



HVAC

GAS FIREPLACE, RESIDENTIAL

SWHC047 - 01

CONTENTS

Measure Name	2
Statewide Measure ID.....	2
Technology Summary	2
Measure Case Description	5
Base Case Description.....	5
Code Requirements	6
Normalizing Unit	9
Program Requirements.....	9
Program Exclusions.....	10
Data Collection Requirements	11
Use Category.....	11
Electric Savings (kWh).....	11
Peak Electric Demand Reduction (kW)	11
Gas Savings (Therms)	11
Life Cycle.....	18
Base Case Material Cost (\$/unit)	19
Measure Case Material Cost (\$/unit).....	20
Base Case Labor Cost (\$/unit)	20
Measure Case Labor Cost (\$/unit)	21
Net-to-Gross (NTG)	21
Gross Savings Installation Adjustment (GSIA)	21
Non-Energy Impacts	21
DEER Differences Analysis.....	21
Revision History	22

MEASURE NAME

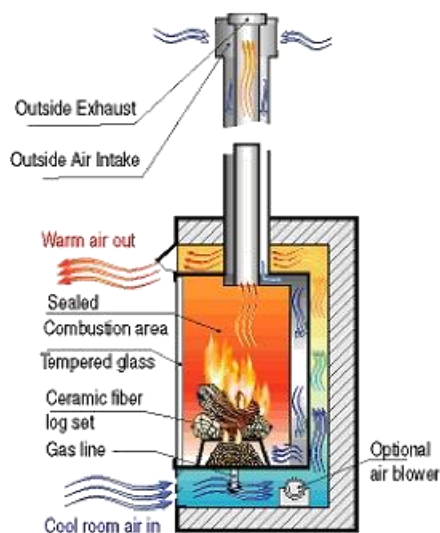
Gas Fireplace, Residential.

STATEWIDE MEASURE ID

SWHC047-01

TECHNOLOGY SUMMARY

This measure pertains to a gas fireplace that is self-contained vented heater that simulates 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. Manufacturers may differentiate gas fireplaces by efficiency rating (annual fuel utilization efficiency, AFUE or fireplace efficiency, FE), input rating (Btu/hr.), and aesthetics.



Typical Gas Fireplace with Concentric Venting

Energy savings will result from the replacement of a less efficient gas fireplace with a more efficient gas fireplace. Increases in FE can typically be achieved through the addition of one or more of the following technologies:

- Indoor air circulation blower ("blower")
- Power venting (fan in the flue/exhaust)
- Flue dampers
- Concentric direct venting
- Condensing technology

Indoor air circulation blower and power venting both 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.

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 electricity supply.

The measure offerings specified are not distinguished by technology but rather by fireplace efficiency (FE). Therefore, they are technology independent even though specific technologies are typically used to achieve higher FE levels. The energy savings calculated in the Gas Savings (Therms) section are based on an increase in FE and for some measure offerings changing from a CPL to an IPL ignition system.

Summary of Relevant Studies

Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule (U.S. Department of Energy, 2010).¹ The U.S. Department of Energy (DOE) published a final rule that established 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 that are not designed to provide heat. Because this measure considers fireplaces that are designed to provide heat, the assumptions of the April 2010 DOE Final Rule are still applicable.

- Representative product class, “Over 27,000 and up to 46,000 Btu/hr”; a representative input rate used was 35,000 Btu/hr
- Pilot light input rate of 350 Btu/hr
- Burner ON hours were a function of house heating load (Btu/yr), 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

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)	Continuously operating pilot light	0	\$502	\$547

¹ U.S. Department of Energy (DOE), Energy Conservation Program. 2010. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule.” *Federal Register*. Vol. 75, No. 73. April 16.

Efficiency Level	Technology	Average Energy Savings, (Therms/yr)	Manufacturer Selling Price (2009 \$)	Installed Cost (2009 \$)
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

Efficient Direct Vent Gas Fireplaces in Oregon (Cadmus, 2013).² To assess the appropriateness of the incentives for and to better understand the market for direct-vent gas fireplaces, the Energy Trust of Oregon (ETO) administered a survey of Oregon hearth dealers. Key results are noted below:

- Vendors believe customer concerns 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.

Northwest Natural's 2015 Energy Efficiency Plan (Northwest Natural, 2014).³ Northwest Natural (NW Natural) began to offer its current energy efficiency programs to Washington customers on October 1, 2009. The Washington Utilities and Transportation Commission ("WUTC") 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 its gas fireplace measures in its 2015 Energy Efficiency Plan.

