|  |
| --- |
| Service & Domestic Hot Water  Heat Pump Water Heater, Commercial, Fuel SubstitutioN  SWWH027-01 |

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Measure Name

Heat Pump Water Heater, Commercial, Fuel Substitution

Statewide Measure ID

SWWH027-01

Effective Date

October 26, 2020

Technology Summary

Domestic water heaters are pressure vessels that transfer heat to water. The heater may heat the domestic water using a heat exchanger that works like an instantaneous water heater with an integral tank and heat exchanger. Heat pump water heaters use a direct expansion (DX) heat pump to transfer heat to the water. Heat pump water heaters achieve higher efficiency compared to electric-resistance or natural gas water heaters and are typically equipped with supplemental electric-resistance elements for periods of high demand.

The most significant barrier to a water heater retrofit is the typical nature of water heater replacements. Approximately 37% of consumers replace their water heaters due to the sudden failure of their existing water heater.[[1]](#footnote-1) When a water heater fails, most consumers will purchase a replacement that is the cheapest and most readily available model that is also easy to install. These prevailing attitudes do not encourage consumers to find more advanced, energy-efficient models that are available.

Definitions of key terms are as follows:

* Instantaneous water heater (a “tankless water heater”): eliminates energy lost to standby operation by only heating when flow sensor is activated. An instantaneous water heater is more efficient than a traditional storage water heater.[[2]](#footnote-2)
* Storage water heater: utilizes a tank of water that is heated by a burner at the bottom. Efficient models have better insulation, heat traps, and secondary heat exchangers at the top of the tank.[[3]](#footnote-3)
* Draw pattern: categorizes hot water first-hour rating and maximum flow parameters for water heaters.[[4]](#footnote-4)  See Code Requirements for draw pattern derivation.
* Uniform energy factor (UEF): an efficiency metric that is normalized based on draw pattern and taken over a 24-hour period. UEF represents the amount of energy delivered per normalized energy consumption.[[5]](#footnote-5)

Measure Case Description

This measure includes efficient heat pump water heaters. Efficiency requirements use the uniform energy factor (UEF) metric, as required by federal regulations.[[6]](#footnote-6) The minimum qualifying measure efficiencies are based on the DEER water heater calculator tool version 4.2 and exceed the California Title 20 and Code of Federal Regulations standards (see Code Requirements).

The measure case heat pump water heater equipment is be classified with following characteristics.

Measure Case Specification

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Storage Capacity (gallons)** | **UEF** |
| Heat Pump Water Heater | > 45 to ≤ 55 | 3.09 |
| > 45 to ≤ 55 | 3.31 |
| > 55 to ≤75 | 3.33 |
| >75 | 3.42 |

As this is a fuel substitution measure, the offerings include the replacement of specific existing base case natural gas water heaters with the measure case equipment specified above.

