Work Paper WPSCGNRHC180524A

**Revision 0**

**Southern California Gas Company**

**High Efficiency Gas Furnace 95% AFUE**

**(1.04 HIR) - Nonresidential**

# Revision History

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| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 7/24/18 | Raad Bashar, SCG | * New workpaper |
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## Measure Summary

Table : Measure Summary Table

| **Section 1. Summary** | **Value** |
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| **Summary & Purpose** | This short form workpaper is based on PG&E’s Work Paper PGECOHVC146[[1]](#endnote-1). The following tables provide a summary of the Ex-ante data base.  Central natural gas furnace rated at 95% AFUE is from DEER 2014.   |  |  |  |  | | --- | --- | --- | --- | | Measure Characteristic | | | | | Measure Codes | DEER Measure ID | Delivery Type | Version-Source | |  | Com-Furnace-dHIR | PreReb | DEER2014- D05 v2.01 | |

| **Section** | **Value** |
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| **1.1 Measure & Baseline Data** | This measure is intended for the replacement of standard efficiency furnaces with high efficiency furnaces, with or without a Variable Speed Motor (VSM). The natural gas furnace must have an Annual Fuel Utilization Efficiency (AFUE) rating of 95% or greater.  Potential Technical Challenges or Impacts on retrofit and new construction:   * Combustion Condensate management must meet local codes and demonstrate adequate freeze protection in colder climate rooftop environments. For that matter, manufacturers’ installation instructions must be followed [[2]](#endnote-2). * Furthermore, Combustion condensate is acidic and must be neutralization by an approved dilution or neutralizing device before discharging into the plumbing system.  |  |  |  |  | | --- | --- | --- | --- | | Measure Characteristic | | | | | Measure Code | DEER Measure Description | DEER Baseline | MeasAppType | |  | Packaged Furnace (Weatherized) 95 AFUE, HIR = 1.11884 | 95 AFUE | ROB | |

| **Section** | **Value** |
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| **1.2 Technical Description** | Traditional furnaces are built with just one heat exchanger. During the combustion process that takes place inside of this heat exchanger, a certain amount of the heat that is produced is lost up the exhaust duct in the form of water vapor. Condensing furnaces typically have high efficiencies, ranging from 89 to 98%, because they have a specially designed secondary heat exchanger that extracts the heat of vaporization of water vapor in the exhaust, where it is condensed and turned into a liquid.  Condensing combustion technology has been applied to indoor equipment for years, primarily to space heating product lines from gas-fired home furnaces to hot water/steam boilers in the residential through industrial sectors. However, its introduction into outdoor, packaged gas heating and electric air conditioning rooftop units (RTUs), used for space conditioning low-rise commercial and institutional buildings, has been slowed by certain economic and technical challenges.  Economically, sufficient net annual operating energy cost savings must be demonstrated to payback the cost premium of the condensing RTU. Installation and any ongoing maintenance costs for ancillary equipment for combustion condensate management must also be accounted for in payback calculations.  According to a 2017 report from Gas Technology Institute (GTI)[[3]](#endnote-3), a 100% outdoor air condensing\_Dedicated Outdoor Air System (DOAS) RTUs, operating at high equivalent full load hours (EFUL) offers the most attractive paybacks for RTUs, as shown in the figure below.  Screen Clipping |
| Code for All Measures | As cited per  ***Title 20:*** This measure does fall under Title 20 of the California Energy Regulations. Under section 1605.1 on Table E-6, the minimum standard for gas furnaces with less than 225,000 rated input Btu/hr is 81% AFUE.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Title 20 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or**  **Reference** | | Weatherized gas furnaces | Base | 81% | AFUE | Table E-6,  Title 20, 2016 |   ***Title 24:*** This measure falls under Title 24 2016 of the California Energy Regulations. Under Title 24, table 4-1 provides the minimum standard for furnaces is 81% AFUE for < 225,000 Btu/hr capacity.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Title 24 Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source or**  **Reference** | | Weatherized gas central furnaces | Base | 81% | AFUE | Table 4-1, Title 24, 2016  (Non-Residential Compliance  Manual-Building HVAC  Requirements) |   ***Federal Standards:*** This measure falls under Federal DOE (10 CFR Part 430)[A] Energy Regulations. Under this regulation, compliance with the standards in the direct final rule will be required on May 1, 2013 for non-weatherized furnaces and on January 1, 2015 for weatherized furnaces and central air conditioners and heat pumps. Since most commercial type furnaces of less than 225,000 Btu/h input capacity are installed outside of the commercial building, it’s considered as weatherized for which the minimum AFUE is 81%.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Federal Std. Description** | **Base or Measure Case** | **Value** | **Units** | **Code Source**  **or Reference** | | Central Furnaces | Non-Weatherized gas | 80% AFUE | Per System | CFR Part 430 | | Central Furnaces | Weatherized gas | 81% AFUE | Per System | CFR Part 430 | |

