**Work Paper PGECODHW106**

**Electric Storage Water Heater**

**Revision # 5**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Electric Heat Pump Water Heater**

**Measure Codes HA47**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | **HA47** |
| **Measure Description:** | Residential Heat Pump Storage Water Heater, EF > 2.0 |
| **Energy Impact Common Units:** | Per water heater  each |
| **Base Case Description:** | Source: DEER 2014, market research  Electrical Storage Water Heater, EF = 0.88 |
| **Base Case Energy Consumption:** | Source: DEER2005 (Residential Heat Pump Water Heater : D03-935)  Dependent on climate zone and dwelling type |
| **Measure Energy Consumption:** | Source: DEER2005 (Residential Heat Pump Water Heater : D03-935)  Dependent on climate zone and dwelling type |
| **Energy Savings**  **(Base Case – Measure):** | Source: DEER2005 (Residential Heat Pump Water Heater : D03-935)  Dependent on climate zone and dwelling type |
| **Costs Common Units:** | Per water heater |
| **Base Case Equipment Cost ($/unit):** | Source: DEER2014 using DEER 2011 cost adjustments (D03-935) $246.95 |
| **Measure Equipment Cost ($/unit):** | Source: DEER2014 using DEER2011 cost adjustments (D03-935) $1,513.64 |
| **Gross Measure Cost ($/unit)** | N/A |
| **Measure Incremental Cost ($/unit):** | $1,266,69 |
| **Effective Useful Life (years):** | 10 |
| **Measure Application Type:** | DEER 2014 ROB, NC |
| **Net-to-Gross Ratios:** | DEER 2014 All Default < 2 years = 0.70  DEER 2014 Res Default HTR-di = 0.85 |
| **Important Comments:** | Some DEER values refer to DEER 2005 which is the last version that included a Heat Pump Measure, subsequent PG&E engineering has taken place to augment the savings |

# Work Paper Approvals

The following Manager(s) approved this workpaper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- |
|  |
| **Grant Brohard**  Manager, Technical Product Support |
| **Carolyn Weiner**  Manager, Appliance Products |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| **Revision 0** | **04/18/2008** | **Original workpaper:**  **Elec Storage Water Heater PGECODHW106** | **Joseph Flores (KEMA Services, Inc.)** |
| **Revision 1** | **05/20/09** | **Revision 1 incorporating new NTG, EUL and IMC costs from 2008 DEER Updates, DEER2008 values will be used from R2 for PY 2010 to 2012** | **Charlene Spoor (PG&E)** |
| **Revision 2** | **3/24/2010** | **Revision 2 incorporated DEER2008 Values for DMO and SFM , MFM using lowest of DMO or SFM until updated to DEER** | **Clci PGE** |
| **Revision 3** | **6/1/2012**  **8/22/2012** | **Revision 3**   1. **Added all climate zones to the calculations** 2. **Added the measure HA47 for the heat pump water heaters measure and incorporated commercial applications** 3. **Updated savings per DEER2011 database** 4. **Used equipment and labor cost adjustment multipliers from DEER2011 to update costs** 5. **Updated NTG and EUL values according to DEER2011**   **Changed Vin and CZ to ANY per READI nomenclature** | **Matt Zwiesler (kW Engineering)**  **Charlene Spoor (PG&E)**  **Charlene Spoor (PG&E)** |
| **Revision 4**  **Revsion 5** | **5/28/2013**  **5/28/2014** | **Added measure code and program qualification for HA47; new template** | **Charlene Spoor (PG&E)**  **Charlene Spoor (PG&E)** |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

This workpaper documents the rationale for the savings methodologies and assumptions for the High Efficiency Heat Pump Water Heaters Rebates as part of Pacific Gas and Electric Company’s Customer Energy Efficiency Program. PG&E offers incentives to residential, multifamily, and nonresidential customers for installing qualifying high efficiency equipment meeting the following criteria:

***Program Restrictions and Guidelines***

**REQUIREMENTS:**

• Electric heat pump water heater must have an Energy Factor (EF) of 2.0 or greater.

• Must be a residential-sized unit.

• Must be new and meet or exceed all applicable local, state and federal standards.

