DOCKETED	
Docket Number:	18-AAER-06
Project Title:	Hearth Products
TN #:	227185
Document Title:	California Investor Owned Utilities Comments on Analysis of Standards Proposal for Hearth Products
Description:	N/A
Filer:	System
Organization:	California Investor Owned Utilities
Submitter Role:	Public
Submission Date:	2/28/2019 9:32:26 AM
Docketed Date:	2/28/2019

Comment Received From: California Investor Owned Utilities
Submitted On: 2/28/2019
Docket Number: 18-AAER-06

Analysis of Standards Proposal for Hearth Products

Additional submitted attachment is included below.

Hearth Products

Codes and Standards Enhancement (CASE) Initiative
For PY 2018: Title 20 Standards Development

Analysis of Standards Proposal for
Hearth Products
18-AAER-06

February 28, 2019

Prepared for:

PACIFIC GAS & ELECTRIC COMPANY

SOUTHERN CALIFORNIA EDISON

SAN DIEGO GAS AND ELECTRIC

Prepared by:
Cassidee Kido, Bryan Boyce, Bijit Kundu, and Leslie Nelson, ENERGY SOLUTIONS

This report was prepared by the California Statewide Investor-Owned Utilities Codes and Standards Program and funded by the California utility customers under the auspices of the California Public Utilities Commission.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Purpose

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Appliance Efficiency Regulations (Title 20) to include new requirements or to upgrade existing requirements for various technologies. The three California Investor-Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE)– sponsored this effort (herein referred to as the Statewide CASE Team). The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve the energy and water efficiency of various products sold in California. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for potential appliance standards. This CASE Report covers a design standard proposal for all hearth products as well as an efficiency standard proposal for gas fireplace heaters.

In the U.S., there are currently no appliance efficiency standards for hearth products. In February 2015, the United States (U.S.) Department of Energy (DOE) considered standards and released a Notice of Proposed Rulemaking (NOPR) on energy conservation standards for hearth products (U.S. DOE 2015c). However, the rulemaking was never finalized and was ultimately withdrawn by U.S. DOE in March 2017.

2. Product/Technology Description

2.1 Product Definitions

U.S. DOE defines a hearth product as "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." The Statewide CASE Team proposes using this same definition for hearth product coverage in California (U.S. DOE 2015d). Hearth products provide consumers with decoration, heating, lighting, or a combination of functions (U.S. DOE 2015d).

The product categories used in this analysis, as determined by U.S. DOE, are: vented fireplaces, inserts, and stoves; unvented fireplaces, inserts, and stoves; vented gas log sets; unvented gas log sets; and outdoor products. Overall, the Statewide CASE Team proposes the same general product definitions as used in the U.S. DOE NOPR. Additionally, due to the incorporation of an efficiency standard that U.S. DOE did not propose, the Statewide CASE Team proposes to align with Natural Resources Canada's (NRCan) further split of vented fireplaces, inserts, and stoves[1] into the designations of gas fireplace heaters and decorative gas fireplaces. Each product is further described below.

2.1.1 Fireplaces

Fireplaces are structures made of fireproof material which are designed to hold a fire; they are often built in conjunction with a chimney or other type of flue to allow smoke and combustion gases to vent to the outside. Fireplaces can be installed during new home construction or as part of a renovation and are installed into the housing envelope or against a wall (NRCan 2015a). Traditional masonry fireplaces are made from brick, stone, or tile and are constructed by builders such that they connect directly to the flue and chimney in the home (Napoleon Fireplaces 2015). Masonry

[1] NRCan does not have the specific category of "fireplaces, inserts, and stoves" but their products align with this category.

fireplaces are typically used for wood-burning fires but can be converted to use gas. An example of a masonry fireplace is shown in Figure 1.

Figure 1: Example of masonry fireplace.

Source: Merlin Goble Masonry, Inc. 2017.

2.1.1.1 Factory-built fireplace

Factory-built fireplaces (also referred to as prefabricated fireplaces) are flame-holding boxes, often made of metal, that resemble gas inserts (explained below in Section 2.1.2) but are entirely manufactured in a factory with an attached chimney or flue prior to being framed into a house's building envelope. Made of non-combustible materials and designed to be installed inches away from combustible materials, factory-built fireplaces require no masonry work (Napoleon Fireplaces 2015). Because these units include the fireplace housing, firebox, and chimney, factory-built fireplaces are often less expensive than masonry fireplaces. These also may be referred to as zero-clearance fireplaces. An example of a factory-built fireplace is shown in Figure 2.

Figure 2: Example of factory-built fireplace.

Source: Fireplaces Doors Online 2018.

