**Workpaper WPSCGNRWH120206A**

**Revision 8**

**Southern California Gas Company**

**Customer Programs Department**

**Storage Tank Water Heaters for Commercial and Industrial Applications**

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision No. | Date | **Description** | **Author** |
| C | Jan. 21, 2006 | Original release | Stu Knoke (EEA) |
| D | Nov. 20, 2008 | Added to terms and conditions | Stu Knoke (ICF) |
| 5 | May 18, 2012 | Updated cost and efficiency data | Stu Knoke (ICF) |
| 6 | May 27, 2014 | * Update to DEER 2014 saving values * Update Workpaper Template * Updated Cost Information | Miguel Urrea (SCG) |
| 7 | Dec. 15, 2014 | Title 20 & 24 baseline change for small storage water heaters with input rate less than 75kBtuh. | Joseph Pan (SCG) |
| 8 | April 03, 2015 | * Updated 40 Gal Storage Water Heater Tier EF from .7 to .67. Made changes to savings and cost to reflect update. * 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 |
| *ShwSef001* | Storage Water Heater ≤75 MBtu/hr (30 gal), (≥0.70EF) | N/A | Storage Water Heater ≤75 MBTUh (30 gal), (≥0.63EF) | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Com | Com-Default >2yrs | Def-GSIA |
| *ShwSef002* | Storage Water Heater ≤75 MBtu/hr (40 gal), (≥0.67EF) | N/A | Storage Water Heater ≤75 MBTUh (40 gal), (≥0.615EF) | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Com | Com-Default >2yrs | Def-GSIA |
| *ShwSef003* | Storage Water Heater ≤75 MBtu/hr (50 gal), (≥0.67EF) | N/A | Storage Water Heater ≤75 MBTUh (50 gal), (≥0.60EF) | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Com | Com-Default >2yrs | Def-GSIA |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | Storage Water Heater >75 MBtu/hr (Large), Tier 1 (≥0.83 TE) | N/A | Storage Water Heater >75 MBTUh, Et = 0.80, Stdby Loss = 0.56%/hr | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-Com | Com-Default >2yrs | Def-GSIA |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | Storage Water Heater >75 MBtu/hr (Large), Tier 2 (≥0.90 TE) | N/A | Storage Water Heater >75 MBTuh, Et = 0.80, Stdby Loss = 0.56%/hr | Com | ROB, NC | PreRebDown, PreReb, PreRebup | WtrHt-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) |
| *ShwSef001* | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 0.77 | $20.54 | $23.37 | $2.83 |
| *ShwSef002* | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 0.58 | $16.03 | $17.50 | $1.47 |
| *ShwSef003* | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 1.67 | $20.59 | $24.27 | $3.68 |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 0.60 | $20.31 | $23.64 | $3.33 |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | Com | Ex | SCG | cAll | Cap-kBTuh | 0 | 0 | 0 | 0 | 0 | 1.85 | $20.31 | $25.99 | $5.68 |

**Note: For the complete list of Measures, refer to the accompanying calculation spreadsheet**

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1. General Measure & Baseline Data

Measure & Delivery Description

Measure Description

These measures apply to energy efficient storage water heaters used in commercial or industrial applications to produce hot water. Relative to standard models, energy efficient units typically have features such as larger heat exchange surfaces and/or additional tank insulation.

Tankless water heaters with a storage tank and control set that are factory mounted on the same skid and that follow the capacity rules listed in the California Titles 20 and 24 standards also qualify as a storage tank water heater[[1]](#endnote-1),[[2]](#endnote-2). Title 20 states, “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 rated input less than 4,000 Btu/hr per gallon of stored water”.

The combined tankless/storage/control system must be a catalog item available to all buyers in order to be qualified as a storage water heater.