- Baseline FE of 66.8% estimated from vendor survey data.
- Proposed efficiency-based measure tiers specified below:

Efficiency Tiers	Annual Gas Savings (Therms)	Incremental Cost
70% FE to 74% FE	79.4	\$1
75% FE and above	90.9	\$173

- Estimated burner ON time of 15 hrs/week during a 40-week heating season (total of 600 burner ON hours)
- Pilot light input rate assumed to be 900 Btu/hr

² Cadmus. 2013. *Efficient Direct Vent Gas Fireplaces in Oregon*. Prepared for the Energy Trust of Oregon, Inc. (ETO). December 5.

³ Northwest Natural. 2014. *NW Natural's 2015 Energy Efficiency Plan*. November 13. See Exhibit A.

- Representative input rate of the burner is assumed to be 33,000 Btu/hr
- Net-to-gross ratio assumed to be 0.81
- Estimated measure life of 20 years

Survey of Hearth Products in U.S. Homes (Lawrence Berkeley National Laboratory, 2017).⁴ Lawrence Berkeley National Laboratory (LBNL) published a survey of hearth product characteristics, usage information, and repair and maintenance practices in June 2017. This survey compiled results of past surveys and metering studies. Results relevant to this measure include:

- 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/hr for fireplaces, inserts, and stoves and 700 Btu/h for log sets.
- Burner input rate reported as 35,000 Btu/hr.

MEASURE CASE DESCRIPTION

The measure case is defined as a high efficiency gas fireplace, defined in by two fireplace efficiency (FE) tiers:

Measures Offerings

FE Efficiency Tier	Statewide Measure Offering ID	Measure Offering Descriptions
Tier 1: 70%-75% FE	SWHC047C	70% FE to 75% FE fireplace with IPL replacing a 61% FE fireplace with a continuously operating pilot light.
	SWHC047A	70% FE to 75% FE fireplace with IPL replacing a 64% FE fireplace with an IPL.
Tier 2: 75%+ FE.	SWHC047D	75% FE or greater FE fireplace with IPL replacing a 61% FE fireplace with a continuously operating pilot light.
	SWHC047B	75% FE or greater FE fireplace with IPL replacing a 64% FE fireplace with an IPL.

BASE CASE DESCRIPTION

The base case is defined as a gas fireplace with either a continuously operating pilot (for accelerated replacement), representing customer's existing equipment, or an intermittent pilot light (for normal replacement or new construction), representing code/standard equipment.

⁴ Siap, D., H. Willem, S. Price, H. Yang, and A. Lekov (Lawrence Berkeley National Laboratory, LBNL). 2017. *Survey of Hearth Products in U.S. Homes*. June.

CODE REQUIREMENTS

Both state and federal standards apply to this measure, as specified below. Gas fireplaces are not mentioned in any of the following codes or standards: California Appliance Efficiency Regulations (Title 20) Environmental Protection Agency (EPA) ENERGY STAR, or the South Coast Air Quality Management District (SCAQMD).

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20	None.	n/a
CA Building Energy Efficiency Standards – Title 24 (2016)	Section 100.1 DEFINITIONS AND RULES OF CONSTRUCTION	January 1, 2017
	Section 110.2(c) MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT	January 1, 2017
	Section 150.0(e) MANDATORY FEATURES AND DEVICES	January 1, 2017
	Section 150.0(m) MANDATORY FEATURES AND DEVICES	January 1, 2017
Federal Standards – Department of Energy	April 2010 DOE Final Rule	n/a

The California Building Energy Efficiency Standards (Title 24)⁵, Section 100.1 includes the following definitions related to fireplaces:

- **Decorative gas appliance:** a gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace.
- **Fireplace:** 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:** 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.

Details pertaining to this measure are provided below. Section 110.2(c) provides the thermostat exemption for fireplaces. Section 150.0(e) specifies the installation requirements specific to fireplaces. Requirement (e)(2) is of importance to this measure as new fireplaces cannot use a continuously operating pilot light. Section 150.0(m) provides requirements for the installation of air-distribution and ventilation system ducts, plenums, and fans.

⁵ California Energy Commission (CEC). 2015. *2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*. CEC-400-2015-037-CMF.

- (c) **Thermostats.** All unitary heating or cooling systems not controlled by a central energy management control system (EMCS) shall have a setback thermostat.
1. **Setback Capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to Program the temperature setpoints for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 110.2(b).
- EXCEPTION to Section 110.2(c):** Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps.

