Short Form Work Paper WPSDGEREWH0023

**Revision 0**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**Central Storage Water Heaters for Multifamily Residential Applications**

**November 8, 2017**

# SDG&E Central Storage Water Heaters for Multifamily Residential Applications

## Introduction

This short form workpaper (WP) documents the values adopted from SCG’s WPs entitled “Central Storage Water Heaters for Multifamily Residential Applications” (WPSCGREWH130613A-Rev01\_CentralStorageWH\_MFRes.docx). SDG&E adopts all the values, with the following exception:

1. SDG&E references only climate zones that are within its territory (CZs 6, 7, 8, 10, 14, 15)
2. SDG&E will offer both Downstream Rebate and Direct Install

## Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 10/23/2017 | Kelvin Valenzuela/SDGE | * Adapted SCG’s workpaper WPSCGREHW130613A Rev 1 * CZs 6, 7, 8, 10, 14, 15 were referenced for SDG&E |
|  |  |  |  |
|  |  |  |  |

## Measure Summary

Table 1: Measure Summary Table

| **Section** | **Value** |
| --- | --- |
| **Summary & Purpose** | This short form workpaper documents ex-ante load impacts and cost-effectiveness values for Central Boilers in the multifamily space. The base energy consumption and measure energy consumption values are from SCG’s workpaper, WPSCGREWH130613A, Rev 1. |
| **1.1 Measure & Baseline Data** | Measure:  464042 – Domestic Hot Water Boiler TE = 84% and input rating > 75 MBtuh  464043 – Domestic Hot Water Boiler TE = 90% and input rating > 75 MBtuh |
| **1.2 Technical Description** | A typical gas-fired storage water heater is a large vertical insulated tank with a gas burner located under the tank. When hot water is drawn from the tank, cold water flows into the bottom of the tank. When the water temperature in the tank gets too low, a thermostat sensing the water temperature (often called an aquastat) calls for heat from the burner. When the water temperature in the tank reaches the set point, the thermostat turns off the burner. The burner may be ignited by an electronic spark ignition, glow plug, or, in some models, by a standing pilot light.  The rated input for a natural gas fueled storage water heater for this multifamily residential measure must exceed 75,000 Btuh (75 kBtuh). Qualifying storage water heaters must also have a storage tank that holds at least 80 gallons of water. This measure will have two tiers of incentive: Tier 1 is for large natural gas non-condensing storage water heaters and Tier 2 is for large natural gas condensing storage water heaters. Tier 2 water heaters will often require flu modifications. These modifications may increase or decrease installation costs. Tier 2 systems also receive higher rebates than Tier 1 systems. Relative to standard models, energy efficient units typically have features such as no standing pilot light, larger heat exchange surfaces, additional tank insulation, and the capability to condense moisture in the flue gas.  The test method for measuring storage water heater thermal efficiency (TE) is ANSI Z21.10.3-1998 §2.9, as referenced in the California Title 20 standard. A parameter for determining the thermal efficiency and energy consumption of water heaters is the cold water temperature at the inlet to the storage water heater. The nominal ANSI standard temperature of the supply water entering the water heater is 70 F. The actual inlet water temperature in California varies with climate zone and season, so adjustment factors were created based on ground temperature data for each climate zone to account for varying water heater consumption due to inlet water temperature. More information regarding these adjustment factors are included in Section 2.02. The California Title 20 standard defines a minimum TE of 80% for the baseline large storage water heaters. The qualifying measure efficiencies for large storage water heaters are the following with an emission limit of 14ng/J or 20 ppm NOx @3% O2 dry:  1. Minimum TE of 83% for Tier 1 (non-condensing) large storage water heaters.  2. Minimum TE of 90% for Tier 2 (condensing) large storage water heaters. |
| Measures | See Requirements |