|  |  |  |
| --- | --- | --- |
| **SW Offering ID** | **Measure Case Description** | **Base Case Description** |
| SWWH027A | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Storage Natural Gas Water Heater, 30 to less than 40 Gal, Med Draw, UEF=0.6 |
| SWWH027B | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Storage Natural Gas Water Heater, 30 to less than 40 Gal, Med Draw, UEF=0.6 |
| SWWH027C | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Storage Natural Gas Water Heater, 40 to less than 50 Gal, Med Draw, UEF=0.58 |
| SWWH027D | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Storage Natural Gas Water Heater, 40 to less than 50 Gal, Med Draw, UEF=0.58 |
| SWWH027E | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Storage Natural Gas Water Heater, 40 to less than 50 Gal, Hi Draw, UEF=0.64 |
| SWWH027F | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Storage Natural Gas Water Heater, 40 to less than 50 Gal, Hi Draw, UEF=0.64 |
| SWWH027G | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Storage Natural Gas Water Heater, 50 to less than 60 Gal, Med Draw, UEF=0.56 |
| SWWH027H | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Storage Natural Gas Water Heater, 50 to less than 60 Gal, Med Draw, UEF=0.56 |
| SWWH027I | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Storage Natural Gas Water Heater, 50 to less than 60 Gal, Hi Draw, UEF=0.63 |
| SWWH027J | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Storage Natural Gas Water Heater, 50 to less than 60 Gal, Hi Draw, UEF=0.63 |
| SWWH027K | Heat Pump Water Heater, 65 Gal, UEF=3.33 | Storage Natural Gas Water Heater, 60 to less than 75 Gal, Hi Draw, UEF=0.61 |
| SWWH027L | Heat Pump Water Heater, 80 Gal, UEF=3.42 | Storage Natural Gas Water Heater, 75 to less than 80 Gal, Hi Draw, UEF=0.59 |
| SWWH027M | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Tankless Natural Gas Water Heater, Low Draw, UEF=0.81 |
| SWWH027N | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Tankless Natural Gas Water Heater, Low Draw, UEF=0.81 |
| SWWH027O | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Tankless Natural Gas Water Heater, Med Draw, UEF=0.81 |
| SWWH027P | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Tankless Natural Gas Water Heater, Med Draw, UEF=0.81 |
| SWWH027Q | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.09 | Tankless Natural Gas Water Heater, Hi Draw, UEF=0.81 |
| SWWH027R | Heat Pump Water Heater, >45 to ≤55 Gal, UEF=3.31 | Tankless Natural Gas Water Heater, Hi Draw, UEF=0.81 |

Base Case Description

The base case is defined as a natural gas storage or instantaneous (“tankless”) domestic hot water heater that meets the minimum federal code (see Code Requirements). The measure assumes that the customer’s existing case and the code/standard case baselines are the same.

Base Case Specification

|  |  |  |  |
| --- | --- | --- | --- |
| **Equipment Type** | **Draw Pattern** | **Storage Capacity (gallons)** | **Efficiency** |
| Storage Natural Gas Water Heater | Med | 30 | 0.60 UEF |
| Med | 40 | 0.58 UEF |
| High | 40 | 0.64 UEF |
| Med | 50 | 0.56 UEF |
| High | 50 | 0.63 UEF |
| High | 60 | 0.61 UEF |
| High | 75 | 0.59 UEF |
| Tankless Natural Gas Water Heater (< 200 kBtu/hr) | Low | N/A | 0.81 UEF |
| Med | N/A | 0.81 UEF |
| High | N/A | 0.81 UEF |

Code Requirements

This measure is governed by the California Building Energy Efficiency Standards (Title 24), California Appliance Efficiency Regulations (Title 20), and Federal Standards. Title 24 adopts the Title 20 requirements. The minimum baseline efficiencies are based on Federal Standards which exceed Title 20 requirements.

**Applicable State and Federal Codes and Standards**

|  |  |  |
| --- | --- | --- |
| **Code** | **Code Reference** | **Effective Date** |
| CA Appliance Efficiency Regulations – Title 20 (2019) | Section 1605.1(f)(1) | January 1, 2019 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 110.1 | January 1, 2020 |
| Federal Standards – Code of Federal Regulations | 10 CFR 430.32(d) | December 29, 2016 |
| Federal Standards – Code of Federal Regulations | 10 CFR 430 Subpart B, Appendix E, Section 5.4.1 | December 29, 2016 |

**Code of Federal Regulations.** In December 2016 the U.S. Department of Energy (DOE) issued a Final Ruling in Docket No. EERE-2015-BT-TP-0007 that established a new efficiency rating for all residential and some commercial water heating technologies are rated.[[7]](#footnote-7) All water heaters within the scope of the ruling will no longer be rated with the energy Factor (EF), thermal efficiency (TE), or standby loss ratings; the Uniform Energy Factor (UEF) is the new metric for the energy efficiency of water heaters. A UEF rating is determined by assigning a water heater into one of four different categories of hot water usage and then evaluating its performance based on that usage.[[8]](#footnote-8) The four categories are based on draw pattern – very small, low, medium, and high. This allows water heaters to be compared more easily between different types (i.e., storage and tankless), as long as units are compared within the same bin.

