**Workpaper PGECODHW101**

**Water Heating Boiler**

**Revision # 5**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Water Heating Boiler**

**Measure Code H105, DWHC3, DWHC4**

# At-a-Glance Summary

|  |  |  |
| --- | --- | --- |
| **Applicable Measure Codes:** | **H105, DWHC3 – Large Domestic Hot Water Boiler** | **DWHC4 – Large Condensing Domestic Hot Water Boiler** |
| **Measure Description:** | Instantaneous domestic water boilers with thermal efficiency > 84%. Minimum 200 kBTUh input rating. | Instantaneous domestic water boilers with thermal efficiency > 90% (condensing units). Minimum 200 kBTUh input rating. |
| **Energy Impact Common Units:** | Per kBTUh input rating | Per kBTUh input rating |
| **Base Case Description:** | Large gas storage water heater with **Thermal efficiency of 80%.**  Source: DEER, D13v1.0, DEER2014 | Large gas storage water heater with **Thermal efficiency of 80%.**  Source: DEER, D13v1.0, DEER2014 |
| **Base Case Energy Consumption:** | Not given. DEER reports savings impacts.  Source: DEER, D13v1.0, DEER2014 | Not given. DEER reports savings impacts.  Source: DEER, D13v1.0, DEER2014 |
| **Measure Energy Consumption:** | Not given. DEER reports savings impacts.  Source: DEER, D13v1.0, DEER2014 | Not given. DEER reports savings impacts.  Source: DEER, D13v1.0, DEER2014 |
| **Energy Savings Base Case – Measure)** | Various. Refer to At-A-Glance Measure List.  Source: DEER, D13v1.0, DEER2014 | Various. Refer to At-A-Glance Measure List.  Source: DEER, D13v1.0, DEER2014 |
| **Costs Common Units:** | Per kBTUh input rating | Per kBTUh input rating |
| **Base Case Equipment Cost ($/unit):** | **$18.66/kBTUh**  Source: DEER 2008 Cost Data | **$18.66/kBTUh**  Source: DEER 2008 Cost Data |
| **Measure Equipment Cost ($/unit):** | **$19.67/kBTUh**  Source: DEER 2008 Cost Data | **$20.68/kBTUh**  Source: DEER 2008 Cost Data |
| **Gross Measure Cost ($/unit)** | **$1.01/kBTUh**  Source: DEER 2008 Cost Data | **$2.02/kBTUh**  Source: DEER 2008 Cost Data |
| **Measure Incremental Cost ($/unit):** | **$1.01/kBTUh**  Source: DEER 2008 Cost Data | **$2.02/kBTUh**  Source: DEER 2008 Cost Data |
| **Effective Useful Life (years):** | EUL: 20.0yrs  RUL: 6.7yrs  Source: DEER 2014 EUL/RUL Values and Summary Documentation | EUL: 20.0yrs  RUL: 6.7yrs  Source: DEER 2014 EUL/RUL Values and Summary Documentation |
| **Program Type:** | ROB | ROB |
| **Net-to-Gross Ratios:** | Com NTG: 0.60  Source: DEER 2011 NTG Values – Commercial; All other EEMs with no evaluated NTGR; existing EEM programs with same delivery mechanism for more than 2 years | Com NTG: 0.60  Source: DEER 2011 NTG Values – Commercial; All other EEMs with no evaluated NTGR; existing EEM programs with same delivery mechanism for more than 2 years |
| **Important Comments:** | Gross measure cost is assumed to be the same as the incremental measure cost. | Gross measure cost is assumed to be the same as the incremental measure cost. |

# 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 |
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# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| **Revision 0** | **04/01/2008** | **Original work paper:**  **Large DHW Boiler PGECODHW101 R0** | **Peter Pollard (kW Engineering)** |
| **Revision 1** | **4/1/2009** | **DEER 2008 Update** | **Breesa Kassing (PG&E)** |
| **Revision 2** | **12/2/2009** | **Update NTGR value to 0.46** | **Charlie Middleton (PG&E)** |
| **Revision 3** | **5/18/2012** | **PGECODHW101 R3 update including available 2011 DEER data savings data, and update NTGR value to 0.60** | **Justin Westmoreland (PG&E)** |
|  | **8/28/2012** | **Nomenclature Update & Non-DEER Building Type “OTR” Defined** | **Justin Westmoreland (PG&E)** |
| **Revision 4** | **2/24/2014** | **Added new measure codes DHWC3 and DHWC4. Work paper values for these measure codes are effective from 1/1/14 to 6/30/14. DEER14 values will be in Rev. 5.** | **Charlie Middleton (PG&E)** |
| **Revision 5** | **04/18/2014** | **DEER 2014 Update; aligned program offerings with DEER.** | **Curtis Lee (kW Engineering)**  **Charlie Middleton (PG&E)** |

