Work Paper WPSCGREHC181220A

**Revision 00**

**Southern California Gas Company**

**Gas Fireplace**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | TBD |
| **Measure Description** | High-efficiency gas fireplace with two tiers:  Tier 1: 70%-75% FE  Tier 2: 75%+ FE |
| **Base Case Description** | A gas fireplace with either:   * Continuously operating pilot (for accelerated replacement[AR]), representing customer’s existing equipment * Intermittent pilot light (for normal replacement[NR] or new construction[NC]) representing code/standard equipment |
| **Units** | Per gas fireplace insert |
| **Energy Savings** | See Table 19 or refer to Excel Calculation Attachment |
| **Full Measure Cost ($/unit)** | See Table 22 |
| **Incremental Measure Cost ($/unit)** | See Table 22 |
| **Effective Useful Life** | 20 years (Source: DEER EUL ID: HV-EffFurn) |
| **Measure Installation Type** | Normal Replacement (NR) (or New Construction [NC]) and  Accelerated Replacement (AR) |
| **Net-to-Gross Ratio** | “All-Default ≤ 2 years” = *0.7* |
| **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). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 12/20/2018 | Navigant Consulting, Inc. |  |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

The gas fireplaces considered in this workpaper are self-contained vented heaters which simulate a wood burning device. Each gas fireplace consists of a heat exchanger, an ignition system, a burner, a combustion chamber, a flue, an intake, a burner control thermostat, aesthetic feature (e.g., ceramic logs or glass), an outer case, and a tempered glass viewing pane (See Figure 1). Manufacturers may differentiate gas fireplaces by efficiency rating (Annual Fuel Utilization Efficiency [AFUE] or Fireplace Efficiency [FE]), input rating (Btu/hr.), and aesthetics.

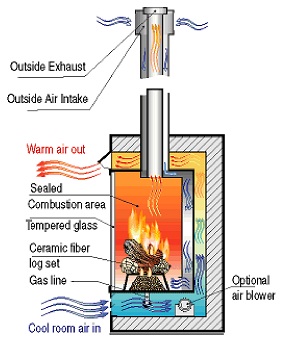


Figure : Typical Gas Fireplace with Concentric Venting[[1]](#endnote-1)

The measures in this workpaper allow for energy to be saved from the installation of efficient gas fireplaces which are replacing less efficient gas fireplaces. The measures are based on efficiency and not technology, so manufacturers are free to design efficient fireplaces without the constraints of required technology options.

Table : Base, Standard, and Measure Cases

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | Efficient fireplace Tier 1: 70%-75% FE  Efficient fireplace Tier 2: 75%+ FE |
| Existing Condition | Fireplace with either a continuously operating pilot (for accelerated replacement[AR]) or Intermittent pilot light (for normal replacement[NR] or new construction[NC]). |
| Code/Standard | N/A |
| Industry Standard Practice | N/A |

Table : Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
| TBD |  |  |  | 70% FE to 75% FE fireplace with IPL replacing a 61% FE fireplace with a continuously operating pilot light. |
| TBD |  |  |  | 75% FE or greater FE fireplace with IPL replacing a 61% FE fireplace with a continuously operating pilot light. |
| TBD |  |  |  | 70% FE to 75% FE fireplace with IPL replacing a 64% FE fireplace with a IPL. |
| TBD |  |  |  | 75% FE or greater FE fireplace with IPL replacing a 64% FE fireplace with a IPL. |

**Eligibility requirements:**

1. The measures described herein are only available to California Investor-Owned Utility (IOU) Customers whom are paying the Public Goods Charge and are Customers of the IOU for which the measure (or measures) described herein are being offered through the IOU’s Energy Efficiency program.
2. Participants in the program must be in good standing with the administering IOU.
3. The applicable market segments allowed to participate are single-family and multi-family residential markets.
4. The purchase invoice for the gas fireplace must be provided as proof of purchase.
5. Customer agrees that the IOU will conduct a post measure implementation inspection.
6. These measures only apply to gas fireplaces manufactured with burner-control thermostats, integrated IPL controls, and FE values within the specified ranges.

**Implementation and installation requirements**:

1. The fireplace shall be functional prior to being installed.
2. Any technology manufacturer qualifies to be used in this program if safety and all other regulations are met and the technology is commercially available.

## 1.2 Technical Description

The measures in this workpaper allow for energy to be saved from the installation of efficient gas fireplaces which are replacing less efficient gas fireplaces. Increases in fireplace efficiency (FE) can typically be achieved through the addition of the following technologies:

* indoor air circulation blower (“blower”),
* power venting (fan in the flue/exhaust),
* flue dampers,
* concentric direct venting, and
* condensing technology.

Both the blower and power venting allow for a larger heat exchange area which can extract more heat from the combustion area. After enough heat is extracted condensation can occur which releases the latent heat in the condensate. Flue dampers are used to trap hot air within the fireplace after the burner has stopped firing, which allows more heat to transfer to the building than if the air were to vent naturally. Concentric direct venting preheats the incoming combustion air allowing for a more efficient burn of the gas. Increased FE’s directly result in energy savings during the operation of a fireplace. When the fireplace does not have the full flame ON, either a continuously operating pilot light (CPL) or an intermittent pilot light (IPL) ignition system is operating. A CPL ignition system is constantly burning gas to enable ignition of the burner in the event of a burner ON signal. An IPL system ignites the pilot when a burner ON signal is received and then the pilot light ignites the burner. The CPL system can be operated without electricity and the IPL system requires an electrical supply from either a battery or hardwired into the building’s electricity supply. The measures in this workpaper are not distinguished by technology but rather by FE. Therefore, they are technology independent though specific technologies are typically used to reach higher FE levels.

The energy savings calculated in section 2 are based on an increase in FE and where appropriate also changing from a CPL to a IPL ignition system.