With this final ruling, the DOE established a mathematical conversion between the values determined using the ER, TE, and SL test procedures and the values determined using the uniform efficiency descriptor test procedure. The DOE used the conversion factors to derive minimum energy performance standards based on UEF. The standards denominated in UEF are neither more nor less stringent than the EF-denominated standards for consumer water heaters and for commercial water-heating equipment based on the TE and SL metrics.

Appendix E Section 5.4 defines the draw patterns definition using the first-hour rated and maximum GPM ratings.

Draw Pattern To Be Used Based on First-Hour Rating

|  |  |  |
| --- | --- | --- |
| **FIRST-HOUR RATING GREATER THAN OR EQUAL TO:** | **… AND FIRST-HOUR RATING LESS THAN:** | **DRAW PATTERN TO BE USED IN SIMULATED-USE TEST** |
| 0 gallons | 18 gallons | Very-small-Usage (Table III.1). |
| 18 gallons | 51 gallons | Low-Usage (Table III.2). |
| 51 gallons | 75 gallons | Medium-Usage (Table III.2). |
| 75 gallons | No upper limit | High-Usage (Table III.4). |

Draw Pattern To Be Used Based on Maximum GPM Rating

|  |  |  |
| --- | --- | --- |
| **MAXIMUM GPM RATING GREATER THAN OR EQUAL TO:** | **AND MAXIMUM GPM RATING LESS THAN:** | **DRAW PATTERN TO BE USED IN SIMULATED-USE TEST** |
| 0 gallons/minute | 1.7 gallons/minute | Very-small-Usage (Table III.1). |
| 1.7 gallons/minute | 2.8 gallons/minute | Low-Usage (Table III.2). |
| 2.8 gallons/minute | 4 gallons/minute | Medium-Usage (Table III.2). |
| 4 gallons/minute | No upper limit | High-Usage (Table III.4). |

**Title 20 1605.1(f)(1) California Minimum Energy Factor Requirements for Water Heaters**



**Federal Standard 10 CFR 430.32(d) Minimum Energy Factor Requirements for Water Heaters**



Normalizing Unit

Each

Program Requirements

Fuel Substitution Test

Per CPUC Decision 19-08-009 Rulemaking 13-11-005 “Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution”, for all fuel substitution measures, the measure must ‘not increase total source energy consumption when compared with the baseline comparison measure available utilizing the original fuel’. [[9]](#footnote-9) Also, the measure ‘must not adversely impact the environment compared to the baseline measure utilizing the original fuel. Fuel substitution calculations were conducted using CPUC’s “Fuel Substitution Calculator” to confirm the measures in this workpaper pass Parts One and Two of the Fuel Substitution Test.**[[10]](#footnote-10)**

Measure Implementation Eligibility

All measure application type, delivery type, and sector combinations 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 | DnDeemed | Com |
| Normal Replacement | DnDeemDI | Com |
| Normal Replacement | UpDeemed | Com |
| New Construction | DnDeemed | Com |
| New Construction | DnDeemDI | Com |
| Accelerated Replacement | DnDeemed | Com |
| Accelerated Replacement | DnDeemDI | Com |
| Normal Replacement | DnDeemed | Ind |
| Normal Replacement | DnDeemDI | Ind |
| Normal Replacement | UpDeemed | Ind |
| New Construction | DnDeemed | Ind |
| New Construction | DnDeemDI | Ind |
| Accelerated Replacement | DnDeemed | Ind |
| Accelerated Replacement | DnDeemDI | Ind |

*Required Documentation for Normal Replacement in Upstream and Mid-Stream Delivery*

For upstream/ midstream delivery types, the participant baselines and spillover effects are unknown. Furthermore, the manufacturer(s) and distributor(s) do not know if the purchased measure is replacing a gas or an electric appliance. Claimed savings for these delivery types will be adjusted using the ratio of baseline gas appliance to total baseline appliances. These ratios will be determined from the California Commercial End-Use Survey (CEUS).[[11]](#footnote-11) The implementer shall survey 10% of the midstream installations to determine actual gas/electric baseline proportions; the program administrator shall adjust claimed savings based upon these survey results. This survey will be conducted monthly, by e-mail. A sample survey question is as follows:

“What was the fuel source of the equipment you replaced?”