# Table of Contents

[At-a-Glance Summary i](#_Toc386184763)

[Work Paper Approvals iii](#_Toc386184764)

[Document Revision History iv](#_Toc386184765)

[Table of Contents v](#_Toc386184766)

[List of Tables vi](#_Toc386184767)

[*Section 1. General Measure & Baseline Data* 7](#_Toc386184768)

[1.1 Product Measure Description & Background 7](#_Toc386184769)

[1.2 Product Technical Description 7](#_Toc386184770)

[1.3 Measure Application Type 8](#_Toc386184771)

[1.4 Product Base Case and Measure Case Data 8](#_Toc386184772)

[1.4.1 DEER Base Case and Measure Case Information 8](#_Toc386184773)

[1.4.2 Codes & Standards Requirements Base Case and Measure Information 11](#_Toc386184774)

[1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information 12](#_Toc386184775)

[1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases 12](#_Toc386184776)

[*Section 2. Calculation Methods* 14](#_Toc386184777)

[2.1 Electric Energy Savings Estimation Methodologies 15](#_Toc386184778)

[2.2 Demand Reduction Estimation Methodologies 15](#_Toc386184779)

[2.3 Gas Energy Savings Estimation Methodologies 15](#_Toc386184780)

[*Section 3. Load Shapes* 15](#_Toc386184781)

[*Section 4. Base Case & Measure Costs* 15](#_Toc386184782)

[4.1 Base Case(s) Costs 16](#_Toc386184783)

[4.2 Measure Case Costs 17](#_Toc386184784)

[4.3 Incremental & Full Measure Costs 18](#_Toc386184785)

[4.3.1 Gross Measure Costs 18](#_Toc386184786)

[4.3.2 Incremental Measure Costs 18](#_Toc386184787)

[Index 20](#_Toc386184788)

[References 21](#_Toc386184789)

# List of Tables

[Table 1 - Measure Application Type 8](#_Toc380749109)

[Table 2 - Net-to-Gross Ratios 11](#_Toc380749110)

[Table 3 - Baseline by Measure Application Type 14](#_Toc380749111)

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# *Section 1. General Measure & Baseline Data*

## 1.1 Product Measure Description & Background

***Catalog Description***

* H105, DHWC3 Large Domestic Hot Water Boiler
* DHWC4 Large Condensing Domestic Hot Water Boiler

***Program Restrictions and Guidelines***

This work paper documents the rationale for the savings methodologies and assumptions for Large Domestic Hot Water Boilers, as listed in the Boilers and Water Heating Rebate Catalog. The Boilers and Water Heating Rebate Catalog is part of Pacific Gas and Electric Company’s Customer Energy Efficiency Program. PG&E offers incentives to non-residential customers for installing qualifying high-efficiency equipment.

The measure code in the current catalog is H105. Measure H105 does not make a distinction between condensing and non-condensing units. Moving forward, measure code H105 and DHWC3 will only cover non-condensing units. Condensing boilers are covered under Measure DHWC4.

**Terms and Conditions:**

Requirements from Boilers and Water Heating Catalog:

* Only boilers with an input rating greater than 200 kBTUh qualify.
* Measures H105, DHWC3 must meet a minimum thermal efficiency of 84 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 boiler must be included with the application.
* Installation address must have a commercial natural gas account with PG&E. Must be a commercial end-use customer.
* Cannot be used for space conditioning.
* Cannot be used for industrial (process) end-use.

**Market Applicability:**

This measure is applicable to any large commercial domestic water heater used for domestic hot water and not applicable to boilers used for process end uses, space heating, pools, or spas. Applicable business types include (but are not limited to) offices, restaurants, retail, school, colleges, hotels, motels, and recreational facilities.

