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| HVAC  Space Heating BoileR, Commercial & Multifamily  SWHC004-03 |

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Measure Name

Space Heating Boiler, Commercial & Multifamily

Statewide Measure ID

SWHC004-03

Technology Summary

A space heating boiler is a pressure vessel that transfer heat to water for use primarily in space heating applications. A boiler heats water using a heat exchanger that works like an instantaneous water heater or by the addition of a separate tank with an internal heat exchanger that is connected to the boiler. An energy efficient unit often features high-efficiency and/or low NOx burners, and typically has features such as forced air burners, relatively large heat exchange surfaces, and/or utilize heat recovery from stack gases.

A high-efficiency gas-fired boiler, typically rated above 90% thermal efficiency, is commonly known as a condensing boiler. A condensing boiler is equipped with larger heat exchanger that can recuperate additional thermal energy from the flue gas – compared to its non-condensing counterpart. Condensing boilers can condense moisture out of the flue gas, recovering the latent heat from the water vapor present. The removal of latent heat in the water vapor results in a lower flue gas temperature than a traditional boiler.

Efficient boilers often use controls strategies to reset supply water temperature based on outdoor air (OA) temperature. This means that when the weather is warmer and heating requirements are lower, the boiler can be set to provide cooler supply water. This reduced the heating energy required by the boiler and saves energy.

Measure Case Description

The measure case is defined as a high-efficiency space heating boiler that meets the specifications below. As shown, measure offerings are designated by two tiers based on boiler efficiency and in some cases OA reset controls.

The OA reset controls shown in the table describe the range of boiler supply water temperature that the reset should span based on outdoor air temperature. For steam boilers is assumed that the steam goes to a heat exchanger that heats a secondary supply hot water loop. This secondary hot water loop is what supplies building heating and it is the loop temperature to which the OA reset control is applied.

Measure Case Specification

| **Boiler Type** | **Rated Input (MBtuh)** | **Base Case Efficiency** | **Tier 1** | | **Tier 2** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure Efficiency** | **OA Reset Control** | **Measure Efficiency** | **OA Reset Control(s)** |
| **Hot Water** | **< 300 (MFm)** | 84% AFUE | 94% AFUE | - | - | - |
| **300 - 2,500** | 80%TE | 85% TE | 140-165 °F | 94% TE | 115-140 °F or  140-165 °F |
| **≥ 2,500** | 80% TE | 83% TE  85% CE | 140-165 °F | 94% TE | 115-140 °F or  140-165 °F |
| **Steam** | **300 - 2,500** | 79%TE | 82% TE | 140-165 °F | - |  |
| **≥ 2,500 (Com)** | 79%TE | 80% TE | 140-165 °F | 82% TE | 140-165 °F |

Measure Offerings

|  |  |  |
| --- | --- | --- |
| **Statewide Measure Offering ID** | **Sector** | **Measure Offering Description** |
| SWHC004A | Res (MFm) | Space Heating Boiler, Hot Water (< 300 kBtu/hr, 94% AFUE, Condensing) |
| SWHC004B | Res (MFm) | Hot water boiler (300 - 2500 kBtuh, 85.0 Et) |
| SWHC004B | Com | Hot water boiler (300 - 2500 kBtuh, 85.0 Et, OA Reset from 140 to 165 F) |
| SWHC004C | Res (MFm) | Hot water boiler (300 - 2500 kBtuh, 94.0 Et, condensing) |
| SWHC004C | Com | Hot water boiler (300 - 2500 kBtuh, 94.0 Et, condensing, OA reset from 140 to 165 F) |
| SWHC004D | Com | Hot water boiler (300 - 2500 kBtuh, 94.0 Et, condensing, OA reset from 115 to 140 F) |
| SWHC004E | Res (MFm) | Hot water boiler (> 2500 kBtuh, 83.0 Et, 85.0Ec) |
| SWHC004E | Com | Hot water boiler (> 2500 kBtuh, 83.0 Et, 85.0Ec, OA Reset from 140 to 165 F) |
| SWHC004F | Res (MFm) | Hot water boiler (> 2500 kBtuh, 94.0 Et, condensing) |
| SWHC004F | Com | Hot water boiler (> 2500 kBtuh, 94.0 Et, condensing, OA reset from 140 to 165 F) |
| SWHC004G | Com | Hot water boiler (> 2500 kBtuh, 94.0 Et, condensing, OA reset from 115 to 140 F) |
| SWHC004H | Res (MFm) | Steam boiler (300 - 2500 kBtuh, 82.0 Et) |
| SWHC004H | Com | Steam boiler (300 - 2500 kBtuh, 82.0 Et, OA Reset from 140 to 165 F) |
| SWHC004I | Com | Steam boiler (> 2500 kBtuh, 80.0 Et, OA Reset from 140 to 165 F) |
| SWHC004J | Com | Steam boiler (> 2500 kBtuh, 82.0 Et, OA Reset from 140 to 165 F) |