1. Gas
2. Electric
3. I don’t know/I’m not sure

In addition, for midstream delivery, the implementer should provide the retailer or distribution location where the product was sold, rated capacity, and proposed commercial building type in which the equipment will be installed.

A survey will not be administered for upstream delivery types.

*Required Documentation for Normal Replacement, New Construction, and Accelerated Replacement for Downstream and Direct Install Delivery*

For downstream deemed and downstream direct-install delivery types, in addition to the standard information such as building type, climate zone, and capacity of the units, the following data must be submitted with each project application by the project developer:

* What is the existing fuel type for space heating?
* Did the site require any electric infrastructure upgrades for the proposed electrification measure? If yes, provide the itemized invoices with infrastructure upgrade costs.
* Did the owner install any other electrification measures at this site? If yes, list the measures and provide the itemized invoices with infrastructure upgrade costs (if any).

*Required Documentation for Accelerated Replacement*

Preponderance of Evidence (POE) must be documented for all accelerated replacement application types. Notably, programs shall document if measure was replaced as a direct result of information, recommendations, and support provided by the Program Administrator, and programs shall require the collection and submission of documentation to ensure proper conformance to eligibility and implementation requirements. The following are the types of information that will be required for all projects:

* Customer/site information
* Specifications of existing equipment
* Proof that water heater is still operating as intended
* Existing water heater nameplate data with manufacturer date to confirm remaining useful life
* Replacement water heater information

To document POE, the POE survey, or similar, should be completed. [[12]](#footnote-12)

Eligible Products

The heat pump water heater must meet the storage capacity and minimum efficiency requirements set forth in the Measure Case Description. Existing base equipment must be disposed.

In some cases, heat pump water heaters may contain multiple heat pump units. The efficiency of the measure case must be the efficiency of the package unit not the efficiency of individual heat pumps which make-up the unit.

Split-system heat pump unit assemblies are eligible. However, they shall be treated as one package of one or more heat pumps serving a storage tank. Efficiency and performance ratings for the entire package shall be provided by the manufacturer. The efficiency of an individual heat pump within the package shall not be sufficient.

Eligible Building Types and Vintages

This measure is applicable for all existing commercial and industrial building types.

Eligible Climate Zones

This measure is applicable in all California climate zones.

Incentive Amounts

Fuel substitution measures face market barriers, including consumer market failures and supplier market failures.[[13]](#footnote-13) Implementation of this measure may require a rebate or financial incentive to participants that exceeds the measure cost.[[14]](#footnote-14)

Incentive Requirements

Deployment of the program may require rebates or financial incentives to participants that exceed the Incremental Measure Cost (IMC). Incentives or rebates that exceed the incremental cost for a measure must be justified by individual PAs in addendum to workpaper submissions to document program implementation practice prior to program implementation.

Program Exclusions

This measure is not applicable for new construction installations. However new services, as defined in *Fuel Substitution Technical Guidance for Energy Efficiency*, are eligible. [[15]](#footnote-15) New service measures are only eligible for Downstream and Direct Install application, when:

* Measures are installed in new areas of an existing building,
* Measures are installed in a major renovation of an existing building, or
* Measures are installed in capacity expansions of existing systems to serve existing and/or new load retrofits that require a new energy service.

These exceptions will follow the same baseline technology requirements as a normal replacement measure application type.

Data Collection Requirements

Baseline equipment type and fuel source must be verified, for downstream and direct install measures.