• Check with your contractor for installation requirements for your installation address as regulations vary in CA.

• Installation address must have an electric account

with PG&E.

**EXCLUSIONS:**

• No instantaneous or tankless water heaters.

• New construction (residential development projects, e.g. subdivisions) installations do not qualify.

• Commercial sized units do not qualify.

• Thermal Efficiency (TE) rated units do not qualify

**The rebate is downstream, provided to the customer at the time of sale upon receipt of application and invoice. This is not a Direct install program for core, however, there is a third party option that is direct install.**

***Market Applicability:*** This measure is applicable to single-family, multi-family, double-wide mobile home residential building types and to nonresidential building where a residential water heater unit is appropriate. The most significant barrier to water heater retrofit is the existing nature of water heater replacement. Two-thirds of consumers replace their water heaters due to the sudden failure of their existing water heater. When a water heater suddenly fails, most consumers purchase replacements that are the cheapest and most readily available model that are also easy to install. These prevailing attitudes do not encourage consumers to make the extra effort to find more advanced, energy-efficient technologies that are now available on the market[[1]](#endnote-1).

## 1.2 Product Technical Description

Heat pump water heaters heat water using a heat pump, allowing them to achieve much higher efficiency (energy factor), compared to electric-resistance water heaters. Similar to electric-resistance water heaters, most heat pump water heaters consists of a glass-lined steel tank with foam insulation. Heat pump waters water heaters are typically equipped with supplemental electric-resistance elements for periods of high demand.

## 1.3 Measure Application Type

The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2014 Database Format* hyperlink, DEER2014, spreadsheet *SPTdata\_format-V0.97.xls*, defines the terms as follows:

Table  Measure Application Type[[2]](#endnote-2)

*Identifies the measure application type in the Measure Implementation table in DEER2011.*

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ER | Early retirement | *measure applied while existing equipment still viable, or retrofit of existing equipment* |
| ROB | Replace on Burnout | *measure applied when existing equipment fails or maintenance requires replacement* |
| NC | New Construction | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

Since electrical storage water heaters are not an appliance that consumers will readily replace because of their high cost and long product life, electric and heat pump storage water heating fall under ROB or NC installation types.

## 1.4 Product Base Case and Measure Case Data

## 1.4.1 DEER Base Case and Measure Case Information

DEER2005 impact run ID *RMFM10AVWHHpm* provides savings values for the conversion from the baseline electric-resistance water heater with EF of 0.88 to heat pump storage water heaters with an EF of 2.0 for a 40-gallon tank. This measure savings are taken from DEER2005 measure ID D03-935 since this is a non-updated measure in DEER2008 or DEER2011, and hence, is not superseded.

Custom PG&E calculations are used to determine the energy savings. These calculations use CEUS data[[3]](#endnote-3) combined with building area from DEER2011[[4]](#endnote-4), as well as total hot water storage requirements and estimated savings percentages from DEER2005[[5]](#endnote-5), to calculate the savings. The savings percentages have not been updated in subsequent versions of DEER. The DEER data used in the calculations is tabulated below:

***Table 2 DEER Use and Technology Type HA47***



**Delta Wattage Assumption (ΔW):** *See section 2.1 for Electric Savings Estimations and calculations*

**EUL Electric Savings** **(ΔW): DEER 2014**

* The EUL electric savings were downloaded from DEER2005 then modified for residential building types directly, they match the intended measures.

**Hours of Operation**: Electric Water Heaters only operate as hot water is called or the tank temperature is lowered, therefore, there is no standby loss such as with gas water heaters, the use is estimated to be less than 24 hours per day.

**Base Case Costs and Measure Case Costs**

**Costs DEER 2014**

* The Base Case and Measure Case Costs were downloaded from DEER directly; they match the intended measures for climate zones and building types and vintages.

