**Workpaper WPSCGNRWH120206C**

**Revision 6**

**Southern California Gas Company**

**Customer Programs Department**

**Commercial Hot Water Boilers**

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision No. | Date | **Description** | **Author** |
| B | Mar. 20, 2006 | Original release | Rick Tidball (EEA) |
| 3 | May 18, 2012 | Updated cost and efficiency data | Stu Knoke (ICF) |
| 4 | May 29, 2014 | * Update to DEER 2014 saving values * Update Workpaper Template * Updated Cost Information | Miguel Urrea (SCG) |
| 5 | April 03, 2015 | * Update small boiler baseline to .82 from .8 per code update * Changed NTG for condensing technology to Com-Default >2 yrs * Added application type New Construction * Added Industrial and Agriculture building type applications | Miguel Urrea (SCG) |
| 6 | July 26, 2016 | * Updates per Water Heater Disposition (Attachment F) * Removed NC for Small tankless Water Heater * Adjust cost to include installation (Labor and Material) * Changed energy impacts to report per IOU * Added air quality emission requirements | Miguel Urrea (SCG) |

Measure Summary Table A

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Measure ID | Measure  Description | Pre-Existing  Description | Code/Standard  Description | Sector | App Type(s) | Delivery Method(s) | EUL ID | NTG ID(s) | GSIA ID |
| ShwInf003 | Commercial Hot Water Boiler,  ≤200 MBtu/hr (Small / Medium),  Tier 1 (≥0.84 EF) | N/A | Com Hot Water Boiler,  ≤200 MBtu/hr (Small / Medium), 0.82 EF | Com | ROB | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| ShwInf004 | Commercial Hot Water Boiler,  ≤200 MBtu/hr (Small / Medium),  Tier 2 (≥0.90 EF) | N/A | Com Hot Water Boiler,  ≤200 MBtu/hr (Small / Medium), 0.82 EF | Com | ROB | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| ShwInt001 | Commercial Hot Water Boiler,  >200 MBtu/hr (Large),  Tier 1 (≥84% TE) | N/A | Com Hot Water Boiler,  >200 MBtu/hr (Large), 80% TE | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| ShwInt002 | Commercial Hot Water Boiler,  >200 MBtu/hr (Large),  Tier 2 (≥90% TE) | N/A | Com Hot Water Boiler,  >200 MBtu/hr (Large), 80% TE | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
|  |  |  |  |  |  |  |  |  |  |

**Note: New Construction saving values are provided only for large water heaters in DEER.**

Measure Summary Table B

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Measure ID | Descriptors | | | | | Above Preexisting/  Customer-Average Savings | | | Above Code/  Standard Savings | | | Cost | | |
| Bldg Type | Bldg Vint | Bldg Loc | Bldg HVAC | Norm Unit | kWh/ unit | kW/unit | therm | kWh/ unit | kW/unit | therm | Code/ Standard ($/unit) | Measure ($/unit) | Incremental  Measure ($/unit) |
| ShwInf003 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 0.41 | $11.96 | $14.83 | $2.87 |
| ShwInf004 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | -0.56 | 0 | 2.07 | $11.96 | $14.55 | $2.59 |
| ShwInt001 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 0.96 | $17.94 | $21.47 | $3.53 |
| ShwInt001 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 1.81 | $17.94 | $22.01 | $4.07 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Note: For the complete list of Measures, refer to the accompanying calculation spreadsheet found in Attachment A**

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1. General Measure & Baseline Data

Measure & Delivery Description

Measure Description

Commercial hot water boilers are pressure vessels that transfer heat to water. In most boilers, a heat exchanger separates the combustion products from the water. Boilers can be configured as an integrated packaged boiler, or, in some cases, the boiler (which may resemble an instantaneous water heater) may be connected to a separate tank that contains an internal heat exchanger. Energy efficient units may have one or more of the following features: high efficiency/low NOx burners, power burners, water tubes, relatively large heat exchanger surfaces, and flue exhaust heat recovery systems.

Due to the relatively larger burner size, these water heating devices are capable of providing hot water on a continuous basis. They have relatively high energy efficiency levels because standby losses from storage tanks are essentially eliminated. The California Titles 20 and 24 standards define an instantaneous water heater to mean “a water heater that has an input rating of at least 4,000 Btu per hour per gallon of stored water” [[1]](#endnote-1),[[2]](#endnote-2). Commercial domestic hot water boilers are included under this definition.

