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WATER HEATING
TANKLESS WATER HEATER, COMMERCIAL
SWWH006-02

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MEASURE NAME

Tankless Water Heater, Commercial

STATEWIDE MEASURE ID

SWWH006-02

TECHNOLOGY SUMMARY

A tankless water heater, or an “instantaneous” or “continuous flow” water heater, is a high-powered water heater that instantly heats water as it flows through the heat exchanger of the unit. In most cases, these types of water heaters heat water directly without the use of a storage tank. When a hot water tap is turned ON, cold water travels through a pipe and into the unit. A gas burner heats the water and as a result, there is a constant supply of hot water at the point-of-use.

Compared to a storage water heater, a tankless unit has a relatively large burner that rapidly heats water to the desired temperature. Due to the rapid “instantaneous” heating, a tankless water heater does not require a storage tank (although a small tank may be included). Due to the larger burner size, tankless water heaters can provide hot water on a continuous basis. They save energy because the standby losses associated with a storage tank are essentially eliminated.

Typically, a tankless water heater can provide hot water at a rate of two to five gallons per minute (gpm) which could limit its applications.¹ A tankless water heater is most useful in a point-of-use application – at the faucet and with no circulation loop. They are inefficient in applications with a circulation loop due to the temperature loss in the circulation system which causes the tankless water heater to run without water demand. A tankless water heater is also problematic in a central system with circulation loops with long pipe runs from the water heater to the faucet.

MEASURE CASE DESCRIPTION

The measure case is defined as a tankless water heater that replaces a storage water heater. The minimum qualifying efficiency ratings of each measure offering are specified below. As shown, small instantaneous water heaters and large instantaneous water heaters each have two measure offerings distinguished by the minimum efficiency rating. These measure case efficiencies were adopted after consideration of the California Appliance Efficiency Regulations (Title 20, see Code Requirements) and as a result of analysis of the distribution of high-efficiency instantaneous water heaters certified in the California Energy Commission (CEC) Modernized Appliance Efficiency Database System.²

¹ U.S. Department of Energy (DOE). (n.d.). “Tankless or Demand-Type Water Heaters.”

² California Energy Commission (CEC). (n.d.) “Modernized Appliance Efficiency Database System (MAEDBS).” Accessed in March 2012 and May 2014

Measure Case Specification

Measure Description	Tier	Min Efficiency Rating	Unit
Small Instantaneous Gas Water Heater	Tier I	0.81	UEF
	Tier II	0.87	UEF
		0.90	TE
Large Gas Instantaneous Water Heater	Tier I	0.80	TE
	Tier II	0.90	TE

BASE CASE DESCRIPTION

The base case technology for this measure is defined as a storage water heater that meets the efficiency ratings specified below. The measures offerings established for this measure are offered as normal replacement and new construction 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. These baselines are utilized for both efficiency tiers of small and large instantaneous gas water heater measures.

Base Case Specification

Measure Case Description	Base Case Description
Small Instantaneous Gas Water Heater	Small Storage Gas Water Heater 40-gallon EF = 0.62 RE = 0.76 Cap = 40 kBtu/hr UA = 6.43 Btu/hr-F AuxBtu/hr: 350
Large Gas Instantaneous Water Heater	Large Gas Storage Water Heater TE = 0.80 Stdby Loss = 0.56%/hr

CODE REQUIREMENTS

Applicable state and federal codes and standards for instantaneous heater/boilers are specified in the tables below.³

³ California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002. Section 1605.3(f).

California Energy Commission (CEC). 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).

Applicable State and Federal Codes and Standards for Direct Contact Water Heaters

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2017)	1605.1 (f), Large water heaters 1605.3(f), Small water heaters	April 1, 2017
CA Building Energy Efficiency Standards – Title 24 (2019)	110.3	January 1, 2020
Federal Standards – Code of Federal Regulations	10 CFR 430.32(d)	December 29, 2016

California Appliance Efficiency Regulations (2016 Title 20)

Equipment Type	Rated Input (kBtu/hr)	Rated Volume (gal)	Efficiency Units	Min. Efficiency	Max. Standby Loss (Btu/hr)
Instantaneous Water Heaters <i>V is the rated volume in gallons; Q is the rated input is Btu/hr</i>					
Small federally-regulated	≤ 200	< 2	EF	0.82-(0.0019*V)	---
Small non-federal regulated	≤ 50	Unspecified	EF	0.62-(0.0019*V)	---
Small non-federal regulated	≤ 200	≥ 2	EF	0.62-(0.0019*V)	---
Large	> 200	< 10	TE	80%	---
Large	> 200	≥ 10	TE	80%	$Q/800 + 110\sqrt{V}$

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.⁴ 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.⁵ 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.