**Table 3 Base Cast and Measure Case Costs**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Costs ($)** | | |  |  |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Base Case** | **Measure Case** | **IMC** | **DEER Version** | **Impact IDs** |
| **Any** | **Any** | **Any** | **$246.95** | **$1513.64** | **$1266.69** | **2011** | **N/A** |

**Net-to-Gross Assumption:** *DEER 2014 list a residential default NTG for any EE measures not specifically listed. For measures offered less than 2 years in a residential portfolio the value is 0.70. For Residential Hard to Reach direct install measures, RES Default HTR di = 0.85.*

***The rebate for HA47 is downstream, provided to the customer at the time of sale upon receipt of application and invoice. This is not a core Direct install program, however, there is a third party implementer that does direct install.***

Table 4 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

Table 4 DEER Net-to-Gross Ratios

|  |  |
| --- | --- |
|  |  |
| Program Approach | NTG |
| ALL Default < 2 years | 0.70 |
| Res Default HTR di | 0.85 |

The NTG Ratios in Table 4 are appropriate for the measure(s) because:

* Since DEER 2014 does not have a specific NTG ratio for Heat Pump water heating, the residential default applies.

**Effective Useful Life / Remaining Useful Life:**

DEER 2014 lists an EUL of 10 Years for electric heat pump water heaters

**Effective Useful Life: DEER2014**

* The Effective Useful Life estimates were downloaded directly from DEER, they match the intended measures for climate zones and building types and vintages.

**Table 5 DEER Effective Useful Life**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **EUL (yrs)** | **RUL (yrs)** | **DEER Version** | **Impact IDs** |
| **Any** | **Any** | **Any** | **10** | **N/A** | **2014** | **N/A** |

**In-service rate/first year installation rate**:

* The rebate for HA47 is downstream, provided to the customer at the time of sale upon receipt of application and invoice. This is not a Direct install program.
* In-service rate: 1
* The in service rates were downloaded from DEER directly, they match the intended measures for climate zones and building types and vintages.

## 1.4.2 Codes & Standards Requirements Base Case and Measure Information

**Title 20:** The residential measures do not fall under Title 20 of the California Energy Regulations, for commercial measures, Title 20 regulations are the same as current Federal Standards. California Code of Regulations, Title 20 Public Utilities and Energy, Article 4 Appliance Efficiency Regulations[[6]](#endnote-6) states that a small electric storage water heater is defined as:

”[A] water heater that is… an electric storage water heater with an input of 12 kW or less…. ‘Storage water heater’ means a water heater that heats and stores water within the appliance at a thermostatically-controlled temperature for delivery on demand, and that has an input less than 4,000 Btu per hour per gallon of stored water.

Small electric storage water heaters must meet the following efficiency values, which were populated using values from Table F-4 (Page 212) from 2010 Title 20[[7]](#endnote-7):

**Table 6 Title 20 and Federal Standards for Electric Water Heaters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title 20 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Electric Water Heater - Small | Measure | 0.97 – (.00132 x V) | Energy Factor | Table F-4 |

\*Note: The Title 20 regulations are the same as the current federal DOE standards.

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

***Federal Standards:*** These measures do fall under Federal DOE Regulations. Under these regulations, the following is required for the proposed equipment standards:

Department of Energy (DOE) Regulations[[8]](#endnote-8) require that all small electric storage water heaters manufactured on or after January 20, 2004 meet the minimum EF requirement. See Table 3 above.

Energy Star criteria[[9]](#endnote-9) require that all heat pump water heaters meet the minimum EF of 2.0 as of January 2009.

The DEER2011 impact run ID *RE-WtrHt-SmlStrg-Elec-lte12kW-40G-0p94EF* base case equipment is a 40 gallon electric storage water heater with an EF equal to 0.88.

The DEER2005 impact run ID *RMFM10AVWHHpm* base case equipment is a 40 gallon electric storage water heater with an EF equal to 0.88.

## 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and

## Measure Case Information

For the Commercial application of this measure, there are no M&V or other studies which apply to this measure.

According to the California Commercial End-Use Survey (CEUS), electric water heating consumes less than 1% of total electric usage in the commercial sector located in PG&E territory. Due to the small percentage of total statewide electricity usage, the potential for a reduction in total energy usage is small relative to total statewide usage.

For the residential application of this measure, data from the California Residential Saturation Survey (RASS) indicates that approximately 9% of residential dwellings in PG&E territory use electricity for domestic water heating. No other studies have been found in regards to residential electrical storage water heaters.