## 1.3 Installation Types and Delivery Mechanisms

Different installation types are considered as described in Table 3.

Table : Installation Type Descriptions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Normal Replacement (NR) or New Construction (NC) | Above Code or Standard | N/A | EUL | N/A |
| Accelerated Replacement (AR) | Above Customer Existing | N/A | RUL | EUL-RUL |

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.

Table : Delivery Method Descriptions

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |

Table : Incentive Method Descriptions

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| 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. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER does not have this type of measure.

Table : DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER READI v.2.4.8 |
| Reason for Deviation from DEER | DEER does not contain this type of measure. |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

Table : NTGR

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| All-Default ≤ 2 years | Measures not covered by other NTG values and measure technology type has been available in marketplace for 2 years or less. | Any | Any | Any | 0.7 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The 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.

Table : GSIA

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

**Effective and Remaining Useful Life**

The EUL is assumed to be consistent with high-efficiency furnaces, which is 20 years per the DEER database and the RUL values were obtained using the DEER definition that the RUL is 1/3 of the EUL value. The RUL value is only applicable to the second baseline period for an AR measure with an applicable baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below. This EUL is also consistent with Northwest Natural’s assessment; see reference in section 1.5.1, above.

Table : EUL

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| HV-EffFurn | High Efficiency Furnace | Res | HVAC | 20 | 6.7 |

### 1.4.2 Codes and Standards Analysis

Table : Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | Section 100.1 DEFINITIONS AND RULES OF CONSTRUCTION | January 1, 2017 |
| Title 24 (2016) | Section 110.2(c) MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT | January 1, 2017 |
| Title 24 (2016) | Section 150.0(e) MANDATORY FEATURES AND DEVICES | January 1, 2017 |
| Title 24 (2016) | Section 150.0(m) MANDATORY FEATURES AND DEVICES | January 1, 2017 |
| DOE | April 2010 DOE Final Rule | N/A |

#### California’s Title 24

California’s Title 24[[2]](#endnote-2), Section 100.1 includes the following definitions related to fireplaces:

* DECORATIVE GAS APPLIANCE is a gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace.
* FIREPLACE is a hearth and fire chamber, or similar prepared place, in which a fire may be made, and which is built in conjunction with a flue or chimney, including but not limited to factory-built fireplaces, masonry fireplaces, and masonry heaters as further clarified in the CBC.
* GAS LOG is a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs and designed for installation only in a vented fireplace.

Figure 2 describes the California’s Title 24, Section 110.2(c) thermostat exemption for fireplaces.

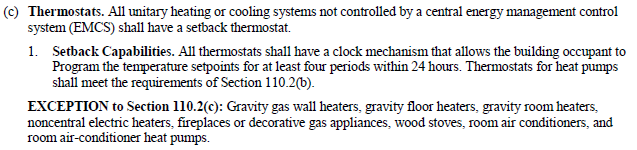


Figure : California’s Title 24, Section 110.2(c) Fireplace Thermostat Requirements

Figure 3 describes the California’s Title 24, Section 150.0(e) installation requirements specific to fireplaces. Requirement (e)(2) is of importance to this workpaper as new fireplaces cannot use a standing pilot light.

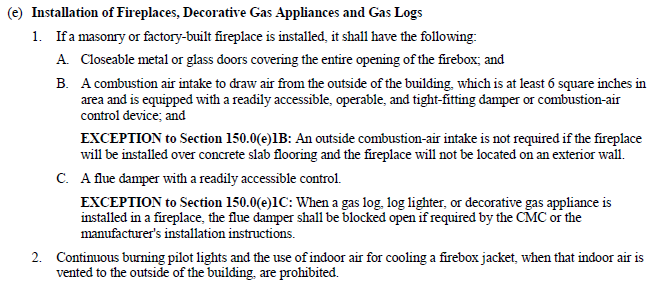


Figure : California’s Title 24, Section 150.0(e) Fireplace Installation Requirements

Figure 4 describes the fireplace exemption in California’s Title 24, Section 150.0(m) for the installation of air-distribution and ventilation system ducts, plenums, and fans.

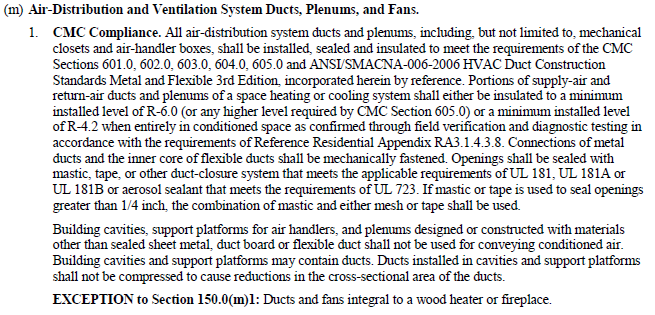


Figure : California’s Title 24, Section 150.0(m) Installation Ducting Requirements

#### Department of Energy (DOE) Standards

DOE published an energy conservation standards final rule on April 16, 2010[[3]](#endnote-3) (“April 2010 DOE Final Rule”) codifying the definition of “vented hearth heater” and establishing energy conservation standards.

The April 2010 DOE Final Rule definition of a vented hearth heater: a vented appliance which simulates a solid fuel fireplace and is designed to furnish warm air, with or without duct connections, to the space in which it is installed. The circulation of heated room air may be by gravity or mechanical means. A vented hearth heater may be freestanding, recessed, zero clearance, or a gas fireplace insert or stove. Those heaters with a maximum input capacity less than or equal to 9,000 British thermal units per hour (Btu/h), as measured using DOE’s test procedure for vented home heating equipment (10 CFR part 430, subpart B, appendix O), are considered purely decorative and are excluded from DOE’s regulations.