⁴ 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.

⁵ A.O. Smith. (n.d.) “What Does UEF Mean To You?”

The following table from the Final Ruling provides the conversion equations from EF to UEF.

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

Product class	Rated storage volume and input rating (if applicable)	Draw pattern	Uniform energy factor	
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Very Small	0.3456 – (0.0020 x V _r)	
		Low	0.5982 – (0.0019 x V _r).	
		Medium	0.6483 – (0.0017 x V _r).	
		High	0.6920 – (0.0013 x V _r).	
	>55 gal and ≤100 gal	Very Small	0.6470 – (0.0006 x V _r).	
		Low	0.7689 – (0.0005 x V _r).	
		Medium	0.7897 – (0.0004 x V _r).	
		High	0.8072 – (0.0003 x V _r).	
	Oil-fired Storage Water Heater	≤50 gal	Very Small	0.2509 – (0.0012 x V _r).
			Low	0.5330 – (0.0016 x V _r).
			Medium	0.6078 – (0.0016 x V _r).
			High	0.6815 – (0.0014 x V _r).
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Very Small	0.8808 – (0.0008 x V _r).	
		Low	0.9254 – (0.0003 x V _r).	
		Medium	0.9307 – (0.0002 x V _r).	
		High	0.9349 – (0.0001 x V _r).	
	>55 gal and ≤120 gal	Very Small	1.9236 – (0.0011 x V _r).	
		Low	2.0440 – (0.0011 x V _r).	
		Medium	2.1171 – (0.0011 x V _r).	
		High	2.2418 – (0.0011 x V _r).	
	Tabletop Water Heater	≥20 gal and ≤120 gal	Very Small	0.6323 – (0.0058 x V _r).
			Low	0.9188 – (0.0031 x V _r).
			Medium	0.9577 – (0.0023 x V _r).
			High	0.9884 – (0.0016 x V _r).

Product class	Rated storage volume and input rating (if applicable)	Draw pattern	Uniform energy factor
Instantaneous Gas-fired Water Heater**.	<2 gal and >50,000 Btu/h	Very Small	0.80
		Low	0.81.
		Medium	0.81.
		High	0.81.
Instantaneous Electric Water Heater**.	< 2 gal	Very Small	0.91.
		Low	0.91.
		Medium	0.91.
Grid-Enabled Water Heater	>75 gal	High	0.92.
		Very Small	1.0136 – (0.0028 x V _r).
		Low	0.9984 – (0.0014 x V _r).
		Medium	0.9853 – (0.0010 x V _r).
		High	0.9720 – (0.0007 x V _r).

* V_r is the "Rated Storage Volume" (in gallons), as determined by 10 CFR 429.17.

**For instantaneous water heaters the standard is represented as a single value rather than as a function of storage volume. Because the UEF standard only applies to models with less than 2 gallons of storage volume, the coefficient becomes zero, and the standard does not vary for models between 0 and 2 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:	and new FHR less than:	Draw pattern
0 gallons	18 gallons	Very Small. Low. Medium. High.
18 gallons	51 gallons	
51 gallons	75 gallons	
75 gallons	No upper limit	

(2) For instantaneous gas-fired water heaters, instantaneous electric water heaters, and residential-duty commercial electric instantaneous water heaters: Use New Max GPM ... to select the applicable draw pattern from the table in this paragraph:

Instantaneous Water Heater Draw Patterns

New max GPM greater than or equal to:	And new max GPM rating less than:	Draw pattern
0 gallons/minute	1.7 gallons/minute	Very Small. Low. Medium. High.
1.7 gallons/minute	2.8 gallons/minute	
2.8 gallons/minute	4 gallons/minute	
4 gallons/minute	No upper limit	

NORMALIZING UNIT

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

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	DnDeemed	Com
Normal replacement	UpDeemed	Com
New construction	DnDeemed	Com
New construction	UpDeemed	Com

Eligible Products

Eligible commercial tankless water heaters must meet the following requirements:

- Meet or exceed the 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 tankless water heater, as defined by the California Energy Commission:
 - Be used primarily for domestic hot water
 - Provide hot water only when there is a hot water draw from the end use.
 - Have an input rating of at least 4,000 Btu/hr per gallon of stored water.