Title 24, Section 110.2(c) Fireplace Thermostat Requirements

- (e) **Installation of Fireplaces, Decorative Gas Appliances and Gas Logs**
1. If a masonry or factory-built fireplace is installed, it shall have the following:
 - A. Closeable metal or glass doors covering the entire opening of the firebox; and
 - B. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device; and

EXCEPTION to Section 150.0(e)1B: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

 - C. A flue damper with a readily accessible control.

EXCEPTION to Section 150.0(e)1C: When a gas log, log lighter, or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.
 2. Continuous burning pilot lights and the use of indoor air for cooling a firebox jacket, when that indoor air is vented to the outside of the building, are prohibited.

Title 24, Section 150.0(e) Fireplace Installation Requirements

- (m) **Air-Distribution and Ventilation System Ducts, Plenums, and Fans.**
1. **CMC Compliance.** All air-distribution system ducts and plenums, including, but not limited to, mechanical closets and air-handler boxes, shall be installed, sealed and insulated to meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to a minimum installed level of R-6.0 (or any higher level required by CMC Section 605.0) or a minimum installed level of R-4.2 when entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.
- Building cavities, support platforms for air handlers, and plenums designed or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.
- EXCEPTION to Section 150.0(m)1:** Ducts and fans integral to a wood heater or fireplace.

Title 24, Section 150.0(m) Installation Ducting Requirements

Federal Standards. The U.S. Department of Energy (DOE) published an energy conservation standards final rule on April 16, 2010 (“April 2010 DOE Final Rule”) codifying the definition of “vented hearth heater” and establishing energy conservation standards.⁶ 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 the DOE 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, the DOE published the following a vented hearth heater definition revision:⁷

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:*
 - i. *Certified to ANSI Z21.50 (incorporated by reference; see § 430.3), but not to ANSI Z21.88 (incorporated by reference; see § 430.3);*
 - ii. *Sold without a thermostat and with a warranty provision expressly voiding all manufacturer warranties in the event the product is used with a thermostat;*
 - iii. *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*
 - iv. *With respect to products sold after January 1, 2015, not equipped with a continuously operating pilot light light or other continuously-burning ignition source.*

On February 8, 2013, the U.S. Court of Appeals for the District of Columbia vacated the DOE definition of “vented hearth heater.”⁸ 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

⁶ U.S. Department of Energy (DOE), Energy Conservation Program. 2010. “Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule.” *Federal Register*. Vol. 75, No. 73. April 16.

⁷ U.S. Department of Energy (DOE), Energy Conservation Program. 2010. “Energy Conservation Program: Energy Conservation Standards for Direct Heating Equipment; Final Rule.” *Federal Register*. Vol. 76, No. 223. November 18.

⁸ 706 F.3d 499. 2013. *Hearth, Patio & Barbecue Association, et al. v. U.S. Department of Energy*. United States Court of Appeals, District of Columbia Circuit.

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, the U.S. DOE published a Notice of Proposed Rulemaking (NOPR) proposing a new definition of “hearth product” and a prescriptive standard stating that hearth products not be equipped with a constant-burning pilot.⁹

“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.”

NORMALIZING UNIT

Each.

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation. Each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Normal Replacement (NR)	DnDeemed	Residential
Accelerated Replacement (AR)	DnDeemed	Residential

For *accelerated replacement* application types, this measure adopts the program-level “Preponderance of Evidence Assessment” described in Version 2.0 of the Accelerated Replacement Using Preponderance of Evidence report developed by the utilities and stakeholders to provide guidance for the California programs (“POEV 2.0”, see Section 7)¹⁰. “Continued viability” and “program influence” must be demonstrated as the evidence of accelerated replacement.

⁹ U.S. Department of Energy (DOE), Energy Conservation Program. 2015. “Energy Conservation Program: Energy Conservation Standards for Hearth Products; Proposed Rule.” *Federal Register*. Vol. 80, No. 26. February 9.

¹⁰ Track 1 Working Group. 2016. Accelerated Replacement Using Preponderance of Evidence. Version 2.0. December 7.