On November 18, 2011, DOE published the following a vented hearth heater definition[[4]](#endnote-4) revision:

Vented hearth heater means a vented appliance which simulates a solid fuel fireplace and is designed to furnish warm air, with or without duct connections, to the space in which it is installed. The circulation of heated room air may be by gravity or mechanical means. A vented hearth heater may be freestanding, recessed, zero clearance, or a gas fireplace insert or stove. The following products are not subject to the energy conservation standards for vented hearth heaters:

1. Vented gas log sets and
2. Vented gas hearth products that meet all of the following four criteria:
   1. Certified to ANSI Z21.50 (incorporated by reference; see § 430.3), but not to ANSI Z21.88 (incorporated by reference; see § 430.3);
   2. Sold without a thermostat and with a warranty provision expressly voiding all manufacturer warranties in the event the product is used with a thermostat;
   3. Expressly and conspicuously identified on its rating plate and in all manufacturer’s advertising and product literature as a “Decorative Product: Not for use as a Heating Appliance”; and
   4. With respect to products sold after January 1, 2015, not equipped with a standing pilot light or other continuously-burning ignition source.

On February 8, 2013, the U.S. Court of Appeals for the District of Columbia vacated[[5]](#endnote-5) the DOE definition of “vented hearth heater.” This also vacated the energy conservation standards established in the April 2010 DOE Final Rule. The main argument for vacating the vented hearth heater provisions was that for hearths installed purely for aesthetics it is desirable to provide no heat to the residence. Because little to no heat is provided to the residence, the efficiency of the hearth as measured by the DOE test procedure is much lower than the standards established in the April 2010 DOE Final Rule. In other words, the April 2010 DOE Final Rule standards made an entire class of hearth products illegal by measuring efficiency instead aesthetic utility. This workpaper notes that the assumptions made in the April 2010 DOE Final Rule about hearths designed to provide heat are still valid and this workpaper is only considering measures for hearths that provide heat.

On February 9, 2015, DOE published a Notice of Proposed Rulemaking[[6]](#endnote-6) (NOPR) proposing a new definition of “hearth product,” found below, and a prescriptive standard stating that hearth products not be equipped with a constant-burning pilot.

“Hearth product” means a gas-fired appliance that simulates a solid-fueled fireplace or presents a flame pattern (for aesthetics or other purpose) and that may provide space heating directly to the space in which it is installed.

#### Other Standards

Gas fireplaces are not mentioned in any of the following codes or standards: Environmental Protection Agency (EPA) ENERGY STAR, South Coast Air Quality Management District (SCAQMD), or California’s Title 20.

### 1.4.3 Fireplace Efficiencies Used

The Natural Resources Canada searchable product list (NRCan database)[[7]](#endnote-7) for gas fireplaces was used, ***Attachment A***, along with manufacturer literature to determine product characteristics and their associated FE values.

The baseline FE for the NR/NC measure was found by taking the average FE within the NRCan database for fireplace models with IPL ignition. The code baseline from California’s Title 24 requires that newly installed fireplaces must not use CPL (Continuously Pilot Light) ignition, therefore IPL ignition is required as the baseline for NR/NC installations.

The baseline FE for the AR measure was found by taking the average FE within the NRCan database for fireplace models with CPL ignition. These fireplaces are being voluntarily replaced before the end of their useful life and therefore the installed fireplaces are used as a baseline. This workpaper assumes that the typical currently installed unit is equipped with CPL.

The FE tiers for both the NR/NC and AR measures aligns with those of the Northwest Natural’s 2015 Energy Efficiency Plan and the current incentive offered by the Energy Trust of Oregon (ETO) discussed in section 1.5.

Table : Fireplace Efficiencies Used

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure** | **Baseline FE** | **FE Range** | | **FE Used in Calculations** | |
| **Tier 1** | **Tier 2** | **Tier 1** | **Tier 2** |
| NR/NC | 64.6 | ≥70% and <75% | ≥75% | 72.1 | 79.1 |
| AR | 60.8 | ≥70% and <75% | ≥75% | 72.1 | 79.1 |

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

This workpaper refers to a memo found within the April 2010 DOE Final Rule, a CADMUS study done for the ETO, Northwest Natural’s 2015 Energy Efficiency Plan, and the current gas fireplace incentives offered by the ETO. These studies quantify potential savings, however this workpaper uses its own methodology described in section 2 to estimate the actual savings presented in this document specifically for each CA climate zone.

### 1.5.1 April 2010 DOE Final Rule

As stated in section 1.4.2, DOE published a final rule establishing a definition for hearth products (fireplaces) and energy conservation standards. The April 2010 DOE Final Rule was vacated by the DC court of appeals because it did not fairly represent fireplaces not designed to provide heat. As this workpaper only considers fireplaces designed to provide heat the assumptions made in the April 2010 DOE Final Rule are still applicable.

* Representative product class, “Over 27,000 and up to 46,000 Btu/h”
  + Representative input rate used was 35,000 Btu/h
* Pilot light input rate used was 350 Btu/h
* Burner ON hours were a function based on house heating load (Btu/y), input rate of the pilot and fireplace, steady state efficiency, and average heating season hours.
* Product lifetime of 10 to 20 years with an average of 15 years.

Table : DOE Efficiency Levels from the April 2010 DOE Final Rule

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Efficiency Level** | **Technology** | **Average Energy Savings**, **(Therms/yr)** | **Manufacturer Selling Price**, **2009$** | **Installed Cost, 2009$** |
| Baseline (AFUE = 64) | Standing Pilot | 0 | 502 | $547 |
| 1 (AFUE = 67) | Electronic Ignition | 20 | 499 | $695 |
| 2 (AFUE = 72) | Fan Assisted (Blower) | 31 | 743 | $695 |
| 3 – Max Tech (AFUE = 93) | Condensing | 62 | 1,239 | $695 |

### 1.5.2 CADMUS Efficient Direct Vent Gas Fireplaces in Oregon

ETO currently offers incentives to consumers purchasing select high-efficiency direct-vent gas fireplaces. To assess the appropriateness of the incentives currently being offered, ETO undertook a survey[[8]](#endnote-8) of Oregon hearth dealers to better understand the market for direct-vent gas fireplaces. The finding below summarize the study published on December 5, 2013.