* + - 1. The 5 measures are as followed:
         1. Small Storage Water Heater (Average saving of 30, 40, and 50 gallon)

30 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF ≥ 0.70)

40 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF≥0.67)

50 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF≥0.67)

Storage Water Heater, >75 MBtu/hr (Large), Tier 1 (≥83% TE)

Storage Water Heater, >75 MBtu/hr (Large), Tier 2 (≥90% TE)

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

Code/Standard Description

* + - 1. 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 (≤75 MBtu/hr) storage water heater base case is a small (≤75 MBtu/hr) storage water heater with an energy factor rated by storage volume in gallons.

Federal Regulations standard effective April 16, 2015 has an EF equation of 0.675 – (0.0015\*V) for ≥ 20 gal and ≤ 55 gal, 0.8012 – (0.00078\*V) for > 55 gal and ≤ 100 gal, where Volume (V) is the rated storage volume in gallons.

30 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF 0.63)

40 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF 0.615)

50 gallons Small Storage Water Heater, ≤75 MBtu/hr, (EF 0.60)

* + - 1. Large (>75 MBtu/hr) storage water heater base case is a medium (>75 MBtu/hr) storage water heaters of 80% TE with standby losses of 0.56% per hour.

Preexisting Description

* + - 1. NA

Measure Descriptors

1. Measure Descriptors

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MeasureID | Use-Category | UseSubCategory | Tech Group | Tech Type | PreTech Group | PreTech Type | StdTech Group | StdTech Type |
| *ShwSef001* | SHW | Heating | WaterHtg\_eq | Stor\_EF | NA | NA | WaterHtg\_eq | Stor\_EF |
| *ShwSef002* | SHW | Heating | WaterHtg\_eq | Stor\_EF | NA | NA | WaterHtg\_eq | Stor\_EF |
| *ShwSef003* | SHW | Heating | WaterHtg\_eq | Stor\_EF | NA | NA | WaterHtg\_eq | Stor\_EF |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | SHW | Heating | WaterHtg\_eq | Stor\_Et | NA | NA | WaterHtg\_eq | Stor\_Et |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | SHW | Heating | WaterHtg\_eq | Stor\_Et | NA | NA | WaterHtg\_eq | Stor\_Et |

Delivery Type

The preferred delivery method is a midstream prescriptive rebate.

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 Types

|  |  |
| --- | --- |
| Delivery Type | Description |
| *PreReb* | *Prescriptive Rebate* |
| *PreRebDown* | *Downstream 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 methods for measuring water heater efficiencies are referenced in the California Titles 20 and 24 standard1,2.

Minimum qualifying energy factor (EF) for small (≤75 MBtu/hr) storage water heaters replacing storage water heaters:

* + - * 1. 0.70 EF for 30 gallons storage tank water heaters
        2. 0.67 EF for 40 gallons storage tank water heaters
        3. 0.67 EF for 50 gallons storage tank water heaters

Equivalent to EF that is above the Federal Regulations Standard effective April 16, 2015.

Table 4 -lists the baseline measure and qualifying measure energy factors for small storage water heaters with selected storage tank rated volumes.

Minimum qualifying thermal efficiency (TE) for large (>75 MBtu/hr) storage water heaters replacing storage water heaters:

83% 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. These modifications increase installation costs and may be eligible for a higher rebate amount.

1. Measure Energy Factors

|  |  |  |  |
| --- | --- | --- | --- |
| Storage Tank Rated Volume (V) (gallons) | Energy Factor Equation | Baseline Energy Factor | Measure Energy Factor |
| *30* | *0.675-(0.0015\*V)* | *0.630* | *0.70* |
| *40* | *0.675-(0.0015\*V)* | *0.615* | *0.67* |
| *50* | *0.675-(0.0015\*V)* | *0.600* | *0.67* |

Implementation Requirements

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

This measure is applicable to any commercial domestic (or “service”) hot water application. Table 5 - displays DEER approved sectors and subsectors.

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

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

This measure is not limited to specific NAICS codes.

This measure includes replacing a storage water heater with a storage water heater.