To demonstrate the viability of the pre-existing system or to show that the program is replacing equipment that is “installed and operating,” the customer must be approached by a direct install implementer. Additionally, the program must obtain and provide additional documentation, including (but not limited to) the following:

- Targeted segment of the market or customers
- Customer/site information
- Make/model of pre-existing equipment and/or
- Performance/flowrate measurements of pre-existing equipment, and/or
- Photograph of pre-existing equipment in place and operating

Program influence evidence can be demonstrated through one of the three alternatives listed in Section 7.3 of POEV 2.0. This measure establishes the program-level evidence of program influence by adopting the net-to-gross (NTG) ratio from prior program evaluation results.

Specific documentation requirements will be determined by the program administrator and will be specified in the program implementation plan.

Eligible Products

Eligibility requirements

These measures only apply to gas fireplaces manufactured with burner-control thermostats, integrated IPL controls, and fireplace efficiency (FE) values within the specified ranges. See Measure Case Description.

The fireplace shall be functional prior to being installed.

Any technology manufacturer qualifies to be used in this program if safety and all other regulations are met and the technology is commercially available.

The purchase invoice for the gas fireplace must be provided as proof of purchase.

The customer agrees to a post measure implementation inspection.

Eligible Building Types and Vintages

This measure is applicable in single-family or multifamily building type of any vintage.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

None.

DATA COLLECTION REQUIREMENTS

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 continuous pilot light (CPL) and the energy savings from an increase in fireplace efficiency (FE).

Future data needs could involve:

- A comprehensive survey to more accurately estimate the annual hours the pilot is ON.
- A thorough survey to more accurately address burner ON times of a manually operated fireplace.

USE CATEGORY

HVAC

ELECTRIC SAVINGS (KWH)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (KW)

Not applicable.

GAS SAVINGS (THERMS)

Methodology

The gas unit energy savings (UES) of this measure is a function of the pilot light usage and efficiency and the fireplace usage and efficiency.

The baseline for the AR measure is assumed to use a continuously operating pilot light, and both measure tiers must use electronic ignition. The UES of an accelerated replacement (AR) is equal to the gas energy savings due the removal of a continuously operating pilot light and the gas energy savings due to the increase in fireplace efficiency (FE).

The baseline for the normal replacement (NR) and new construction (NC) measure offerings is assumed to use electronic ignition and both must use electronic ignition, therefore the UES of the NR and NC measure offerings is equal to the UES due to an increase in FE only.

$$UES_{AR} = UES_P + UES_{FE}$$

$$UES_{NR,NC} = UES_{FE}$$

UES_{AR} = Energy savings for the AR Measure (Therms).

UES_P = Total energy savings due to the removal of the pilot light (Therms).

UES_{FE} = Energy savings due to an increase in FE (Therms).

$UES_{NR,NC}$ = Energy savings for the NR and NC measure offerings (Therms).

Energy Savings from Removal of the Continuously operating pilot light

There are different methods of calculating the energy savings due to removing the continuously operating pilot light, depending upon the pilot operating state. The three pilot operating states are:

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.

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 in efficiency.

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.

The energy savings for the removal of the continuously operating pilot light for each pilot operation state are calculate

$$E_1 = t_1 \times I_p \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$E_2 = 0$$

$$E_3 = t_3 \times I_p \times (1 - \eta) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$UES_p = E_1 + E_2 + E_3$$

$E_1 =$	<i>Pilot light energy savings when the pilot light was ON for the entire hour (Therms)</i>
$t_1 =$	<i>Pilot light ON time when the pilot light was ON for the entire hour (hours)</i>
$I_p =$	<i>Input rate of the pilot light</i>
$E_2 =$	<i>Pilot light energy savings when the pilot light <u>and</u> burner were ON for a portion of the hour (Therms)</i>
$E_3 =$	<i>Pilot light energy savings when the pilot light was ON and the burner was OFF for a portion of the hour (Therms)</i>
$t_3 =$	<i>Pilot light ON time when the pilot light was ON and the burner was OFF for a portion of the hour (hours)</i>
$\eta =$	<i>Efficiency of the pilot light</i>
$E_p =$	<i>Total energy saving from the removal of the pilot light.</i>

Energy Savings from an Increase in Fireplace Efficiency

The energy savings from an increase in FE (below) is a function of the total hours per year the burn is ON, the input rate of the fireplace, and increase in FE.

$$UES_{FE} = t_{\text{Burner ON}} \times I_{\text{Burner}} \times \left(\frac{1}{FE_{\text{Baseline}}} - \frac{1}{FE_{\text{Measure}}} \right) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

UES_{FE}	=	Energy savings from an increase in fireplace efficiency (Therms).
$t_{\text{burner ON}}$	=	Total hours per year the burner is ON
I_{burner}	=	Input rate of a fireplace
FE_{Baseline}	=	Fireplace efficiency of fireplace at the baseline (%)
FE_{Measure}	=	Fireplace efficiency of fireplace of the measure (%)

Operation Assumptions

The fireplaces included in this measure are assumed to be thermostatically operated. The baseline technology options for fireplaces in the U.S. Department of Energy (DOE) April 2010 Rulemaking include a burner control thermostat. The DOE 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.¹¹ Thermostatically operated fireplaces will only use as much heating is necessary to maintain a specified temperature setpoint.