Base Case Description

The base case efficiency for multifamily space heating hot water boilers < 300 kBtuh is 84% AFUE. The base case for all other space heating hot water boilers is a thermal efficiency of 80%. The base case for space heating steam boilers is a thermal efficiency of 79%.

Code Requirements

A space heating boiler installed in commercial or multifamily premise is subject to state regulation – as codified in the California State Appliance Efficiency Regulations (Title 20) and the California Building Energy Efficiency Standards (Title 24). Note that the more stringent code is applied in all relevant situations. In this case, 2019 California Title 24 code supersedes the 2019 Title 20 code as the regulatory baseline for all measure offerings.

Applicable State and Federal Codes and Standards

|  |  |  |
| --- | --- | --- |
| **Code** | **Applicable Code Reference** | **Effective Date** |
| CA Appliance Efficiency Regulations – Title 20 (2019) | Section 1605.1(e) | January 1, 2019 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 110.2 | January 1, 2019 |
| Federal Standards | None. | n/a |

**Title 20, Section 1605.1(e):[[1]](#footnote-2)**

*Central Gas Furnaces, Central Gas Boilers, Central Oil Furnaces, Central Oil Boilers and Electric Residential Boilers. The AFUE, thermal efficiency, and combustion efficiency, as applicable, of central gas furnaces, central gas boilers, central oil furnaces, and central oil boilers manufactured on or after the effective dates shown shall be not less than the applicable values shown in Tables E-3 and E-4. Electric hot water residential boilers manufactured on or after September 1, 2012 shall meet the design standard shown in Table E-3.*

Title 20 Section 1605.1(e), Table E-3 & E-4, Standards for Gas- and Oil-Fired Central Boilers and Electric Residential Boilers

| **Title 20 Std. Description** | **Min. Efficiency Rating** | **Units** | **Code Source or Reference** |
| --- | --- | --- | --- |
| Boiler, hot water, Gas-Fired (< 300 kBTUh) | 84% | AFUE | Table E-3 |
| Boiler, hot water, Gas Fired (≥ 300 kBTUh, ≤ 2,500 kBTUh) | 80% | Thermal Efficiency | Table E-4 |
| Boiler, steam, Gas-Fired all except natural draft (≥ 300 kBTUh, ≤ 2,500 kBTUh) | 79% | Thermal Efficiency | Table E-4 |

The minimum efficiency rating of the measure, Boiler, hot water, Gas-Fired (< 300 kBTUh) was updated to 84% effective from January 15, 2021.

