Work Paper PGECODHW101

**Revision #7**

**Pacific Gas & Electric Company**

**Instantaneous Tankless Domestic Water Heaters**

**For Work Paper Reviewer Use Only**

**List all major comments that occurred during the review. This table may only be removed during management review.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major Comment** | **Reviewer Name** | **Date** | **Outcome/Resolution** |
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# At-a-Glance Summary

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Codes** | DWHC1 - Instantaneous Domestic Water Heater - Condensing, 76-200 kBTUh, TE ≥ 90% | DWHC3 - Instantaneous Domestic Water Heater, > 200 kBTUh, ≥ 84% TE | DWHC4 - Instantaneous Domestic Water Heater - Condensing, > 200 kBTUh, ≥ 90% TE |
| **Measure Description** | Condensing instantaneous domestic water boiler with thermal efficiency ≥ 90%. Input rating must be between 76 and 200 kBTUh | Instantaneous domestic water boilers with thermal efficiency ≥ 84%. Greater than 200 kBTUh input rating | Condensing instantaneous domestic water boilers with thermal efficiency ≥ 90%. Greater than 200 kBTUh input rating |
| **Base Case Description** | Gas storage water heater with thermal efficiency of 80%.  Source: DEER 2016 | Gas storage water heater with thermal efficiency of 80%.  Source: DEER 2016 | Gas storage water heater with thermal efficiency of 80%.  Source: DEER 2016 |
| **Units** | Per kBTUh of boiler rated input | Per kBTUh of boiler rated input | Per kBTUh of boiler rated input |
| **Energy Savings** | Source: DEER2016. READI v2.3.0, Custom Calculations  **kW: 0.00/kBTUh**  **kWh: 0.05/kBTUh**  **Therm: 3.26/kBTUh** | Source: DEER2016. READI v2.3.0, Custom Calculations  **kW: 0.00/kBTUh**  **kWh: 0.03/kBTUh**  **Therm: 1.54/kBTUh** | Source: DEER2016. READI v2.3.0, Custom Calculations  **kW: 0.00/kBTUh**  **kWh: 0.03/kBTUh**  **Therm: 2.65/kBTUh** |
| **Full Measure Cost ($/unit)** | Source: Vendor Survey. See measure cost section for further details.  **$38.59/kBTUh** | Source: Vendor Survey. See measure cost section for further details.  **$19.00/kBTUh** | Source: Vendor Survey. See measure cost section for further details.  **$34.09/kBTUh** |
| **Incremental Measure Cost ($/unit)** | Source: 2010-2012 WO017 Ex Ante Measure Cost Study Final Report  **$22.31/kBTUh** | Source: 2010-2012 WO017 Ex Ante Measure Cost Study Final Report  **$5.59/kBTUh** | Source: 2010-2012 WO017 Ex Ante Measure Cost Study Final Report  **$20.68/kBTUh** |
| **Effective Useful Life** | **20 years** (DEER EUL ID: HVAC-Blr) | **20 years** (DEER EUL ID: HVAC-Blr) | **20 years** (DEER EUL ID: HVAC-Blr) |
| **Measure Installation Type** | Replace on Burnout (ROB) | Replace on Burnout (ROB) | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | **0.6** (DEER NTGR ID: Com-Default>2yrs)  **0.55** (DEER NTGR ID: Res-Default>2yrs) | **0.6** (DEER NTGR ID: Com-Default>2yrs)  **0.55** (DEER NTGR ID: Res-Default>2yrs) | **0.6** (DEER NTGR ID: Com-Default>2yrs)  **0.55** (DEER NTGR ID: Res-Default>2yrs) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| Revision 0 | 4/01/2008 | Peter Pollard (kW Engineering) |  |
| Revision 1 | 4/1/2009 | Breesa Kassing (PG&E) | Space Heating Boilers PGECOHVC101 R1 update including available 2008 DEER cost data, and update NTGR value to 0.70. |
| Revision 2 | 12/2/2009 | Charlie Middleton (PG&E) | Space Heating Boilers PGECOHVC101 R2 update including available 2011 DEER data savings data, and update NTGR value to 0.58 |
| Revision 3 | 5/18/2012 | Justin Westmoreland (PG&E) | Nomenclature Update & Non-DEER Building Type “OTR” Defined |
|  | 8/28/2012 | Justin Westmoreland (PG&E) | DEER 2014 Update; expanded measure list to align program offerings with DEER |
| Revision 4 | 2/24/2014 | Charlie Middleton (PG&E) | DEER 2016 Update; collapsed measure list to align program offerings with DEER measures. Removed measures no longer offered by PG&E. Updated costs to align with WO017. Adjusted delivery types. |
| Revision 5 | 4/18/2014 | Curtis Lee (kW Engineering)  Charlie Middleton (PG&E) | Added delivery type to midstream. |
| Revision 6 | 4/1/2016 | Tai Voong (PG&E) | Added Mfm to measure codes DHWC3 and DHWC4, Ex Ante Database Format update |
| Revision 7 | 12/19/2017 | Curtis Lee (kW Engineering)  Tai Voong (PG&E) | Updated report to new format. Updated measure costs based on vendor survey. Performed custom eQUEST calculations for the MFm building type. Added measure DWHC1 from DHW122. Removed downstream. |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS | 6/2/15 | 6/15/15 | * Comment 1 * Comment 2 | * Response 1 * Response 2 |
| 0 | Cal TF | 6/2/15 | 6/15/15 | * Comment 1 * Comment 2 | * Response 1 * Response 2 |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