## 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

There are no further data or calculations provided for the support of the measures in the residential portions of this workpaper.

The commercial application, as discussed in section 1.4.1, notes savings for this measure cannot be taken directly from DEER. Therefore, the energy savings are determined using custom PG&E calculations. Please refer to Section 2 for a discussion of the calculation method. The following discusses the calculation inputs and data sources:

The custom calculations use inputs from DEER, as discussed in section 1.4.1, and use the following inputs from other sources as well:

* The average storage capacity of small electric storage water heaters on the market today was gathered from the California Energy Commission (CEC) Appliance Database. The data indicates that the average small electric storage water heater is 58.7 gallons[[10]](#endnote-10). This average doesn’t include those heaters whose rated volume is below the measure requirement of 40 gallons. CEC database electric water heater size ranges from 40 to 120 gallons.
* Energy-Use Indices (EUI) provided by CEUS3. An EUI value is defined as the annual energy usage for a specific fuel and end-use per square foot of area served. EUI values for electric water heating were used. The various EUI values used are shown below in Table 7.

**Table 7: CEUS EUI Values3**



After the average number of units per building type is calculated, the total annual electricity savings are divided by average number of smaller-sized electric water heaters. The result is the total annual savings per water heater.

***1.4.5 Time-of-Use Adjustment Factor***

*We are required by CPUC decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since this is not an A/C measure, the TOU adjustment factor is 0.*

***1.5 Summary of Inputs for Savings Calculations***

The following table provides references to sections that document the inputs for calculation:

**Table 8 Summary of inputs for Savings Calculations**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings** | None | N/A | N/A | 2247.92 | Section 1.4.1 |
| **Gas Savings** | None | N/A | N/A | N/A | Section 1.4.1 |
| **Hours of operation** | None | N/A | N/A | N/A | Section 1.4.1 |
| **Full Cost** | None | 246.95 | N/A | 1513.64 | Section 1.4.1 |
| **Incremental Cost** | None | 246.95 | N/A | 1266.69 | Section 1.4.1 |
| **EUL /RUL** | None | 13 | 13 | 10 | Section 1.1.1 |
| **NTG** | None | 0.55 | 0.55 | 0.70 | Section 1.1.1 |
| **ISR** | Yes | 1 | 1 | 1 | Section 1.1.1 |
| **TOU Factor** | A/C projects only | N/A | N/A | N/A | Section 1.4.5 |

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# Section 2. Calculation Methods

Table9 Baseline by Measure Application Type

|  |  |  |  |
| --- | --- | --- | --- |
| ****Measure Application Type**** | ****Measure Life Basis**** | ****First Baseline Period: Energy Savings Baseline**** | ****Second Baseline Period: Energy Savings Baseline**** |
| ***ER* (early retirement)** | **EUL** | Customer Average Baseline | Code Baseline |
| ***ROB* (replace-on-burnout)** | **EUL** | Code Baseline | N/A |
| ***NC* (new construction)** | **RUL/EUL-RUL** | Code Baseline | N/A |

Notes:

* For ROB measures, First Baseline is the baseline for the full EUL. There is no second baseline.
* For ER measures, First Baseline Period is the period for the RUL(remaining useful life),defined by the CPUC as RUL=1/3 EUL. Second baseline period for ER is Code baseline for the period EUL-RUL.

## 2.1 Electric Energy Savings Estimation Methodologies

* This measure does not includes HVAC interactive effects savings.
* This measure is not an Early Retirement measure.
* Electric savings reference DEER2005 impact run ID *RMFM10AVWHHpm* for single family and multifamily homes. Savings are based on the 2005 DEER savings methodology for measure HA47, high efficiency heat pump storage water heater.

**Table 10 DEER Data Used In PG&E Calculations**

****

**∆Watts/unit:** The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit. It is used in the calculations for both demand and energy savings.

The assumptions and values used in each column of the calculation are explained below, starting with the leftmost column:

DEER2011 Building Type:

* DEER2011 provided the building types used in this calculation. Data was available to generate savings for all DEER2011 building types except ‘Storage - Conditioned’ and ‘Storage – Unconditioned.’ Savings for these building types are therefore included in the other ‘OTR’ category.