Eligible Building Types

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

Eligible Climate Zones

The measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

This measure does not include water heaters or hot water boilers used for space conditioning, industrial (process) end-use applications, pools, or spas.

This measure cannot be used to supply hot water to a circulation loop without an intermediary hot water storage tank.

DATA COLLECTION REQUIREMENTS

The data utilized for the impact and cost analysis of this measure are considered to be sufficient. The energy and demand impact values are approved values through the Database for Energy Efficient Resources (DEER) Remote Ex-Ante Database Interface (READI) tool. However, available product databases published by the California Energy Commission (CEC) and the Air Conditioning, Heating, and Refrigeration Institute (AHRI) do not include sufficient quantities of UEF-rated water heaters to develop typical code baseline and measure level performance criteria. Therefore, DEER measure and baseline definitions were not revised.⁶ Additionally, the small instantaneous water heater, as implemented in nonresidential building types, should be re-evaluated for future versions of the DEER water heating calculator.

USE CATEGORY

Service & domestic hot water

⁶ California Public Utilities Commission (CPUC). 2018. *Resolution E-4952*. October 11.

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (kW)

Not applicable.

GAS SAVINGS (Therms)

The gas unit energy savings (UES) of small instantaneous water heaters rated by an energy factor (EF) were modeled using the Database for Energy Efficient Resources (DEER) methodologies. Results were reported in the Remote Ex-Ante Database Interface (READI) tool. The following table indicates measures taken directly from or created with the DEER READI tool.

DEER Measure Codes

Statewide Measure Offering ID	Energy Impact ID	Measure Description	DEER Version
SWWH006A	<i>(scaled from)</i> NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p82EF-40g	Small Instantaneous Gas Water Heater ≤ 200 kBtuh, UEF ≥ 0.81	DEER 2014
SWWH006B	<i>(scaled from)</i> NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p92EF-40g	Small Instantaneous Gas Water Heater ≤ 200 kBtuh, UEF ≥ 0.87	DEER 2014
SWWH006C	NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et	Large Gas Instantaneous Water Heater ≥ 200 kBtuh, Et = 0.80	DEER 2014
SWWH006D	NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et	Large Gas Instantaneous Water Heater ≥ 200 kBtuh, Et = 0.90	DEER 2014
SWWH006E	<i>(weighted from)</i> NG-WtrHt-MedInst Gas-76to200kBtuh-0p90Et	Small Gas Instantaneous Water Heater ≤ 200 kBtuh, Et = 0.90	DEER 2014

Additional calculations, explained below, were required to convert UES values in DEER to reflect the uniform energy factor (UEF) rating, and to standardize the normalizing unit to kBtu per hour of rated input capacity (Cap-kBtuh).

Conversion from Energy Factor to Uniform Energy Factor

Tankless water heaters follow a different calculation methodology to convert the energy factor (EF) to uniform energy factor (UEF) than storage water heaters. The UEF is largely dependent on the recovery efficiency (n_r) and the maximum gallons per minute (gpm) rating of the unit. Due to the design of a tankless water heater, other factors, like standby losses, play a minimal role in their energy rating. The

U.S. Department of Energy (DOE) Final Ruling,⁷ as described Code Requirements, provides a simple calculation to convert EF to UEF for these units.

$$UEF_{model} = \frac{n_r}{1 + A * n_r}$$

$n_r =$ Recovery efficiency
 $A =$ Coefficient for UEF conversion factor

The UEF_{model} is first calculated based on the recovery efficiency (n_r) of the unit. This recovery efficiency can be a tested value but is typically manufacturer rated and can be found as a nameplate value on the unit. The value of A is the coefficient specified within the Final Ruling. This variable is given for all four draw patterns for electric and gas units.