Hot water boilers are most efficient in combination with a large hot water storage tank or in point-of-use applications with no circulation loop. They are very inefficient in applications without a storage tank on a circulation loop due to the temperature loss in the circulation system which causes the instantaneous water heater to run without water demand. They are problematic in central systems with circulation loops which have long pipe runs from the water heater to the faucet.

The four measures are as followed:

ShwInf003 – Commercial Hot Water Boilers ≤200 MBtu/hr (Small / Medium), Tier 1 (≥0.84 EF)

ShwInf004 – Commercial Hot Water Boilers, ≤200 MBtu/hr (Small / Medium), Tier 2 (≥0.90 EF)

ShwInt001 – Commercial Hot Water Boilers, >200 MBtu/hr (Large), Tier 1 (≥84% TE)

ShwInt002 – Commercial Hot Water Boilers, >200 MBtu/hr (Large), Tier 2 (≥90% TE)

The 2006 Commercial Boiler Workpaper includes a more detailed technology description in its Appendix A[[3]](#endnote-3).

Code/Standard Description

Small (≤200 MBtu/hr) hot water boilers base case is a small (≤200 MBtu/hr) hot water boiler with an energy factor of 0.82 with an emission limit of 10ng/J or 15 ppm Nox @3% O2 dry.

Large (>200 MBtu/hr) hot water boilers base case is a large (>200 MBtu/hr) hot water boiler of 80% TE with standby losses of 0.56% per hour with an emission limit of 14ng/J or 20 ppm NOx @3% O2 dry.

Preexisting Description – NA

Measure Descriptors

1. Measure Descriptors

| **MeasureID** | **Use-Category** | **UseSubCategory** | **Tech Group** | **Tech**  **Type** | **PreTech Group** | **PreTech Type** | **StdTech Group** | **StdTech Type** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ShwInf003 | SHW | Heating | WaterHtg\_eq | Instant\_EF | NA | NA | WaterHtg\_eq | Instant\_EF |
| ShwInf004 | SHW | Heating | WaterHtg\_eq | Instant\_EF | NA | NA | WaterHtg\_eq | Instant\_EF |
| ShwInt001 | SHW | Heating | WaterHtg\_eq | Instant\_Et | NA | NA | WaterHtg\_eq | Instant\_Et |
| ShwInt002 | SHW | Heating | WaterHtg\_eq | Instant\_Et | NA | NA | WaterHtg\_eq | Instant\_Et |

Delivery Type

The preferred delivery method is a downstream prescriptive rebate offered to the gas customer purchasing the new boiler.

However, a midstream point-of-sale prescriptive rebate or an upstream manufacturer prescriptive rebate strategy may also be implemented.

Table 2 - display the DEER approved delivery methods. Each IOU may select its own preferred delivery method in their ex ante database submission.

1. Delivery Types

|  |  |
| --- | --- |
| ***Code*** | ***Description*** |
| PreRebDown | Downstream Prescriptive Rebate |
| PreReb | Prescriptive Rebate |
| PreRebUp | Upstream Prescriptive Rebate |
| NonUpStrm | All non-upstream delivery types for deemed measures |

Measure Application Type

1. Measure Application Type

|  |  |  |
| --- | --- | --- |
| ***Code*** | ***Description*** | ***Comment*** |
| ROB | Replace on Burnout | measure applied when existing equipment fails or maintenance requires replacement |
| *NC* | *New Construction* | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

\*NC app type applies to only large tankless water heaters since DEER doesn’t contain NC impacts for small tankless water heaters

* + 1. Eligibility Requirements

Test methods for measuring water heater efficiencies are referenced in the California Titles 20 and 24 standards1,2.

Minimum qualifying energy factor (EF) for small (≤200 MBtu/hr) commercial hot water boilers replacing less efficient commercial hot water boilers:

0.84 for Tier 1 (non-condensing)

0.90 for Tier 2 (condensing)

Minimum emission requirements per air district.

Minimum qualifying thermal efficiency (TE) for large (>200 MBtu/hr) commercial hot water boilers replacing less efficient commercial hot water boilers:

84% for Tier 1 (non-condensing)

90% for Tier 2 (condensing)

Tier 2 hot water heaters are condensing and often require flue modifications to handle the condensate.

Implementation Requirements

The rebate applies to gas-for-gas equipment replacements on burnout or to new installations.

New Construction rebates only available for large tankless water heater.

This measure is applicable to any commercial domestic (or “service”) hot water application. Table 4 - displays approved sectors and subsectors.

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

Applicable building/business types include (but are not limited to) offices, restaurants, retail establishments, schools, colleges, hotels, motels, and recreational facilities.