## 1.2 Product 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 boilers, typically rated above 90% thermal efficiency, are commonly known as “condensing” boilers. Condensing boilers 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 boilers because the additional heat recuperation results a lower flue gas temperature and water vapor condensing out of the flue gas.

## 1.3 Measure Application Type

The DEER measure application types are defined in the table below:

Table 1 - Measure Application Type[[1]](#endnote-1)

*Identifies the measure application type in the Measure Implementation table in DEER2013.*

|  |  |  |
| --- | --- | --- |
| **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* |

Measures H105, DWHC3 and DWHC4 are applicable to commercial installations. The savings for all measures are calculated assuming that the installation is replace-on-burnout (ROB).

## 1.4 Product Base Case and Measure Case Data

## 1.4.1 DEER Base Case and Measure Case Information

The DEER measures below include gas energy savings, base and measure equipment costs, incremental equipment costs and equipment useful lives.

**H105, DHWC3 – Large Domestic Hot Water Boiler**

Qualifying boilers for these measures must have an input rating greater than 200 kBTUh but less than 10,000 kBTUh and a thermal efficiency of greater than 84%. We have selected the following measure from the 2014 DEER database that exactly matches the catalog offering:

* NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et

The DEER measure is based on instantaneous water boilers with an input rating of greater than 200 kBTUh, with a thermal efficiency of greater than 85%. The DEER measure exactly matches the catalog requirements for a large water boiler for domestic hot water and is applicable to these measures.

**DHWC4 – Large Condensing Domestic Hot Water Boiler**

Qualifying boilers for this measure must have an input rating greater than 200 kBTUh but less than 10,000 kBTUh and a thermal efficiency greater than 90%. We have selected the following measure from the 2014 DEER database that exactly matches the catalog offering:

* NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et

The DEER measure is based on instantaneous water boilers with an input rating of greater than 200 kBTUh, with a thermal efficiency of greater than 90%. The DEER measure exactly matches the catalog requirements for a large water boiler for domestic hot water and is applicable to these measures.

|  |  |  |  |
| --- | --- | --- | --- |
| **Use Category Description** | **Use Category** | **Use Sub Category Description** | **Use Sub Category** |
| Service and Domestic Hot Water | SHW | Water Heating | Heating |
| **Technology Groups Description** | **Technology Groups** | **Technology Types Descriptions** | **Technology Types** |
| Water Heating Equipment | WaterHtg\_eq | Et Rated Boiler | Instant\_Et |

The data cited by DEER is exactly applicable to the measures H105, DHWC3, and DHWC4.

**EUL Electric Savings (ΔW): DEER Version and Impact IDs**

* The electric savings were downloaded directly from DEER.
* Energy savings are the difference between installed boilers and minimum code requirements.
* The following table is a sample of the electric savings from the catalog measures. Please refer to Appendix B[[2]](#endnote-2) for a full list of DEER savings.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Interactive Only?**  **Yes / No** | **Electric Savings kW** | **DEER units** | **DEER Version** | **Impact IDs** |
| Com | EX | PG&E | Yes | 1.22E-05 | Per kBTUh | D13v1.00  DEER2014 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et |
| Com | EX | PG&E | Yes | 1.22E-05 | Per kBTUh | D13v1.00  DEER2014 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

RUL savings are not applicable to this measure because this measure only covers ROB measure types.

**Therms Savings Assumption (ΔTh) DEER Version and Impact IDs**

**EUL Gas Savings (ΔTh): DEER Version and Impact IDs**

* The gas savings were downloaded directly from DEER.
* Energy savings are the difference between installed boilers and minimum code requirements.
* The following table is a sample of the gas savings from the catalog measures. Please refer to Appendix B2 for a full list of DEER savings.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Interactive Only?**  **Yes / No** | **Gas Savings therms** | **DEER units** | **DEER Version** | **Impact IDs** |
| Com | EX | PG&E | No | 1.35 | Per kBTUh | D13v1.00  DEER2014 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et |
| Com | EX | PG&E | No | 2.27 | Per kBTUh | D13v1.00  DEER2014 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

**Hours of Operation**:

* The hours of operation vary by building type and climate zone. The assumed hours are embedded in the prototype building definitions in the DEER runs/calculations. Refer to DEER documentation for further detail regarding the assumed hours of operation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Building type** | **Building Vintage** | **Climate Zone** | **Hours of Operation hrs/yr** | **Reference** |
| BCR | ALL | ALL | 8,760 | N/A |

**Base Case Costs and Measure Case Costs**

The base and measure case costs were downloaded from the DEER 2008 cost data[[3]](#endnote-3). The costs match the intended measure for climate zones, building types and vintages.