Per CPUC Decision 19-08-009, building infrastructure costs which include panel upgrades or gas line installations/upgrades required to facilitate these fuel substitution measures shall be collected for all downstream and direct install measures. [[16]](#footnote-16)

Use Category

Service & domestic hot water

Electric Savings (kWh)

The unit energy savings (UES) values for a heat pump water heater are available in the 2020 version of the Database of Energy Efficient Resources (DEER). However, the DEER UES values are based upon an electric resistance baseline and are not applicable to this fuel substitution measure.

Therefore, the unit energy consumption (UEC) and UES were derived from the DEER water heater calculator tool version 4.2, a macro-enabled Excel workbook developed by consultants of the California Public Utilities Commission (CPUC) Energy Division to standardize the inputs and savings calculations for water heating measures.[[17]](#footnote-17) The calculator "utilizes hourly output from the DEER2014 DOE-2 building prototypes for hot water loads (in gallons per minute, by building type) and ambient conditions (incoming “mains” water temperature, ambient indoor space temperature) to estimate hourly energy use for a variety of water heaters.”[[18]](#footnote-18)

The DEER Water Heater Calculator tool version 4.2 includes a Com building list which includes two building types which are classified as Industrial (MBT and MLI). These two building types were removed from the Com results and new Energy Impact IDs and Measure IDs were created for Industrial sector using the DEER Water Heater Calculator tool version 4.2 results for MBT and MLI building types.

peak electric Demand Reduction (kW)

In accordance with the requirements of the *Fuel Substitution Technical* *Guidance* issued by the California Public Utilities Commission (CPUC) in October 2019, there will not be any peak demand reduction or penalty towards peak demand goal achievement from fuel substitution measures.[[19]](#footnote-19)

Gas Savings (therms)

Gas unit energy consumption and savings were calculated using the same methodology as the electric energy savings. See Electric Savings for details.

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 represents the estimated lifetime of a heat pump water heater. The RUL is based upon the base case of either a storage or tankless natural gas water heater for the accelerated replacement (AR) application type. RUL is not applicable for the normal replacement (NR) application type.

**Effective Useful Life and Remaining Useful Life**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Measure: EUL (yrs) (*EUL ID: WtrHt-HtPmp*) | 10.0 | California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update\_2014-02-05.xlsx.” |
| Baseline: RUL (yrs) (RUL ID: *WtrHt-Com*) | 5.0 | California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update\_2014-02-05.xlsx.” |
| Baseline: RUL (yrs) (RUL ID: *WtrHt-Instant-Com*) | 6.67 | California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update\_2014-02-05.xlsx.” |

Base Case Material Cost ($/unit)

The workpaper will reference SWWH025-01 Residential Heat Pump Water Heater, Fuel Substitution costs. Due to the size of the units it is assumed costs would be the same for commercial and residential material cost. Baseline cost data was collected using online web scraping of applicable natural gas water heaters during the second quarter of 2020.[[20]](#footnote-20) Retailers referenced include Home Depot, Lowes, Grainger, Menards, ABT, SupplyHouse, Supply.com, Zoro, AFSupply, TotalHomeSupply, GlobalIndustrial, HomePerfect, and AceHardware. Costs were averaged based on water heater type and relevant storage capacity bins. Since all the equipment collected were featured standard efficiency UEF values, only single cost values were calculated per storage capacity bin. Similarly, costs collected for the tankless water heaters showed flow rates which included only high-draw models, thus only a single base case tankless water heater cost was calculated. The table below show the resultant baseline technologies and their respective costs and sample sizes.