Typical NAICS codes include but not limited to: 111-112, 42, 44-45, 48-49, 51-56, 61-62, 71-72, 81, and 92.

This measure includes replacing an instantaneous water heater or a commercial hot water boiler with a more efficient instantaneous water heater or a commercial hot water boiler of similar rated input.

1. Sector and Subsector

|  |  |  |
| --- | --- | --- |
| ***Sector*** | ***Subsector*** | ***Comment*** |
| Com | Com | measure applicable to any commercial subsectors |
| Ind | Any | measure applicable to any industrial subsectors |
| Ag | Any | measure applicable to any agricultural subsectors |

Documentation Requirements

The manufacturer’s name and equipment model number must be provided.

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

Terms & Conditions

* + - 1. Only instantaneous water heaters as defined by the California Energy Commission qualify, and they must:

Be used primarily for domestic hot water

Have an input rating of at least 4,000 Btu per hour per gallon of stored water.

Never be used to supply hot water to a circulation loop without an intermediary hot water storage tank

DEER Differences Analysis

1. DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | Yes |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | * Changed normalized units for small instantaneous water heater from “each” to “per cap-KBtuh” * Modified DEER three tiers to two tiers for large instantaneous water heaters * DEER does not contain cost data for these measures |
| DEER Version | DEER2015 |
| DEER Run ID and Measure Name | * Instantaneous Water Heater ≤200 MBtu/hr (Small / Medium), Tier 1 (≥0.84 EF)   + NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p84EF-82EF * Instantaneous Water Heater ≤200 MBtu/hr (Small / Medium), Tier 2 (≥0.90 EF)   + NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p92EF-82EF * Instantaneous Water Heater >200 MBtu/hr (Large), Tier 1 (≥84% TE)   + NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et * Iinstantaneous Water Heater >200 MBtu/hr (Large), Tier 2 (≥90% TE)   + NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

Measure Efficiency

The 2015 Database for Energy-Efficient Resources (DEER)[[4]](#endnote-4) does not cover Large (>200Mbtu/hr) high efficiency commercial domestic hot water boilers being used to replace less efficient commercial domestic hot water boilers. Therefore, the instantaneous water heater cases in the DEER 2014 database were adapted for this purpose.

Small (<75 MBtu/hr) tankless water heater -- The smallest instantaneous water heater category in DEER 2014 has been dropped, since units with rated input less than 75 MBtu/hr are rarely used in commercial applications.

The small (76-200 MBtu/hr) instantaneous water heater qualifying energy factors from DEER 2105 are used.

The large (>200 MBtu/hr) instantaneous water heater qualifying thermal efficiencies from DEER 2014 are used for large commercial boilers, except that the three DEER tiers for instantaneous water heater thermal efficiency have been reduced to two tiers for large commercial boilers.

The following measure efficiencies are adopted after consideration of the California Titles 20 and 24 standards, and the high-efficiency instantaneous water heaters listed in the California Energy Commission Energy Efficiency Appliance Database[[5]](#endnote-5):

Small (≤200 MBtu/hr) Tier 1 hot water boiler – since about 6% of the models in the CEC Appliance Efficiency Database have EF at 0.84, the qualifying EF is set to 0.84 while calculating the savings at 85% TE to be consistent with DEER.

Small (≤200 MBtu/hr) Tier 2 hot water boiler – the qualifying EF is set to the standard Tier 2 value of 0.90 to be consistent across all types of boiler and water heaters (90% efficiency can only be achieved with condensing boilers). The measure is available at 0.90 EF while calculating the savings at 0.92 EF to be consistent with DEER.

Large (>200 MBtu/hr) Tier 1 hot water boiler – since the Titles 20 and 24 standard is 80% thermal efficiency, the qualifying TE is set to 84% because there is a good selection of boilers with TE between 84% and 87%.

Large (>200 MBtu/hr) Tier 2 hot water boiler – the qualifying TE is set to the standard Tier 2 value of 90% to be consistent across all types of boiler and water heaters.

Baseline Efficiency

The 2015 Database for Energy-Efficient Resources (DEER) does not cover large high efficiency commercial domestic hot water boilers being used to replace less efficient commercial domestic hot water boilers. However, the instantaneous water heater data in the DEER 2014 database are adapted for this purpose. The following baseline standards are adopted after consideration of the California Titles 20 and 24 standards, and the high-efficiency instantaneous water heaters listed in the California Energy Commission Energy Efficiency Appliance Database:

Small (≤200 MBtu/hr) hot water boiler – Titles 20 and 24 standard value of .82 EF is used in this Workpaper.