The Cal TF approved the version X of this workpaper found under the “Approved Measures” section of the website, <http://www.caltf.org/approved-measures/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | DWHC1 - Instantaneous Domestic Water Heater - Condensing, 76-200 kBTUh, TE ≥ 90% |
| Existing Condition | N/A |
| Code/Standard | 80% Et, 2015 Title 20 |
| Industry Standard Practice | 80% Et, 2015 Title 20 |

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | DWHC3 Instantaneous Domestic Water Heater, > 200 kBTUh, ≥ 85% TE |
| Existing Condition | N/A |
| Code/Standard | 80% Et, 2015 Title 20 |
| Industry Standard Practice | 80% Et, 2015 Title 20 |

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | DWHC4 - Instantaneous Domestic Water Heater - Condensing, > 200 kBTUh, ≥ 90% TE |
| Existing Condition | N/A |
| Code/Standard | 80% Et, 2015 Title 20 |
| Industry Standard Practice | 80% Et, 2015 Title 20 |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  |  | DHWC1 | Instantaneous Domestic Water Heater – Condensing (76-200 kBTUh, TE ≥ 90%) |
|  |  |  | DHWC3 | Instantaneous Domestic Water Heater (> 200 kBTUh, ≥ 85% TE) |
|  |  |  | DHWC4 | Instantaneous Domestic Water Heater - Condensing (> 200 kBTUh, ≥ 90% TE) |

**Program Eligibility Requirements:**

Requirements from Boilers and Water Heating Catalog:

## Only water heaters with an input rating greater than 75 kBTUh qualify.

## Measure DHWC3 must meet a minimum thermal efficiency of 85 percent or higher.

## Measure DHWC4 must meet a minimum thermal efficiency of 90 percent or higher.

## Manufacturer’s specification sheet documenting the input rating and efficiency of the water heater must be included with the application.

## Installation address must have a commercial or residential multi-family (MFm) natural gas account with PG&E. Must be a commercial or MFm end-use customer.

## Cannot be used for space conditioning.

## Cannot be used for industrial (process) end-use.

## 1.2 Technical Description

## This measure is for upgrading from minimum to higher efficiency domestic water heaters. It applies to instantaneous domestic water heaters only.