1. Sector and Subsector(Building Type)

|  |  |  |  |
| --- | --- | --- | --- |
| Measure ID | Sector | Subsector | Subsector(Building Type) Description |
| *ShwSef001* | *Com, Ind, Ag* | *Com, Any, Any* | *measure applicable to any commercial, industrial, and Agricultural subsectors* |
| *ShwSef002* | *Com, Ind, Ag* | *Com, Any, Any* | *measure applicable to any commercial, industrial, and Agricultural subsectors* |
| *ShwSef003* | *Com, Ind, Ag* | *Com, Any, Any* | *measure applicable to any commercial, industrial, and Agricultural subsectors* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | *Com, Ind, Ag* | *Com, Any, Any* | *measure applicable to any commercial, industrial, and Agricultural subsectors* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | *Com, Ind, Ag* | *Com, Any, Any* | *measure applicable to any commercial, industrial, and 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 and Conditions

* + - 1. Only storage 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 less than 4,000 Btu per hour per gallon of stored water.

Never be used for process end-use.

DEER Differences Analysis

1. DEER Difference Summary

|  |  |
| --- | --- |
| Modified DEER Methodology | Yes |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | * Changed normalized units for small storage water heater from “each” to “per cap-KBtuh” |
| DEER Version | DEER 2015 |
| DEER Run ID and Measure Name | * WtrHt-Storage-30gal/40gal/50gal-Replace-Storage   + NG-WtrHt-SmlStrg-Gas-lte75kBtuh-30G-0p70EF   + NG-WtrHt-SmlStrg-Gas-lte75kBtuh-40G-0p67EF   + NG-WtrHt-SmlStrg-Gas-lte75kBtuh-50G-0p67EF * WtrHt-Storage- Large -Replace-Storage Tier 1   + NG-WtrHt-LrgStrg-Gas-gte75kBtuh-0p83Et * WtrHt-Storage-Large-Replace-Storage Tier 2   + NG-WtrHt-LrgStrg-Gas-gte75kBtuh-0p90Et |

Measure Efficiency

The minimum qualifying measure efficiencies are similar to the “2015 Database for Energy-Efficient Resources (DEER)[[4]](#endnote-4)”, with some exceptions. The following measure efficiencies are adopted after consideration of the California Titles 20 and 241,2 standards, Code of Federal Regulation[[5]](#endnote-5) standards, and the high-efficiency instantaneous water heaters listed in the California Energy Commission Energy Efficiency Appliance Database[[6]](#endnote-6):

* + - * 1. Small (≤75 MBtu/hr) storage water heater – the Federal Regulations Standard equations for the energy factor of small (≤75 MBtu/hr) storage water heaters {0.675-(0.0015\*V)} and {0.8012 – (0.00078\*V)} are used in this workpaper, where Volume (V) is the rated storage volume. The DEER 2015 Database provides data for three tiers of energy factor in each storage tank rated volume (30, 40, and 50 gallons). 70%EF is set for 30 gal storage water heater measure and 67% EF is set for 40 gal and 50 gal storage water heater measures based on the product availability from the California Energy Commission Energy Efficiency Appliance Database and DEER available measures.
        2. Large (>75 MBtuh) Tier 1 storage water heater – the DEER 2014 value of 83% TE is used in this Workpaper.
        3. Large Tier 2 storage water heater – the DEER 2014 value of 90% TE is used in this Workpaper.

Baseline Efficiency

Small (≤75 MBtu/hr) storage water heater – the Federal Regulations Standard equations for the baseline energy factor {0.675-(0.0015\*V)} and {0.8012 – (0.00078\*V)} are used for storage volume ≤55 gal and >55 gal, where Volume (V) is the rated storage volume

Large storage water heater – the DEER 2015 value of 80% TE is used in this Workpaper.

Incremental Measure Cost

* + - 1. Data were collected through a survey of vendors that sell storage water heaters in California for each of the categories of storage water heater type, rated input, 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 (2014) | 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 Code of Federal Regulations standards.

Code of Federal Regulations standards for residential water heaters are set to be updated on April 15, 2015. These standards are not used in this Workpaper due to unavailable qualifying equipment.