Large (>200 MBtu/hr) hot water boiler – the Titles 20 and 24 standard value of 80% TE is used in this Workpaper.

Incremental Measure Cost

DEER 2015 does not contain cost data associated with these measures.

Code Analysis

1. Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 24 (2013) | Section 110.3 | 11/26/2013 |
| Title 20 (2012) | Section 1605.3(f) | 1/20/2004 |
| Code of Federal Regulations | 10 CFR 430.32(d) | 04/16/2015 |
| South Coast AQMD | Rule 1121, Rule 1146.2 | See Rule |
| Bay Area AQMD | Regulation 9, Rule 6 | See Rule |
| San Joaquin Valley APCD | Rule 4902 | See Rule |
| Sacramento Metropolitan AQMD | Rule 414 | See Rule |
| Yolo-Solano AQMD | Regulation II, Rule 2.37 | See Rule |
| Ventura County Air Pollution Control District | Rule 74.11 | See Rule |

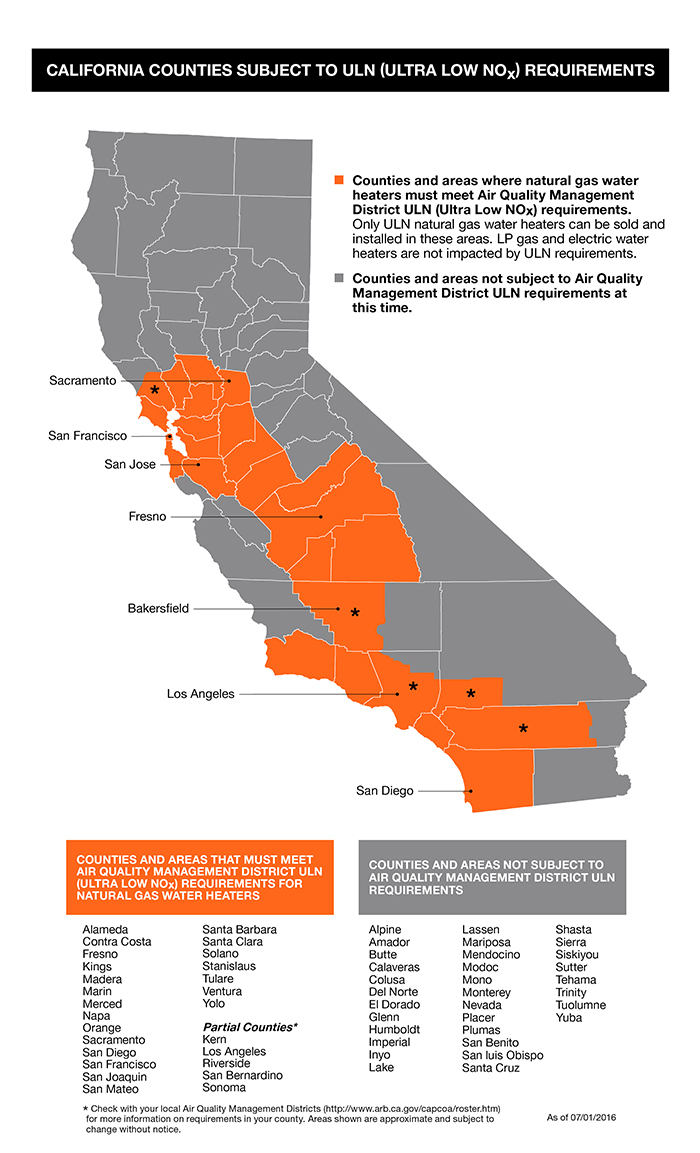
1. Code Summary - NOx Requirements for AQMDs