**Title 24, Section 110.2:** [[2]](#footnote-3)

*Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified to the Commission that the equipment complies with all the applicable requirements of this section.*

1. ***Efficiency.*** *Equipment shall meet the applicable efficiency requirements in TABLE 110.2-A through TABLE 110.2- K subject to the following:*
   1. *If more than one efficiency standard is listed for any equipment in TABLE 110.2-A through TABLE 110.2-K, the equipment shall meet all the applicable standards that are listed; and*
   2. *If more than one test method is listed in TABLE 110.2-A through TABLE 110.2-K, the equipment shall comply with the applicable efficiency standards when tested with each listed test method; and*
   3. *Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the efficiency standards applicable to each function; and*
   4. *Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.*

2019 California Title 24, Section 110.2, Table 110.2-K, Gas- and Oil-Fired Boilers, Minimum Efficiency Requirements.

|  |  |  |  |
| --- | --- | --- | --- |
| **Title 24 Std. Description** | **Min. Efficiency Rating** | **Units** | **Code Source or Reference** |
| Boiler, hot water, Gas-Fired  (< 300 kBTUh) | 82% | AFUE | Table 110.2-K |
| Boiler, hot water, Gas Fired  (≥ 300 kBTUh, ≤ 2,500 kBTUh) | 80% | Thermal Efficiency | Table 110.2-K |
| Boiler, hot water, Gas Fired  (> 2,500 kBTUh) | 82% | Combustion Efficiency | Table 110.2-K |
| Boiler, steam, Gas-Fired all except natural draft  (≥ 300 kBTUh, ≤ 2,500 kBTUh) | 79% | Thermal Efficiency | Table 110.2-K |
| Boiler, steam, Gas-Fired all, except natural draft  (> 2,500 kBTUh) | 79% | Thermal Efficiency | Table 110.2-K |

Normalizing Unit

Cap-kBTUh (kBtu/hr of boiler rated input)

Program Requirements

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

*Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.*

Implementation Eligibility

| **Measure Application Type** | **Delivery Type** | **Sector** |
| --- | --- | --- |
| Normal Replacement (NR) | DnDeemDI | Com |
| Normal Replacement (NR) | UpDeemed | Com |
| Normal Replacement (NR) | DnDeemed | Com |
| Normal Replacement (NR) | DnDeemDI | Res (Multifamily) |
| Normal Replacement (NR) | UpDeemed | Res (Multifamily) |
| Normal Replacement (NR) | DnDeemed | Res (Multifamily) |
| New Construction (NC) | DnDeemDI | Com |
| New Construction (NC) | UpDeemed | Com |
| New Construction (NC) | DnDeemed | Com |
| New Construction (NC) | DnDeemDI | Res (Multifamily) |
| New Construction (NC) | UpDeemed | Res (Multifamily) |
| New Construction (NC) | DnDeemed | Res (Multifamily) |

Eligible Products

The boiler must be used for space heating to induce human comfort, as defined by the California Appliance Efficiency Regulations (Title 20) and Building Energy Efficiency Standards (Title 24).

The boiler must meet efficiency and reset requirements based on input ratings and types shown in the Measure Case Description.

The installation address must have a commercial natural gas account with a California IOU.

Eligible Building Types and Vintages

This measure is applicable for the following existing and new commercial and multifamily installations.

| **Building Type Sector** | **Building Types(s)** |
| --- | --- |
| Residential | Residential Multi-family |
| Commercial | Commercial |
| Commercial | Education - Community College |
| Commercial | Education - Secondary School |
| Commercial | Education - University |
| Commercial | Health/Medical - Hospital |
| Commercial | Lodging - Hotel |
| Commercial | Health/Medical - Nursing Home |
| Commercial | Office - Large |
| Commercial | Office - Small |
| Commercial | Retail - Multistory Large |
| Commercial | Manufacturing Biotech |

The following table shows which sector’s building type are applicable for each measure:

|  |  |
| --- | --- |
| **Statewide Measure Offering ID** | **Sector(s)** |
| SWHC004A | Res (MFm) Only |
| SWHC004B, SWHC004C, SWHC004E, SWHC004F, SWHC004H | Res (MFm) and Commercial |
| SWHC004D, SWHC004G, SWHC004I, SWHC004J | Commercial Only |

Eligible Climate Zones

This measure is applicable in all California climate zones.