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| **Section** | **Value** |
| **1.3 Installation Type and Delivery Mechanisms** |  |
| Measure Application Type | ROB and NC |
| Measure Delivery Type | PreReb |
| **1.4.1 DEER Data** | Com-Furnace-dHIR |
| **Section** | **Value** |

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| Net-to-Gross Ratio | The data cited by DEER is not exactly applicable to the measures because the DEER data are scaled and converted to the appropriate savings per unit (therms/MBtuh) for incentive purposes. See the calculation section (2) for this conversion. DEER values are used for Net-to-Gross, EUL, and ISR.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Net-to-Gross Ratio | | | | | | | **NTGR\_ID\*** | **Description\*** | **Sector\*** | **BldgType\*** | **ProgDelivID** | **NTG\*** | | All-Default<=2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for less than 2 years | All | Any | Any | 0.70 | |
| GSIA | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **GSIA** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** | | Def-GSIA | Default GSIA | Any | Any | Any | 1 | |
| Effective and Remaining Useful Life | |  |  |  |  |  | | --- | --- | --- | --- | --- | | **EUL ID** | **Enduse** | **Measure** | **EUL (Years)** | **RUL (Years)** | | HVAC-Frnc | HVAC | High Efficiency Gas Furnace | 20 | 6.7 | |
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| **Section 2. Calculation Methodology** | Energy Savings for the measures included in this workpaper are taken from DEER and compiled from READI v.2.4.7. These results have been modified for different normalizing units and the calculation spreadsheet are included in ***Attachment-A***. |
| Energy Savings/Peak Demand Reduction – All Measures | Scaling of DEER Results  The gas savings for this measure are calculated from the DEER2014 database impact ID, Furnace-Pkg\_AFUE95, as described below. DEER presents the savings in annual therms/1,000 square feet served which are converted to units of therms/MBtuh. The calculation is described below under Normalization.  Normalization by MBtuh Furnace Input Rating  DEER2014 gas energy savings are presented in units of annual therms/1,000 square feet served. To convert the DEER units of therms/1,000sqft to therms/MBtuh (Input Rating), the units are first converted from 1000 sqft to MBtuh using a heating Connected Load in (sqft/MBtuh) from California’s Commercial End-Use Survey (CEUS)[[4]](#endnote-4).  However, the CEUS[[5]](#endnote-5) Energy-use data had to be adjusted in this analysis for the following:   1. The building type used by CEUS are matched by a CEC key building type (Commercial, Grocery, Hotel, Hospital, Large Office, Misc, Restaurant, Retail, School, Small Office, University, Warehouse – non- refrigerated, and Warehouse – refrigerated) since CEUS and DEER building types are dissimilar. 2. The CEUS heating connected load data is based on the Forecasting Climate Zone Map (FCZ) and not the (16) California Weather Climate Zones currently used in DEER. Therefore, the data for each building type in the CEUS weather climate zones are normalized to the most appropriate CEC Title 24 climate zones.   The normalized DEER savings are given by the following:  Where:  = is the DEER2014 (Measure ID: Furnace-Pkg\_AFUE95) savings data.  = is the heating “connected load” data obtained from the CEUS website, that is, the average furnace output capacity installed per conditioned area. The CEUS website provides this data for different forecast climate zones and building types.    For example, the annual gas savings for a small office (OFS) DEER building type in climate zone 06 can be calculated as follows:  While, the gas savings for a Nursing Home (Nrs) in zone 06 will be:  And the gas savings for an Assembly hall (Asm) in zone 06, will be: |
| **Section 3. Load Shapes** |  |
| **Section 4. Costs** |  |
| Section 4.1 Modeled Costs | The cost estimate for central natural gas furnace (weatherized) is not in DEER. Therefore, the estimated cost of a non-residential furnaces was based on vendor’s data and the 2016 RSMeans Mechanical Cost Data (equipment and labor) for different sizes and type of equipment (standard efficiency and condensing), (*Attachment-B*).  The base case estimate for Rooftop units, sizes from 4 to 12.5 tons cooling (14 SEER) and 95,000 to 200,000 Btuh heating input capacity (81% AFUE) were calculated as $53.35 per MBtuh.  *For example, 5 ton gas htg/ elec clg RTU in RSMeans Mech Book, are as follows:*  *Equipment cost = $5,275*  *Labor estimate cost = $1,500*  *Total installed cost = $6,775 per unit (or $60.49 /MBtuh)*  There are very few producers of condensing gas RTUs due to their high cost and lack of promoting these systems.  The average cost for the proposed condensing type furnace of 95% AFUE and same rated capacity is $94.09/MBtuh. Therefore, the IMC is $40.74/MBtuh. |
| Base Cost – | |  |  | | --- | --- | | Base Cost | | | **Base Measure Cost ID** | **Base Equipment Cost** | | Federal code | $53.35 /MBtuh | |
| Measure Cost – | |  |  |  |  | | --- | --- | --- | --- | | Measure Cost | | | | | **Implementation ID** | **Measure Name** | **Measure Cost ID** | **Measure Equipment Cost** | |  | Packaged Furnace (Weatherized) 95 AFUE, | Com-Furnace-dHIR | $94.09/MBtuh | |
| IMC Measure Cost – | |  |  |  |  | | --- | --- | --- | --- | | IMC Measure Cost | | | | | **Install/Program Type** | **Gross Measure Cost**  **(First Baseline Period)** | **Gross Measure Cost**  **(Second Baseline Period)** | **Incremental Measure Cost** | | ROB and NC | $40.74/MBtuh | N/A | $40.74/MBtuh | |

