**Workpaper WPSCGNRWH120206B**

**Revision 5**

**Southern California Gas Company**

**Customer Programs Department**

**Tankless Water Heaters For Commercial Applications**

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision No. | Date | **Description** | **Author** |
| B | Jan. 25, 2006 | Original release | Stu Knoke (EEA) |
| 3 | May 18, 2012 | Updated cost and efficiency data from B-REP-05-599-17B | Stu Knoke (ICF) |
| 4 | May 29, 2014 | * Update to DEER 2014 saving values * Update Workpaper Template * Updated Cost Information * Added Electric Savings | Miguel Urrea (SCG) |
| 5 | April 6, 2015 | * Updated small tankless measures for DEER 2015 code update * Changed NTG for condensing technology to Com-Default >2 yrs * Added application type New Construction * Changed Midstream rebates to preferred delivery method instead of downstream. * Added Industrial and Agriculture building type applications | 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 |
| ShwInf001 | Tankless Water Heater ≤200 MBtu/hr (Small / Medium), Tier 1 (≥0.82 EF) | N/A | Storage Water Heater 40 Gal ≤75 MBTUh EF 0.615 | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| ShwInf002 | Tankless Water Heater ≤200 MBtu/hr (Small / Medium), Tier 2 (≥0.90 EF) | N/A | Storage Water Heater 40 Gal ≤75 MBTUh EF 0. 615 | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et | Tankless Water Heater >200 MBtu/hr (Large), Tier 1 (≥80% TE) | N/A | Storage Water Heater >75 MBTuh, Et = 0.80, Stdby Loss = 0.56%/hr | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et | Tankless Water Heater >200 MBtu/hr (Large), Tier 2 (≥90% TE) | N/A | Storage Water Heater >75 MBTuh, Et = 0.80, Stdby Loss = 0.56%/hr | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Instant-Com | Com-Default >2yrs | Def-GSIA |
|  |  |  |  |  |  |  |  |  |  |

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) |
| SHWINF001 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 2.01 | $3.72 | $5.93 | $2.21 |
| SHWINF002 | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | -0.56 | 0 | 4.32 | $3.72 | $7.40 | $3.68 |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0.04 | 0 | 0.31 | $8.86 | $9.91 | $1.05 |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0.04 | 0 | 2.12 | $8.86 | $20.12 | $11.26 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**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

Tankless water heaters have become available in recent years for a variety of applications. Relative 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 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). All “tankless” water heaters are “instantaneous” water heaters, but the term instantaneous water heater also includes large commercial hot water boilers, which are not covered by this Workpaper. Tankless water heaters generally have rated inputs less than 200 MBtu/hr.

Tankless water heaters are most useful in point-of-use applications, i.e., at the faucet and with no circulation loop. They are very 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. 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:

* + - * 1. ShwInf003 – Tankless Water Heater, ≤200 MBtu/hr (Small / Medium), Tier 1 (≥0.82 EF)
        2. ShwInf004 – Tankless Water Heater, ≤200 MBtu/hr (Small / Medium), Tier 2 (≥0.90 EF)
        3. NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et – Tankless Water Heater, >200 MBtu/hr (Large), Tier 1 (≥80% TE)
        4. NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et – Tankless Water Heater, >200 MBtu/hr (Large), Tier 2 (≥90% TE)

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

Code/Standard Description

Storage water heater means a water heater that heats and stores water within the appliance at a thermostatically-controlled temperature for delivery on demand, and that has an input less than 4,000 Btu per hour per gallon of stored water. Each Measure has a unique base case as followed.

Small (≤200 MBtu/hr) tankless water heater base case is a small 40 gal (≤75 MBtu/hr) storage water heater with an energy factor of 0.615.

Large (>200 MBtu/hr) tankless water heater base case is a medium (>75 MBtu/hr) storage water heaters of 80% TE with standby losses of 0.56% per hour.