| Code for All Measures | Large storage water heaters for multifamily residential applications are not specified in the 2014 Database for Energy-Efficiency Resources (DEER2014) Update for 2014 Codes. Table 1 lists the baseline and measure efficiencies for commercial storage water heaters found in the DEER2014. This workpaper uses commercial storage water heaters because they are typically found in multifamily buildings. All of these storage water heaters have standby losses of 0.56% per hour. Standby losses are expressed as a percentage of the energy stored in the hot water relative to the average ambient air temperature. The minimum baseline DEER efficiencies listed in Table 1 were applied to the baseline large storage water heaters for multifamily residential applications. The minimum qualifying DEER measure efficiencies listed in Table 1 were applied to the Tier 1 and Tier 2 large storage water heater measures for multifamily residential applications.  **Table 1 - Commercial Storage Water Heater Thermal Efficiencies in DEER2014**   |  |  |  | | --- | --- | --- | | **Equipment Type** | **DEER Baseline** | **DEER Measure** | | Commercial Storage Water Heater >75 kBtuh, Tier 1 (non-condensing),  Readi ID: NG-WtrHt-LrgStrg-Gas-gte75kBtuh-0p83Et | 80% | 83% | | Commercial Storage Water Heater >75 kBtuh, Tier 2 (condensing),  Readi ID: NG-WtrHt-LrgStrg-Gas-gte75kBtuh-0p90Et | 80% | 90% | |
| Requirements | 1. The rebate applies to gas-for-gas equipment replacements on burnout (ROB).  2. Qualifying storage water heaters must have an input rate of at least 75 kBtuh and a storage tank size of at least 80 gallons.  3. Tankless water heaters or hot water boilers with a separate storage tank that are factory mounted on the same skid do not qualify as a storage water heater.  4. Storage water heaters used for space heating applications do not qualify.  5. Water heaters used for pools or spas do not qualify.  6. The manufacturer’s name and equipment model number must be provided.  7. If necessary, customer must provide proof of unit efficiency (e.g., manufacturer’s equipment specification sheet).  8. The equipment model must be listed on California Energy Commission Energy Efficiency Appliance Database (CEC Database) to qualify for the rebate.  9. The equipment must meet the minimum emission requirements per air district. |
| **1.3 Installation Type and Delivery Mechanisms** |  |
| Installation Type | Replace on Burn-out (ROB) |
| Delivery Mechanisms | Downstream Rebate – Deemed  Direct Install |
| **1.4.1 DEER Data** |  |
| Net-to-Gross Ratio | Res-Default>2yrs (0.55) |
| Effective and Remaining Useful Life | WtrHt-LrgStrg-Gas (EUL = 15 Years)  Since commercial storage water heaters are used as central storage water heaters in multifamily residential applications, the appropriate EUL for use in this workpaper is 15 years |
| **Section 2. Calculation Methodology** |  |
| Energy Savings/Peak Demand Reduction – All Measures | The annual water heater gas energy use for the 16 California Energy Commission are estab-lished by applying 16 adjustment factors to the state average storage water heater gas con-sumption for multifamily apartments/units from the 2009 California Residential Appliance Satu-ration Study (RASS).  The adjustment factors were developed using 2013 ground temperature data and the “Build-ing America Multi-Family Central Water Heating Evaluation Tool” from the Department of En-ergy’s Office of Energy Efficiency and Renewable Energy to model the annual water heater gas consumption for the 16 climate zones. The annual consumption associated with each climate zone was then divided by the median of consumptions in all 16 climate zones to estimate the adjustment factor for each climate zone, which are presented in Figure 1.  Figure 1 - Water Heater Gas Consumption Adjustment Factors for the California 16 Climate Zones    The calculated adjustment factors are applied to the state average gas consumption for multi-family apartment unit from RASS to establish the baseline water heater gas consumption for the 16 climate zones.  The following steps were then taken to derive the gas savings per unit of water heater capacity (kBtuh):  Determine average rated input of central storage water heater per dwelling unit along with average number of occupants per dwelling unit. These resources can be found in Attachment E.  Calculate gas savings per kBtuh rated input from the baseline thermal efficiency and the measure thermal efficiency.   1. For calculating energy savings, the following assumptions are used: 2. The average efficiency for the baseline products is a minimum TE of 80% based on California Title 20 code standard. 