## 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 a separate tank for storage of hot water or may have an integral tank and heat exchanger. Energy efficient units often feature high-efficiency and/or low NOX burners, and typically have features such as forced air burners, relatively large heat exchange surfaces, and/or utilize heat recovery from stack gases.

## High-efficiency gas-fired water heaters, typically rated above 90% thermal efficiency, are commonly known as “condensing” water heaters. Condensing water heaters are equipped with larger heat exchangers that are able to recuperate additional thermal energy from the flue gas – compared to their non-condensing counterparts. They are known as condensing water heaters because the additional heat recuperation results a lower flue gas temperature and water vapor condensing out of the flue gas.

## 1.3 Installation Types and Delivery Mechanisms

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |
| New Construction (NEW/NC) | Above Code or Standard | N/A | EUL | N/A |
| Retrofit or Early Replacement (RET/ER) | Above Customer Existing | Above Code or Standard | RUL | EUL-RUL |
| Retrofit First Baseline Only (REF) | Above Customer Existing | N/A | EUL | N/A |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | EUL | N/A |

The measures in this work paper are applicable to commercial and multifamily residential installations. The savings for all measures are calculated assuming that the installation is replace-on-burnout (ROB).

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Appliance Turn-in and Recycling | The program motivates customers, through financial incentives, to recycle appliances that are functional but inefficient. This prevents the continued use of those appliances, by both the current owner and potential future owners. |
| Audit/Information/Testing Services | The program performs a free assessment of a customer’s facility and provides the customer with information and guidance on energy efficiency opportunities. |
| Commissioning and Retrocommissioning | The program modifies or repairs existing equipment to ensure that it works as intended. |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Innovative Design | The program funds new ideas that meet reasonable scientific scrutiny for potential energy savings. These innovative measures typically have small market penetration (less than 5%) or are targeted toward relatively unreached market segments. |
| New Construction | The program offers financial incentives and/or design assistance to customers involved with new building construction. This is intended is to motivate customer to exceed Title 24 building energy efficiency requirements (residential or nonresidential). |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |
| Performance Based | The program offers financial incentives that vary based on the energy efficiency performance of specific projects. |
| Up-Stream Programs | See Up-Stream Incentive and Up-Stream Buy Down in the Incentive Method table. |

The measures in this work paper are claimed though the Financial Support delivery method. Customers receive a monetary rebate based on equipment size and type after the equipment has been purchased and installed.

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Incentive | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, to encourage the manufacture, provision, or distribution of an efficient measure. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Buy Down | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, with specific requirements to pass down the incentive to the end use customer. Such an incentive buys-down the cost of an efficient measure for the end-use customer by at least the amount of the financial incentive. |
| Giveaway | The program provides customers with energy efficiency equipment or services for free. |
| Exchange/Replacement | The utility program holds events where customers can trade functional equipment for similar but more energy efficient equipment, free of charge. |
| On-bill Finance/Loan | The program offers financing for the cost an efficient measure as part of the utility bill. This can be an add-on option to an existing program or can serve as an organizing principle for its own program. |

The measures in this work paper are incentivized through three methods: Direct Install and Up-Stream. See the above table for descriptions of each incentive method. The rebate amount varies based on installed equipment size and type.

## 1.4 Measure Parameters

### 1.4.1 DEER Data

The measures in this work paper were directly taken from the Database of Energy Efficient Resources (DEER) READI v.2.3.0.

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Work Paper?** |
| Modified DEER methodology | Yes |
| Scaled DEER measure | Yes |
| DEER Base Case | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | Yes |
| DEER Version | DEER 2016, READI v2.3.0 |
| Reason for Deviation from DEER | N/A |
| DEER Measure IDs Used | NG-WtrHt-MedInst-Gas-76to200kBtuh-0p90Et, NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et, NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

**Net-to-Gross Ratio**

The Net-to-Gross Ratio (NTGR) values were obtained using the DEER READI tool. The relevant NTGR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.6 |
| Res-Default>2 | Res | Any | Any | 0.55 |

**Installation Rate**

The Installation Rate (IR) values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Effective and Remaining Useful Life**

The effective useful life and remaining useful life (EUL and RUL, respectively) values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| WtrHt-Com | Commercial water heater | Com | WtrHt | 20 | 6.7 |

### 1.4.2 Codes and Standards Analysis

It should be noted that the more stringent code be applied in all applicable situations.