Table III.7 -- Coefficients for the Analytical UEF Conversion Factor for Consumer Instantaneous Water Heaters

Draw pattern	A	
	Electric	Gas
Very Small	0.003819	0.026915
Low	0.001549	0.010917
Medium	0.001186	0.008362
High	0.000785	0.005534

As seen above, each draw pattern is assigned a different coefficient. This draw pattern correlates with the maximum GPM of the unit. Note that due to the energy rating change, the measurement of the maximum GPM has changed and the equation to convert the original maximum GPM to the “new” maximum GPM was provided with the DOE documentation. This calculation determines the appropriate draw pattern of each unit.

$$New\ Max\ GPM = 1.1461 \times Max\ GPM_p$$

The $Max\ GPM_p$ correlates with the manufacturer-rated Max GPM rating. The new volumetric flow rating can then be used to determine the draw pattern of the unit (see Code Requirements).

The new UEF value for gas-fired instantaneous water heaters is calculated as follows.

$$New\ UEF = 0.1006 + 0.8622 \times UEF_{model}$$

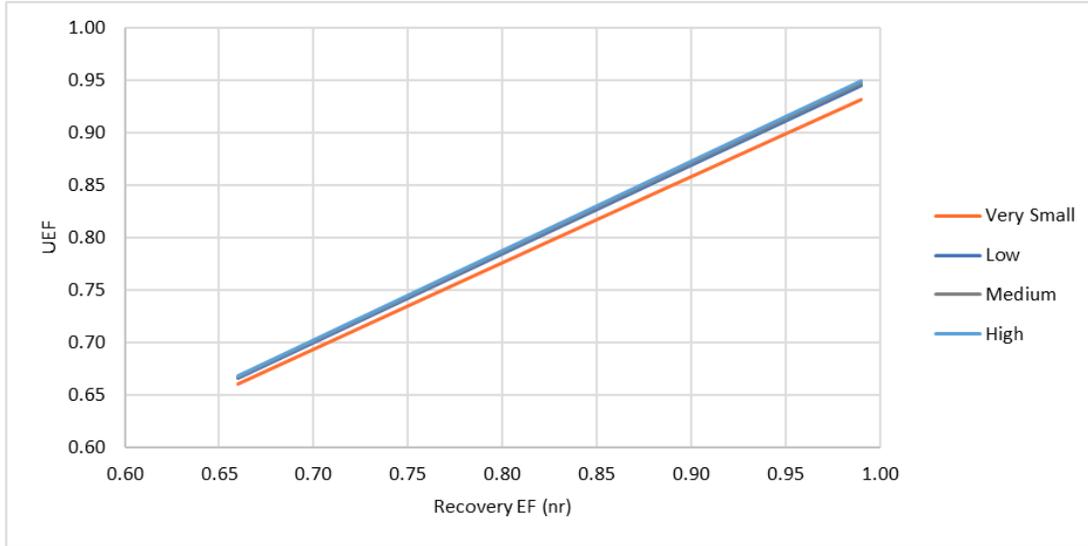
A plot of the UEF calculation for small instantaneous water heaters for all four draw patterns is provided in the figure below.⁸ As shown, the difference in UEF ratings are miniscule between the low, medium, and

⁷ 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.

⁸ Southern California Gas Company (SCG). 2018. "WPSCGNRWH120206B-Rev7_Att A_Savings Calculations and Measure Summary.xlsx." See “UEF Calcs” tab.

high draw patterns. Due to this small difference, *the analysis for this measure utilizes one UEF value and one savings value for both medium and high draw patterns for nonresidential tankless water heaters.*

Plot of UEF and Recovery Efficiency Ratings, by Draw Pattern



Sample Calculation

To illustrate the conversion from EF to UEF, information for a small tankless gas fired water heaters was drawn from the CEC database.⁹

Example Tankless Gas Water Heater

Manufacturer	Model Number	Energy Source	Maximum GPM	Input Btu/hr	Recovery Efficiency	Energy Factor
Rheem Sales Co. Inc.	PH2-20RDVSLN	Natural Gas	3	150,000	84	0.82