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 in the scope of this measure.

This measure analysis also assumes that the fireplace is the only non-centralized heat source within the room. The assumptions for this measure analysis are parallel to those of the intermittent pilot light for a gravity wall furnace (SWHC002); in general a fireplace provides 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.

Calculation Inputs

The inputs for the calculation of savings from the removal of a continuously operating pilot light and the gas energy savings due to the increase in fireplace efficiency (FE) are provided and explained below. Note that many assumptions are adopted from the intermittent pilot light measure (SWHC002) and wall furnace measure (SWHC001), insofar as many inputs apply to gas fireplace inserts.

Input	Value	Source
Pilot light heat loss (%)	67%	California Public Utilities Commission (CPUC), Energy Division. 2017. "DEER-WaterHeater-Calculator-v2.1.xlsm." Updated July 10, 2017.
Pilot light input rate (Btu/hr)	501.4	Attachment C

¹¹ U.S. Department of Energy (DOE), Energy Conservation Program. 2010. "Energy Conservation Program: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters; Final Rule." *Federal Register*. Vol. 75, No. 73. April 16. Section 3.3.1.2.

Input	Value	Source
Fireplace burner input rate (Btu/hr)	40,980	WPSCGREHC181220A_Rev00_Att. A-Fireplace Analysis.xlsx
Heating degree days, HDD (base of 65 °F)	<i>Varies by climate zone</i>	Southern California Gas Company (SCG). 2018. "IPL Energy Savings Analysis 2018 .xlsx" See "IPL_REA Savings" tab. Southern California Gas Company (SCG). 2013. "WPSCGREHC180723A-Rev00_Intermittent Pilot Light_Att C_CompareWeatherData-v4.xlsm." July 3.
Regression coefficient (Therm/HDD*Home)	0.1310	Southern California Gas Company (SCG). 2013. "WPSCGREHV110603A_2013_Wall_Furnace_Results-Rev2.xlsx."
Home area – single family (ft ²)	1,366	Southern California Gas Company (SCG). 2014. "WPSCGREHC110603A.2 2013 Analysis 012014.xlsx." January 20. See "Raw+Swift" tab.
Assumed area heated by fireplace (ft ²)	400	Professional judgement.
Total hours fireplace can heat	5,088	Southern California Gas Company (SCG). 2013. "WPSCGREHC180723A-Rev00_Intermittent Pilot Light_Att C_CompareWeatherData-v4.xlsm." July 3

Pilot Light Heat Loss

Currently there are no studies that have quantified pilot light efficiency. The DEER water heater calculator assumes that 67% pilot light heat is transferred in conditioned space,¹² which is adopted for this measure. In other words, during these periods, this measure will only claim 33% of the pilot light energy as savings.

Pilot Light Input Rate

The pilot light hourly heat rate was drawn from an Emerging Technologies study that tested the functionality of battery-driven IPL controls¹³

Fireplace Burner Input Rate

A representative burner input rate is used for both the baseline and measure case fireplace measure offerings. A constant input rate is also used in the DOE April 2010 Rulemaking¹⁴ across all efficiency options. A representative input rate effectively means that a replacement fireplace will be sized the same as the fireplace it is replacing.

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/hr and 35,000 Btu/hr, respectively.

The input rate of the burner adopted for this analysis is the average input rate of a gas wall furnace sized for a single-family home, using California climate zone outdoor air temperatures. This assumption is

¹² California Public Utilities Commission (CPUC), Energy Division. 2017. "DEER-WaterHeater-Calculator-v2.1.xlsm." Updated July 10, 2017.

¹³

¹⁴ U.S. Department of Energy (DOE). 2010. "2010-03-24_Life_Cycle_Cost_DHE_Equipment.xlsx."

reasonable, given the consumer utility and burner input rates of gas wall furnaces and fireplaces are similar.