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 |

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

Measure Effective Useful Life

* + 1. For storage water heaters, the effective useful life (EUL) for WtrHt-Com of 15 years is taken from DEER 2014 update[[7]](#endnote-7).

1. Effective Useful Life

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MeasureID | EUL ID | EUL Yrs | RUL Yrs | Description |
| *ShwSef001* | *WtrHt-Com* | *15* | *N/A* | *Commercial Water Heater* |
| *ShwSef002* | *WtrHt-Com* | *15* | *N/A* | *Commercial Water Heater* |
| *ShwSef003* | *WtrHt-Com* | *15* | *N/A* | *Commercial Water Heater* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | *WtrHt-Com* | *15* | *N/A* | *Commercial Water Heater* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | *WtrHt-Com* | *15* | *N/A* | *Commercial Water Heater* |

Net-to-Gross Ratios for Different Program Strategies

The 2014 DEER documents recommend a net-to-gross ratio (NTGR) Com-Default>2yrs[[8]](#endnote-8) of 0.60 for all other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years.

1. Net-to Gross Ratio

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MeasureID | NTGR ID | NTGR\_therm | Description | Delivery Type |
| *ShwSef001* | *Com-Default>2yrs* | *0.6* | *All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years* | *PreReb, PreRebDown, PreRebUp* |
| *ShwSef002* | *Com-Default>2yrs* | *0.6* | *All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years* | *PreReb, PreRebDown, PreRebUp* |
| *ShwSef003* | *Com-Default>2yrs* | *0.6* | *All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years* | *PreReb, PreRebDown, PreRebUp* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | *Com-Default>2yrs* | *0.6* | *All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years* | *PreReb, PreRebDown, PreRebUp* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | *Com-Default>2yrs* | *0.6* | *All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years* | *PreReb, PreRebDown, PreRebUp* |

Time-of-Use Adjustment Factor

* + 1. N/A

Gross Savings and INstallation Adjustment (GSIA)

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

1. GSIA Table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MeasureID | GSIA ID | GSIA Type | GSIA Value | Description |
| *ShwSef001* | *Def-GSIA* | *Annual Installation Rate* | *1* | *Default GSIA Value* |
| *ShwSef002* | *Def-GSIA* | *Annual Installation Rate* | *1* | *Default GSIA Value* |
| *ShwSef003* | *Def-GSIA* | *Annual Installation Rate* | *1* | *Default GSIA Value* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p83Et* | *Def-GSIA* | *Annual Installation Rate* | *1* | *Default GSIA Value* |
| *NG-WtrHt-LrgStrg-Gas-gte75Btuh-0p90Et* | *Def-GSIA* | *Annual Installation Rate* | *1* | *Default GSIA Value* |

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

* + 1. N/A

1. Energy Savings & Demand Reduction Calculations

Load Shapes

* + 1. N/A

Energy Savings

Annual Gas Energy Savings

* + - 1. The annual gas energy savings are based on DEER 2014 and DEER 2015.
         1. 30-gallon storage water heaters minimum Energy Factor (EF) 0.70 as seen in DEER 2015 data.
         2. 40-gallon storage water heaters minimum Energy Factor (EF)0.67 as seen in DEER 2015 data.
         3. 50-gallon storage water heaters minimum Energy Factor (EF)0.67 as seen in DEER 2015 data.

The large Tier 1 storage water heater minimum thermal efficiency (TE) is 83% as seen in DEER 2014 data.

* + - * 1. The large Tier 2 storage water heater minimum thermal efficiency (TE) is 90% as seen in DEER 2014 data.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Equipment Type** | **Gallons** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **DEER  Baseline  Efficiency** | **DEER  Measure  Efficiency** |
| Small | 30 | ≤ 75 | EF | 0.63 | 0.65, 0.70, 0.72 |
| Small | 40 | ≤ 75 | EF | 0.615 | 0.65, 0.67, 0.70, 0.82 |
| Small | 50 | ≤ 75 | EF | 0.6 | 0.67 , 0.70, 0.82 |
| Large, Tier 1 (non-condensing) | NA | > 75 | TE | 80% | 83% |
| Large, Tier 2 (condensing) | NA | > 75 | TE | 80% | 90% |

V is the rated volume in gallons.