* + 1. Preexisting Description – NA
    2. Measure Descriptors

1. Measure Descriptors

| **MeasureID** | **Use-Category** | **UseSubCategory** | **Tech Group** | **Tech**  **Type** | **PreTech Group** | **PreTech Type** | **StdTech Group** | **StdTech Type** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SHWINF001 | SHW | Heating | WaterHtg\_eq | Instant\_EF | NA | NA | WaterHtg\_eq | Stor\_EF |
| SHWINF002 | SHW | Heating | WaterHtg\_eq | Instant\_EF | NA | NA | WaterHtg\_eq | Stor \_EF |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et | SHW | Heating | WaterHtg\_eq | Instant\_Et | NA | NA | WaterHtg\_eq | Stor \_Et |
| NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et | SHW | Heating | WaterHtg\_eq | Instant\_Et | NA | NA | WaterHtg\_eq | Stor\_Et |

Delivery Method

The preferred delivery method is a midstream prescriptive.

However, a downstream prescriptive rebate or an upstream manufacturer prescriptive rebate strategy may also be implemented.

Table 2 - display the DEER approved delivery methods

1. Delivery Methods

|  |  |
| --- | --- |
| ***Code*** | ***Description*** |
| PreRebDown | Downstream Prescriptive Rebate |
| PreReb | Prescriptive Rebate |
| PreRebUp | Upstream Prescriptive Rebate |

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 |

Eligibility Requirements

Test[[4]](#endnote-4) 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) tankless water heaters replacing storage water heaters:

0.82 for Tier 1 (non-condensing)

0.90 for Tier 2 (condensing)

Minimum qualifying thermal efficiency (TE) for large (≥200 MBtu/hr) tankless water heaters replacing storage water heaters:

80% 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.

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 a storage water heater with a tankless water heater.

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

Provide hot water only when there is a hot water draw from the end use

Not be connected to an external storage tank.

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.

DEER Differences Analysis

1. DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodolgy | Yes |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | * Changed normalized units for small tankless water heater from “each” to “per cap-KBtuh” * Modified DEER three tiers to two tiers for large tankless water heaters * DEER does not contain cost data for measures |
| DEER Version | DEER2014 |
| DEER Run ID and Measure Name | * Instantaneous Water Heater ≤200 MBtu/hr (Small / Medium), Tier 1 (≥0.82 EF)   + NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p82EF-40g * • Instantaneous Water Heater ≤200 MBtu/hr (Small / Medium), Tier 2 (≥0.90 EF)   + NG-WtrHt-SmlInst-Gas-150kBtuh-lt2G-0p92EF-40g * • Instantaneous Water Heater >200 MBtu/hr (Large), Tier 1 (≥80% TE)   + NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p80Et   + NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et * • Instantaneous Water Heater >200 MBtu/hr (Large), Tier 2 (≥90% TE)   + NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

Measure Efficiency

The minimum qualifying measure efficiencies are similar to the 2014 Database for Energy-Efficient Resources (DEER)[[5]](#endnote-5), with some exceptions. The following measure efficiencies are adopted after consideration of the California Titles 20 and 24 standards, Code of Federal Regulation[[6]](#endnote-6) standards, and the high-efficiency instantaneous water heaters listed in the California Energy Commission Energy Efficiency Appliance Database[[7]](#endnote-7):

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.

Small (≤200 MBtu/hr) Tier 1 instantaneous water heater – the small (150 MBtu/hr) DEER 2015 value of 0.82 EF for non-condensing instantaneous water heaters is used in this Workpaper.

Small (≤200 MBtu/hr) Tier 2 instantaneous water heater – the small (150 MBtu/hr) DEER 2015 value of 0.92 EF for condensing instantaneous water heaters is used in this Workpaper. The measure is available at 0.90 EF while calcalulating the savings using 0.92 EF to be consistent with DEER.

Large (>200 MBtu/hr) Tier 1 instantaneous water heater – the large (>200 MBtu/hr) DEER 2014 value of 80% TE for non-condensing instantaneous water heaters is used in this Workpaper, except that the three DEER tiers for thermal efficiency have been reduced to two tiers.

Large (>200 MBtuh) Tier 2 instantaneous water heater – the large (>200 MBtu/hr) DEER 2014 value of 90% TE for condensing instantaneous water heaters is used in this Workpaper.