First, the calculation of the New Max gpm will determine the proper coefficient used for UEF conversion:

$$New\ Max\ GPM = 1.1461 \times 3\ gpm$$

$$New\ Max\ GPM = 3.4383\ gpm$$

This unit is assigned to the medium draw category. Using figure 1, the medium draw unit correlates with a coefficient (A) equal to 0.008362 for a gas-fired unit. Using the recovery efficiency (nr) of the unit, the UEF_{model} and New UEF are calculated as follows:

⁹ Southern California Gas Company (SCG). 2018. "WPSCGNRWH120206B-Rev7_Att A_Savings Calculations and Measure Summary.xlsx." See "CEC Database" tab.

$$UEF_{model} = \frac{n_r}{1 + A \times n_r}$$

$$UEF_{model} = \frac{0.84}{1 + 0.008362 \times .84} = 0.834$$

$$New\ UEF = 0.1006 + 0.8622 \times 0.834 = 0.820$$

Conversion to Cap-kBTUh Savings

To standardize the normalizing unit to kBtu per hour of rated input capacity (Cap-kBtu/hr) for all measure offerings, it was necessary to convert the DEER UES values that are based on “each” to UES values based upon Cap-kBtu/hr.

For *small instantaneous gas water heaters*, this conversion utilized the average input rating per unit provided in the READI Database. The corresponding input rating used in the calculator for each capacity is equal to 150 kBtu/hr for both Tier 1 and Tier 2 small gas instantaneous water heaters. Thus, the gas UES value based on “each” provided in DEER was divided by the corresponding average input rating to calculate the gas UES per Cap-kBtu/hr input rating.¹⁰

This conversion was not necessary for large instantaneous gas water heaters.

The table below maps each California climate zone to an IOU service area to identify the appropriate saving value for each California climate zone.

Climate Zone-IOU Service Area Mapping

Program Administrator	Climate Zone
SCG	CZ06, CZ08, CZ09, CZ10, CZ14, CZ15, CZ16
PG&E	CZ01, CZ02, CZ03, CZ04, CZ05, CZ11, CZ12, CZ13
SDG&E	CZ07

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 provided below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures and is not applicable for this measure.

¹⁰ Southern California Gas Company (SCG). 2018. "WPCGNRWH120206B-Rev7_Att A_Savings Calculations and Measure Summary.xlsx." See "Msr001 & Msr002" tab.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	20.0	California Public Utilities Commission (CPUC), Energy Division. 2003. <i>Energy Efficiency Policy Manual v 2.0</i> . Page 18 Table 4.1. California Public Utilities Commission (CPUC), Energy Division. 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs)	n/a	n/a

BASE CASE MATERIAL COST (\$/UNIT)

For a *normal replacement* installation, the customer must purchase a new water heater to continue operating, therefore the base case material cost is that of a base case (standard) boiler/tankless water heater.

The base case material costs were derived from two U.S. Department of Energy (DOE) Technical Support Documents (TSDs): Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)¹¹ and Commercial Water Heating Equipment (EERE-2014-BT-STD-0042).¹²

- TSD "Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)" reports total installed cost (IP) for small tankless water heaters as the sum of consumer product price (CPP) and cost to the consumer to install products (INST) (IP = CPP + INST).
- TSD "Commercial Water Heating Equipment (EERE-2014-BT-STD-0042)" reports the total installed cost for large tankless water heaters as the sum of equipment retail price and the installation cost but does not present the exact equipment retail and installation cost values used in the summation. The large tankless water heaters are reported as one single cost value.

An online vendor cost survey and the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc. were considered to develop the cost data. The vendor cost survey provided a reference point for product costs but did not provide sufficient data for installation cost due to the various installation set-ups. The 2010-2012 Measure Cost Study did not appear to take ultra-low NOx production cost into consideration for gas tankless water heaters. Air quality regulations were only mentioned in the study in reference to boiler projects.

¹¹ U.S. Department of Energy (DOE). 2009. *Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters*. Prepared by Navigant Consulting, Inc. and Lawrence Berkeley National Laboratory. Docket ID: EERE-2006-STD-129.

¹² U.S. Department of Energy (DOE). 2016. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment*. Prepared by Navigant Consulting, Inc. and Pacific Northwest National Laboratory. Docket ID: EERE-2014-BT-STD-0042.