Program Exclusions

None.

Data Collection Requirements

For midstream and upstream deliveries, when possible, the program administrator (PA) shall claim the “specific building type savings” in which the equipment will be installed and submit that information at claims level on CEDARS website. In cases where there is no “building type” information available for a given project, program administrator shall claim the weighted savings of “Com” building type.”

Documentation may be required, such as the manufacturer specification sheet that lists the boiler type, input rating, and efficiency rating.

Use Category

HVAC

Electric Savings (kWh)

Electric impacts are approved for condensing boilers measures in the 2020 version of the Database for Energy Efficient Resources (DEER). See Gas Savings section for DEER IDs.

Peak Electric Demand Reduction (kW)

There is peak demand reduction approved for this measure in the 2020 version of the Database for Energy Efficient Resources (DEER).

Gas Savings (Therms)

Commercial

The gas energy savings of a space heating boiler were drawn directly from the Database of Energy Efficient Resources (DEER). The version used to calculate savings for these measures is DEER 2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool (version v.2.5.1); the results have not been modified. Building HVAC type cAVVG was selected for all measures.

Statewide Measure Offering IDs and DEER Energy Impact IDs

| **Statewide Measure Offering ID** | **Measure Offering Description** | **DEER Energy Impact ID** |
| --- | --- | --- |
| SWHC004B | Hot water boiler (300 - 2500 kBtuh, 85.0 Et, OA Reset from 140 to 165 F) | NG-HVAC-Blr-HW-300to2500kBtuh-85p0Et-Drft |
| SWHC004C | Hot water boiler (300 - 2500 kBtuh, 94.0 Et, condensing, OA reset from 140 to 165 F) | NG-HVAC-Blr-HW-300to2500kBtuh-94p0Et-CndStd |
| SWHC004D | Hot water boiler (300 - 2500 kBtuh, 94.0 Et, condensing, OA reset from 115 to 140 F) | NG-HVAC-Blr-HW-300to2500kBtuh-94p0Et-CndLow |
| SWHC004E | Hot water boiler (> 2500 kBtuh, 83.0 Et, 85.0Ec, OA Reset from 140 to 165 F) | NG-HVAC-Blr-HW-gt2500kBtuh-83p0Et-Drft |
| SWHC004F | Hot water boiler (> 2500 kBtuh, 94.0 Et, condensing, OA reset from 140 to 165 F) | NG-HVAC-Blr-HW-gt2500kBtuh-94p0Et-CndStd |
| SWHC004G | Hot water boiler (> 2500 kBtuh, 94.0 Et, condensing, OA reset from 115 to 140 F) | NG-HVAC-Blr-HW-gt2500kBtuh-94p0Et-CndLow |
| SWHC004H | Steam boiler (300 - 2500 kBtuh, 82.0 Et, OA Reset from 140 to 165 F) | NG-HVAC-Blr-Stm-300to2500kBtuh-82p0Et-Drft |
| SWHC004I | Steam boiler (> 2500 kBtuh, 80.0 Et, OA Reset from 140 to 165 F) | NG-HVAC-Blr-Stm-gt2500kBtuh-80p0Et-Drft |
| SWHC004J | Steam boiler (> 2500 kBtuh, 82.0 Et, OA Reset from 140 to 165 F) | NG-HVAC-Blr-Stm-gt2500kBtuh-82p0Et-Drft |

Multifamily

The unit energy savings (UES) of a space heating boiler in a multifamily property was calculated as the difference between the base case and measure case unit energy consumption (UEC) derived from building energy use simulations in eQUEST 3-65.[[3]](#footnote-4) The base case energy models were based on DEER prototype buildings for each climate zone (CZ01-CZ16) and for the following existing and new building vintages: 2003,2007, 2011, 2015 and 2020. Each model was modified to include a heating hot water circulation loop, heating hot water boiler, and a hot water coil at each air handling unit. Inputs were left to DEER prototype defaults unless otherwise noted below.

eQUEST was allowed to auto-size equipment specifications based on DEER prototype zone load requirements. All auto-sized components were left unchanged between the base case and measure cases.