* “Vendors believe customer concern about heating efficiency is increasing”
* “83% of vendors said they actively sell high efficiency direct vent gas fireplaces, compared to 69% of vendors in 2009”
* “74% of vendors said that one-half or more of their customers rely on their fireplaces as a major heat source during the heating season”
* “For top selling fireplaces where FE ratings were available, the average rating was 68, compared to an average rating of 61 in 2009.”
* Based upon vendor reports, the prices across all 74 top models ranged from $1,076 to $4,500, with an average price of $2,653. More efficient models have higher average prices.
* The average cost to install and vent three types of direct vent gas fireplaces ranged from $838 for fireplace inserts, to $947 for free-standing fireplaces/stoves, and to $975 for zero clearance fireplaces.

Table : FE Ratings for IPI, Pilot on Demand, and Standing Pilot options

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pilot Light Type** | **Number of Models** | **Mean FE Rating, %** | **FE Rating - Range** | **Average Price** |
| Standing Pilot | 10 | 61.6% | 50.6 to 66.1 % | $2,245 |
| Pilot on Demand | 8 | 68.9% | 66.4 to 71.9 % | $2,807 |
| Intermittent Pilot | 23 | 69.6% | 62.8 to 77.2 % | $2,633 |

Table : Frequencies and Mean Price of Models at Select Efficiency Levels

|  |  |  |  |
| --- | --- | --- | --- |
| **FE Rating** | **Number** | **Average Price** | **Median Price** |
| <55 | 1 | $1,799 | $1,799 |
| 55-59 | 1 | $1,800 | $1,800 |
| 60-65 | 9 | $2,531 | $2,517 |
| 66-70 | 15 | $2,621 | $2,500 |
| Over 70 | 15 | $2,666 | $2,542 |
| Total & Overall Average | 41 | $2,581 | $2,500 |

Table : Price of Installing and Venting Direct Vent Fireplace Styles

|  |  |  |
| --- | --- | --- |
| **Zero Clearance Price** | **Response Total** | **Response Percent** |
| $500-$700 | 5 | 26% |
| $751-$1000 | 8 | 42% |
| $1001-$1500 | 6 | 32% |
| **Average Cost = $975** | | |
| **Fireplace Inserts Price** | **Response Total** | **Response Percent** |
| $500-$700 | 8 | 42% |
| $751-$1000 | 8 | 42% |
| $1001-$1500 | 3 | 16% |
| **Average Cost = $838** | | |
| **Free-Standing Stoves Price** | **Response Total** | **Response Percent** |
| $500-$700 | 2 | 11% |
| $751-$1000 | 12 | 63% |
| $1001-$1500 | 5 | 26% |
| **Average Cost = $947** | | |

### 1.5.3 Northwest Natural’s 2015 Energy Efficiency Plan

Northwest Natural (NW Natural) began offering its current energy efficiency programs to Washington customers on October 1, 2009. The Washington Utilities and Transportation Commission’s (“WUTC’s”) Order No. 04 in the Company’s 2008 rate case, docketed as UG-080546, directed NW Natural to create and begin offering a program. NW Natural characterized their latest gas fireplace measures in an updated Blessing Memo, last updated on November 13, 2014, included as EXHIBIT A of their 2015 Energy Efficiency Plan.[[9]](#endnote-9), [[10]](#footnote-1)

* Baseline FE of 66.8% was found through a vendor survey.
* Proposed efficiency-based measure tiers of:

Table : Northwest Natural’s Proposed Fireplace Measure Tiers

|  |  |  |
| --- | --- | --- |
| **Efficiency Tiers** | **Annual Gas Savings, Therms** | **Incremental Cost** |
| 70% FE to 74% FE | 79.4 | $1 |
| 75% FE and above | 90.9 | $173 |

* Burner ON time estimated as 15 hr/wk during a 40-week heating season (600 burner ON hours)
* Pilot light input rate assumed to be 900 Btu/h
* Representative input rate of the burner is assumed to be 33,000 Btu/h
* Net to Gross Ratio assumed to be 0.81
* Measure life 20 years

### 1.5.4 Energy Trust of Oregon Current Gas Fireplace Incentives

Safe and easy to operate, high-efficiency direct-vent gas fireplaces provide heat directly to the interior spaces where they are installed. Direct-vent units are also easier to operate than traditional wood-burning fireplaces and offer better indoor air quality.

Table : ETO Gas Fireplace Incentives[[11]](#endnote-10)

|  |  |  |
| --- | --- | --- |
|  | **Incentive** | **Requirements** |
| High-efficiency direct-vent gas fireplace | $250 | 75.0+ FE with electronic pilot ignition |
| High-efficiency direct-vent gas fireplace | $150 | 70.0-74.9 FE with electronic pilot ignition |

To qualify for this incentive, your gas fireplace must also be vented to the outside with sealed combustion.

### 1.5.5 LBNL Survey of Hearth Products in U.S. Homes

Lawrence Berkeley National Laboratory (LBNL) published a survey[[12]](#endnote-11) of hearth product characteristics, usage information, and repair and maintenance practices in June 2017. This survey compiled past surveys and metering studies.

* National average burner ON time reported as 234 hours
* National average pilot ON time reported as 4593 hours
* Pilot light input rate of 1000 Btu/h for fireplaces, inserts, and stoves and 700 Btu/h for log sets.
* Burner input rate reported as 35,000 Btu/h.