Matching CEUS Building Type:

* In order to calculate the savings, EUI values from CEUS were attributed to each DEER building type. The DEER building types, however, are not identical to the building types listed in CEUS. For all DEER building types, the water heater EUI from the closest matching CEUS building type was selected to model the savings. If no CEUS building types matched the DEER building type, the ‘Miscellaneous’ CEUS building type was used.

Building Area:

* The previous revision of this work paper used building square footage from DEER2005. DEER2011 now includes updated building areas and building types. All building areas either stayed the same or increased from the DEER2005 data.

Typical Water Heater Storage:

* DEER2005 provides typical water heating sizes for gas storage water heaters used in non-residential settings. It is assumed that the gas storage water heater size is a proxy for electric storage water heaters. However, electric storage water heaters have smaller capacities. No updates to these typical storage values are in the latest DEER updates. However, since the area of some buildings has increased in DEER2011, we increased the required hot water storage capacity for those building types as well. We increased the typical storage capacity by the same factor as the building area increased.

EUI:

* The CEUS water heater EUI for each building type provides the average electric water heater energy consumption (kWh/yr) per floor area (sq. ft.). This value, multiplied by the DEER2011 building area, yields the total baseline electric water heater energy consumption for each building type. The EUI values in CEUS are not separated by climate zone. The energy uses for each building type are therefore assumed to reflect the average use across all California climate zones.

Number of Water Heaters per Bldg:

* The total kWh savings must be normalized per measure-case water heater. This paper assumes that residential-style electric storage water heaters are used to provide domestic hot water to the buildings. The building types with larger hot water storage requirements will therefore require multiple water heaters to serve the demand. Therefore we must find the number of units that serve each building type in order to determine the normalized savings. From the market research data gained from CEC Appliance Database, the storage capacity of the average small electric storage water heater is 58.7 gallons10. The number of water heaters in each building is determined by dividing the total required hot water storage by the average storage water heater size.

Energy Savings per Unit:

* The normalized energy savings are determined using the above inputs and the following calculation. Energy Savings/unit = 

This equation is applied to each line item in Table 10, above. The following is an example calculation for an assembly-type building in California:

**Table 9: Assembly Building Sample Calculation**

|  |  |
| --- | --- |
| **Variable** | **Value** |
| EUI (kWh per year per sq. feet) | 0.35 |
| Area (sq. feet) | 34,000 |
| # of Water Heaters per building type 200gal/58.7 gal average=3.41 | 3.41 |

=

= 188.6 kWh/year per unit

## 2.2. Demand Reduction Estimation Methodologies

Demand savings reflect DEER2005 impact run ID *RMFM10AVWHHpm* for single family and multifamily homes. Savings are based on the 2005 DEER savings methodology for measure HA47, high efficiency heat pump storage water heater. The demand savings were downloaded directly from the DEER2005 database for this measure.

Refer to the At-A-Glance Table or the appendix for the completed list of demand savings per solution code.

Demand savings are calculated by applying the DEER energy/peak factor to the energy savings from Section 2.1. Energy/peak factor is defined as a ratio of the connected load reduction to peak energy demand. Peak demand impact is based on the load shapes contained in the California Energy Commission’s (CEC) peak demand forecasting model. In all cases, the energy/peak factor for water heating measures is 0.22 Watts/kWh[[11]](#endnote-11). In order to determine the normalized demand savings, this factor is applied to the normalized energy savings calculated for each building type using the following equation:

*Demand Savings (kW/unit) =*

The following is a sample calculation for assembly building type.

*Demand Savings =* 

*=0.041 kW/unit*

The DEER peak demand period is defined as the period from 2:00 PM to 5:00 PM during the three hottest consecutive days for each particular climate zone.

## 3.1 Base Case Load Shapes

The closest load shape chosen for this measure is the DEER:Residential Water Heating load shape. See Table 11 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 11 DEER Base Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Residential New Construction | 21=Res. Wtr. Heating | 21 |
| PG&E Residential | 21=Res Wtr. Heating | 21 |

## 

## 3.2 Measure Load Shapes

The measure load shape for this measure is determined based on the applicable residential market sector and the residential water heating end-use. This load shape is the same as the base case due to the savings impact of the measures and is shown by the load shapes listed below.