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Rated heat input capacity | Rule | Emission Limit |
| Mobile Home Water Heater | All | YSAQMD-2.37, SJVUAPCD-4902, BAAQMD-Reg 9-Rule 6, SMAQMD- 414, VCAPCD-74.11 | 40ng/J or 55 ppm NOx @3% O2 dry |
| Small Water Heater | <75,000 Btu/hr | YSAQMD-2.37, SJVUAPCD-4902 , SCAQMD-1121, BAAQMD-Reg 9-Rule 6, SMAQMD-414, SBCAPCD-352, VCAPCD-74.11 | 10ng/J or 15 ppm NOx @3% O2 dry |
| Large Water Heater | 75,000 - 400,000 Btu/hr | YSAQMD-2.37, BAAQMD-Reg 9-Rule 6, SMAQMD-414, VCAPCD-74.11.1, SCAQMD-1146.2 | 14ng/J or 20 ppm NOx @3% O2 dry |
| Small Boiler | 400,000-1,000,000 Btu/hr | YSAQMD-2.37, BAAQMD-Reg 9-Rule 6\*, SMAQMD-414, VCAPCD-74.11.1, SCAQMD-1146.2 | 14ng/J or 20 ppm NOx @3% O2 dry |
| Pool/Spa Heater | 400,000-1,000,000 Btu/hr | YSAQMD-2.37, BAAQMD-Reg 9-Rule 6, SMAQMD-414\*\* | 14ng/J or 20 ppm NOx @3% O2 dry |
| Instantaneous Water Heater\*\*\* | Unspecified | SJVUAPCD-4902, BAAQMD-Reg 9-Rule 6, SMAQMD-414, SCAQMD-1146.2\*\*\*, YSAQMD-2.37\*\*\* | 14ng/J or 20 ppm NOx @3% O2 dry |

\*BAAQMD Defines Small Boiler input capacity as 400,000 - 2,000,000 Btu/hr

\*\*SMAQMD regulates Pool/spa heaters at 40 ng/J

\*\*\*SCAQMD does not set emission requirements for instantaneous water heaters, but any instantaneous water heaters within Type 1 water heaters (75,001 Btu/h – 400,000 Btu/h) rated input capacity must meet this requirement. YSAQMD requirements are based on small and large water heaters ( < 75,000 and 75,001 – 400,000 btu/h). Any instantaneous water heater within this rated input capacity must meet this requirement.



1. California Counties Subject to Ultra Low NOx Requirements

The minimum baseline efficiencies are consistent with the Code of Federal Regulations standards.

The minimum qualifying measure efficiencies exceed the California Titles 20 and Code of Federal Regulations standards[[6]](#endnote-6).

1. California Title 20 Gas Appliance Standards And Code Of Federal Regulations

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Rated Volume (gal)** | **Efficiency Units** | **Minimum**  **Efficiency** | **Maximum Standby Loss (Btu/hr)** |
| **Instantaneous Water Heaters** | | | | | |
| 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√V |

\*V is the rated volume in gallons; Q is the rated input is Btu/hr

Measure Effective Useful Life

* + 1. For commercial boilers, the EUL for WtrHt-Instant-Com of 20 years is taken from the DEER 2015 EUL Table[[7]](#endnote-7).

Net-to-Gross Ratios for Different Program Strategies

The 2015 DEER documents recommend a net-to-gross ratio (NTGR) of 0.60 for all other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years listed as Com-Default>2yrs[[8]](#endnote-8).

Gross Realization Rate

Gross realization rate of 1.00 is applied to the measures in this document.

Time-of-Use Adjustment Factor

N/A

Gross Savings and Installation Adjustment (GSIA)

1. GSIA Table

|  |  |  |  |
| --- | --- | --- | --- |
| ***GSIA ID*** | ***GSIA Type*** | ***GSIA Value*** | ***Description*** |
| Def-GSIA | Annual Installation Rate | 1 | Default GSIA Value |

EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

N/A

1. Energy Savings & Demand Reduction Calculations

Load Shapes

N/A

Energy Savings

Annual Gas Energy Savings.

The annual gas energy savings are based on DEER 2015, with changes to the normalized units. Table 10 - lists the baseline and qualifying efficiency measure efficiencies for instantaneous water heaters replacing storage water heaters in the DEER 2015.

The California Titles 20 and 24 standards use energy factor to describe the efficiency of small (rated input ≤200 MBtu/hr) instantaneous water heaters.

The DEER 2015 data do not cover more efficient large commercial domestic hot water boilers being used to replace less efficient commercial domestic hot water boilers.

1. Base and Measure Instantaneous Water Heater Efficiencies in DEER 2015

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Base Efficiency** | **Qualifying Efficiency** |
| Small, < 2 gallons | ≤ 75 | EF | 0.60 | ≥ 0.82 |
| Small | 150 | TE | 0.82 | 0.84, 0.92 |
| Large | > 200 | TE | 80% | 80%, 85%, 90% |
| Standby Loss | 0.56% per hour | N/A |

Boiler Efficiencies.

