eTRM
best in class

WATER HEATING

BOILER, MULTIFAMILY

SWWH010-01

CONTENTS

MEASURE NAME

Boiler, Multifamily

STATEWIDE MEASURE ID

SWWH010-01

TECHNOLOGY SUMMARY

A boiler (also referred to as an instantaneous water heater) is commonly used to heat domestic hot water (DHW) for a multifamily residential building. These systems can either utilize a direct source-to-use configuration or a recirculation loop. Relative to a standard model, an energy efficient boiler typically has features such as no standing pilot light, a larger heat exchange surface, additional tank insulation, and the capability to condense moisture in the flue gas.

MEASURE CASE DESCRIPTION

The measure case is defined as the replacement of a standard efficiency boiler of a multifamily central water heating system with a high efficiency boiler, or a boiler replacement with multiple instantaneous water heaters. The minimum qualifying thermal efficiency (TE) ratings for each measure offering are specified in the table below. Tier 1 denotes high-efficiency natural gas non-condensing boilers and Tier 2 denotes high-efficiency natural gas condensing boilers. Tier 2 models may require additional modifications to the existing system configuration as the flue requirements are substantially different than the non-condensing alternative. Energy savings were calculated by climate zone for each measure offering.

Measure Case Specification

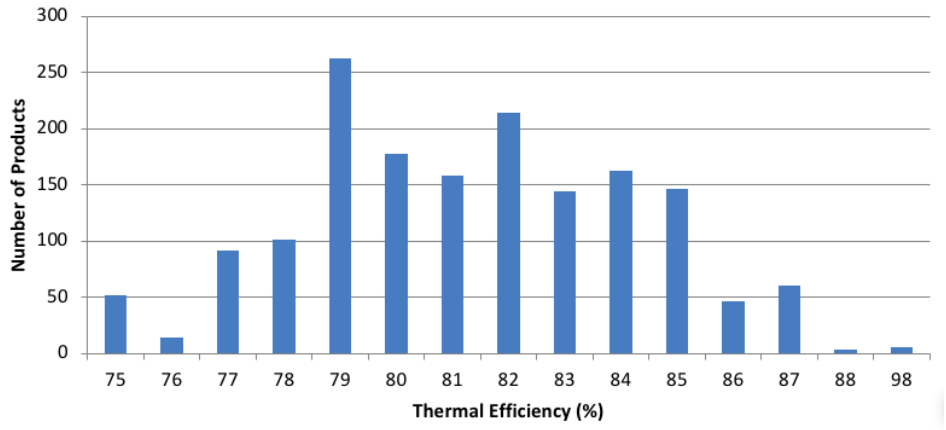
Boiler Type	Min. Qualifying Thermal Efficiency (TE)
Non-condensing Boiler – Tier 1	84.0%
Condensing Boiler – Tier 2	90.0%

The minimum qualifying measure case efficiency ratings *exceed* the California Appliance Efficiency Regulations (Title 20) and the Code of Federal Regulations (See Code Requirements). The minimum qualifying TE ratings were established from analysis of the availability of high-efficiency boilers certified in the California Energy Commission (CEC) Modernized Appliance Efficiency Database System, as of March 2012.[1] The figures below show the distribution of TE ratings for 1,640 boiler products in the CEC database. About 65% of the products are considered to meet the California Building Energy Efficiency Standards (Title 24) baseline while 26% of the products meet the minimum TE for Tier 1. The distribution

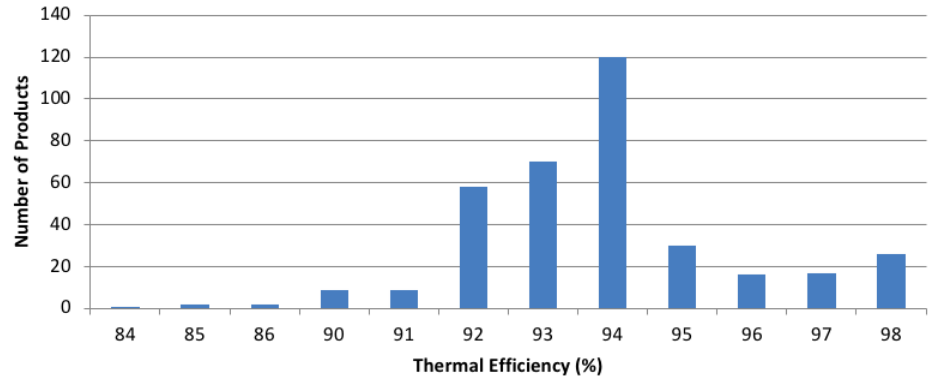
[1] Southern California Gas Company. 2012. "2013-12 - SCG - CEC Boiler Database2.xlsx." March 7.

of TE ratings for 360 condensing boilers found in the CEC database. Over 96% of the products meet the minimum TE for Tier 2.