Title 20: These measures do fall under Title 20 of the California Energy Regulations. Title 20 states:

*Large Water Heaters. The thermal efficiency and standby loss of large water heaters manufactured during the applicable time period shall be not less than the applicable values shown in Table F-2.*

Table F-2 lists the minimum thermal efficiencies for domestic water heaters and is found in the 2016 California Title 20 Appliance Efficiency Regulations, Section 1605.1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title 20 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Instantaneous Domestic Water Heater – Condensing (76-200 kBTUh, TE > 90%) | Base | 80% | Thermal Efficiency | Table F-2 |
| Instantaneous Domestic Water Heater (> 200 kBTUh, > 84% TE) | Base | 80% | Thermal Efficiency | Table F-2 |
| Instantaneous Domestic Water Heater - Condensing (> 200 kBTUh, > 90% TE) | Base | 80% | Thermal Efficiency | Table F-2 |

***Title 24:*** These measures do not fall under Title 24 of the California Energy Regulations.

***Federal Standards:*** These measures do not fall under Federal DOE or EPA Energy Regulations.

The applicable codes and standards for these measures do not dictate the associated hours of operation, measure or baseline costs, EUL, NTGR, or in-service rate for the equipment involved.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2016) | Section 1605.1(e) Gas and Oil Space Heaters and Electric Residential Boilers | July 1, 2014 |

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

There are no M&V or other studies which apply to these measures.

# Section 2. Calculation Methodology

The following table indicates which measures are taken directly from or created with the DEER READI tool for the COM building type only. There are no DEER measures that match the catalog measures for the MFm building type. Therefore, custom calculations were used to estimate energy savings for the MFm building type. See below for further details.

READI Data Used for COM Only

|  |  |  |
| --- | --- | --- |
| **Measure Code** | **Measure Name** | **READI Data** |
| DWHC1 | Instantaneous Domestic Water Heater - Condensing, 76-200 kBTUh, TE ≥ 90% | NG-WtrHt-MedInst-Gas-76to200kBtuh-0p90Et |
| DWHC3 | Instantaneous Domestic Water Heater, ≥ 200 kBTUh, ≥ 85% TE | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et |
| DWHC4 | Instantaneous Domestic Water Heater - Condensing, ≥ 200 kBTUh, ≥ 90% TE | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

**MFm Building Type – All Measures**

Energy savings for this building type was calculated using energy models in eQUEST. The energy models were based on DEER prototype buildings for each climate zone (CZ01-CZ16) over the following building vintages: 1975, 1985, 1996, 2003 and 2005. These prototype models were generated using eQUEST 3-5. We modified each model to include a domestic hot water circulation loop, and domestic hot water boiler. Inputs were left to DEER prototype defaults unless otherwise noted. Below is a summary table of the changes to the prototype eQUEST models by DOE-2 keyword.

|  |  |  |
| --- | --- | --- |
| **System** | **DOE-2 Keyword Change** | **Notes** |
| Circulation Loops | "DHW Loop" = CIRCULATION-LOOP |  |
| Circulation Loops | TYPE = DHW |  |
| Circulation Loops | PROCESS-FLOW = ( {parameter("flow")} ) | Process flow determines DHW usage. See attached calculations |
| Circulation Loops | PROCESS-SCH = ( "APARTMENTS DHW" ) | See below for more details |
| Domestic Water Heaters | TYPE = Gas | Defined water heater type based on measure |
| Domestic Water Heaters | TANK-VOLUME = {parameter("Tank size")} | Defined tank size by a global parameter to allow for storage/instantaneous water heater changes based on measure |
| Domestic Water Heaters | CAPACITY-RATIO = {parameter("capacity  ratio")} | Defined water heater capacity by a global parameter to allow for water heater input capacity adjustments based on measure |
| Domestic Water Heaters | HEAT-INPUT-RATIO = {parameter("HIR")} | Defined water heater efficiency by a global parameter to allow for water heater efficiency adjustments based on measure |
| Domestic Water Heaters | TANK-UA = 0.3 | Assumed |
| Domestic Water Heaters | DHW-LOOP = "DHW LOOP" | Assigned the DHW heater to serve the “DHW LOOP” circulation loop |