Water heating products in the CEC Appliance Database intermingle instantaneous, storage, non-condensing, and condensing water heaters. The ratio of rated input to rated storage volume is used to sort the data for hot water boilers. First, water heating products having a ratio less than 4,000 Btu/hr/gallon (“storage water heaters”) were removed from the database. Table 11 -shows the range of water heater efficiencies found in the CEC Appliance Database for water heating products having a rated input to storage volume ratio greater than 4,000 Btu/hr/gallon. Non-condensing and condensing water heaters are intermingled, although a water heater with energy factor or thermal efficiency above about 88% is most likely a condensing water heater. See Attachment C for complete list. Note: The CEC Appliance Database does not consider emission compliance which would reduce the number of available water heaters for more than 77% of California’s populations[[9]](#endnote-9).

Figure 2 shows the distribution of energy factors for small instantaneous water heaters (rated input 75-200 MBtu/hr) in the CEC Appliance Database.

Figure 3 shows the distribution of thermal efficiencies for large instantaneous water heaters (rated input above 200 MBtu/hr) in the CEC Appliance Database.

These data are applicable to commercial domestic hot water boilers.

1. Instantaneous Water Heater Efficiency Ranges from California Energy Commission Appliance Efficiency Database

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Minimum Efficiency** | **Maximum Efficiency** |
| Small | 50 – 199 | EF | 0.78 | 0.985 |
| Large | 200 – 2,400 | TE | 75.4% | 99% |

1. Energy Factor Distribution for Small Instantaneous Water Heaters (i.e., Commercial Hot Water Boilers) in the CEC Appliance Efficiency Database
2. Thermal Efficiency Distribution for Large Instantaneous Water Heaters (i.e., Commercial Hot Water Boilers) in the CEC Appliance Efficiency Database

Standard Efficiencies.

Table 6 -lists the California Titles 20 and 24 standards for instantaneous water heaters. Title 20 defines an "instantaneous water heater" to be a water heater that has an input rating of at least 4,000 Btu/hr per gallon of stored water.

Energy factor is the standard efficiency unit for instantaneous water heaters with rated input ≤200 MBtu/hr. Thermal efficiency is the standard efficiency unit for instantaneous water heaters with rated input >200 MBtu/hr. The efficiencies of all of the instantaneous water heaters found in the CEC Appliance Database meet these standards. Commercial domestic hot water boilers are included as instantaneous water heaters.

Baseline and Measure Efficiencies.

Table 12 -lists the efficiency units and efficiency values for commercial hot water boilers.

1. Baseline and Qualifying Measure Efficiencies for High Efficiency Commercial Hot Water Boilers Replacing Baseline Commercial Hot Water Boilers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Minimum Base  Efficiency** | **Qualifying  Efficiency** |
| Small, Tier 1 (non-condensing) | ≤200 | EF | 0.82 | 0.84 |
| Small, Tier 2\* (condensing) | ≤200 | EF | 0.82 | 0.90 |
| Large, Tier 1\*\* (non-condensing) | >200 | TE | 80% | 84% |
| Large, Tier 2 (condensing) | >200 | TE | 80% | 90% |

\*Small, Tier 2 measure efficiency is calculated at 0.92, but measure offering is listed as starting at 0.90

\*\*Large, Tier 1 measure efficiency is calculated at 85%, but measure offering is listed as starting at 84%

Energy Savings Calculation

The energy savings data calculated for DEER 2015 are used as the basis for this Workpaper.

* + - * 1. The small instantaneous water heater replacing a small instantaneous water heater measure normalized units were changed from “each” to “Cap-kBTUh” by dividing by inputting rating of 150 Cap-kBTUh.

For calculating energy savings, the following assumptions are used:

The average efficiencies for the baseline units for commercial hot water boilers are an energy factor of 0.82 for small hot water boilers and a thermal efficiency of 80% for large hot water boilers. This matches the California Title 20 code efficiency standards for instantaneous water heaters.

The average efficiencies for commercial hot water boiler measure units are the Tier 1 and Tier 2 qualifying efficiencies for commercial hot water boilers stated above.

Table 13 -lists the base efficiencies, measure efficiencies, and calculated values for the three measures reported in the DEER calculations for instantaneous water heaters replacing storage water heaters. The data and calculations are included in an Excel file embedded as Attachment A.

The energy savings calculated for DEER 2015 are across all “Com” building types to produce a single value for each climate zone.

Table 14 -shows the adjusted energy savings calculations for commercial hot water boilers replacing commercial hot water boilers. The data and calculations are included in an Excel file embedded as Attachment A.

The top section of the table shows the results of taking the appropriate differences between the DEER 2015 values for annual energy savings from Table 13 -. This Tier 1 is the difference between the DEER Tier 2 and the DEER Tier 1; and this Tier 2 is the difference between the DEER Tier 3 and the DEER Tier 1. This changes the baseline from a storage water heater to an instantaneous water heater with thermal efficiency of 80%.