Table 9 DEER Measure Case Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Residential New Construction | 21=Res. Wtr. Heating | 21 |
| PG&E Residential | 21=Res Wtr. Heating | 21 |

# 

# Section 4. Base Case & Measure Costs

* The base case, measure case, and incremental costs were downloaded from DEER directly; they match the intended measures for climate zones and building types and vintages for these measures.
* Base costs directly reference DEER Measure ID D03-939 data for a standard efficiency electric storage water heater. The base cost includes only the equipment cost as the labor costs for both base and proposed are identical. The base cost is listed as $251.11 per unit. This base cost is used for both the high efficiency electric storage water heater measures and the heat pump water heater measure (HA47).
* Base case costs reference DEER2005. The measure costs are further adjusted using the cost adjustments found in DEER2011 for AdjustType “DH50” (Domestic Hot Water measures). This results in various measure costs per climate zone.
* Measure costs reference DEER2005 measure ID D03-935 data for a high efficiency heat pump storage water heater. The measure costs are further adjusted using the cost adjustments found in DEER2011 for AdjustType “DH50” (Domestic Hot Water measures). This results in various measure costs per climate zone.

**Table 13 DEER Incremental Measure Costs**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **Costs ($)** | | |  |  |
| **Measure Code** | **Building type** | **Bldg Vin-tage** | **Cli-mate Zone** | **Base Case** | **Measure Case** | **IMC** | **DEER Version** | **Impact IDs** |
| HA47 | MFm | 6 | CZ10 | $246.95 | $1,513.64 | $1,266.69 | DEER2005 | RMFM10AVWHHpm |
| HA47 | MFm | 6 | CZ07 | $246.95 | $1,513.64 | $1,266.69 | DEER2005 | RMFM07AVWHHpm |
| HA47 | SFm | 6 | CZ09 | $246.95 | $1,513.64 | $1,266.69 | DEER2005 | RSFM09AVWHHpm |

**Table 14 DEER Base Case and Measure Case Cost Definitions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Full Measure Cost (RUL)** | **Second Baseline Period Full Measure Cost (EUL – RUL)** |
| ***NC (new construction)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ROB(replace on burnout)*** | EUL | Calculated as Incremental Measure Cost | N/A |
| ***ER (early retirement)*** | RUL/  EUL-RUL | Calculated as Full Gross Measure Cost | Calculated as Negative Full Gross Base Case Cost |

## Since electrical storage water heaters are not an appliance that consumers will readily replace because of their high cost and long product life, electric and heat pump storage water heating fall under ROB or NC installation types1. Refer to the At-A-Glance Table and the appendix for a complete table of base, measure, and incremental measure costs per measure and climate zone.

## 4.1 Base Case(s) Costs

* The base case cost taken from DEER2008 measure ID D03 939 for a standard efficiency electric storage water heater is $251.11. In order to update this cost, we applied the DEER2011 cost multipliers for “DH50” – Domestic Host Water measures. The cost multipliers differ by climate zone. However, since the savings for this measure are the same across all climate zones, the average cost multiplier was used to determine the updated costs. The average DEER2011 material cost multiplier for all 16 climate zones in California is 0.983, which yields an updated base case cost of $246.95.
* There are no installation costs because the measure application type is ROB and NC, and we assume that the installation costs for both standard and high efficiency equipment is the same.
* Costs do not vary by building type, building vintage, or climate zone.

The following Measure Application Types are appropriate to this measure. The Base Case Costs are:

**Table 15: DEER Base Case Costs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| HA47 | NC, ROB | Industry average | $246.95 | $ 0 | $0 | $ 246.95 |

*All costs are noted as $ per measure unit*

## 4.2 Measure Case Costs

* The measure case cost taken from DEER2008 measure ID D03 939 for a high efficiency electric storage water heater is $323.41. In order to update this cost, we applied the DEER2011 cost multipliers for “DH50” – Domestic Host Water measures. The cost multipliers differ by climate zone. However, since the savings for this measure are the same across all climate zones, the average cost multiplier was used to determine the updated costs. The average DEER2011 material cost multiplier for all 16 climate zones in California is 0.983, which yields an updated measure case cost of $318.05.
* There are no installation costs because the measure application type is ROB and NC, and we assume that the installation costs for both standard and high efficiency equipment is the same.
* Costs do not vary by building type, building vintage, or climate zone.