* + 1. Storage Water Heater Efficiencies in CEC Database
       1. Water heating products in the CEC Appliance Database intermingle non-condensing and condensing water heaters, although a water heater with energy factor or thermal efficiency above about 88% is most likely a condensing water heater. Table 13 -shows the range of storage water heater efficiencies found in the CEC Appliance Database.

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Minimum Efficiency** | **Maximum Efficiency** |
| Small | 26 – 75 | EF | 0.48 | 0.71 |
| Large | 75.1 – 2,400 | TE | 77% | 99% |

* + 1. Standard Efficiencies.

Table 8 -lists the California Titles 20 and Federal Regulations standards for storage 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.

* + - 1. Energy factor is the standard efficiency unit for storage water heaters with rated input ≤ 75 MBtu/hr. Thermal efficiency is the standard efficiency unit for storage water heaters with rated input > 75 MBtu/hr.
    1. Baseline and Measure Efficiencies

Table 14 -lists the efficiency units and efficiency values recommended for storage water heaters. The minimum baseline efficiencies and efficiency units match the Federal Regulations standards5. The qualifying measure efficiencies have the following changes compared to the DEER 2014 and DEER 20154:

The small storage water heater minimum energy factor (EF) has three tiers available in DEER 2015. One tier for each storage size has been chosen. The qualifying energy factors for the measures are developed based on the unit availability from CEC Appliance Database and DEER 2015 availability.

Figure 1 shows that there are 12 30-gallon small storage water heaters with energy factor at or above 0.70 (the standard is 0.63). According to CEC Appliance Database, there is no unit in efficiencies between the baseline of 0.63EF and 0.70EF, thus it is reasonable to set the measure efficiency to be at 0.70EF, which is also a listed available measure from DEER 2015.

Figure 2 shows that there are 41 40-gallon small storage water heaters with energy factor at or above 0.70 and 110 between .67 and .70 EF(the standard is 0.615). According to CEC Appliance Database and market availability, it is reasonable to set the measure efficiency to be at 0.67EF, a measure definition with this efficiency was submitted and approved for addition in DEER 2015.

Figure 3 shows that there are 65 50-gallon small storage water heaters with energy factor at or above 0.67 (the standard is 0.60). According to CEC Appliance Database and market availability, it is reasonable to set the measure efficiency to be at 0.67EF, which is also a listed available measure from DEER 2015.

The large Tier 1 storage water heater minimum thermal efficiency (TE) is 83%; and the Tier 2 storage water heater minimum thermal efficiency is 90%, as seen in DEER 2014 data.

Figure 4 show that there are 413 large storage water heater models with thermal efficiency at or above 83% and less than 88%.

Figure 4 show that there are 382 large storage water heater models with thermal efficiency at or above 90%.

1. Baseline and Qualifying Measure Efficiencies for Storage Water Heaters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment Type** | **Rated Input (MBtu/hr)** | **Efficiency Units** | **Base Efficiency** | **Qualifying Efficiency** |
| Small (30-75 gallon) | ≤ 75 | EF | 0.675-(0.0015\*V) | 0.8012-(0.00078\*V) |
| Large, Tier 1 (non-condensing) | > 75 | TE | 80% | 83% |
| Large, Tier 2 (condensing) | > 75 | TE | 80% | 90% |

V is the rated volume in gallons

1. Energy Factor for 30-gallon Small Storage Water Heaters in the CEC Appliance Efficiency Database
2. Energy Factor for 40-gallon Small Storage Water Heaters in the CEC Appliance Efficiency Database
3. Energy Factor for 50-gallon Small Storage Water Heaters in the CEC Appliance Efficiency Database
4. Thermal Efficiency for Large Storage Water Heaters in the CEC Appliance Efficiency Database
   * 1. Energy Savings Calculation

The energy savings data calculated from DEER 2014 and DEER 2015 are used as the basis for this Workpaper.