The bottom section shows the calculation results for annual energy savings using Equation 3. The six variables in Equation 3 are identified in the row labels.

The annual energy savings for Tier 1 instantaneous water heaters are reduced about 20% compared to the DEER 2014 results in the top section, but the annual energy savings for the Tier 2 instantaneous water heaters are the same as the DEER 2014 in the top section (since the efficiencies are unchanged).

1. DEER Calculations of Annual Energy Savings for Instantaneous Water Heaters Replacing Storage Water Heaters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Large, Tier 1** | **Large, Tier 2** | **Large, Tier 3** | |
| **Rated Input (MBtu/hr) 🡪** | **>200** | **>200** | **>200** |
| Storage Base Standby Loss | 0.56%/hr | 0.56%/hr | 0.56%/hr |
| Efficiency units | TE | TE | TE |
| Storage Base Efficiency | 80% | 80% | 80% |
| Instantaneous Standby Loss | 0.23%/hr | 0.23%/hr | 0.23%/hr |
| Instantaneous Measure Efficiency | 80% | 85% | 90% |
| Average Annual Energy Savings (therms/yr/MBtuh) | 0.31 | 1.27 | 2.12 |

1. Calculations of Annual Energy Savings for More Efficient Commercial Hot Water Boilers Replacing Baseline Commercial Hot Water Boilers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Equipment Type** | **Small, Tier 1** | **Small, Tier 2\*** | **Large, Tier 1\*\*** | **Large\*, Tier 2** | |
| **Rated Input (MBtu/hr) 🡪** | **≤200** | **≤200** | **>200** | **>200** |
| **DEER 2015 with Instantaneous Water Heater Baseline** | | | | |
| Efficiency units | EF | EF | TE | TE |
| Boiler Base Efficiency, *E1* | 0.82 | 0.82 | 80% | 80% |
| Boiler Measure Efficiency, *E2* | 0.84 | 0.92 | 85% | 90% |
| Adjusted Annual Energy Savings (therms/yr/MBtuh), *∆Q1-2* | 0.41 | 2.07 | 0.96 | 1.81 |

\*Small, Tier 2 measure efficiency is calculated at 0.92, but measure offering is listed as starting at 0.90

\*\*Large, Tier 1 measure efficiency is calculated at 85%, but measure offering is listed as starting at 84%

\*\*\*Large instantaneous water heater standby loss is 0.23% for measure and baseline.

1. Base Case & Measure Costs

Cost data derived from two Technical Support Documents (TSD) for Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)[[10]](#endnote-10) and Commercial Water heating Equipment (EERE-2014-BT-STD-0042)[[11]](#endnote-11). This data includes both labor and material cost. 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 heaters9. The cost difference in venting material and installation is captured in the above referenced documents. The cost data and calculations are included in an Excel file embedded as Attachment D. Summary of cost data captured from the TSDs are included in Attachment E.

* + - 1. Both online vendor cost survey and the Ex Ante Measure Cost Study[[12]](#endnote-12) were taken into consideration 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. Citing the CEC’s Appliance Database as the source for qualifying water heaters (CEC’s Appliance Database does not take air quality regulations into consideration). 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 TSD’s were used for final cost data. Both the Measure Cost Study and online vendor study are included in the cost data Attachment D for reference
    1. TSD “Pool Heaters, Direct Heating Equipment and Water Heaters (EERE-2006-STD-0129)”10 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). The small tankless water heaters are reported in those cost details.
    2. TSD “Commercial Water Heating Equipment (EERE-2014-BT-STD-0042)”11 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.

Base Case Cost

When the customer is replacing equipment on burnout (ROB) or buying new equipment, the customer must buy a new water heater to continue operating, so the base case cost is that of a baseline (standard) boiler/tankless water heater.

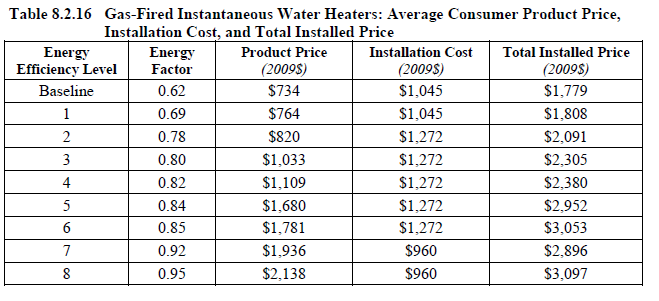
* + 1. The base case costs are shown in Table 15 - below.