The following Measure Application Types are appropriate to this measure. The Measure Case Costs are:

**Table16 DEER Measure Case Costs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost (Average)** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost (Average)** |
| HA47 | NC, ROB | Industry Average | $1,513.64 | $0.0 | $0.00 | $1,513.64 |

*All costs are noted as $ per measure unit*

Measure costs reference DEER2005 measure ID D03-935 data for a high efficiency heat pump storage water heater. The measure costs are further adjusted using the cost adjustments found in DEER2011 for AdjustType “DH50” (Domestic Hot Water measures). This results in various measure costs per climate zone.

## 4.3 Incremental & Full Measure Costs

**Table 17 DEER Incremental and Full Measure Case Cost Definitions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Full Measure Cost**  **(RUL Period/First Baseline)** | **Full Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ER | Measure Equipment Cost  +Measure Labor Cost | (-1)x(Base Equipment Cost  + Base Labor Cost) | Measure Equipment Cost  – Base Case Equipment Cost |
| ROB | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |
| NC | Measure Equipment Cost  – Base Case Equipment Cost | N/A | Measure Equipment Cost  – Base Case Equipment Cost |

# *4.3.1 Full Measure Cost*

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

This Measure Application Type is: **NC** or **ROB**, so the Full Measure Cost (FMC) is represented by the equation below (choose):

FMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

\*Note: We assume that, unless stated otherwise, the measure case labor and base case labor are assumed to be the same value reducing the equation to the following:

FMC = Measure Equipment Cost – Base Case Equipment *Cost*

*FMC = $ 1513.64 per (unit) - $ 256.95 per (unit) = $ 1266.69 per unit*

\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.

# *4.3.2 Incremental Measure Costs*

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straightforward definition depending on the Measure Application type, the equation does vary.

This Measure Application Types is: **ROB,** and **NC** so the Incremental Measure Cost (IMC) is represented by the appropriate equation below:

IMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

In this work paper, the measure case and base case labor costs are assumed to be the same.

**Table 18: Incremental Measure Costs HA47**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Measure Application Types** | **Base Case Total Cost** | **Measure Case Total Cost[[12]](#endnote-12)** | **Gross Measure Case Cost** | **Incremental Measure Cost (Average)** |
| HA47 | ROB, NC | $246.95 | 1513.64 | N/A | $1,266.69 |

# 

# Input Appendices

***A. (1.4.1) DEER Base Case and Measure Case Information***

**Demand Savings (ΔW):**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Demand Savings Watts** | **Deer units** | **DEER Version** | **Impact IDs** |
| HA47 | MFm | 6 | CZ01 | 0.2665 | Per water heater | DEER2005 | RMFM01AVWHHpm |
| HA47 | MFm | 6 | CZ02 | 0.2665 | Per water heater | DEER2005 | RMFM02AVWHHpm |
| HA47 | MFm | 6 | CZ03 | 0.2665 | Per water heater | DEER2005 | RMFM03AVWHHpm |
| HA47 | MFm | 6 | CZ04 | 0.2665 | Per water heater | DEER2005 | RMFM04AVWHHpm |
| HA47 | MFm | 6 | CZ05 | 0.2665 | Per water heater | DEER2005 | RMFM05AVWHHpm |
| HA47 | MFm | 6 | CZ11 | 0.2414 | Per water heater | DEER2005 | RMFM11AVWHHpm |
| HA47 | MFm | 6 | CZ12 | 0.2414 | Per water heater | DEER2005 | RMFM12AVWHHpm |
| HA47 | MFm | 6 | CZ13 | 0.2414 | Per water heater | DEER2005 | RMFM13AVWHHpm |
| HA47 | MFm | 6 | CZ16 | 0.2665 | Per water heater | DEER2005 | RMFM16AVWHHpm |
| HA47 | SFm | 6 | CZ01 | 0.5105 | Per water heater | DEER2005 | RSFM01AVWHHpm |
| HA47 | SFm | 6 | CZ02 | 0.5105 | Per water heater | DEER2005 | RSFM02AVWHHpm |
| HA47 | SFm | 6 | CZ03 | 0.5105 | Per water heater | DEER2005 | RSFM03AVWHHpm |
| HA47 | SFm | 6 | CZ04 | 0.5105 | Per water heater | DEER2005 | RSFM04AVWHHpm |
| HA47 | SFm | 6 | CZ05 | 0.5105 | Per water heater | DEER2005 | RSFM05AVWHHpm |
| HA47 | SFm | 6 | CZ11 | 0.4625 | Per water heater | DEER2005 | RSFM11AVWHHpm |
| HA47 | SFm | 6 | CZ12 | 0.4625 | Per water heater | DEER2005 | RSFM12AVWHHpm |
| HA47 | SFm | 6 | CZ13 | 0.4625 | Per water heater | DEER2005 | RSFM13AVWHHpm |
| HA47 | SFm | 6 | CZ16 | 0.5105 | Per water heater | DEER2005 | RSFM16AVWHHpm |