**Storage Water Heaters Base Material Cost**

|  |  |  |
| --- | --- | --- |
| **Baseline Technology** | **Average NGWH Cost** | **Sample Count** |
| 30-gallon Natural Gas Storage Water Heater | $628.88 | 23 |
| 40-gallon Natural Gas Storage Water Heater | $717.85 | 57 |
| 50-gallon Natural Gas Storage Water Heater | $961.68 | 48 |
| 60-gallon Natural Gas Storage Water Heater | $1,139.46 | 11 |
| 75-gallon Natural Gas Storage Water Heater | $1,437.09 | 26 |
| Tankless Natural Gas Storage Water Heater | $1,082.68 | 58 |

As the existing case and standard case equipment is assumed to be the same, they use the same costs.

See cost spreadsheet for the collected baseline costs. [[21]](#footnote-21)

Measure Case Material Cost ($/unit)

Measure cost data was collected in another workpaper, SWWH014-02 “Heat Pump Water Heater”.

In SWWH014-02 the costs for heat pump water heaters were calculated as the average of costs of qualifying units sold by online retailers.[[22]](#footnote-22) The market is limited for heat pump water heaters ≥ 2.91 UEF; costs were based upon seven models (represented by five manufacturers). These costs were determined to be representative of unit costs based on online retailer checks in the second quarter of 2020.

This workpaper adopts these heat pump water heater costs as material costs directly. See cost spreadsheet for the collected measure costs.[[23]](#footnote-23)

**Infrastructure Costs**. For a natural gas water heater to heat pump water heater infrastructure, upgrades would include a capping off the natural gas line, closing exhaust vents, and running 240 power to the heater. Existing gas water heaters will typically only be using 120V power. These infrastructure costs were estimated using 2020 RSMeans Online data[[24]](#footnote-24) and online retailer costs. RSMeans hourly labor rates for a residential electrician[[25]](#footnote-25) were used to estimate labor costs. See the table below for details and the cost calculations for more details.[[26]](#footnote-26) Infrastructure costs are provided for informational purposes only and are not included as part of the labor or measure cost. Infrastructure costs will be collected during program implementation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description of Work** | **Labor Hours** | **Labor Cost** | **Material Cost** | **Total Cost** |
| Cap Existing Gas Line w/ Brass Plug for Natural Gas lines. | 0.250 | $22.90 | $4.04 | $26.94 |
| Demolish Existing Vent | 0.727 | $66.60 | $0.00 | $66.60 |
| Water heater electrical hookup, includes breaker box, 20' of wiring | 1.248 | $114.32 | $54.50 | $168.82 |
| **Total** | **2.225** | **$203.82** | **$58.54** | **$262.36** |

For AR measures, it is required to use the Accelerated Replacement Cost (ARC)[[27]](#footnote-27). ARC is the cost of the efficiency measure installed in an Accelerated Replacement situation. The ARC is the FMC of the efficiency measure, reduced by the net present value of the FMC that would have been incurred to install the Standard Practice second baseline equipment at the end of the RUL. The ARC is calculated using the following formula:

Where:

FMC = full measure cost

IMC = incremental measure cost

D = CPUC-adopted PA discount rate (7.66% for PG&E service territory, 7.65% for SCE service territory, 7.38% for SCG service territory, and 7.55% for SDG&E service territory)

RUL = Remaining useful life (in years) of the early retired equipment

Base Case Labor Cost ($/unit)

The workpaper will reference SWWH025-01 Residential Heat Pump Water Heater, Fuel Substitution costs. Due to the size of the units it is assumed costs would be the same for commercial and residential installation. The estimated installation hours for each of the baseline water heater technologies and capacities in the workpaper were obtained from RSMeans 2020[[28]](#footnote-28) and multiplied by the RSMeans 2020 hourly plumber rate ($/hr).[[29]](#footnote-29)

Measure Case Labor Cost ($/unit)

The workpaper will reference SWWH025-01 Residential Heat Pump Water Heater, Fuel Substitution costs. Due to the size of the units it is assumed costs would be the same for commercial and residential installation. The estimated installation hours for each of the heat pump water heater capacities in the workpaper were obtained from RSMeans 2020[[30]](#footnote-30) and multiplied by the RSMeans 2020 hourly plumber rate ($/hr).[[31]](#footnote-31) Labor hours for heat pump water heaters were not specifically called out so the hours for electric water heaters were used and are assumed to be applicable.