Summary of the Changes to the Prototype eQUEST Models by DOE-2 Keyword

| **System** | **DOE-2 Keyword Change** | **Notes** |
| --- | --- | --- |
| HVAC Systems / Zones | HEAT-SOURCE = HOT-WATER | Changed AHU heat source from a natural gas furnace heating section to heating hot water coils. This was performed to each AHU |
| Circulation Loops | "DEFAULT-HW" = CIRCULATION-LOOP  LIBRARY-ENTRY "DEFAULT-HW" | Created DHW circulation loop using eQUEST defaults |
| Boilers | TYPE = HW-BOILER-W/DRAFT | Defined baseline boiler type based on DEER database |
| Boilers | HEAT-INPUT-RATIO = {Parameter ("Boiler HIR")} | Defined boiler efficiency by a global parameter to allow for boiler efficiency adjustments based on measure |
| Boilers | CAPACITY-RATIO = {Parameter ("Boiler Cap")} | Defined boiler capacity by a global parameter to allow for boiler input capacity adjustments based on measure |
| Boilers | HW-LOOP = "DEFAULT-HW" | Assigned the boiler to serve the “DEFAULT-HW” circulation loop |

The base case and measure case energy use models were changed to reflect the appropriate boiler efficiency, boiler type and capacity ratio for each measure offering. The following table provides the boiler type, boiler efficiency, and boiler heat input ratio (HIR) for each measure offering. These inputs were modified in each eQUEST model based on the measure. For the small boiler offering A, the average AFUE of all qualifying units ≤ 300kBtu/hr and ≥ 94% AFUE was used as the measure case AFUE in eQUEST.

eQUEST Boiler Input Summary Table

| **Measure** | **Case** | **TYPE**  **(DOE2 Keyword Listed)** | **Boiler Thermal Efficiency** | **HEAT-INPUT-RATIO** |
| --- | --- | --- | --- | --- |
| SWHC004A | Base | HW-BOILER-W/DRAFT | 84% (AFUE) | 1.1904 |
| Measure | HW-BOILER-W/DRAFT | 95.4% (AFUE) | 1.0638 |
| SWHC004B | Base | HW-BOILER-W/DRAFT | 80% | 1.2500 |
| Measure | HW-BOILER-W/DRAFT | 85% | 1.1764 |
| SWHC004C | Base | HW-BOILER-W/DRAFT | 80% | 1.2500 |
| Measure | HW-CONDENSING | 94% | 1.0638 |
| SWHC004E \* | Base | HW-BOILER-W/DRAFT | 80% | 1.2500 |
| Measure | HW-BOILER-W/DRAFT | 83% | 1.2048 |
| SWHC004F | Base | HW-BOILER-W/DRAFT | 80% | 1.2500 |
| Measure | HW-CONDENSING | 94% | 1.0638 |
| SWHC004H | Base | STM-BOILER | 79% | 1.2658 |
| Measure | STM-BOILER | 82% | 1.2195 |

\* This measure offering uses combustion efficiency as the efficiency metric in both the baseline and measure case. DEER uses a 2% loss in converting from combustion to thermal efficiency. Therefore 2% was subtracted from both the baseline and measure combustion efficiencies to obtain the thermal efficiency.