Total Hours per year the Continuously operating pilot light is ON

Total hours per year the pilot light is ON was determined from Southern California Gas Company (SCG) data of customer calls for gravity wall furnace pilot ignition and to turn the pilot turn OFF (e.g., the hours per year the fireplace pilot light is ON and the unit can provide heat). Gravity wall furnace calls for pilot light ON and OFF inquiries are a reasonable proxy 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.

The data reveal that customers called SCG to turn OFF pilot lights throughout the year, however the intensity of calls is highest from April to July, with the maximum number of calls received in July. Due to July experiencing the highest call volume, July is considered to be the month when pilot lights are turned ON.

The same process was followed to determine the month when pilot lights are turned ON; the months with the highest intensity were from October through January, with the maximum number of calls received in December. December is considered to be 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 weather data approved by the California Public Utilities Commission (CPUC),¹⁵ the annual ON and OFF hours are identified from the 8760 annual hours available. The ON hours are found to be from hours #1-4344 and hours #8017-8760; hours #4345-8016 are determined to be OFF hours.

Therefore, out of the 8,760 hours in a year, the total pilot light ON hours are 5,088 and the total pilot light OFF hours are 3,672.

Total Hours Per Year the Burner is ON

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

$$t_{\text{Burner ON}} = S * \sum_{i=1}^{8760} \frac{\left(\frac{HDD_i * P}{Area * C} * A \right) * \frac{100,000 \text{ Btu}}{1 \text{ Therm}}}{A}$$

$t_{\text{Burner ON}}$	=	Total hours per year the furnace burner is ON.
S	=	Scaler to adjust the equations output to reflect the impact of heating only a portion of the home instead of the entire home
i	=	each hour in a year.
HDD_i	=	Heating degree days at each hour in a year
P	=	Regression coefficient (Therm/HDD*home)
$Area$	=	Single-family home area

¹⁵ Southern California Gas Company (SCG). 2013. "WPSCGREHC180723A-Rev00_Intermittent Pilot Light_Att C_CompareWeatherData-v4.xlsm." July 3.

$$C = \text{Fireplace input rate (Btu/hr/ft}^2\text{)}$$

$$A = \text{Fireplace output capacity, (Btu/hr)}$$

The **regression coefficient** relates HDD and furnace size per home and was determined using all data from all climate zones and does not vary by climate zone.

The **average furnace input rate** per square foot over all climate zones was from **Attachment F**¹⁶. This analysis assumes that manufacturers will not manufacture a unique fireplace for each climate zone.

The **fireplace output capacity**, A, cancels out in this equation.

Scaling Factor to Adjust Portion of Home Heated. 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 x 10 ft to 22 ft x 28 ft) depending on the size of the home.¹⁷ This measure analysis assumes the fireplace heats a floor space of 20 ft x 20 ft (400 ft²). This 400 ft² floor space is greater than 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 in which it is installed. Also, as stated in the LBNL Hearth Study, hearth ownership increases with income.¹⁸ It is also assumed that home size increases with income so a slightly larger than average floor space is appropriate.

Therefore, the burner ON time is decreased by the ratio of the area heated by the fireplace to the area of a single-family residence (400/1,366), or 29%. This results in burner ON hours from 85 to 404 hours (3 to 13 hours per week during a 30-week heating season) depending on the climate zone. This is consistent with expectations from the 15 hours per week burner ON hours published in the Northwest Natural's 2015 Energy Efficiency Plan (600 hours across a 40-week heating season)¹⁹ and the 234 burner ON hours per year from the LBNL Hearth Study.²⁰ In the Southern California Gas Company's (SCG's) most populous climate zones, 8 and 9, there is an average of 4.2 and 4.9 hours per week of operation, respectively, which is reasonable given the more temperate climate in these climate zones (respectively 127 and 148 hours per 30-week heating season).

The table below provides the burner operating hours calculated with the above equation.

Burner Operating Hours by Climate Zone

Climate Zone	HDD	Burner Operating Hours (hrs/wk)
1	5,094	10.3

¹⁶ WPCSGREHC181220A_Rev00_Att. F-Furnace Calculations.xls

¹⁷ 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.

¹⁸ Siap, D., H. Willem, S. Price, H. Yang, and A. Lekov (Lawrence Berkeley National Laboratory, LBNL). 2017. *Survey of Hearth Products in U.S. Homes*. June.

¹⁹ Northwest Natural. 2014. *NW Natural's 2015 Energy Efficiency Plan*. November 13. See Exhibit A.