Please refer to section “Measure Case Material Cost” for AR measure cost calculation.

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. The NTG for fuel substitution measures was stipulated in Decision 19-08-009, *Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution,* issued by the California Public Utilities Commission (CPUC).[[32]](#footnote-32) “When a fuel substitution measure passes the Fuel Substitution Test, it shall be included in the cost-effectiveness analysis of the portfolio with a net-to-gross (NTG) ratio assumption of 1.0, until such time as evaluated NTG information is available, when the assumption shall be updated on a prospective basis.” (OP 1)

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| NTG – FuelSubst-Default | 1.0 | California Public Utilities Commission (CPUC). 2019. Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005). Issued August 5. OP 1  California Public Utilities Commission (CPUC), Energy Division. 2019. *Fuel Substitution Technical Guidance, Version 1.1.* October 31. |

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) rate 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.

Gross Savings Installation Adjustment Rates

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

DEER Differences Analysis

This section provides a summary of DEER-based inputs and methods, 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 | No |
| DEER Version | 2021 |
| Reason for Deviation from DEER | The DEER 2021 commercial measures use a Norm Unit of per kBTUh. This workpaper uses a Norm Unit of per Each. |
| DEER Measure IDs Used | N/A |
| NTG | Source: DEER. The NTG of 1.0 is associated with NTG ID: FuelSubst-Default |
| GSIA | Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | Source: DEER. The EUL value of 10 years with EUL ID: WtrHt-HtPmp  Source: DEER. The RUL value of 5 years with RUL ID: WtrHt-Com  Source: DEER. The RUL value of 6.67 years with RUL ID: WtrHt-Instant-Com |

Revision History

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Number** | **Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| 01 | 7/30/2020 | Keith Valenzuela, Engineering Manager, AESC | First draft of workpaper. |
|  | 1/7/2021 | Jesse Manao, SCE | Corrections:  - EAD Table & Workpaper Text: Removed MeasureID SWWH027S through SWWH027AJ (intended for industrial sector) and replaced with duplication for IDs SWWH027A through SWWH027R  - EAD Table: Included missing ElecImpactProfileID and GasImpactProfileID  - EAD Table: Columns in EnergyImpactIDs are corrected to default order |