Distribution of Thermal Efficiencies of Non-condensing Boilers



Distribution of Thermal Efficiencies of Condensing Boilers



BASE CASE DESCRIPTION

The base case is defined as a standard efficiency boiler of a multifamily central water heating system, as specified below. Base case efficiency ratings are based on the minimum efficiency of boilers stipulated by the California Appliance Efficiency Regulations (Title 20) and the Building Energy Efficiency Standards (Title 24). The minimum base case efficiency ratings are consistent with the Code of Federal Regulations (See Code Requirements).

Base Case Specification

Boiler Type	Thermal Efficiency (TE)
Hot Water Boiler	80.0%

CODE REQUIREMENTS

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

following table;[2] followed by the specific California standards. Additionally, water heating equipment must comply with nitrogen oxide (NOx) emissions limits set forth by air quality management districts (AQMDs) or air pollution control districts (APCDs) throughout the California.[3]

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

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2012)	Section 1605.3(f)	January 20, 2004
CA Building Energy Efficiency Standards – Title 24 (2013)	Section 110.3	November 26, 2013
Federal Standards – Code of Federal Regulations	10 CFR 430.32(d)	April 16, 2015
	10 CFR 431.110(a)	October 9, 2015
California Air Quality Management District		
South Coast AQMD	Rule 1121, Rule 1146.2	September 3, 2004 May 5, 2006
Bay Area AQMD	Regulation 9, Rule 6	November 7, 2007
San Joaquin Valley APCD	Rule 4902	March 19, 2009
Sacramento Metropolitan AQMD	Rule 414	March 25, 2010.
Yolo-Solano AQMD	Regulation II, Rule 2.37	April 8, 2009.
Ventura County Air Pollution Control District	Rule 74.11	January 12, 2010

California Title 20 Gas Appliance Standards and Code of Federal Regulations

Equipment Type	Rated Input (kBtu/hr)	Rated Volume (gal)	Efficiency Units	Minimum Efficiency	Maximum Standby Loss (Btu/hr)
Instantaneous Water Heaters *V is the rated volume in gallons; Q is the rated input in Btu/hr.*					

[2] California Energy Commission (CEC). 2012. *2012 Appliance Efficiency Regulations*. CEC-400-2012-019-CMF. Section 1605.3(f).

California Energy Commission (CEC). 2012. *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24).* CEC-400-2012-004-CMF-REV2. Section 110.3.

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

[3] South Coast Air Quality Management District (AQMD). 2004. Rule 1121 - Control of Nitrogen Oxides from Residential-Type, Natural Gas-Fired Water Heaters. Amended September 3, 2004.

South Coast Air Quality Management District (AQMD). 2006. Rule 1146.2 - Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters. Amended May 5, 2006.

Bay Area Air Quality Management District (BAAQMD). 2007. *Regulation 9 – Inorganic Gaseous Pollutants: Rule 6 – Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters.* November 7.

San Joaquin Valley Air Pollution Control District. 2009. *Rule 4902 - Residential Water Heaters.* Amended March 19, 2009.

Sacramento Metropolitan Air Quality Management District. 2010. *Rule 414, Water Heaters, Boilers and Process Heaters Rated Less Than 1,000,000 BTU Per Hour.* Amended March 25, 2010.

Yolo-Solano Air Quality Management District. 2009. *Rule 2.38 - Natural Gas-Fired Water Heaters and Small Boilers.* Revised April 8, 2009.

Ventura County Air Pollution Control District. 2010. Rule 74.11 - Natural Gas-Fired Water Heaters. Revised January 12, 2010.