²⁰ Siap, D., H. Willem, S. Price, H. Yang, and A. Lekov (Lawrence Berkeley National Laboratory, LBNL). 2017. *Survey of Hearth Products in U.S. Homes*. June.

Climate Zone	HDD	Burner Operating Hours (hrs/wk)
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

Total Hours Per Year the Continuously operating pilot light 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:

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.

Pilot plus Burner on-time – If the HDD is not zero, then heating is required for a part of the hour. The continuously operating pilot light will be ON at the same time as the burner.

Pilot-only on-time (heat call) – If the HDD is not zero, then heating is required for a part of the hour. The continuously operating pilot light will be ON for the remainder of the hour while the burner is OFF.

The hours per year for each of the three continuously operating pilot operating states was calculated with the following equations:

$$t_1 = \sum_{i=1}^{8760} \begin{cases} 1, & HDD_i = 0 \\ 0, & HDD_i \neq 0 \end{cases}$$

$$t_2 = t_{\text{Burner ON}}$$

$$t_3 = t_{\text{Fireplace ON}} - t_2 - t_1$$

$t_1 =$ 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

$HDD_i =$ Heating degree days at each hour in a year

$t_2 =$ Total hours the pilot light is ON while the burner is also ON.

$$\begin{aligned}
 t_{\text{Burner ON}} &= \text{Total hours per year the furnace burner is ON (see above)} \\
 t_3 &= \text{Total hours the pilot light is ON while the burner is OFF and heat was required during the hour} \\
 t_{\text{Fireplace ON}} &= \text{Total hours the fireplace is capable of heating}
 \end{aligned}$$

Sample Calculation

A sample calculation of the energy savings for an AR installation of a Tier 1 fireplace in climate zone 1 is as follows:

$$\begin{aligned}
 UES_{AR} &= \text{Energy savings for the AR Measure (Therms).} \\
 UES_p &= \text{Total energy savings for the removal of the pilot light (Therms)} \\
 EUES_{FE} &= \text{Energy savings for an increase in FE (Therms)}
 \end{aligned}$$

$$UES_{AR}(\text{tier 1 CZ 1}) = UES_p + EUES_{FE}$$

$$UES_p = t_1 \times I_p + t_3 \times I_p \times (1 - \eta) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$UES_p = 15 \times 501.42 + 4,761 \times 501.42 \times (1 - .67) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$UES_p = 8 \text{ therm}$$

$$UES_{FE} = t_{\text{Burner ON}} \times I_{\text{Burner}} \times \left(\frac{1}{FE_{\text{Baseline}}} - \frac{1}{FE_{\text{Measure}}} \right) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$UES_{FE} = 312 \times 40,980 \times (1/.608 - 1/.721) \times \frac{1 \text{ Therm}}{100,000 \text{ Btu}}$$

$$UES_{FE} = 33 \text{ therm}$$

$$UES_{AR}(\text{tier 1 CZ 1}) = 8 + 33$$

$$UES_{AR}(\text{tier 1 CZ 1}) = 41 \text{ therm}$$

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further

study results are available to establish more accurate values.”²¹ This approach provides a reasonable RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.²² Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised add-on measures so that the EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component.”²³

The EUL and RUL for Gas Fireplaces are specified below. Because an EUL has not been established for a fireplace, this measure adopts the EUL of a high efficiency gas furnace. The high efficiency furnace EUL was updated in 2008 and assumed the maximum EUL, as stipulated in the *Energy Efficiency Policy Manual*, which states, “[i]n order to minimize uncertainty, EULs will be limited to a maximum of 20 years, even if particular devices may be expected to survive longer.”

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs)	20	California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update_2014-02-05.xlsx.” California Public Utilities Commission (CPUC), Energy Division. 2008. “EUL_Summary_10-1-08.xls.” California Public Utilities Commission (CPUC), Energy Division. 2003. <i>Energy Efficiency Policy Manual v 2.0. Page 16.</i>
RUL (yrs)	6.7	-

BASE CASE MATERIAL COST (\$/UNIT)

Base case material costs for this measure were estimated from a regression analysis of retail costs obtained from web-scraping in 2017 and a comparison with costs developed for the Energy Trust of Oregon (ETO).²⁴ The base case for the normal replacement (NR) and new construction (NC) offerings assumes intermittent pilot light (IPL) technology. The retail cost regression results for IPL ignition systems are consistent with both the average cost of IPL fireplaces and the fireplace efficiency (FE) based retail cost values developed for the ETO.²⁵ Because the IPL retail cost regression is in line with previously published ETO data, the cost regression is used to determine the base case material costs for NR and NC installations.