**Electric Savings (ΔkWh):**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Demand Savings Watts** | **Deer units** | **DEER Version** | **Impact IDs** |
| HA47 | MFm | Any | CZ01 | 1,211.19 | Per water heater | DEER2005 | RMFM01AVWHHpm |
| HA47 | MFm | Any | CZ02 | 1,211.19 | Per water heater | DEER2005 | RMFM02AVWHHpm |
| HA47 | MFm | Any | CZ03 | 1,211.19 | Per water heater | DEER2005 | RMFM03AVWHHpm |
| HA47 | MFm | Any | CZ04 | 1,211.19 | Per water heater | DEER2005 | RMFM04AVWHHpm |
| HA47 | MFm | Any | CZ05 | 1,211.19 | Per water heater | DEER2005 | RMFM05AVWHHpm |
| HA47 | MFm | Any | CZ11 | 1,097.34 | Per water heater | DEER2005 | RMFM11AVWHHpm |
| HA47 | MFm | Any | CZ12 | 1,097.34 | Per water heater | DEER2005 | RMFM12AVWHHpm |
| HA47 | MFm | Any | CZ13 | 1,097.34 | Per water heater | DEER2005 | RMFM13AVWHHpm |
| HA47 | MFm | Any | CZ16 | 1,211.19 | Per water heater | DEER2005 | RMFM16AVWHHpm |
| HA47 | SFm | Any | CZ01 | 2,320.64 | Per water heater | DEER2005 | RSFM01AVWHHpm |
| HA47 | SFm | Any | CZ02 | 2,320.64 | Per water heater | DEER2005 | RSFM02AVWHHpm |
| HA47 | SFm | Any | CZ03 | 2,320.64 | Per water heater | DEER2005 | RSFM03AVWHHpm |
| HA47 | SFm | Any | CZ04 | 2,320.64 | Per water heater | DEER2005 | RSFM04AVWHHpm |
| HA47 | SFm | Any | CZ05 | 2,320.64 | Per water heater | DEER2005 | RSFM05AVWHHpm |
| HA47 | SFm | Any | CZ11 | 2,102.49 | Per water heater | DEER2005 | RSFM11AVWHHpm |
| HA47 | SFm | Any | CZ12 | 2,102.49 | Per water heater | DEER2005 | RSFM12AVWHHpm |
| HA47 | SFm | Any | CZ13 | 2,102.49 | Per water heater | DEER2005 | RSFM13AVWHHpm |
| HA47 | SFm | Any | CZ16 | 2,320.64 | Per water heater | DEER2005 | RSFM16AVWHHpm |

# References

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   Division 2 - State Energy Resources Conservation and Development Commission  
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7. Same as endnote #6. Page 212. [↑](#endnote-ref-7)
8. Federal Register. Department of Energy. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule”. April 16, 2010 . [↑](#endnote-ref-8)
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11. Same as endnote. Page 2-19. [↑](#endnote-ref-11)
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     [↑](#endnote-ref-12)