Equipment Type	Rated Input (kBtu/hr)	Rated Volume (gal)	Efficiency Units	Minimum Efficiency	Maximum Standby Loss (Btu/hr)
Small federally-regulated	≤ 200	< 2	EF	0.82-(0.0019xV)	---
Small non-federal regulated	≤ 50	Unspecified	EF	0.62-(0.0019xV)	---
Small non-federal regulated	≤ 200	≥ 2	EF	0.62-(0.0019xV)	---
Large	> 200	< 10	TE	80%	n/a
Large	> 200	≥ 10	TE	80%	Q/800 + 110√V

NORMALIZING UNIT

The normalizing unit is per kBtu/hr of rated input capacity.

PROGRAM REQUIREMENTS

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	Res
Normal replacement	UpDeemed	Res
New construction	DnDeemed	Res
New construction	UpDeemed	Res

Eligible Products

The eligibility requirements for a multifamily boiler are enumerated below:

- The boiler must meet the minimum qualifying efficiency ratings in the Measure Case Description.
- Only a gas-for-gas equipment replacement is permitted.
- A qualifying boiler must meet the minimum efficiency requirements and emission requirements per their AQMD regulations that apply.
- Any size boiler is eligible.
- The boiler must serve two or more dwelling units.

Eligible Building Types

This measure is only applicable in existing and new multifamily buildings of any vintage.

Eligible Climate Zones

The measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

This measure does not include storage water heaters or boilers used for space heating applications. Water heaters used for pools or spas do not qualify.

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 annual gas unit energy savings (UES) from the installation of a Tier 1 or Tier 2 boiler at a multifamily facility were determined by using the Building America Central Water Heating Evaluation Tool, modified for California.[4] (The Building America calculation tool was modified to model central gas water heaters in the Southern California Gas Company service area.)

The fundamental calculation of annual gas unit energy savings (UES) from the installation of a Tier 1 or Tier 2 boiler at a multifamily facility, represented below, is the difference between the annual gas unit energy consumption (UEC) of the base case and the measure case boilers.

[4] Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx."

$$UES = UEC_{base} - UEC_{measure}$$

UES= *Unit energy savings, therms/kBtu/hr input rating*
UEC_{base} = *Unit energy consumption, base case, therms/kBtu/hr input rating*
$UEC_{measure}$ = *Unit energy consumption, measure case, therms/kBtu/hr input rating*

Unit Energy Consumption

The baseline and measure case UEC, represented below, are a function of heating load, operating hours, and boiler efficiency (TE). The calculations to derive these parameters are presented below.

$$UEC = \frac{HeatLoad \times OpHours}{TE} \times \frac{1\ Btu}{100{,}000\ Therms}$$

where:

HeatLoad = *Heating load, Btu/hr*
OpHours = *Annual operating hours*
TE = *Thermal efficiency rating (%)*

Heating Load. The heating load calculation and input assumptions for the heating load simulations are provided below.

$$Heating\ Load, Btu/hr = \frac{FluidFactor \times (Average\ GPM) \times (Temperature\ Differential)}{(Design\ Efficacy\ Factor)}$$

Fluid Factor. The fluid factor is a constant conversion factor equal to the weight of a gallon of water (8.33 lbs.) multiplied by the specific heat of the water (1.0 Btu/lb.°F) multiplied by 60 (minutes).

Temperature Differential. The temperature differential represents the temperature change between the groundwater entering the water heating system and the water heating system loop temperature.

Design Efficacy Factor. The design efficacy factor is a generalized factor that serves as a calibration value to the monitored data from the RASS study. More specifically, this factor is designed to represent the averaged impacts of various factors that increase the heat load to a DHW system. The factors include but are not limited to: 1) boiler heat loss, 2) transmission heat loss, and 3) degraded efficiencies due to the age of the equipment.

According to the RASS study,[5] a typical dwelling consumes an average of 183 Therms per year. This is consistent within the range of climate zone results of the heating load simulations for this measure. Variations within the simulation are attributed to climate conditions within each region. Variations from the average between the simulated Therm usage and the measured values found in the RASS study can be attributed to statistical weighting and maintenance related inefficiencies.

[5] KEMA, Inc. 2010. *2009 California Residential Appliance Saturation Survey. Volume 2: Results.* Prepared for the California Energy Commission. CC-200-2010-004. Page 21.