All eQUEST simulations were performed using CZ2010 weather data specific to each climate zone. The previous version of the workpaper used various capacity ratios to get the average boiler capacity to fall within the size requirements for each measure offering. However, it was found that this methodology either greatly oversized or undersized the boiler capacity in relation to the heating loop load. Boilers below 300 kBtuh were found to be accurately sized for the net heating loop load generated by DEER models. Therefore, the DEER prototype models for existing and new vintages and all the 16 climate zones were simulated using a Capacity-Ratio of 1, while using appropriate baseline and measure case efficiencies for boiler capacity ranges listed in table above.

The boiler performance curve for condensing boiler was modified based on test data from boiler research project for ASHRAE Standard 155P.[[4]](#footnote-5) Boiler curve based on unit 2 (condensing boiler) was used to simulate the appropriate measure case.

The thermostat setting was updated in both baseline and measure case models to Tstat #4. A thermostat setting of 4 has both the highest average and median setpoint values (a conservative setting).

The final UES for each measure offering was calculated as the weighted average savings of all building vintages using the DEER impact weights.[[5]](#footnote-6) The impact weights are expressed as percentages for each of the “eras” used for DEER weighted measures. The impact weights were used to weight savings values provided for specific building vintages of each era. The eras and their vintages that were used within the calculations for this measure are as follows: “Ex” - Existing/Median Vintage: 2003, 2007, 2011, and 2015; “New” – New Vintage: New. The impact weights were found by normalizing the DEER weight (“wt\_vint”) for each permutation of Building Type, Climate Zone, and Vintage by the total for its Building Type, Climate Zone, and Era.

The weighted UES values were then normalized to Therms/kBtuh of input capacity.

Life Cycle

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for the space heating boiler measure are presented below. Note that RUL is only applicable for add-on equipment and early replacement installations, thus not applicable for this measure.

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| EUL (yrs) | 20.0 | California Public Utilities Commission (CPUC), Energy Division.  2003. Energy Efficiency Policy Manual v 2.0. Page 17. |
| RUL (yrs) | n/a | - |

Base Case Material Cost ($/unit)

Base case equipment costs for conventional and condensing boilers were obtained from 2020 distributor quotes. Using Microsoft Excel’s Data Analysis tool, multiple regression analysis was performed to calculate the relationship between dependent variable Cost ($) and independent variables Capacity (kBtuh) and Efficiency. Cost metrics ($/kBtuh) were then established based on the capacity and efficiency ranges of the measures[[6]](#footnote-7). The multiple regression analysis follows the same strategy used in *2010-2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc.[[7]](#footnote-8)

For boilers with capacities <300 kBtuh the multiple regression analysis was found not to be reasonable. As such, the average costs per kBtuh for all the relevant base case boilers <300 kBtuh was used for the base case material costs.

Distributor quotes did not include pricing for steam boilers, so base case equipment costs for steam boilers were obtained from the *2010-2012 WO017 Ex Ante Measure Cost Study*. These costs were scaled to reflect 2020 pricing using RS Means Historical Cost Index using the average price index across 12 California cities.[[8]](#footnote-9)

As a secondary check, boiler costs were compared to online retailers in Q4 of 2020 and were found to be reasonable.

Measure Case Material Cost ($/unit)

Measure case equipment costs for conventional and condensing boilers were obtained from 2020 distributor quotes. Using Microsoft Excel’s Data Analysis tool, multiple regression analysis was performed to calculate the relationship between dependent variable Cost ($) and independent variables Capacity (kBtuh) and Efficiency. Cost metrics ($/kBtuh) were then established based on the capacity and efficiency ranges of the measures [[9]](#footnote-10). The multiple regression analysis follows the same strategy used in *2010-2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc.[[10]](#footnote-11)

For boilers with capacities <300 kBtuh the multiple regression analysis was found not to be reasonable. As such, the average costs per kBtuh for all the eligible measure case boilers <300 kBtuh was used for the measure material costs.