Baseline Efficiency

The minimum baseline efficiencies are similar to the 2014 Database for Energy-Efficient Resources (DEER), with some exceptions. The following measure efficiencies are adopted after consideration of the California Titles 20 and 24 standards:

Small (<75 MBtu/hr) instantaneous 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.

Small (≤200 MBtu/hr) instantaneous water heater – the Federal Regulations Standard equation for small (≤75 MBtu/hr) storage water heaters of energy factor equal to {0.675-(0.0015\*V)} is used in this Workpaper, where Volume (V) is the rated storage volume. A storage water heater sized to meet the hot water demand equivalent to a instantaneous water heater with a rated input in the range of 75 to 200 MBtu/hr is a 40-gallon storage water heater, for which the Federal Regulations energy factor is 0.615. A request for a measure with a small instantaneous water heater replacing a 40 gallon small storage water heater was approved in DEER 2015.

Large (>200 MBtu/hr) instantaneous water heater – the 2014 DEER value for medium (>75 MBtu/hr) storage water heaters of 80% TE with standby losses of 0.56% per hour is used in this Workpaper.

Incremental Measure Cost

DEER 2015 does not contain cost data associated with these measures.Data were collected through a survey of vendors that storage and instantaneous water heaters in California. The incremental measure costs used in this Workpaper are the arithmetic average of the survey cost data for each of the categories of water heater type and efficiency used in this Workpaper.

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 |

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

The minimum qualifying measure efficiencies exceed the California Titles 20 and 24 and the Code of Federal Regulations standards.

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)** |
| **Storage Water Heaters** | | | | | |
| Small federally-regulated | ≤ 75 | ≤ 55 | EF | 0.675-(0.0015\*V) | --- |
| Small federally-regulated | ≤ 75 | > 55 | EF | 0.8012-(0.00078\*V) | --- |
| Small non-federal regulated | ≤ 75 | < 20 | EF | 0.62-(0.0019\*V) | --- |
| Small non-federal regulated | ≤ 75 | > 100 | EF | 0.62-(0.0019\*V) | --- |
| Large | 75 < x ≤ 155 | Unspecified | TE | 80% | Q/800 + 110√V |
| Large | > 155 | Unspecified | TE | 80% | Q/800 + 110√V |
| **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

For instantaneous water heaters, the EUL for WtrHt-Instant-Com of 20 years is taken from the DEER 2014 EUL Table[[8]](#endnote-8).

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[[9]](#endnote-9).

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 2014 DEER, with changes to the baseline and measure efficiency values based on the California Titles 20 and 24 standards, Federal Regulations standards, and the CEC Appliance Database. Table 9 - lists the baseline and qualifying efficiency measure efficiencies for instantaneous water heaters in the DEER 2014.

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

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 | .615 | 0.82, 0.92 |
| Large | > 200 | TE | 80% | 80%, 85%, 90% |
| Standby Loss | 0.56% per hour | N/A |

Water Heater 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. First, water heating products having a ratio less than 4,000 Btu/hr/gallon (“storage water heaters”) were removed from the database. Table 10 -shows the range of water heater efficiencies found in the CEC Appliance Database for products having a ratio ≥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.

Less than 1% of the instantaneous water heaters on the market have rated input less than 75,000 MBtu/hr, implying this category is not worth considering in this Workpaper.

Figure 1 -shows the distribution of energy factors for small instantaneous water heaters (rated input under 200 MBtu/hr) in the CEC Appliance Database.

Figure 2 -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 as well as instantaneous water heaters.

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 | 0.98 |
| Large | 200 – 2,400 | TE | 75.4% | 99% |

1. Energy Factor Distribution for Small Instantaneous Water Heaters in the CEC Appliance Efficiency Database
2. Thermal Efficiency Distribution for Large Instantaneous Water Heaters in the CEC Appliance Efficiency Database

Standard Efficiencies.