# Attachments

Attachment-A\_ EnergyImpacts and normalized DEER savings calculations

Attachment-B\_Cost estimates

# References

1. PG&E Work Paper PGECOHVC146 High Efficiency Gas Furnace 95% AFUE

   (1.04 HIR) – Nonresidential, Revision-4. [↑](#endnote-ref-1)
2. Gas Technology Institute, High-Efficiency Heating Rooftop Units (RTUs) – Pages 13 and 14 of “The Final Frontier for Condensing Gas Furnaces, May 19, 2014.”

   <http://www.gastechnology.org/Expertise/Documents/ETP/ETP-CenterPoint-Energy-Conference-Condensing-RTU-Presentation-05-21-2014.pdf>

   TECHNOLOGY SNAPSHOT: Condensing Rooftop Units (RTUs)

   <http://www.gastechnology.org/Expertise/Documents/ETP/Condensing-Roof-Top-Units-Technology-Snapshot-02-2017.pdf> [↑](#endnote-ref-2)
3. GTI’s New and Emerging Natural Gas Technologies, 2017 Energy Efficiency and Technology Conference [https://www.centerpointenergy.com/en-us/Documents/Track 3 Session 2\_New and Emerging Natural Gas Technologies.pdf](https://www.centerpointenergy.com/en-us/Documents/Track%203%20Session%202_New%20and%20Emerging%20Natural%20Gas%20Technologies.pdf) [↑](#endnote-ref-3)
4. California Commercial End-Use Survey (CEUS), published by the California Energy Commission (CEC), CEC-400-2006-005, accessed at <http://www.energy.ca.gov/ceus/index.html>, March 2006. [↑](#endnote-ref-4)
5. CEUS Energy-use data <http://capabilities.itron.com/CeusWeb/ChartsSF/Default2.aspx>

   [↑](#endnote-ref-5)