1. Small and Large Water Heater Energy Savings from 2015 DEER

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Description | | | Small Storage Water Heater | | | Large Storage Water Heater | |
| 30 gal EF70 | 40 gal EF67 | 50 gal EF67 | Large ET83 | Large ET90 |
| IOU | BldgVint | BldgLoc | therm/Each | therm/Each | therm/Each | therm/kBtuh | therm/kBtuh |
| Any | EX | CZ01 | 29.8 | 99.40 | 93.50 | 0.70 | 2.16 |
| Any | EX | CZ02 | 25.9 | 85.50 | 82.90 | 0.68 | 2.10 |
| Any | EX | CZ03 | 26.2 | 84.30 | 83.40 | 0.68 | 2.10 |
| Any | EX | CZ04 | 25.2 | 78.10 | 73.80 | 0.64 | 1.96 |
| Any | EX | CZ05 | 25.7 | 91.13 | 84.50 | 0.77 | 2.37 |
| Any | EX | CZ06 | 23.4 | 72.53 | 69.57 | 0.62 | 1.91 |
| Any | EX | CZ07 | 23.1 | 71.60 | 67.40 | 0.61 | 1.87 |
| Any | EX | CZ08 | 23.2 | 68.40 | 65.30 | 0.58 | 1.78 |
| Any | EX | CZ09 | 23.1 | 68.50 | 65.20 | 0.61 | 1.86 |
| Any | EX | CZ10 | 23.0 | 67.87 | 66.97 | 0.56 | 1.72 |
| Any | EX | CZ11 | 24.7 | 76.90 | 70.00 | 0.61 | 1.87 |
| Any | EX | CZ12 | 25.5 | 79.00 | 73.60 | 0.61 | 1.89 |
| Any | EX | CZ13 | 24.5 | 75.60 | 69.57 | 0.58 | 1.77 |
| Any | EX | CZ14 | 24.5 | 74.47 | 67.43 | 0.60 | 1.83 |
| Any | EX | CZ15 | 21.2 | 63.20 | 53.07 | 0.51 | 1.57 |
| Any | EX | CZ16 | 28.3 | 97.80 | 94.40 | 0.74 | 2.27 |
| Any | EX | SCG | 23.2 | 69.50 | 66.90 | 0.60 | 1.85 |

* + - 1. Table 15 shows the savings reported from DEER 2015 and DEER 2014. The savings for the small storage water heater measures are in the unit of therm/Each for the small storage water heaters. We adjusted the savings to the unit of therm/kBtuh. The corresponding input rate used in the DEER Water Heater Calculator for each capacity is 30kBtuh for 30 gallon and 40kBtuh for 40 and 50 gallon.