Distributor quotes did not include pricing for steam boilers, so measure case equipment costs for steam boilers were obtained from the *2010-2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc. These costs were scaled to reflect 2020 pricing using RS Means Historical Cost Index using the average price index across 12 California cities.[[11]](#footnote-12)

The WO017 Study did not report measure costs for the steam boiler 82% TE, > 2,500 kBtuh. Thus, the cost for this measure offering was determined using a multiple regression modeling approach outlined in the 2010-2012 WO017 Study. Costs are reported on a per input kBtuh basis.

As a secondary check, boiler costs were compared to online retailers in Q4 of 2020 and were found to be reasonable.

Base Case Labor Cost ($/unit)

The base case installation labor hours were obtained from the *2010-2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc. Labor rate was determined using 2020 RS Means pricing for a steamfitter and scaled to California pricing using the RS Means City Cost Index across 37 California cities.11 Costs are reported on a per input kBtuh basis.**Error! Bookmark not defined.**

Measure Case Labor Cost ($/unit)

The measure case installation labor hours were obtained from the *2010-2012 WO017 Ex Ante Measure Cost Study* conducted by Itron, Inc. Labor rate was determined using 2020 RS Means pricing for a steamfitter and scaled to California pricing using the RS Means City Cost Index across 37 California cities. 11 Costs are reported on a per input kBtuh basis. **Error! Bookmark not defined.**

Net-to-Gross (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. This NTG value is based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG (“default NTG”) is applicable to all energy efficiency measures that have been offered through commercial sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| NTG – Residential  NTG ID: *Res-Default>2* | 0.55 | Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Pages 15-4 Table 15-3. |
| NTG – Commercial  NTG ID: *Com-Default>2yrs* | 0.60 |
| NTG – Commercial (Downstream)  NTG ID: *NonRes-sAll-mHVAC-NGBoiler* | 0.20 |

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. The assigned GSIA value for this measure is specified below. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| GSIA | 1.0 | California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31. |

Non-Energy Impacts

Non-energy benefits for this measure have not been quantified.

DEER Differences Analysis

This section provides a summary of inputs and methods from the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

| **DEER Item** | **Comment / Used for Workpaper** |
| --- | --- |
| Modified DEER methodology | Yes |
| Scaled DEER measure | No |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | DEER 2020, READI v2.5.1 |
| Reason for Deviation from DEER | DEER does not include boiler measures for the Multifamily (MFm) building type. |
| DEER Measure IDs Used | NG-HVAC-Blr-Stm-300to2500kBtuh-82p0Et-Drft  NG-HVAC-Blr-Stm-gt2500kBtuh-80p0Et-Drft  NG-HVAC-Blr-Stm-gt2500kBtuh-82p0Et-Drft  NG-HVAC-Blr-HW-300to2500kBtuh-85p0Et-Drft  NG-HVAC-Blr-HW-300to2500kBtuh-94p0Et-CndStd  NG-HVAC-Blr-HW-300to2500kBtuh-94p0Et-CndLow  NG-HVAC-Blr-HW-gt2500kBtuh-83p0Et-Drft  NG-HVAC-Blr-HW-gt2500kBtuh-94p0Et-CndStd  NG-HVAC-Blr-HW-gt2500kBtuh-94p0Et-CndLow |
| NTG | Source: DEER 2019. The NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs.* The NTG of 0.55 is associated with NTG ID: *Res-Default>2.*  Source:DEER 2022. The NTG of 0.20 is associated with NTG ID: *NonRes-sAll-mHVAC-NGBoiler* per CPUC Resolution E-5082 |
| GSIA | Source: DEER 2011. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER 2013. The value of 20 years is associated with EUL ID: *HVAC-Blr* |