3. The average efficiencies for the qualifying products are: 1) a minimum TE of 83% for Tier 1 (non-condensing) large storage water heaters, 2) a minimum TE of 90% for Tier 2 (condensing) large storage water heaters. 4. With these assumptions, the energy saved by a high-efficiency measure storage water heater can be calculated as follows:   *∆Q = Qb x (1 - Eb/Em) Eqn-1*  where   1. *∆Q* – Gas Saved (therms/yr). Savings which results from installing the high-efficiency measure equipment. 2. *E* – Efficiency (%). Efficiency of equipment in appropriate efficiency units (thermal efficiency). 3. *Subscript b* = Baseline (or base case) equipment 4. *Subscript m* = Measure (new high-efficiency) equipment 5. The gas savings are calculated for each or climate zone. The energy savings data and calculations are included in an Excel file embedded as Attachment B.   The calculated gas consumption and savings per climate zone and tier are summarized in Table 2:  **Table 2. Annual Gas Consumption and Savings by Tier and Climate Zone**   | **Climate Zone** | **Tier** | **Annual Gas Consumption per Apartment Unit (Therms/Yr/Dwelling Unit)** | **Annual Gas Savings (Therms/Yr/Dwelling Unit)** | **Annual GasSavings (Therms/Yr/ kBtuh)** | | --- | --- | --- | --- | --- | | 1 | 1 | 196 | 7.1 | 1.09 | | 2 | 1 | 189 | 6.8 | 1.05 | | 3 | 1 | 189 | 6.8 | 1.05 | | 4 | 1 | 186 | 6.7 | 1.03 | | 5 | 1 | 190 | 6.9 | 1.06 | | 6 | 1 | 183 | 6.6 | 1.02 | | 7 | 1 | 182 | 6.6 | 1.01 | | 8 | 1 | 181 | 6.5 | 1.01 | | 9 | 1 | 181 | 6.5 | 1.01 | | 10 | 1 | 181 | 6.5 | 1.00 | | 11 | 1 | 182 | 6.6 | 1.01 | | 12 | 1 | 185 | 6.7 | 1.03 | | 13 | 1 | 181 | 6.5 | 1.01 | | 14 | 1 | 183 | 6.6 | 1.02 | | 15 | 1 | 168 | 6.1 | 0.93 | | 16 | 1 | 195 | 7.1 | 1.09 | |  |  |  |  |  | | 1 | 2 | 196 | 21.7 | 3.34 | | 2 | 2 | 189 | 21.0 | 3.22 | | 3 | 2 | 189 | 21.0 | 3.23 | | 4 | 2 | 186 | 20.7 | 3.18 | | 5 | 2 | 190 | 21.1 | 3.25 | | 6 | 2 | 183 | 20.4 | 3.13 | | 7 | 2 | 182 | 20.3 | 3.12 | | 8 | 2 | 181 | 20.1 | 3.09 | | 9 | 2 | 181 | 20.1 | 3.09 | | 10 | 2 | 181 | 20.1 | 3.09 | | 11 | 2 | 182 | 20.2 | 3.11 | | 12 | 2 | 185 | 20.5 | 3.15 | | 13 | 2 | 181 | 20.1 | 3.09 | | 14 | 2 | 183 | 20.3 | 3.12 | | 15 | 2 | 168 | 18.6 | 2.87 | | 16 | 2 | 195 | 21.7 | 3.34 |   The savings are also calculated for two sizes of central water heaters, smaller than or equal to 200,000 kBtuh and larger than 200,000 kBtuh. Based on the SoCal Gas rebate application data for central storage water heaters in multifamily buildings, the average capacity of water heaters smaller than or equal to 200,000 kBtuh is about 150,000 kBtuh and average capacity of water heaters larger than 200,000 kBtuh is about 265,000 kBtuh. These average sizes are multiplied by the Annual Gas Savings per kBtu (Therms/Yr/kBtuh) for each climate zone from Table 3 to estimate the gas savings per system for the 16 climate zones. The annual gas savings per water heater system are summarized in Table 3:  **Table 3. Annual Gas Savings per Water Heater System**   | **Climate Zone** | **Tier** | **Annual Gas Savings (Therm/Yr) per Water Heater System <= 200 kBtuh** | **Annual Gas Savings (Therm/Yr) per Water Heater System > 200 kBtuh** | | --- | --- | --- | --- | | 1 | 1 | 163 | 288 | | 2 | 1 | 157 | 278 | | 3 | 1 | 157 | 279 | | 4 | 1 | 155 | 274 | | 5 | 1 | 159 | 281 | | 6 | 1 | 153 | 270 | | 7 | 1 | 152 | 269 | | 8 | 1 | 151 | 267 | | 9 | 1 | 151 | 267 | | 10 | 1 | 150 | 266 | | 11 | 1 | 152 | 268 | | 12 | 1 | 154 | 272 | | 13 | 1 | 151 | 267 | | 14 | 1 | 152 | 269 | | 15 | 1 | 140 | 247 | | 16 | 1 | 163 | 288 | |  |  |  |  | | 1 | 2 | 501 | 887 | | 2 | 2 | 483 | 855 | | 3 | 2 | 484 | 856 | | 4 | 2 | 476 | 843 | | 5 | 2 | 487 | 863 | | 6 | 2 | 470 | 831 | | 7 | 2 | 467 | 827 | | 8 | 2 | 464 | 821 | | 9 | 2 | 463 | 820 | | 10 | 2 | 463 | 819 | | 11 | 2 | 466 | 825 | | 12 | 2 | 473 | 837 | | 13 | 2 | 463 | 820 | | 14 | 2 | 468 | 828 | | 15 | 2 | 430 | 761 | | 16 | 2 | 500 | 886 |   SDG&E will not be modifying these savings. Only cite in our ex ante tables the savings for climate zones 6, 7, 8, 10, 14, and 15. |
| **Section 3. Load Shapes** | SDGE: 13-MFM-ResidentialMulti-family-WAT\_HEAT Annual |
| **Section 4. Costs** |  |
| **Section 4.1 Base and Measure Costs** |  |
| Base Cost | 464042:  WPSDGEREWH0023-Rev00-Msr001-BASE = $23.29  464043:  WPSDGEREWH0023-Rev00-Msr002-BASE = $23.29 |
| Measure Cost | 464042:  WPSDGEREWH0023-Rev00-Msr001-FULL = $25.85  464043:  WPSDGEREWH0023-Rev00-Msr002-FULL = $32.10 |