF_{WHAM}$ .

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

$\eta_r$  = recovery 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-v4.1” for measure “RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-Op64UEF”. Considering hour 8, which heats 0.6 gallons of water in climate zone 9 for a single-family dwelling.

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

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

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

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

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

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

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 specified for this measure is presented 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)	11.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs)	3.67	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."

**BASE CASE MATERIAL COST (\$/UNIT)**

The base case material and labor costs were derived from data drawn from the 2010-2012 WO017 Ex Ante Measure Cost Study Final Report<sup>7</sup> prepared by Itron, Inc. Because this study presents material and labor cost for water heaters units rated with energy factor (EF), the EF values were converted to UEF and a regression analysis was completed to determine the cost for each corresponding UEF rating.<sup>8</sup>

**MEASURE CASE MATERIAL COST (\$/UNIT)**

The measure case material and labor costs were derived from data drawn from the 2010-2012 WO017 Ex Ante Measure Cost Study Final Report<sup>9</sup> prepared by Itron, Inc. Because this study presents material and labor cost for water heaters units rated with energy factor (EF), the EF values were converted to UEF and a regression analysis was completed to determine the cost for each corresponding UEF rating.<sup>10</sup>

Condensing type storage water heaters were not included in the study above. Therefore, a vendor study was done by SoCalGas to determine the average cost of measure qualifying condensing 40 and 50 gallon water heaters.<sup>11</sup>

**BASE CASE LABOR COST (\$/UNIT)**

Base case labor costs were derived using the same methodology to develop base case material costs. The labor cost is assumed to be equal for the base and measure case, as the process of installation is the same.

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<sup>7</sup> Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission. Appendix F.1, page 11.

Southern California Edison (SCE). 2019. "SWCR014-01 High Efficiency Display Case - calcs.xlsx"

<sup>8</sup> Southern California Gas Company. 2018. "WPSCGREWH180207A-Rev00\_Att. A - Cost Regression.xlsx"

<sup>9</sup> Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission. Appendix F.1, page 11.

Southern California Edison (SCE). 2019. "SWCR014-01 High Efficiency Display Case - calcs.xlsx"

<sup>10</sup> Southern California Gas Company. 2018. "WPSCGREWH180207A-Rev00\_Att. A - Cost Regression.xlsx"

<sup>11</sup> Southern California Gas Company 2020. "Condensing Storage Water Heater Cost Estimates.xlsx"

### MEASURE CASE LABOR COST (\$/UNIT)

Measure case labor costs were derived using the same methodology to develop the measure case material costs. The labor cost is assumed to be equal for the base and measure case, as the process of installation is the same.

### 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 residential programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs (“default NTGs”) are applicable to all energy efficiency measures that have been offered through residential programs for more than two years and for which impact evaluation results are not available.

#### Net-to-Gross Ratios

Parameter	Value	Source
NTG - residential	0.55	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Table 15-3 Page 15-4.

### 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. <i>Energy Efficiency Policy Manual Version 5</i> . 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. New higher tier measures were added into the calculator to represent new emerging technology of high efficiency residential gas condensing type water heaters.

#### DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	Yes
Scaled DEER measure	No

DEER Base Case	Yes
DEER Measure Case	Yes
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	Yes
DEER Version	DEER-WaterHeater-Calculator-v4.1
Reason for Deviation from DEER	New higher tier units added into the measure tab for condensing type units
DEER Measure IDs Used	RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-MD-Op64UEF Added: RG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-HI-Op68UEF RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-MD-Op64UEF RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-Op68UEF RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-MD-Op64UEF RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-Op68UEF Added: RG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-HI-Op83UEF Added: RG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-HI-Op88UEF
NTG	Source: DEER2019. NTG of 0.55 is associated with NTG ID: <i>Res-Default&gt;2. (electric/gas)</i>
GSIA	GSIA ID: <i>Def-GSIA</i>
EUL/RUL	Source: DEER2014. The EUL of 11 years is associated with EUL ID: <i>WtrHt-Res-Gas</i>

## REVISION HISTORY

## Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	03/08/2018	Jennifer Holmes, Cal TF Staff	The draft of the text fields for this statewide measure is based upon: PGECODHW104, Revision 6 (April 1, 2017) PGECODHW104, Revision 5 (April 1, 2016) WPSDGEREWH0023, Revision 0 (March 24, 2014) Consensus reached among Cal TF members
	02/07/2019	Jennifer Holmes, Cal TF Staff	Update with: WPSCGREWH180207A, Revision 00 (August 31, 2018)
	02/27/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.
	07/02/2019	Ayad Al-Shaikh, Cal TF Staff	Update DEER IDs.
02	6/15/2020	Anders Danryd, Engineer, SoCalGas	Update savings using DEER 2021 Water Heater Calculator v4.1, add new "Tier 2" Condensing Storage Water Heater
	07/07/2020	Anders Danryd, Engineer, SoCalGas	Per CPUC comment: Fixed formatting issues, updated Title 20 references, added RUL to the workpaper.
	08/09/2021	Soe K Hla PG&E	Adopted all measures for PG&E. Corrected DEER Measure ID from Measure Tab- EAD. Corrected EnergyImpact ID from EnergyImpact Tab- EAD.