## 1.6 Data Quality and Future Data Needs

The quality of the data used in this workpaper is appropriate for computations purposes. Primarily the data is used to establish the precedent of energy consumption from the use of a CPL and the energy savings from an increase in FE.

Future data needs could involve:

* A thorough survey to more accurately compute an appropriate value for the annual hours the pilot is kept on throughout the service territory population.
* A thorough survey to more accurately address burner ON times of a manually operated fireplace.

# Section 2. Calculation Methodology

The fireplaces analyzed in this workpaper are assumed to be thermostatically operated. The baseline technology options for fireplaces in DOE’s April 2010 Rulemaking include a burner control thermostat. DOE’s baseline technology options are carried through to more efficient fireplaces and were assumed to be present in all fireplaces examined for the April 2010 Rulemaking.[[13]](#footnote-2) Thermostatically operated fireplaces will only use as much heating is necessary to maintain a specified set point temperature.

A representative burner input rate is used for both the baseline and efficient fireplace options. A constant input rate is also used in DOE’s April 2010 Rulemaking[[14]](#footnote-3) across all efficiency options. A representative input rate effectively says that a replacement fireplace will be sized the same as the fireplace it is replacing.

If a fireplace is operated manually, without the thermostat, under or overheating from the setpoint temperature can occur. This typically occurs when the fireplace is being used for purely aesthetic reasons. During manual operation of the fireplace, the time the burner is ON is independent of the room temperature. Because the burner input rate and ON time for baseline and efficient fireplaces are the same, the energy use is same. For a manually-operated fireplace to save energy, it must have shorter runtime than its less efficient counterpart, such as, if it is shut off sooner because it heats the room faster. The manually operated state is not examined in this workpaper.

Throughout this section assumptions are taken from the IPL workpaper for gravity wall furnaces, (see **Attachment B)**. The IPL workpaper states, in section 1.1, that its conclusions also apply to fireplace inserts. The assumptions from the IPL workpaper are discussed as they appear but in general fireplaces provide a similar utility to that of gravity wall furnaces, that is, they both typically heat individual rooms as opposed to a centralized heating system for an entire residence. The input rates commonly used by wall furnaces are similar to those used by fireplaces. For example, in the April 2010 DOE Final Rule, the representative input rate for gravity wall furnaces and fireplaces were 32,000 Btu/h and 35,000 Btu/h, respectively.

This workpaper assumes that the fireplace is the only non-centralized heat source within the room.

The energy savings for this measure are computed by assessing the annual operating hours (from hourly data specific to each California Climate Zone) and energy use in three different states of operation.

1. When the pilot light is on and no heating is required for the hour
2. When the burner is on for a fraction of the hour
3. When the pilot light is on and heating is required during the hour

With these time values, input rates, and efficiency assumptions the annual energy savings can be calculated. For the measures with a baseline including CPL ignition technology, the savings from the removal of the pilot light and installing an efficient fireplace are added to calculate the total savings. For the measures with a baseline including IPL ignition technology, the savings come only from the higher efficiency (FE).

## 2.1 Total Hours per year the Standing Pilot Light is ON

SoCalGas’ data of customer calls for pilot ignition and pilot turn OFF inquiries for gravity wall furnaces was used to determine the heating season, i.e., the hours per year the fireplace’s pilot light is ON and the unit can provide heat. Gravity wall furnace calls for pilot light ON and OFF inquiries are a reasonable surrogate for annual pilot light ON hours for gas fireplaces because the heating season characterization is all that is of interest here and that should not differ between products.

From **Attachment C**, customers were found to call SoCalGas to turn off pilot lights throughout the year, however the intensity of calls occurs yearly from April to July, with the maximum number of calls taking place in July. Due to July experiencing the highest calls, this workpaper will consider July as the month when pilot lights are turned OFF. For ON instances, the same process was taken and the months with the most intensity are from October to January, with December experiencing the highest number of calls. December is taken as the month when pilot lights are turned on. Since pilot lights are turned ON in December and turned OFF in July, the pilot lights are ON for seven months and OFF for five. Using CPUC approved weather data, **Attachment D**, the annual ON and OFF hours are identified from the 8760 annual hours available. The ON hours are found to be from hour 1 to hour 4344 and from hour 8017 to hour 8760, while hours 4345-8016 are found to be OFF hours. Therefore, of the 8760 hours in a year the total pilot light ON hours are 5088 and the total pilot light OFF hours are 3672.

## 2.2 Hours Per Year the Burner is ON

The total hours per year the burner is ON can be calculated using the following equation:

Where,

= Total hours per year the furnace’s burner is ON.

S = Scaler to adjust the equations output to reflect the impact of heating only a portion of the home vs. the whole home, as was done in the furnace workpaper from which this originated (29%)

i = each hour in a year.

= Heating Degree Days at each hour in a year, Source: **Attachment D**, CompareWeatherData-v4

P = Regression coefficient from **Attachment E**, (0.1310 ), Source: WPSCGREHC110603A

Area = Single-family home area **Attachment E**, (1366 ), Source: WPSCGREHC110603A

C = Fireplace input from **Attachment E**, (30 ), Source: WPSCGREHC110603A

A = Fireplace Output capacity, (Btu/hr)

Heating Degree Days (HDD) are from **Attachment D**, with a base of 65°F for each California climate zone (CZ). P is a regression coefficient found using SCG market data which relates HDD and furnace size per home and is from **Attachment E**. P was found using all data from all CZs and does not change with CZ. Area refers to the average area of a home being heated by the fireplace and is from **Attachment E**. Single-family home values for P and Area are used. C is the average furnace input rate per square foot over all CZ from **Attachment F**. This workpaper assumes that manufacturers will not manufacture a unique fireplace for each CZ. The fireplace output capacity, A, cancels out in this equation.