eQUEST was allowed to auto-size equipment specifications based on DEER prototype domestic hot water load. All auto-sized components were left unchanged between the baseline and measure cases. All calculations were performed using eQUEST 3.64.

The baseline and proposed energy models were changed to reflect the appropriate boiler efficiency, boiler type and capacity ratio for each measure. The following table shows the tank size, boiler efficiency, boiler HIR and boiler input capacity ratio for each measure. These were the inputs that were modified in each eQUEST model based on measure.

**eQUEST Domestic Hot Water Input Summary Table**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure** | **Case** | **Tank Size (Gallons)** | **Boiler Efficiency (Thermal unless otherwise noted)** | **HEAT-INPUT-RATIO** | **CAPACITY-RATIO** |
| DWHC1 | Baseline | 3,120 | 80% | 1.25 | 0.5 |
| Measure | 240 | 90% | 1.11 | 0.5 |
| DWHC3 | Baseline | 3,120 | 80% | 1.25 | 1.0 |
| Measure | 240 | 85% | 1.176 | 1.0 |
| DWHC4 | Baseline | 3,120 | 80% | 1.25 | 1.0 |
| Measure | 240 | 90% | 1.11 | 1.0 |

eQUEST includes a domestic hot water schedule for multifamily buildings and apartments that is derived from Model National Energy Code of Canada for Buildings (MNECB 1997)[[1]](#endnote-1). The following table, and figure show the domestic hot water schedule, and profile used in the calculations.

|  |  |
| --- | --- |
|  |  |

eQUEST DHW Schedule – *APARTMENTS DHW*

The domestic hot water heating load was obtained from a New York State Energy Research and Development Authority (NYSERDA) study performed in 1991[[2]](#endnote-2). Based on the study’s results, the average DHW usage is approximately 115 gallons per day per unit. Based on the number of units in the DEER prototype, we have calculated the daily DHW usage for the entire building to be 5,520 gallons (115 gal/unit x 48 units)[[3]](#footnote-1). The total daily DHW usage was used to calculate the process flow rate. Using the above DHW load profiles, we back calculated the process flow amount using the follow equations:

Where,

VD = Average hot water usage for each day, 5,520 gal

Vh = Hot water usage for each hour, gal

The hourly hot water load is calculated by multiplying the process flow by the hourly percentage demand.

Where,

Dh-WD = Hourly DHW demand weighting factor, weekday, %

Dh-WE = Hourly DHW demand weighting factor, weekend, %

gph = Peak process flow per hour, gal/h

The peak process flow (rated in gallons per minute, gpm) was determined by the following equation:

Where,

gpm = Process flow eQUEST input, gal/min

Using the goal seek function in excel, we determined the process flow to be 13.54 gpm based on the equations above.

All eQUEST runs were performed using CZ2010 weather data specific to each climate zone. The capacity ratio was determined in order to get the average domestic hot water heater capacity to fall within the size requirements for each measure. All eQUEST models and processing calculations can be found in the Attachments section.

Energy savings for MFm were calculated by taking the weighted average of all building vintages using the DEER impact weights[[4]](#endnote-3). Impact weights are specific to the MFm building type and include all climate zones for the following building vintages: 1975, 1985, 1996, 2003 and 2005.

Weighted energy savings were then normalized to therms/kBTUh of input capacity.