Table 7 -lists the California Titles 20 and 24 and Federal Regulations standards for storage and instantaneous water heaters. Title 20 defines a "storage water heater" to be a water heater that heats and stores water within the appliance at a thermostatically-controlled temperature for delivery on demand, and that has an input less than 4,000 Btu/hr per gallon of stored water. Title 20 also 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 storage water heaters with rated input ≤ 75 MBtu/hr and for tankless water heaters with rated input ≤ 200 MBtu/hr. Thermal efficiency is the standard efficiency unit for storage water heaters with rated input > 75 MBtu/hr and for tankless water heaters with rated input > 200 MBtu/hr. The efficiencies of all of the storage water heaters and instantaneous water heaters found in the CEC Appliance Database meet these standards.

Baseline and Measure Efficiencies.

Table 11 -lists the efficiency units and efficiency values recommended for tankless water heaters.

The minimum baseline efficiencies and efficiency units for tankless water heaters match the California Titles 20 and 24 and Federal Regulation standards for storage water heaters:

Small (≤75 MBtu/hr) 40-gallon storage water heaters are matched with the small (≤200 MBtu/hr) tankless water heaters.

Large (>75 MBtu/hr) storage water heaters are matched with the large (>200 MBtu/hr) tankless water heaters.

The baseline efficiencies have the following changes compared to the 2015 Database for Energy-Efficient Resources (DEER):

The smallest (< 75 MBtu/hr) instantaneous water heater category in DEER has been dropped, since units with rated input less than 75 MBtu/hr are rarely used in commercial applications and few models are on the market.

The qualifying measure efficiencies have the following changes compared to the 2014 Database for Energy-Efficient Resources (DEER):

The smallest (< 75 MBtu/hr) instantaneous water heater category in DEER has been dropped, since units with rated input less than 75 MBtu/hr are rarely used in commercial applications and few models are on the market.

1. Baseline and Qualifying Measure Efficiencies for Tankless Water Heaters Replacing Storage Water Heaters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Base Efficiency (Storage Water Heater)** | **Qualifying Efficiency (Tankless Water Heater)** |
| **Tankless Water Heaters** | | | | |
| Small, Tier 1 (non-condensing) | ≤ 200 | EF | 0.615 | 0.82 |
| Small, Tier 2 (condensing) | ≤ 200 | EF | 0615 | 0.90 |
| Large, Tier 1 (non-condensing) | > 200 | TE | 80% | 80% |
| Large, Tier 2 (condensing) | > 200 | TE | 80% | 90% |

Energy Savings Calculation

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

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

Table 12 -lists the base efficiencies, measure efficiencies, and calculated values for the two measures reported in the DEER calculations for small instantaneous water heaters replacing small storage water heaters. The data and calculations are included in an Excel file embedded as Attachment A.

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

Only existing building vintages are used for the calculations.

Table 13 -shows the adjusted energy savings calculations for small instantaneous water heaters replacing small storage water heaters and the DEER values for the large instantaneous water heater replacing large storage water heater. The data and calculations are included in an Excel file embedded as Attachment A.

The top section of the table shows the results of the original normalized unit calculations for small storage water heaters

The bottom section shows the calculation results for annual energy savings with the revised normalized unit

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

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Small, Tier 1** | **Small, Tier 2** |
| **Rated Input (MBtu/hr) 🡪** | **≤ 200** | **≤ 200** |
| Normalized Unit | Each | Each |
| Storage Base Energy Factor | 0.615 | 0.615 |
| Instantaneous Measure Thermal Efficiency | 0.82 | 0.92 |
| Average Annual Energy Savings (therms/yr/MBtuh) | 0.48 | 1.43 |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Equipment Type** | **Small, Tier 1** | **Small, Tier 2** | **Large, Tier 1** | **Large, Tier 2** | |
| **Rated Input (MBtu/hr) 🡪** | **≤ 200** | **≤ 200** | **> 200** | **> 200** |
| **2014 DEER** |  |  |  |  |
| Revised normalized units | Each | Each | Cap-kBTUh | Cap-kBTUh |
| Base Efficiency (Storage water heater) | 0.615 | 0.615 | 80% | 80% |
| Measure Efficiency (Tankless water heater) | 0.82 | 0.92 | 80% | 90% |
| Average Annual Energy Savings (therms/yr/unit) | 301 | 648 | 0.31 | 2.12 |
|  |  |  |  |  |
| **Adjusted Values** |  |  |  |  |
| Revised normalized units | Cap-kBTUh | Cap-kBTUh | Cap-kBTUh | Cap-kBTUh |
| Base Efficiency (Storage water heater) | 0.594 | 0.594 | 80% | 80% |
| Measure Efficiency (Tankless water heater) | 0.82 | 0.92 | 80% | 90% |
| Adjusted Annual Energy Savings (therms/yr/unit) | **2.01** | **4.32** | **0.31** | **2.12** |