Gross Measure Cost

* + 1. The gross measure costs include the cost of the equipment, including installation and start-up costs.

The gross measure costs are shown in Table 15 - below.

* + 1. 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 temperatures limits and are not suitable for non-condensing water heaters. The cost differences in these set-ups are taken into consideration in the cost analysis
       1. 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. A snap shot of this cost data is provided below.

1. Gas-Fired Instantaneous Water Heaters : Average Consumer Product Price, Installation Cost, and Total Installed Price
   * + 1. 

Incremental Measure Cost

The incremental measure cost (IMC) is the difference between the cost of the average baseline unit and the average high efficiency measure.

The incremental measure costs are shown in Table 15 -below. Table 15 -is focused on more efficient commercial hot water boilers replacing baseline commercial hot water boilers for domestic hot water use. The cost data and calculations are included in an Excel file embedded as Attachment D.

1. Gross and Incremental Measure Cost for More Efficient Commercial Hot Water Boilers Replacing Baseline Commercial Hot Water Boilers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Small Tier 1** | **Small Tier 2** | **Large Tier 1** | **Large Tier 2** |
| **Rated Input (MBtu/hr) 🡪** | **≤200** | **≤200** | **>200** | **>200** |
| **2014 Vendor Survey Data Cost per MBtuh** |  |  |  |  |
| Base Cost – Product ($/MBtuh) | $5.57 | $5.57 | N/A | N/A |
| Base Cost – Installation ($/MBtuh) | $6.39 | $6.39 | N/A | N/A |
| **Total Base Cost ($/MBtuh)** | **$11.96** | **$11.96** | **$17.94** | **$17.94** |
| Gross Measure Cost – Product ($/MBtuh) | $8.44 | $9.73 | N/A | N/A |
| Gross Measure Cost – Installation ($/MBtuh) | $6.39 | $4.82 | N/A | N/A |
| **Total Gross Measure Cost ($/MBtuh)** | **$14.83** | **$14.55** | **$21.47** | **$22.01** |
| **Average Incremental Measure Cost**  **($/MBtuh)** | **$2.87** | **$2.59** | **$3.53** | **$4.07** |

Attachments

*Attachment A – Commercial HW Boiler & Instantaneous Water Heater Gas Savings*



*Attachment B – Commercial Boilers Workpaper*, EEA Report No. B-REP-05-599-20B, March 2006



*Attachment C – CEC Database*

**

*Attachment D – Commercial Water Heater Cost Data*

**

*Attachment E – Water Heater & Boiler Cost Summary*

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*Attachment F – Water Heater Disposition*



References

1. (2014 Appliance Efficiency Regulations, 2014) <http://www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf>  [↑](#endnote-ref-1)
2. (2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings - Revised, 2013) <http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf> [↑](#endnote-ref-2)
3. (B-REP-05-599-20B – Commercial Boilers, 2006) Attachment B [↑](#endnote-ref-3)
4. (Database for Energy Efficiency Resources, 2014) <http://www.deeresources.com/> [↑](#endnote-ref-4)
5. (California Energy Commission Appliance Efficiency Database, 2014) <http://www.appliances.energy.ca.gov/AdvancedSearch.aspx> [↑](#endnote-ref-5)
6. (Standards for Residential Water Heaters, 2013) <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27>

   [↑](#endnote-ref-6)
7. (EUL table update, 2014), <http://deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>

   [↑](#endnote-ref-7)
8. (DEER2011 Update Net-To-Gross table, 2012), <http://deeresources.com/files/DEER2011/download/DEER2011_NTGR_2012-05-16.xls> [↑](#endnote-ref-8)
9. (Team, 2011) <http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Reports/Residential/Water_Heating/2013_CASE_WH2.WH5_WaterHeaterReady-10.28.2011.pdf> [↑](#endnote-ref-9)
10. (DOE, Docket ID: EERE-2006-STD-0129, 2010)

    <https://www.regulations.gov/#!docketDetail;D=EERE-2006-STD-0129> [↑](#endnote-ref-10)
11. (DOE, Docket ID: EERE-2014-BT-STD-0042, 2016)

    <https://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0042> [↑](#endnote-ref-11)
12. (Itron, Inc, 2014)

    <http://www.calmac.org/publications/2010-2012_WO017_Ex_Ante_Measure_Cost_Study_-_Final_Report.pdf> [↑](#endnote-ref-12)