The single-family home area and fireplace input per square foot were taken from **Attachment E**. These assume that the entire home is being heated with the gravity wall furnace that was the subject of that workpaper. Because fireplaces would only be expected to heat a room (plus some adjacent hall or neighboring room space) in a residence, the time the burner is on is scaled down to account for not needing to heat the whole house. Typical room dimensions of a living or family room range from 70 ft2 to 616 ft2 (7 ft by 10 ft to 22 ft by 28 ft) depending on the size of the home.[[15]](#footnote-4) The fireplace in this workpaper is assumed to heat a floor space of 20 ft by 20 ft (400 ft2). This 400 ft2 floor space is above the middle of the ranges found. It is larger than some living spaces where a hearth would typically be found but a fireplace will typically heat more floor space than just the room it is installed in. Also, as stated in the LBNL Hearth Study, hearth ownership increases with income. It follows that home size also increases with income so a slightly larger than average floor space is appropriate. Therefore, the burner ON time is decreased by 400/1366, or 29%. This results in burner ON hours from 85-404 hours (3-13 hours/wk for a 30-week heating season) depending on the climate zone. This is in line with expectations from the 15 hrs/wk burner ON hours published in the Northwest Natural’s 2015 Energy Efficiency Plan (600 hours across a 40-week heating season) and the 234 burner ON hours per year from LBNL’s Hearth Study. SCG’s most populous climate zones, 8 and 9, result in 4.2 and 4.9 hrs/wk of operation, respectively, which is reasonable given the more temperate climate that is found in these CZs (respectively 127 and 148 hours per 30-week heating season). Table 18 shows the burner operating hours resulting from equation (1).

Table : Burner Operating Hours by Climate Zone

| **Climate Zone** | **HDD** | **Burner Operating Hours (hrs/wk** |
| --- | --- | --- |
| 1 | 5,094 | 10.3 |
| 2 | 3,835 | 8.2 |
| 3 | 3,257 | 7.3 |
| 4 | 3,050 | 7.0 |
| 5 | 3,715 | 7.9 |
| 6 | 2,013 | 4.9 |
| 7 | 1,478 | 3.9 |
| 8 | 1,702 | 4.2 |
| 9 | 2,000 | 4.9 |
| 10 | 2,240 | 5.4 |
| 11 | 3,027 | 7.5 |
| 12 | 3,122 | 7.4 |
| 13 | 2,794 | 6.9 |
| 14 | 3,322 | 8.0 |
| 15 | 1,102 | 2.8 |
| 16 | 5,578 | 13.3 |

## 2.3 Hours Per Year the Standing Pilot is ON

Within the heating season (when the pilot is lit) there are three different operating states that must be considered for calculating pilot light ON hours, these instances depend on the HDD for each hour and are as follows:

1. **Pilot-only on-time (no heat call)** – If the HDD is equal to zero, then no heating is required, and the entire hour is counted towards pilot ON time.
2. **Pilot plus Burner on-time** – If the HDD is not zero, then heating is required for a part of the hour. The standing pilot will be ON at the same time as the burner.
3. **Pilot-only on-time (heat call)** – If the HDD is not zero, then heating is required for a part of the hour. The standing pilot will be ON for the remainder of the hour while the burner is OFF.

The hours per year for each of the three standing-pilot operating states can be calculated with the following equations:

Where,

= Total hours the pilot light is ON for the entire hour and no heat was required during the hour

i = each hour in the year

= Heating Degree Days at each hour in a year, Source: **Attachment D**, CompareWeatherData-v4

= Total hours the pilot light is ON while the burner is also ON.

= as calculation in section 2.2.

= Total hours the pilot light is ON while the burner is OFF and heat was required during the hour

= Total hours the fireplace is capable of heating (5088 hrs) from section 2.1.

## 2.4 Energy Savings from Removal of a Standing Pilot

The three pilot operating states have different methods of calculating the energy savings from removing the standing pilot.

1. **Pilot ON for the entire hour.** No heating is required during this hour, so all the heat provided by the pilot to the conditioned space is wasted.
2. **Pilot and Burner ON for part of the hour.** The input rate and efficiency of a fireplace are found using the total gas entering the fireplace when the burner is ON. Therefore, the energy savings from the removal of a pilot light are accounted for more appropriately within the energy savings for an increase of efficiency (See section 2.5).
3. **Pilot ON and Burner OFF for part of the hour.** Heating is required during this hour, so the heat provided by the pilot can be considered useful. This case will also consider a pilot light efficiency, a value that captures the amount of heat produced from the pilot light that is transferred to the conditioned space. Currently there are no studies assessing this value; however, the DEER water heater calculator **Attachment G**, uses a pilot light efficiency of 67%, which this measure will also use. In other words, during these periods, this measure will only claim 33% of the pilot light energy as savings for energy that would have otherwise been wasted, while 67% of the pilot heat rate is assumed to be transferred into the conditioned space.

The energy savings for the removal of the standing pilot light can be calculated using the equations below for each instance of standing pilot energy use:

Where,

= Pilot light energy savings from instance 1 when the pilot light was on for the entire hour (Therms).

= Pilot light ON time for instance 1 when the pilot light was on for the entire hour (hours), as calculated in section 2.3.

= Input rate of the pilot light (501.4 ) from **Attachment C**.

= Pilot light energy savings from instance 2, when the pilot light and burner were ON for a portion of the hour (Therms)

= Pilot light energy savings from instance 3, when the pilot light was ON and the burner was OFF for a portion of the hour (Therms).

= Pilot light ON time for instance 3 when the pilot light was ON and the burner was OFF for a portion of the hour (hours), as calculated in section 2.3.