1. Base Case & Measure Costs

Base Case Cost

* + 1. 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) water heater. The baseline water heater is a storage water heater.
    2. The base case costs are shown in Table 14 - below. Table 14 - is focused on instantaneous water heaters replacing storage water heaters for domestic hot water use.

The table lists the results of a survey of equipment vendors that sell water heaters in California. The vendor calls produced data for most of the categories of water heater type, rated input, and efficiency used in this Workpaper. The base measure costs shown in Table 14 - represent an arithmetic average of the corresponding equipment cost/MBtuh in each category. The cost data and calculations are included in an Excel file embedded as Attachment E.

Gross Measure Cost

* + 1. The gross measure costs include the cost of the equipment, excluding installation and start-up costs. For the purposes of determining incremental measure costs, the installation and start-up costs are assumed to be the same for the base case and measure equipment.

The gross measure costs are shown in Table 14 - below.

The table lists the results of a survey of equipment vendors that sell water heaters in California, normalized to cost per MBtu/hr rated input. The gross measure costs shown in Table 14 - represent an arithmetic average of the equipment cost per MBtu/hr in each category. The cost data and calculations are included in an Excel file embedded as Attachment E.

Incremental Measure Cost

* + 1. The incremental measure cost (IMC) is the difference between the cost of the average baseline unit and the average high efficiency measure.
    2. The incremental measure costs are shown in Table 14 - below. Table 14 - is focused on instantaneous water heaters replacing storage water heaters for domestic hot water use. The cost data and calculations are included in an Excel file embedded as Attachment E.

1. Gross and Incremental Measure Cost for Tankless Water Heaters Replacing Storage Water Heaters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 per MBtuh** |  |  |  |  |
| Average Base Cost ($/MBtuh) | $3.72 | $3.72 | $8.86 | $8.86 |
| Average Gross Measure Cost ($/MBtuh) | $5.93 | $7.40 | $9.91 | $20.12 |
| Average Incremental Measure Cost ($/MBtuh) | **$2.21** | **$3.68** | **$1.05** | **$11.26** |

Attachments

*Attachment A – Tankless Water Heater Gas Savings*



*Attachment B –* B-REP-05-599-17A - Instantaneous (Tankless) Water Heaters



*Attachment C – CEC Database*



*Attachment D – Method for Calculating Energy Savings*

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*Attachment E – Tankless Water Heater Vendor Cost Data*



# 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-05-599-17A - Instantaneous (Tankless) Water Heaters, 2005) Attachment B [↑](#endnote-ref-3)
4. (Test Procedure for Water Heaters, 1998) <http://www.gpo.gov/fdsys/pkg/FR-1998-05-11/pdf/98-12296.pdf> [↑](#endnote-ref-4)
5. (Database for Energy Efficiency Resources, 2014) <http://www.deeresources.com/> [↑](#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. (California Energy Commission Appliance Efficiency Database, 2014) <http://www.appliances.energy.ca.gov/AdvancedSearch.aspx> [↑](#endnote-ref-7)
8. (EUL table update, 2014), <http://deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>

   [↑](#endnote-ref-8)
9. (DEER2011 Update Net-To-Gross table, 2012), <http://deeresources.com/files/DEER2011/download/DEER2011_NTGR_2012-05-16.xls> [↑](#endnote-ref-9)