* The base and measure case costs for H105, DWHC3 were calculated from DEER; see Section 4 for further detail.
* The base case costs for DWHC4 were calculated from DEER; see Section 4 for further detail.
* The measure case costs for DWHC4 were not available from DEER. Incremental costs were used to estimate the measure cost; see Section 4 for further detail.
* The following table is a sample of the DEER measure costs for DWHC3. Please refer to Appendix B2 for a full list of DEER costs.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Costs ($)** | | |  |  |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Base Case** | **Measure Case** | **IMC** | **DEER Version** | **Impact IDs** |
| Com | EX | PG&E | $18.66 | $19.67 | $1.01 | DEER 2008 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et |
| Com | EX | PG&E | $18.66 | $20.67 | $2.02 | DEER 2008 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et |

*All costs are noted as $ per rated kBTUh.*

**Net-to-Gross Assumption:**

Table 2 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by these measures.

Table 2 – Net-to-Gross Ratios[[4]](#endnote-4)

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **DEER Spreadsheet** | |
| Program Approach | NTG | File name | Cell # |
| Com-Default>2yrs | 0.6 | Appendix D - DEER2014 NTGR | 47 |
| Res-Default>2yrs | 0.55 | Appendix D - DEER2014 NTGR | 45 |

The NTG Ratios in Table 2 are appropriate for the measures because:

* Measures are for commercial and residential applications
* No evaluated NTGR available for this measure
* Equipment has the same delivery mechanism for more than two years

**Effective Useful Life:**

The Effective Useful Life estimates were downloaded from DEER[[5]](#endnote-5). The values match the intended measures for climate zones, building types and vintages.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building Type** | **Building Vintage** | **Climate Zone** | **EUL (yrs)** | **RUL (yrs)** | **DEER Version** | **Impact IDs** |
| ALL | EX | PG&E | 20 | 6.7 | DEER2011 | NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et  NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et |

The EUL and RUL for H105, DHWC3 and DHWC4 are taken from DEER directly5.

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

In-service rate was not found in DEER or any supporting documentation. We have therefore assumed that the ISR is 1.0 for all measures based on engineering judgment.

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

***Title 20:*** These measures do fall under Title 20 of the California Energy Regulations. Title 20 states[[6]](#endnote-6):

*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-3.*

Table F-3 lists the minimum thermal efficiencies for large domestic water heaters and is found in the 2012 California Title 20 Appliance Efficiency Regulations, Section 1605.1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Title 20 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or Reference** |
| Large Gas Inst. Wtr. Ht  (>=200 kBtu/h) | Base | 80% | Thermal Efficiency | Table F-3 |
| Large Gas Storage Wtr. Ht (>=75 kBtu/h) | Base | 80% | Thermal Efficiency | Table F-3 |

***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 to not dictate associated hours of operation, measure or baseline costs, EUL, NTG, or in-service rate for the equipment involved

## 1.4.3 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. Information on the base and measure case is found in the sub-sections of 1.4.

## 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 this work paper.

***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 the inputs for calculation.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input Variable** | **Variations** | **Base Case 1 Average Value** | **Base Case 2 Average Value** | **Measure Case Average Value** | **Reference Section** |
| **Electric Savings (kW)\*** | CZ, BT | 1.22E-05 | N/A | N/A | *1.4.1* |
| **Gas Savings**  **(therms)\*** | CZ, BT | 1.81 | N/A | N/A | *1.4.1* |
| **Hours of operation** | None | 8,760 | N/A | N/A | *1.4.1* |
| **Full Cost** | CZ, BT | $21.37 | N/A | N/A | *1.4.1* |
| **Incremental Cost** | CZ, BT | $1.52 | N/A | N/A | *1.4.1* |
| **EUL /RUL**5 | None | 20/6.7 | N/A | N/A | *1.4.1* |
| **NTG** | BT | 0.58 | N/A | N/A | *1.4.1* |
| **ISR** | None | 1 | N/A | N/A | *1.4.1* |