Revision History

Measure Characterization Revision History

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| --- | --- | --- | --- |
| **Revision Number** | **Revision Complete Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| 01 | 06/30/2018 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  PGECOHVC101, Revision 6 (January 1, 2017)  WPSDGENRHC1061, Revision 1 (September 23, 2016) – short form  WPSCGNRHC12026A, Revision 4 (March 17, 2014)  Consensus reached among Cal TF members. |
| 6/12/2019 | Lake Casco  TRC | Updates to:  Condensing boiler measures with OA temp reset from 115 to 140°F and Steam boiler 82% TE, >2500 kBtuh added  Code requirement updated to reflect 2019 Title 20 and 2019 Title 24 versions.  Measure Offering updated to reflect newest DEER  Material and Labor Cost for the Base case and Measure case updated to reflect current pricing.  Net-to-Gross ratio for Residential sector included. |
| 06/27/2019 | Jennifer Holmes  Cal TF Staff | Revisions for submittal of version 01. |
| 02 | 12/25/2020 | Stephen Brett Reno, P.E.  TRC  Tai Voong  PG&E | Updated costs to 2020 values  Updated NTG values for Commercial Downstream measures to NonRes-sAll-mHVAC-NGBoiler per CPUC Resolution E-5082  Added new commercial building types  Used “Any” PA impacts for all DEER commercial building savings |
| 4/30/2021 | TRC  Anders Danryd,  SoCalGas | Updated Offering A minimum AFUE due to code update to the base case. Updated descriptions for outdoor reset control, clarified eligible building types.  Removed NTG ID update for 2022. Fixed errors in the EAD tables. |
| 09/14/2021 | Soe K. Hla  PG&E | Replaced PGE measure code for measures with Res Sector, adopted remaining PGE measures  Remove OA Reset Control from measure B Res-Sector from Measure Tab- EAD, Updated measure descriptions in Implementation Tab- EAD to match description from Measure Tab- EAD. Added new ElecImpactProfile IDs instead of “blank” in EAD.  Corrected OA Reset Control temperature in Measure Case Specification Table in Word Doc. Corrected DEER Measure IDs Used in DEER Difference Summary Table in Word Doc. |
| 03 | 06/07/2021 | Anders Danryd,  SoCalGas | Updated NTG values for Commercial Downstream measures to NonRes-sAll-mHVAC-NGBoiler per CPUC Resolution E-5082 |
| 11/19/2021 | Soe K. Hla  PG&E | Copied all the changes incorporated to rev. 02 updated on 09/14/2021. |
| 12/09/2021 | Jeff Cun,  SoCalGas | Updated EAD table with correct values from WBStd colums and HVAC type updated to cAVVG. Updated text to cAVVG. |

1. California Energy Commission (CEC). 2019. California Code of Regulations Title 20. CEC-140-2019-002. January. [↑](#footnote-ref-2)
2. California Energy Commission (CEC). 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24).* CEC-400-2018-020-CMF. [↑](#footnote-ref-3)
3. Pacific Gas and Electric Company (PG&E). 2019. “SWHC004-01 eQUEST Calculations.zip.” [↑](#footnote-ref-4)
4. Pacific Gas and Electric Company (PG&E), Applied Technology Services. *2012. Boiler Research Project – ASHRAE Standard 155P.* ET Project Number: ET11PGE5271. February 29. [↑](#footnote-ref-5)
5. Pacific Gas and Electric Company (PG&E). 2019. “SWHC004-01 DEER 2020 Building Weights Tables.xlsx.” [↑](#footnote-ref-6)
6. Pacific Gas & Electric (PGE). (n.d.) "SWHC04-02 MeasureDataSpec.xls", “Cost Data” tab. [↑](#footnote-ref-7)
7. Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission. Table 3-20. [↑](#footnote-ref-8)
8. Gordian. (n.d.) “RSMeans Cost Index.pdf.” [↑](#footnote-ref-9)
9. Pacific Gas & Electric (PGE). (n.d.) "SWHC04-02 MeasureDataSpec.xls", “Cost Data” tab. [↑](#footnote-ref-10)
10. Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission. Table 3-20. [↑](#footnote-ref-11)
11. Gordian. (n.d.) “RSMeans Cost Index.pdf.” [↑](#footnote-ref-12)