Average GPM. The equipment capacity (gallons per minute) as a function of the number of people:

$$DesignAverageGPM = \frac{(Daily\ Gal./Person)*(Number\ of\ People)}{(Number\ of\ Active\ Hours/Day)*(60\ Minutes/Hr)} = 5.42\ gpm$$

Daily Gal./Person =	*Daily water consumption per person*
Number of Active Hours/Day =	*A specific hour of the day is considered active if the eQuest fractional profile has a value greater than 40%.*
Number of People =	*Number of people residing in property*

Design Capacity. With the design flow rate (gpm), the design capacity is represented as:

$$Design\ Capacity = (FluidFactor) \times (Design\ GPM) \times (Design\ Temperature\ Differential) = 216{,}667\ Btu/hr$$

Design Temperature Differential =	*Typical temperature rise from groundwater temperature to temperature of water exiting the system*
Design GPM =	*Gallons per minute*
Fluid Factor =	*Fluid factor is a constant, based on water as the heat transfer fluid.*

The results of the heating load design calculations for the number of people served by the system are provided in the following table.

Design Analysis Results[6]

# of People	Design DHW Flow (gpm)	Calculated Capacity (Btu/hr)	Equipment Selection (Btu/hr)
60	2.00	80,000	100,000
70	2.33	93,333	125,000
80	2.67	106,667	125,000
90	3.00	120,000	150,000
100	3.33	133,333	150,000
110	3.67	146,667	175,000
120	4.00	160,000	200,000
130	4.33	173,333	200,000
140	4.67	186,667	225,000
150	5.00	200,000	225,000
160	5.33	213,333	250,000
170	5.67	226,667	250,000
180	6.00	240,000	275,000
190	6.33	253,333	300,000
200	6.67	266,667	300,000
210	7.00	280,000	325,000
220	7.33	293,333	325,000
230	7.67	306,667	350,000
240	8.00	320,000	375,000
250	8.33	333,333	375,000
155	5.17	206,667	250,000
160	5.33	213,333	250,000

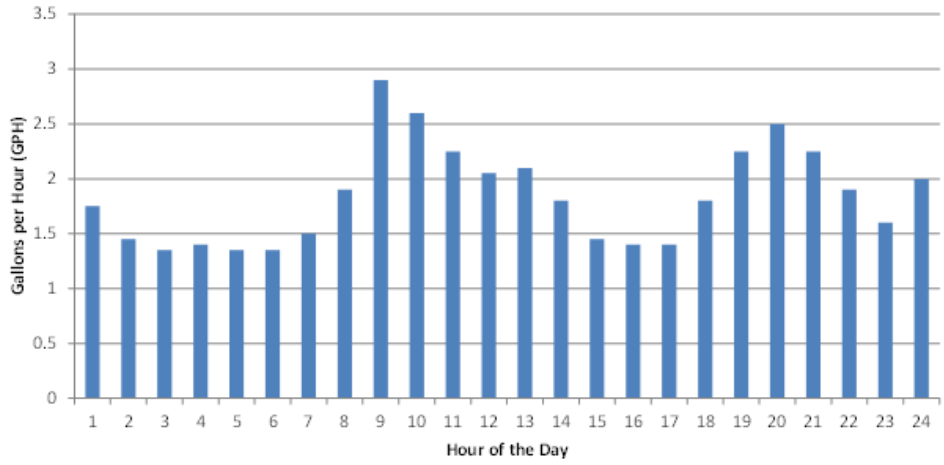
[6] Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." DWH Simulation tab.

# of People	Design DHW Flow (gpm)	Calculated Capacity (Btu/hr)	Equipment Selection (Btu/hr)
165	5.50	220,000	250,000
170	5.67	226,667	250,000
175	5.83	233,333	275,000
180	6.00	240,000	275,000
185	6.17	246,667	275,000
190	6.33	253,333	300,000
195	6.50	260,000	300,000
200	6.67	266,667	300,000
210	7.00	280,000	325,000
220	7.33	293,333	325,000
230	7.67	306,667	350,000
240	8.00	320,000	375,000
250	8.33	333,333	375,000

With the calculated design capacity, a common boiler size was selected using a minimum factor of safety of 1.1.

Flow Rate (gpm). The average gallon per hour for any given apartment profile was derived from ASHRAE 50.19.[7] This apartment profile was first averaged to a single hourly average then normalized to gallons per minute as a function of the number of people being served. The ASHRAE profiles are provided in in the following figure.