1. Modified Small and Large Water Heater Energy Savings from 2015 DEER

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Description | | | Small Storage Water Heater | | | Large Storage Water Heater | |
| 30 gal EF70 | 40 gal EF67 | 50 gal EF67 | Large ET83 | Large ET90 |
| IOU | BldgVint | BldgLoc | therm/kBtuh | therm/kBtuh | therm/kBtuh | therm/kBtuh | therm/kBtuh |
| Any | EX | CZ01 | 0.99 | 2.49 | 2.34 | 0.70 | 2.16 |
| Any | EX | CZ02 | 0.86 | 2.14 | 2.07 | 0.68 | 2.10 |
| Any | EX | CZ03 | 0.87 | 2.11 | 2.09 | 0.68 | 2.10 |
| Any | EX | CZ04 | 0.84 | 1.95 | 1.85 | 0.64 | 1.96 |
| Any | EX | CZ05 | 0.86 | 2.28 | 2.11 | 0.77 | 2.37 |
| Any | EX | CZ06 | 0.78 | 1.81 | 1.74 | 0.62 | 1.91 |
| Any | EX | CZ07 | 0.77 | 1.79 | 1.69 | 0.61 | 1.87 |
| Any | EX | CZ08 | 0.77 | 1.71 | 1.63 | 0.58 | 1.78 |
| Any | EX | CZ09 | 0.77 | 1.71 | 1.63 | 0.61 | 1.86 |
| Any | EX | CZ10 | 0.77 | 1.70 | 1.67 | 0.56 | 1.72 |
| Any | EX | CZ11 | 0.82 | 1.92 | 1.75 | 0.61 | 1.87 |
| Any | EX | CZ12 | 0.85 | 1.98 | 1.84 | 0.61 | 1.89 |
| Any | EX | CZ13 | 0.82 | 1.89 | 1.74 | 0.58 | 1.77 |
| Any | EX | CZ14 | 0.82 | 1.86 | 1.69 | 0.60 | 1.83 |
| Any | EX | CZ15 | 0.71 | 1.58 | 1.33 | 0.51 | 1.57 |
| Any | EX | CZ16 | 0.94 | 2.45 | 2.36 | 0.74 | 2.27 |
| Any | EX | SCG | 0.77 | 1.74 | 1.67 | 0.60 | 1.85 |

1. Base Case & Measure Costs

Base Case Cost

* + 1. When the customer is replacing equipment on burnout (ROB) or buying new equipment (NC), the customer must buy a new storage water heater to continue operating, so the base case cost is that of a baseline (standard) storage water heater.
    2. The base case costs are shown in Table 17 - below.

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 17 -represent an arithmetic average of the equipment cost per MBtu/hr in each category.

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 17 - below.

* + - 1. 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 17 - 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 G.

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 17 -below.

1. Gross and Incremental Measure Cost by Equipment Type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Equipment Type** | **Small (30 gal)** | **Small (40 gal)** | **Small (50 gal)** | **Large Tier 1** | **Large Tier 2** |
| **Rated Input (MBtu/hr) 🡪** | **≤ 75** | **≤ 75** | **≤ 75** | **> 75** | **> 75** |
| **2014 Vendor Survey Data per MBtuh** |  |  |  |  |  |
| Average Base Cost ($/MBtuh) | $20.54 | $16.03 | $20.59 | $20.31 | $20.31 |
| Average Gross Measure Cost ($/MBtuh) | $23.37 | $17.50 | $24.27 | $23.64 | $25.99 |
| Average Incremental Measure Cost ($/MBtuh) | **$2.83** | **$1.47** | **$3.68** | **$3.33** | **$5.68** |

Attachments

Attachment A – B-REP-05-599-16D *– Storage Tank Water Heaters*



*Attachment B –Therm Saving Calculation*

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*Attachment C – WorkPAD Measure Upload*



*Attachment D – WorkPAD Measure Template Support Tables*



*Attachment E –Small Storage Water Heater Cost Data*



*Attachment F –Large Storage Water Heater Cost Data*



*Attachment G –CEC Appliance Database*

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# References

1. (2014 Appliance Efficiency Regulations, 2014)[*http://www.energy.ca.gov/2012publications/CEC-400-2012-019/CEC-400-2012-019-CMF.pdf*](http://www.energy.ca.gov/2012publications/CEC-400-2012-019/CEC-400-2012-019-CMF.pdf) [↑](#endnote-ref-1)
2. (2013 Building Energy Efficiency Standards, 2013) <http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf> [↑](#endnote-ref-2)
3. (B-REP-05-599-16D – Storage Tank Water Heaters, 2008) Attachment A [↑](#endnote-ref-3)
4. (Database for Energy Efficiency Resources, 2015) <http://www.deeresources.com/> [↑](#endnote-ref-4)
5. (Code of Federal Regulations, 2014) <http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27> [↑](#endnote-ref-5)
6. (California Energy Commission Appliance Efficiency Database, 2014) <http://www.appliances.energy.ca.gov/AdvancedSearch.aspx> [↑](#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)