MEASURE CASE MATERIAL COST (\$/UNIT)

The measure case material costs were derived from two U.S. Department of Energy (DOE) Technical Support Documents (TSDs): Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)¹³ and Commercial Water Heating Equipment (EERE-2014-BT-STD-0042).¹⁴

- TSD “Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)” reports total installed cost (IP) for small tankless water heaters as the sum of consumer product price (CPP) and cost to the consumer to install products (INST) (IP = CPP + INST).
- TSD “Commercial Water Heating Equipment (EERE-2014-BT-STD-0042)” reports the total installed cost for large tankless water heaters as the sum of equipment retail price and the installation cost but does not present the exact equipment retail and installation cost values used in the summation. The large tankless water heaters are reported as one single cost value.

Venting material used with non-condensing water heaters are not suitable for condensing due to material properties. Plastics used for condensing water heaters have lower vent temperature limits and are not suitable for non-condensing water heaters. Condensing tankless water heaters are able to use PVC for venting which cost less than traditional venting for non-condensing tankless water heaters. This cost difference can lead to lower overall cost for the Tier 2 small tankless water heater in some cases. Data taken from the TSD “Pool Heaters, Direct Heating Equipment and Water Heaters” (EERE-2006-STD-0129) presents this case. The cost differences in these set-ups are reflected in the cost analysis.

An online vendor cost survey and the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc. were considered to develop the cost data. The vendor cost survey provided a reference point for product cost but did not provide sufficient data for installation cost due to the various installation set-ups. The Measure Cost Study did not appear to take ultra-low NOx production cost into consideration for gas tankless water heaters. Air quality regulations were only mentioned in the study in reference to boiler projects.

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.

¹³ U.S. Department of Energy (DOE). 2009. *Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters*. Prepared by Navigant Consulting, Inc. and Lawrence Berkeley National Laboratory. Docket ID: EERE-2006-STD-129.

¹⁴ U.S. Department of Energy (DOE). 2016. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment*. Prepared by Navigant Consulting, Inc. and Pacific Northwest National Laboratory. Docket ID: EERE-2014-BT-STD-0042.

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.

Net-to-Gross Ratios

Parameter	Value	Source
NTG – commercial	0.60	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . 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. <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.

DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	Yes
Scaled DEER measure	Yes
DEER Base Case	Yes
DEER Measure Case	Yes
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	Yes
DEER Version	DEER2014 READI v2.4.7

DEER Item	Comment / Used for Workpaper
Reason for Deviation from DEER	DEER tankless water heating measures include ratings with Energy factor and Thermal Efficiency. Due to recent DOE ruling, the ratings in DEER will be converted to UEF values. The savings for small instantaneous water heaters were also converted to Cap-kBtuh.
DEER Run and Measure IDs Used	NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-Op82EF-40g NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-Op92EF-40g NG-WtrHt-LrgInst-Gas-gt200kBtuh-Op80Et (<i>scaled</i>) NG-WtrHt-LrgInst-Gas-gt200kBtuh-Op90Et (<i>scaled</i>) NG-WtrHt-MedInst-Gas-76to200kBtuh-Op90Et (<i>weighted</i>)
NTG	Source: DEER2015. NTG of 0.60 is associate with NTG ID: <i>Com-Default>2yrs</i>
GSIA	The value of 1.0 is associated with GSIA ID: <i>Def-GSIA</i>
EUL/RUL	Source: DEER 2015. The EUL of 20 years is associated with EUL ID: <i>WtrHt-Instant-Com</i>

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	03/13/2018	Jennifer Holmes, Cal TF Staff	The draft of the text fields for this statewide measure is based upon: WPSCGNRWH12026B Revision 6 (July 26, 2016) Consensus reached among Cal TF members
	01/04/2019	Jennifer Holmes, Cal TF Staff	Updated draft based upon: WPSCGNRWH12026B, Revision 7 (October 1, 2018)
	02/26/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.
	07/02/2019	Ayad Al-Shaikh, Cal TF Staff	Update DEER IDs
02	04/20/2020	Sergio A Corona, TRC Tai Voong, PG&E	Added measure offering SWWH006E, based upon: <i>NG-WtrHt-MedInst-Gas-76to200kBtuh-Op90Et</i> weighted for Commercial building type