Average Flow Rate for Multifamily Applications



The average gallons per minute was derived by:

- Calculated the single hourly average flow rate, estimated at 1.85 gallons per hour per apartment
- Dividing by unit occupancy three (3) persons per residential unit

[7] American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). 2015. *2015 ASHRAE Handbook – HVAC Applications.* Atlanta (GA): ASHRAE. Chapter 50, Service Water Heating.

- Dividing by 60 minutes/hour to convert to gallons per minute
- Multiplying by the stipulated number of persons per multifamily property

Unit Energy Savings

The UES from the typical multifamily property occupancy was used with the typical climate zone ground water temperature and climate zone adjustment factors to estimate UES per tier and per climate zone. The results were normalized by the input capacity (kBtu/hr) of the boiler in accordance direction issued by the Energy Division of the California Public Utilities Commission (CPUC) in April 2016.[8]

All parameters developed for the UEC and UES calculations are provided below.

Unit Energy Consumption and Unit Energy Savings Inputs

Variable	Value	Source
Average Hourly DHW Flow Rate (gph/dwelling unit)	1.85	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). 2015. *2015 ASHRAE Handbook – HVAC Applications.* Atlanta (GA): ASHRAE. Chapter 50, Service Water Heating. Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." ASHRAE tab.
Hot Water Use (design flow) (gpd/occupant)	16.00	Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." Single Family Load Assumptions tab.
Unit Occupancy (persons per dwelling unit)	3	
Facility Occupants (persons per property)	162.5	Calculated as the average of 30 entries (60 - 200 people per facility). See: Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." DHW Simulation Tab.
Average Flow Rate (gpm/person)	0.0103	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE). 2015. *2015 ASHRAE Handbook – HVAC Applications.* Atlanta (GA): ASHRAE. Chapter 50, Service Water Heating. Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." ASHRAE tab.
Facility DHW Flow Rate (gpm/facility)	1.67	Calculated as: (Avg. Flow Rate per Person) x (Facility DHW Flow Rate)
Loop (Supply) temperature (°F)	130.0	Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." ASHRAE tab.
Groundwater Temperature, (°F)	Varies by climate zone	Reeves, P. (Consultant to California Public Utilities Commission, Energy Division). 2013. "Comparison-of-Ground-Temperatures-v2_byPaulReeves.xlsx."
Operating Hours (hours/yr)	8,760	Professional judgement.
Hours/Day of Hot Water Use (hrs/day)	8	Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." See "eQuest DHW Schedules" tab.

[8] California Public Utilities Commission (CPUC), Energy Division. 2016. *Disposition for Workpapers Covering Natural Gas Water Heaters.* Issued April 8, 2016.

Variable	Value	Source
		The multifamily hot water usage profile in eQuest is not an exact match to the ASHRAAE average flow rate in the figure above. Therefore, 8 hours per day is a reasonable rounding up for the weighted average hours of water use per day.
Calculated Capacity (Btu/hr)	216,667	Calculated, based on 80 °F Temperature Differential
Equipment Selection (Btu/hr)	250,833	Calculated as the average of 30 entries. See: Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." DHW Simulation Tab.
Efficacy Factor	0.90	Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx."
Thermal Efficiency – Base (%)	80%	California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002.
Thermal Efficiency – Measure, Tier 1 (%)	84%	Southern California Gas Company. 2012. "2013-12 - SCG - CEC Boiler Database2.xlsx." March 7.
Thermal Efficiency – Measure, Tier 2 (%)	90%	
Conversion Factor - Btu/therm	100,000	-
Conversion Factor - min/hr	60	-
Conversion Factor Btu/kBtu	1,000	-

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 boiler measure is specified below. Note that RUL is only applicable for add-on equipment and accelerate replacement installations and is not applicable for this measure.

Effective Useful Life and Remaining Useful LIfe

Parameter	Value	Source
EUL (yrs)	20.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs)	n/a	n/a

BASE CASE MATERIAL COST ($/UNIT)

A customer who is replacing equipment on burnout (ROB) must buy a new boiler to continue operations, so the base case cost is that of a base case (standard) boiler. Cost data was derived from the Technical Support Document (TSD) for the U.S. Department of Energy Commercial Water Heating Equipment

docket (EERE-2014-BT-STD-0042).[9,] Condensing water heaters typically use PVC for venting flue exhaust which is cheaper and easier to install than sheet metal used for non-condensing water heaters. The cost difference in venting material and installation is captured in the TSD.