*\*Note: DEER 2014 database does not include base case or measure values, only energy savings. Values listed represent energy savings.*

# *Section 2. Calculation Methods*

Table 3 - 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)** | **RUL/EUL-RUL** | Customer Average Baseline | Code Baseline |
| ***ROB* (replace-on-burnout)** | **EUL** | Code Baseline | N/A |
| ***NC* (new construction)** | **EUL** | Code Baseline | N/A |

Notes:

* For ROB measures, First Baseline is the baseline for the full EUL. There is no second baseline.

**H105, DHWC3 – Large Domestic Hot Water Boiler**

Qualifying boilers for these measures must have an input rating greater than 200 kBTUh but less than 10,000 kBTUh and a thermal efficiency greater than 84%. We have selected the following measure from the 2014 DEER database that exactly matches the catalog offering:

* NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p85Et

The DEER measure is based on instantaneous water boilers with an input rating of greater than 200 kBTUh, with a thermal efficiency greater than 85%. The DEER measure exactly matches the catalog requirements for a large water boiler for domestic hot water and is applicable to these measures.

**DHWC4 – Large Condensing Domestic Hot Water Boiler**

Qualifying boilers for this measure must have an input rating greater than 200 kBTUh but less than 10,000 kBTUh and a thermal efficiency of greater than 90%. We have selected the following measure from the 2014 DEER database that exactly matches the catalog offering:

* NG-WtrHt-LrgInst-Gas-gt200kBtuh-0p90Et

The DEER measure is based on instantaneous water boilers with an input rating of greater than 200 kBTUh, with a thermal efficiency of greater than 90%. The DEER measure exactly matches the catalog requirements for a large water boiler for domestic hot water and is applicable to these measures.

## 2.1 Electric Energy Savings Estimation Methodologies

There are DEER measures that exactly match catalog measures H105, DHWC3 and DHWC4. Therefore, we took savings values from DEER directly.

**∆kWh per kBTUh:** The electrical energy savings (kWh per kBTUh) for measures H105, DHWC3 and DHWC4 are taken from DEER directly.

## 2.2 Demand Reduction Estimation Methodologies

There are DEER measures that exactly match catalog measures H105, DHWC3 and DHWC4. Therefore, we took savings values from DEER directly.

**∆kW per kBTUh:** The demand reduction (kW per kBTUh) for measures H105, DHWC3 and DHWC4 are taken from DEER directly.

## 2.3 Gas Energy Savings Estimation Methodologies

There are DEER measures that exactly match catalog measures H105, DHWC3 and DHWC4. Therefore, we took savings values from DEER directly.

**∆Therms per kBTUh:** The gas energy savings (Therms per kBTUh) for measures H105, DHWC3 and DHWC4 are taken from DEER directly.

# *Section 3. Load Shapes*

Load shapes are not applicable to gas measures, because the price of gas is not dependent on time-of-use.

# *Section 4. Base Case & Measure Costs*

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***ER* (Early Retirement)** | **RUL/EUL-RUL** | Calculated as Full Gross Measure Cost | Calculated as Negative Full Gross Base Case Cost |
| ***ROB* (Replace on Burnout)** | **EUL** | Calculated as Incremental Measure Cost | N/A |
| ***NC* (New Construction)** | **EUL** | Calculated as Incremental Measure Cost | N/A |

## 4.1 Base Case(s) Costs

The following Measure Application Types are appropriate to these measures. The Base Case Costs are from DEER.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Base Case Cost** |
| H105, DWHC3 | NC, ROB | Title 20 – compliant natural gas water heater | $ 18.66 | $0.80 | $ N/A | $ 19.46 |
| DWHC4 | NC, ROB | Title 20 – compliant natural gas water heater | $ 18.66 | $1.59 | $ N/A | $ 20.25 |

*All costs are noted as $ per rated kBTUh. Costs are averages across all climate zones and building vintages.*