Demand reduction estimates must consider the DEER peak demand period, which is 2:00 PM to 5:00 PM during specific weekday periods and varies by climate zone:

|  |  |
| --- | --- |
| **Climate Zone** | **3-Weekday Period** |
| 1 | Sep 16 – Sep 18 |
| 2 | July 8 – July 10 |
| 3 | July 8 – July 10 |
| 4 | Sep 1 – Sep 3 |
| 5 | Sep 8 – Sep 10 |
| 6 | Sep 1 – Sep 3 |
| 7 | Sep 1 – Sep 3 |
| 8 | Sep 1 – Sep 3 |
| 9 | Sep 1 – Sep 3 |
| 10 | Sep 1 – Sep 3 |
| 11 | July 8 – July 10 |
| 12 | July 8 – July 10 |
| 13 | July 8 – July 10 |
| 14 | Aug 26 – Aug 28 |
| 15 | Aug 25 – Aug 27 |
| 16 | July 8 – July 10 |

Demand savings for these measures were taken directly from DEER under the COM building type and IOU climate zone. The savings value for this category is a weighted average across all climate zones. Therefore, the claimable demand savings is the same across all PG&E climate zones.

The electrical savings and demand reduction is largely due to the reduction in water heater fan usage.

# Section 3. Load Shapes

Load shapes are not applicable to gas measures, because the price of gas is not dependent on time-of-use. While there are electrical impacts, they are relatively small and are not considered in this work paper.

# Section 4. Costs

There are no DEER measure costs for this workpaper. We have also confirmed with Itron, that the 2010-2012 WO017 Ex Ante Measure Cost Study Final Report does not cover commercial instantaneous domestic hot water heaters. Therefore, we have calculated the full measure and incremental measure costs independently.

## 4.1 Base Case Cost

Baseline measure costs were taken from 2010-2012 WO017 Ex Ante Measure Cost Study Final Report and RSMeans[[5]](#footnote-2).

Unit costs were divided by the input capacity of each unit in order to determine the baseline measure cost per unit of input capacity ($/therm). The baseline cost was calculated by taking the average cost per unit input capacity from both costing sources based on size.

## 4.2 Measure Case Cost

The Measure Case cost information was obtained via a vendor survey. We have contacted several manufacturers and have confirmed pricing estimates for various hot water heaters. See attachments for vendor survey emails and pricing information.

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |
| REF | (MEC + MLC) – (BEC + BLC) | MEC + MLC | N/A |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| DWHC1 | ROB | $22.30 | $38.59 | N/A |
| DHWC3 | ROB | $5.59 | $19.00 | N/A |
| DHWC4 | ROB | $20.70 | $34.09 | N/A |

Note: All costs are rated per kBTUh of input capacity

# Attachments

PGECODHW101 R7 12-19-2016.xlsx

PGECODHW101 R7 eQUEST Calculations.zip

Attachment 1 – Costing Data

Attachment 2 - Vendor Survey Correspondence.pdf

Attachment 3 - Multifamily Residential Domestic Hot Water Usage.pdf

Attachment 4 - eQUEST Load Profile Documentation.pdf

# References

1. Yang, Xiangjin. “DISPARATE STANDARDS: COMPARING STANDARD DOMESTIC HOT WATER MODELING METHODS FOR MULTI-RESDENTIAL BUILDINGS.” ASHRAE, August 2016 [↑](#endnote-ref-1)
2. Goldner, Fredric S. “Multi-Family Building Energy Monitoring and Analysis, Domestic Hot Water Use and System Sizing Criteria Development: A Status Report.” NYSERDA, 1991 [↑](#endnote-ref-2)
3. The eQUEST models include a total of 48 units in multifamily apartment buildings. [↑](#footnote-ref-1)
4. DEER 2014 Energy Impact Weights Tables [↑](#endnote-ref-3)
5. RSMeans Online is a web-based service that provides accurate and up-to-date cost information [↑](#footnote-ref-2)