The TSD reports the total installed cost for large tankless/boiler 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/boiler water heaters are reported as one single cost value.

Both online vendor cost survey and the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc. were considered while developing the cost data. 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. Due to thorough investigation of water heater cost and installation set-ups, including updated cost for large water heaters, the TSDs were used for final cost data.

MEASURE CASE MATERIAL COST ($/UNIT)

Measure case cost data was derived from the Technical Support Document (TSD) for the U.S. Department of Energy Commercial Water Heating Equipment docket (EERE-2014-BT-STD-0042).[10] Condensing water heaters typically use PVC for venting flue exhaust which is cheaper and easier to install than sheet metal used for non-condensing water heaters. The cost difference in venting material and installation is captured in the TSD.

The TSD reports the total installed cost for large tankless/boiler 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/boiler water heaters are reported as one single cost value.

Both online vendor cost survey and the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc. were considered while developing the cost data. 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

[9] 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.

Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." TSD Cost Data tab.

[10] 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.

Southern California Gas Company (SCG). 2016. "WPSCGREWH131030A Rev0__MF_CentralBlr_Tankless 2016.xlsx." TSD Cost Data tab.

projects. Due to thorough investigation of water heater cost and installation set-ups, including updated cost for large water heaters, the TSDs were used for final cost data.

BASE CASE LABOR COST ($/UNIT)

Base case installation labor costs are embedded in the base case costs described in the Base Case Material Cost.

MEASURE CASE LABOR COST ($/UNIT)

Measure case installation labor costs are embedded in the measure case costs described in the Measure Case Material Cost.

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. This NTG value is 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. This NTG is a "default" NTG that is applicable to all energy efficiency measures that have been offered through residential sector 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. *DEER Database 2011 Update Documentation.* 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. *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 the inputs and methods based upon the California Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment
Modified DEER methodology	
Scaled DEER measure	
DEER Base Case	
DEER Measure Case	
DEER Building Types	
DEER Operating Hours	
DEER eQUEST Prototypes	
DEER Version	
Reason for Deviation from DEER	See below.
DEER Measure IDs Used	n/a
NTG	Source: DEER2014. NTG of 0.55 is associate with NTG ID: Res-*Default>2.*
GSIA	GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER2014. The EUL of 20 years is associated with EUL ID: *WtrHt-Instant-Res*

Boilers for multifamily residential applications are not specified in the 2013 Database for Energy-Efficient Resources (DEER2013) Update for 2014 Codes. The following table lists the baseline and measure efficiencies for commercial instantaneous water heaters found in the DEER 2014. It should be noted that the 80% baseline of the DEER model references commercial storage water heaters, which is anticipated to be similar to a commercial boiler when all standby losses are omitted from the analysis. The DEER base case efficiencies were applied to the baseline large boiler for multifamily residential applications.

- The DEER measure efficiency for high-efficiency non-condensing boilers is 85%, which is higher than the Tier 1 minimum efficiency of 84%. This difference is based on trends observed on the data from previous years.
- The DEER measure case efficiency for the condensing boilers is 90% which is identical to the minimum requirements for a Tier 2 application.

Boiler Thermal Efficiencies in DEER2013

Equipment Type and DEER ID	DEER Base Case Efficiency	DEER Measure Case Efficiency
MF Central DHW Boiler & Tankless WH, Tier 1 (non-condensing)	80%	85%
MF Central DHW Boiler & Tankless WH, Tier 2 (condensing)	80%	90%

Finally, DEER2013 cost data are reported as the cost per boiler, not the cost per kBtu/hr. Because the input rates are not provided in DEER cost data, cost/kBtu/hr cannot be calculated, and thus these DEER data are not used for determining the incremental measure cost.

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	03/02/2018	Jennifer Holmes, Cal TF Staff	The draft of the text fields for this statewide measure is based upon: WPSCGREWH131030A Revision 1 (September 20, 2016) Consensus reached among Cal TF members Revision approval TBD. Effective date TBD.
	02/28/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.
	08/02/2021	Soe K Hla PG&E	Adopted all measures for PG&E. Fixed incorrect StdCost ID in EAD- MeasureExAnte Tab.