**Measure Case Costs for H105, DHWC3, DHWC4**

Base case material and labor costs are directly from DEER (DEER2008, Cost Case ID: Code Standard - Water Heater). A material and labor cost multiplier was used to account for cost variation in each climate zone. Costs can be found in Appendix C3. Material costs are calculated as:

Where,

= material base case cost for climate zone, $ per kBTUh

= DEER material base cost, $ per kBTUh

= material cost multiplier for climate zone, no units

­

Labor costs are calculated as:

Where,

= labor cost for climate zone, $ per kBTUh

= DEER labor base cost, $ per kBTUh

= labor cost multiplier for climate zone, no units

## 4.2 Measure Case Costs

The following Measure Application Types are appropriate to these measures.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Measure Code*** | **Measure Application Type** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| H105, DWHC3 | NC, ROB | Title 20 – compliant natural gas water heater | $19.67 | $0.80 | $ N/A | $20.47 |
| DWHC4 | NC, ROB | Title 20 – compliant natural gas water heater | $20.68 | $1.59 | $ N/A | $22.27 |

*All costs are noted as $ per rated kBTUh. Costs are averages across all climate zones and building vintages.*

Material and labor costs are multiplied by a climate multiplier to account for cost variation in each climate zone. Costs can be found in Appendix C3. Material costs are calculated as:

Where,

= material measure case cost for climate zone, $ per kBTUh

= DEER material measure cost, $ per kBTUh

= material measure cost multiplier for climate zone, no units

Labor costs are calculated as:

Where,

= labor cost for climate zone, $ per kBTUh

= DEER labor measure cost, $ per kBTUh

= labor cost multiplier for climate zone, no units

**Measure Case Costs for H105, DHWC3**

Measure case material and labor costs ($ per kBTUh) for measures H105 and DHWC3 are directly from DEER2008.

**Measure Case Costs for DHWC4:**

The measure case costs ($ per kBTUh) for measure DHWC4 are based their non-condensing counterparts. Measure costs for DHWC4 are calculated from the incremental costs of catalog measures H105, and DHWC3. The measure costs for the condensing boilers are calculated as the base cost plus twice the incremental costs of their forced draft counterparts.

Where,

MCC = Measure Case Condensing Cost, $ per kBTUh

BCC = Base Case Cost, $ per kBTUh

IMCNC= Incremental Measure Cost Non-Condensing, $ per kBTUh

**Example for DHWC4:**

$ per kBTUh

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Application Type** | **Gross Measure Cost**  **(RUL Period/First Baseline)** | **Gross 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 Gross Measure Costs

Gross 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 Types is: **ROB**, so the Gross Measure Cost (GMC) is represented by the equation below (choose):

**GMC =** (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:

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

**Example:**

GMC = $19.67/ kBTUh - $18.66 / kBTUh = $ 1.01 / kBTUh

## 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,** 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)

\*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:

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

**Example:**

IMC = $19.67/ kBTUh - $18.66 / kBTUh = $ 1.01 / kBTUh

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Measure Application Types** | **Average Base Case Total Cost** | **Average Measure Case Total Cost** | **Average Gross Measure Case Cost** | **Average Incremental Measure Cost** |
| DWHC3 | ROB, NC | $ 19.46 | $ 20.47 | $ 1.01 | $ 1.01 |
| DWHC4 | ROB, NC | $ 20.25 | $ 22.27 | $ 2.02 | $ 2.02 |

*All costs are noted as $ per rated kBTUh. Costs are averages across all climate zones and building vintages.*

# Index

EUL 13, 14, 15

Load shapes 15

New Construction 8, 15

NTG Ratios 11

Replace on Burnout 8, 15

Title 20 11, 12, 16, 17

Title 24 12

# References

1. Appendix A - DEER2014 Measure Type [↑](#endnote-ref-1)
2. Appendix B - Energy and Cost Savings PGECODHW101 R5 [↑](#endnote-ref-2)
3. Appendix C - DEER Measure Cost Summary [↑](#endnote-ref-3)
4. Appendix D - DEER NTG Values [↑](#endnote-ref-4)
5. Appendix E - DEER2014 EUL [↑](#endnote-ref-5)
6. Appendix F - 2012 California Title 20 Appliance Efficiency Regulations, Section 1605.1, Table F-3 [↑](#endnote-ref-6)