η = efficiency of the pilot light (67%) from **Attachment G**.

= Total energy saving from the removal of a pilot light.

## 2.5 Energy Savings from an Increase in Efficiency

The energy savings from an increase in efficiency can be calculated using the following equations:

Where,

= Energy savings from an increase in efficiency (Therms).

= as calculation in section 2.2.

= Representative Input rate of a fireplace (40,980 ) from **Attachment E**.

= Fireplace efficiency of fireplace at the baseline (%)

= Fireplace efficiency of fireplace of the measure (%)

The input rate of the burner used is the average input rate of a gas wall furnace sized for a single-family home, using California CZ outdoor air temperatures, as found in **Attachment E**. This workpaper has previously established that the consumer utility and burner input rates of gas wall furnaces and fireplaces are similar.

## 2.6 Total Energy Savings

The baseline for the AR measure is assumed to use a standing pilot and both measure tiers must use electronic ignition, therefore energy savings for the AR measure will include savings from the removal of a standing pilot light and savings from an increase in FE. The baseline for the NR/NC measure is assumed to use electronic ignition and both measure tiers must use electronic ignition, therefore the energy savings for the NR/NC measure will include savings from an increase in FE only. The following equations can be used to calculate the energy savings for the AR and NR/NC measures.

Where,

= Energy savings for the AR Measure (Therms).

= Total energy savings for the removal of the pilot light (Therms) as calculated in section 2.4.

= Energy savings for an increase in FE (Therms) as calculated in section 2.5.

= Energy savings for the NR/NC Measure (Therms).

Table 19 shows the energy savings broken out by pilot light and measure tier along with the total energy savings.

Table : Energy Savings by Measure and Climate Zone

| **Climate Zone** | **HDD** | **AR** | | | | | **NR/NC** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Savings Components**  **(therms/yr.)** | | | **Total Savings**  **(therms/yr.)** | | **Total Savings**  **(therms/yr.)** | |
| **Pilot Light** | **Tier 1** | **Tier 2** | **Tier 1** | **Tier 2** | **Tier 1** | **Tier 2** |
| 1 | 5,094 | 8 | 33 | 49 | 41 | 57 | 20 | 36 |
| 2 | 3,835 | 11 | 26 | 39 | 37 | 50 | 16 | 29 |
| 3 | 3,257 | 9 | 23 | 34 | 33 | 44 | 14 | 26 |
| 4 | 3,050 | 11 | 22 | 33 | 33 | 44 | 14 | 24 |
| 5 | 3,715 | 10 | 25 | 37 | 35 | 47 | 16 | 28 |
| 6 | 2,013 | 12 | 16 | 23 | 27 | 35 | 10 | 17 |
| 7 | 1,478 | 10 | 12 | 18 | 23 | 29 | 8 | 14 |
| 8 | 1,702 | 13 | 13 | 20 | 26 | 32 | 8 | 15 |
| 9 | 2,000 | 13 | 16 | 23 | 28 | 36 | 10 | 17 |
| 10 | 2,240 | 13 | 17 | 25 | 30 | 38 | 11 | 19 |
| 11 | 3,027 | 13 | 24 | 35 | 36 | 48 | 15 | 26 |
| 12 | 3,122 | 12 | 24 | 35 | 35 | 47 | 15 | 26 |
| 13 | 2,794 | 13 | 22 | 33 | 35 | 46 | 14 | 24 |
| 14 | 3,322 | 13 | 26 | 38 | 38 | 50 | 16 | 28 |
| 15 | 1,102 | 17 | 9 | 13 | 26 | 31 | 6 | 10 |
| 16 | 5,578 | 10 | 43 | 63 | 52 | 73 | 27 | 47 |

# Section 3. Load Shapes

The savings for this measure do not include any electric savings, as such, this workpaper does not identify a relevant load shape.

# Section 4. Costs

To determine the base and measure case costs, retail prices were pulled from online retailers using web scraping software. Retail cost information was found for 105 gas fireplaces currently on the market. Linear regressions were derived to estimate the retail costs of CPL and IPL ignition fireplaces separately. The regressions are dependent on FE values. The retail cost and regressions are displayed in Figure 5. Also displayed in Figure 5 are the average retail cost for CPL and IPL ignition systems and the retail cost versus FE values as published in the ETO vendor survey.

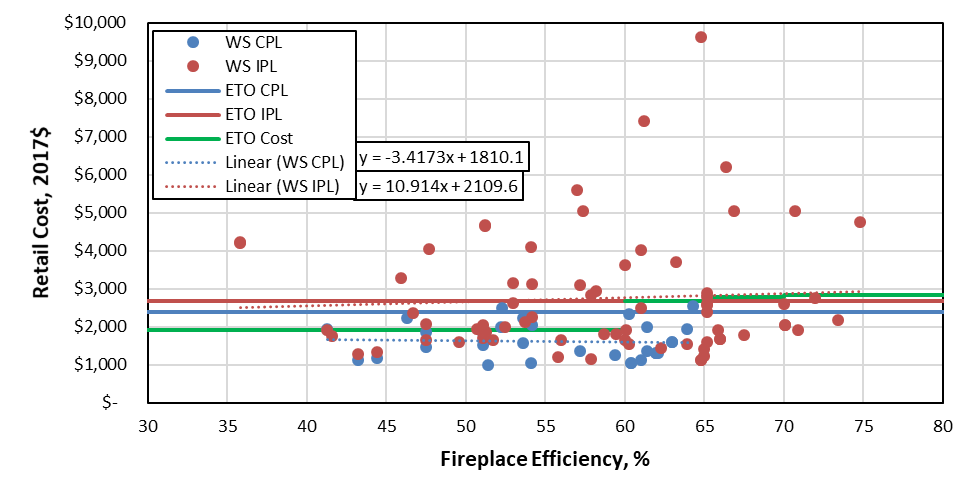


Figure : Web Scraped Retail Cost, Linear Regressions, and ETO Published Costs

In the April 2010 DOE Final Rule, retail cost information was published. These costs when transferred to 2017$ are much lower than the retail costs shown in Figure 5. Therefore, they were considered too out of date to be used.