1. Ciani, A. (Russell Research). 2018. Water Heater Market Characterization Report. Prepared for the Northwest Energy Efficiency Alliance (NEEA). Report # E18-395. April 3. [↑](#footnote-ref-1)
2. ENERGY STAR. (n.d.) “How it Works – Whole-Home Gas Tankless Water Heaters.”  [↑](#footnote-ref-2)
3. ENERGY STAR. (n.d.) “How it Works – High-Efficiency Gas Storage Water Heaters.” [↑](#footnote-ref-3)
4. U.S. Department of Energy (DOE). 2016. “Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters.” *Federal Register: The Daily Journal of the United States.* 81 Fed. Reg. 250. December 29, 2016. [↑](#footnote-ref-4)
5. Healy, B. (National Institute of Standards and Technology, NIST). (n.d.) “Water Heating Technologies and Ratings.” [↑](#footnote-ref-5)
6. U.S. Department of Energy (DOE). 2016. “Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters.” *Federal Register: The Daily Journal of the United States.* 81 Fed. Reg. 250. December 29, 2016. [↑](#footnote-ref-6)
7. U.S. Department of Energy (DOE). 2016. “Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters.” Federal Register. Vol. 81, No. 250. December 29. [↑](#footnote-ref-7)
8. A.O. Smith. (n.d.) “What Does UEF Mean To You?”  [↑](#footnote-ref-8)
9. California Public Utilities Commission (CPUC). 2019. “Decision 19-08-009 Rulemaking 13-11-005 Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution”. August 1. OP 1. [↑](#footnote-ref-9)
10. Southern California Edison (SCE). 2020. “SWWH027-01 Fuel Substitution Calculator.xlsx”. [↑](#footnote-ref-10)
11. Itron, Inc. 2006. California Commercial End Use Survey. Prepared for the California Energy Commission. CEC-400-2006-005.  [↑](#footnote-ref-11)
12. SWWH027-01 HPWH-FS POE Survey.docx [↑](#footnote-ref-12)
13. Energy and Environmental Economics, Inc. 2019. Residential Building Electrification in California. Consumer economics, greenhouse gases and grid impacts. April. San Francisco (CA): Energy and Environmental Economics, Inc. [↑](#footnote-ref-13)
14. Originally defined in D.92-09-080, the dual test was last modified in D.05-04-051 [↑](#footnote-ref-14)
15. California Public Utilities Commission (CPUC), Energy Division. 2019. Fuel Substitution Technical Guidance, Version 1.1. October 31. Page 3. [↑](#footnote-ref-15)
16. California Public Utilities Commission (CPUC). 2019. “Decision 19-08-009 in Rulemaking 13-11-005 Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution”. August 1. [↑](#footnote-ref-16)
17. California Public Utilities Commission (CPUC), Energy Division. 2020. DEER2021 DEER Water Heater Calculator. " DEER-WaterHeater-Calculator-v4.2.xlsm." Updated September, 2020. [↑](#footnote-ref-17)
18. California Public Utilities Commission (CPUC), Energy Division. 2020. DEER Water Heater Calculator Documentation v4.0 for DEER2021. " DEER-WaterHeater-Documentation-v4.0.pdf." Updated April 30, 2020. [↑](#footnote-ref-18)
19. California Public Utilities Commission (CPUC), Energy Division. 2019. *Fuel Substitution Technical Guidance, Version 1.1.* October 31. [↑](#footnote-ref-19)
20. Southern California Edison (SCE). 2020. " SWWH027-01 MeasureDataSpec.xlsm", Cost Data tab [↑](#footnote-ref-20)
21. Southern California Edison (SCE). 2020. " SWWH027-01 MeasureDataSpec.xlsm", Cost Data tab [↑](#footnote-ref-21)
22. Southern California Edison (SCE). 2018. "SCE17WH001.2 A3 - Costs Calculations.xlsx." [↑](#footnote-ref-22)
23. Southern California Edison (SCE). 2020. " SWWH027-01 MeasureDataSpec.xlsm", Cost Data tab [↑](#footnote-ref-23)
24. 2020 RSMeans Electrical Cost Data [↑](#footnote-ref-24)
25. RSMeans Residential Labor Rates, https://www.rsmeansonline.com/References/LABORRATE/2-Year%202020%20Labor%20Rates/Residential%20Labor%20Rates.PDF , “Residential Labor Rates.pdf” [↑](#footnote-ref-25)
26. Southern California Edison (SCE). 2020. " SWWH027-01 MeasureDataSpec.xlsm", Cost Data tab [↑](#footnote-ref-26)
27. *Statewide Deemed Workpaper Rulebook, Version 3.0.* January 2020. [↑](#footnote-ref-27)
28. 2020 RSMeans Electrical Cost Data [↑](#footnote-ref-28)
29. RSMeans 2020 Residential Labor Rates. https://www.rsmeansonline.com/References/LABORRATE/2-Year%202020%20Labor%20Rates/Residential%20Labor%20Rates.PDF [↑](#footnote-ref-29)
30. 2020 RSMeans Electrical Cost Data [↑](#footnote-ref-30)
31. RSMeans 2020 Residential Labor Rates. https://www.rsmeansonline.com/References/LABORRATE/2-Year%202020%20Labor%20Rates/Residential%20Labor%20Rates.PDF [↑](#footnote-ref-31)
32. California Public Utilities Commission (CPUC). 2019. Decision 19-08-009 in the Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues (R.13-11-005). Issued August 5. OP 1. [↑](#footnote-ref-32)