The base case for the accelerated replacement (AR) offerings assumes continuously operating pilot light (CPL) technology. The retail cost regression is lower than both the ETO average cost of CPL fireplaces and

²¹ California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5. Page 32.*

²² KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

²³ California Public Utilities Commission (CPUC). 2016. *Resolution E-4807*. December 16. Page 13.

²⁴ WPSCGREHC181220A_Rev00_Att. A-Fireplace Analysis.xls “Cost” tab

²⁵ *Efficient Direct Vent Gas Fireplaces in Oregon*. Prepared for the Energy Trust of Oregon, Inc. (ETO). December 5

the FE-based retail cost values. The 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.

Base Case Retail Costs

Measure Application Type	Assumed Baseline FE (%)	Retail Cost (2017 \$)
NR and NC	64.6	\$2,815
AR	60.8	\$2,382

MEASURE CASE MATERIAL COST (\$/UNIT)

Measure case material costs were estimated from a regression analysis of retail costs obtained from web-scraping in 2017.²⁶ The retail cost regression results for IPL ignition systems is consistent with the IPL retail costs of units with FE values higher than 60%. The web scraped retail cost data shows most models with an FE greater than 60% use IPL ignition technology. Because the retail cost regression is in line with previously published ETO cost data,²⁷ the regression was used to determine the measure case costs.

$$\text{Retail Cost} = 2109.6 + 10.914 \times \text{FE}$$

Measure Case Retail Costs

Measure Application Type	FE Range	FE Used in Calculations	Retail Cost (2017 \$)
NR and NC	≥70% and <75%	72.1%	\$ 2,897
	≥75%	79.1%	\$ 2,973
AR	≥70% and <75%	72.1%	\$ 2,897
	≥75%	79.1%	\$ 2,973

BASE CASE LABOR COST (\$/UNIT)

The U.S. Department of Energy (DOE) and the Energy Trust of Oregon (ETO) publish labor installation cost data.²⁸ 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.

Base Case Installation Costs

Measure	Assumed Baseline FE (%)	Installation Cost (2017 \$)
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²⁶ WPCSGREHC181220A_Rev00_Att. A-Fireplace Analysis.xls "Cost" tab

²⁷ *Efficient Direct Vent Gas Fireplaces in Oregon*. Prepared for the Energy Trust of Oregon, Inc. (ETO). December 5

²⁸ [https://ohpba.org/Resources/Documents/ETO%20 Gas Fireplace Survey Results 12-5-13.pdf](https://ohpba.org/Resources/Documents/ETO%20Gas%20Fireplace%20Survey%20Results%2012-5-13.pdf)

NR and NC	64.6	\$ 976
AR	60.8	\$ 976

MEASURE CASE LABOR COST (\$/UNIT)

Measure case labor installation costs are the costs to install a gas fireplace and are assumed to be the same for both the baseline and the measure case gas fireplace. See Base Case Labor Cost.

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The NTG value adopted for this measure was established in the 2011 DEER Update Study conducted by Itron, Inc. and is applicable to all energy efficiency measures that have been offered through California programs for less than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
All-Default<=2yrs	0.70	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment

Parameter	GSIA	Source
GSIA - Default	1.00	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 31.

NON-ENERGY IMPACTS

Non-energy benefits for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	No
DEER Operating Hours	Yes
DEER eQUEST Prototypes	No
DEER Version	DEER READI v2.5.1 (26-Sep-2018)
Reason for Deviation from DEER	DEER does not contain Energy Efficient Gas Fireplaces.
DEER Measure IDs Used	None
NTG	Source: DEER. The NTG of 0.70 is associated with NTG ID: <i>All-Default<=2yrs</i>
GSIA	The GSIA of 1.0 is associated with GSIA ID: <i>Def-GSIA</i>
EUL/RUL	Source: DEER. The value of 20 years is associated with EUL ID: <i>HV-EffFurn</i>

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	10/31/2019	RMS Energy Consulting, LLC.	Draft of consolidated text for this statewide measure is based upon: WPSCGREHC181220A_R0
	05/27/2020	Eduardo Reynoso, SDG&E	Workpaper measure adoption by SDG&E, no changes to energy efficiency savings or cost. Updated Ex-ante Implementation data table. No other changes.
	03/15/2021	Adan Rosillo PG&E	Added PG&E's measure codes to adopt indicated measures.