## 4.1 Base Case Cost

The base case for the NR/NC measure assumes IPL technology. The retail cost regression for IPL ignition systems is in line with both the ETO average cost of IPL fireplaces and the FE based retail cost values. Because the retail cost regression is in line with previously published ETO data, the regression is used to determine the measure case costs.

The base case for the AR measure assumes CPL technology. The retail cost regression is lower than both the ETO average cost of CPL fireplaces and the FE based retail cost values. ETO costs based on FE were used to determine the base case cost for the AR measure. The ETO costs are more conservative and previously established.

DOE and ETO both publish installation cost data. DOE states that the installation of fireplaces using CPL and IPL technology will cost $622 and $790, respectively. ETO states that the average installation cost for fireplaces is $920. This workpaper uses the ETO values because it is more representative of the western US (DOE uses national average values in its calculations) and it is more recently published.

Table : Base Case Retail and Installation Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | **Assumed Baseline FE, %** | **Retail Cost, 2017$** | **Installation Cost, 2017$** |
| NR/NC | 64.6 | $ 2,815 | $ 976 |
| AR | 60.8 | $ 2,382 | $ 976 |

## 4.2 Measure Case Cost

The web scrape derived retail cost regression for IPL ignition systems closely tracks with the ETO retail costs above FE values of 60%. The web scraped retail cost data shows most models above a FE of 60% use IPL ignition technology. Because the retail cost regression is in line with previously published ETO data, the regression is used to determine the measure case costs.

Table : Measure Case Retail and Installation Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **FE Range** | **FE Used in Calculations** | **Retail Cost, 2017$** | **Installation Cost, 2017$** |
| NR/NC | ≥70% and <75% | 72.1% | $ 2,897 | $976 |
| ≥75% | 79.1% | $ 2,973 | $976 |
| AR | ≥70% and <75% | 72.1% | $ 2,897 | $976 |
| ≥75% | 79.1% | $ 2,973 | $976 |

## 4.3 Full and Incremental Measure Cost

Table : Full and Incremental Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **FE Range** | **Incremental Measure Cost** | **Full Measure Cost** |
| NR/NC | ≥70% and <75% | $82 | $3,872 |
| ≥75% | $158 | $3,948 |
| AR | ≥70% and <75% | $515 | $3,872 |
| ≥75% | $591 | $3,948 |

**Attachments**

Attachment A: Fireplace Analysis

Attachment B: WPSCGREHC180723A: Wall Furnace Intermittent Pilot Light (IPL)

Attachment C: WPSCGREHC180723A: Energy Savings Analysis from WPSCGREHC180723A

Attachment D: WPSCGREHC180723A: CompareWeatherData-v4

Attachment E: WPSCGREHC110603A: Gravity Wall Furnaces in Single-Family and Multi-Family Homes

Attachment F: Furnace Calculations

Attachment G: DEER-WaterHeater-Calculator-v2.1

Attachment H: Measure Summary Table

# References

1. Fireplace graphic for Figure 1: <http://architectstrace.wordpress.com/2010/07/19/feeling-lightheaded-gas-fps-explained> [↑](#endnote-ref-1)
2. California’s Title 24: <https://www.energy.ca.gov/title24/2016standards/index.html> [↑](#endnote-ref-2)
3. April 2010 DOE Final Rule: <https://www.regulations.gov/document?D=EERE-2006-STD-0129-0005> [↑](#endnote-ref-3)
4. DOE Vented Hearth Heater Definition Revision: <https://www.regulations.gov/document?D=EERE-2011-BT-STD-0047-0376> [↑](#endnote-ref-4)
5. Hearth Def Vacation: <https://www.leagle.com/decision/infco20130208115> [↑](#endnote-ref-5)
6. DOE Hearth Products NOPR: <https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0010> [↑](#endnote-ref-6)
7. NRCan Database: [http://oee.nrcan.gc.ca/pml-lmp/index.cfm](http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.welcome-bienvenue&language_langue=en) [↑](#endnote-ref-7)
8. ETO Efficient Direct Vent Gas Fireplaces in Oregon: <https://ohpba.org/Resources/Documents/ETO%20_Gas_Fireplace_Survey_Results_12-5-13.pdf> [↑](#endnote-ref-8)
9. NW Natural’s 2015 Energy Efficiency Plan: <https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=9&year=2014&docketNumber=143895> [↑](#endnote-ref-9)
10. NW Natural’s 2015 Energy Efficiency Plan, containing updated Blessing Memo for gas fireplace measures as Exhibit A, available at: <https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=9&year=2014&docketNumber=143895> [↑](#footnote-ref-1)
11. ETO Gas Fireplace Incentives: <https://www.energytrust.org/incentives/gas-fireplaces/> [↑](#endnote-ref-10)
12. LBNL Survey of Hearth Products in U.S. Homes: <https://eta.lbl.gov/sites/default/files/publications/lbnl-2001030.pdf> [↑](#endnote-ref-11)
13. Section 3.3.1.2 of the April 2010 DOE Energy Conservation Standards Rulemaking TSD [↑](#footnote-ref-2)
14. From the DHE Life-Cycle Cost spreadsheet: <https://www.regulations.gov/document?D=EERE-2006-STD-0129-0148> [↑](#footnote-ref-3)
15. Living room sizes were estimated from an array of different online retail and home improvement websites. However, no specific study was identified to provide an average room size. [↑](#footnote-ref-4)