2.1.1.2 Flame Housing

The firebox, or flame housing, is the part of the hearth product where the actual fire resides. In factory-built gas fireplaces and gas inserts, the firebox is a sealed unit—usually with glass doors to

showcase the flames and to dissipate the heat from the fire to the room (Fireside Hearth & Home 2018a). To vent any gases or smoke created by the fire, the firebox leads to the smoke chamber which eventually leads to the flue. Before the smoke can pass into the smoke chamber, it must also pass through the damper (a valve that closes the flue when the fireplace is not in use) (Wilkens Contracting, Inc. 2015).

2.1.1.3 Venting

Fireplaces may be vented or unvented. A vented fireplace has a flue or chimney to channel the exhaust of the fire outside the room, while an unvented fireplace does not have a vent to expel the fumes from the room in which the fireplace is installed (NRCan 2015a; Houselogic 2018). Unvented fireplaces generally provide better space heating because the heated flue gas is not lost to the outside area. However, unvented fireplaces are prohibited in California through the Health and Safety Code (CA HSC 1998). These unvented products are banned because they vent unburned combustion products directly into the home. While unvented products are usually designed to include an oxygen depletion sensor which automatically shuts off the main burner if oxygen levels are depleted to a certain level, the potential release of harmful gases, including carbon monoxide, has led California to continue to implement this ban since 1970 (The Bulletin 2015).

2.1.1.4 Intended Use

NRCan differentiates between decorative gas appliances and gas fireplace heaters based on the intended use. Both are defined below.

Decorative gas fireplaces are intended primarily to burn with an aesthetically pleasing flame with minimal heat being directed towards the room side of the appliance. Since decorative appliances are not intended to be used as a heater, they are not permitted to be fitted with or controlled by a thermostat. These appliances fall under the scope of ANSI Z21.50/CSA 2.22 – 2016 (NRCan 2017a).

Gas fireplace heaters are appliances that simulate a solid fuel fireplace and are intended to be used as a heat source for the space in which it is installed. They may circulate heated room air by gravity or mechanical means and can be equipped with thermostats. These fall under the scope of Z21.88/CSA 2.33-2016 (NRCan 2017a).

2.1.2 Inserts

A gas insert is designed to be installed into an existing wood-burning fireplace as shown in Figure 3. Gas inserts are encased in a metal housing that fits into the existing fireplace cavity and resemble factory-built fireplaces, but unlike fireplaces (see Section 2.1.1) they can be installed anytime—not just during new construction or major renovations. Because gas inserts are more versatile, they are considered a low-cost option as compared to a renovation to install a gas fireplace or replacement of an existing masonry fireplace. Inserts may include gas log sets, rocks, or other materials in contact with the flames as decoration (Napoleon Fireplaces 2015).

Figure 3: Example of gas insert.

Source: Pine Lake Stoves 2014.

2.1.3 Stoves

A gas stove is a freestanding device, often made of cast-iron, that resembles a wood-burning stove as shown in Figure 4. This type of hearth product is not recessed into a wall; all surfaces are exposed to the room. It often has heat exchangers, high levels of insulation, and tight-fitting door hinges that help prevent heat from escaping—making it more efficient at heating the room (High's Chimney Service 2018). Stoves can be vented (if the flue gas is vented to an outdoor area) or unvented (if the flue gas is deposited in the room containing the stove). However, unvented products are banned in California under the Health and Safety Code (CA HSC 1998). Stoves may include imitation logs, rocks, or other materials in contact with the flames as decoration. They may be referred to as freestanding fireplaces.

Figure 4: Example of vented gas stove.

Source: Fireside Hearth & Homes 2018b.

2.1.4 Gas Log Sets

Gas log sets are "logs" made from ceramic, refractory cement, or other material that can withstand high heat as shown in Figure 5 (Woodland Direct 2018). In addition to imitation logs, units often include a burner and a grate (U.S. DOE 2015d). Gas log sets are often installed into masonry fireplaces to convert a naturally wood burning fireplace to gas burning (Nordic Stove & Fireplace Center 2013). Gas logs sets can be vented or unvented. Vented sets must be installed in a fireplace that has a chimney or other vent to dispose of the fire fumes. These gas log sets are known to have larger flame patterns but produce less heat because much of the heat is vented out. Unvented gas log sets do not vent out the heat from the fire and are therefore considered to be better for heating (Fleet Plummer 2014). However, unvented products are banned in California under the Health and Safety Code (CA HSC 1998).

Figure 5: Example of gas log set.

Source: The Fireplace Shop & Grill Center 2018.

2.1.5 Outdoor Hearth Products

Outdoor hearth products are very similar to the indoor hearth product categories mentioned but are designed with materials specifically for installation and use outdoors (U.S. DOE 2015d). They may take the form of a fireplace, insert, fire pit, or other design. One example of an outdoor product is shown in Figure 6. Outdoor products do not have a vented or unvented distinction because their outdoor installation inherently means any combustion byproducts are released outdoors. The units can be free standing or permanently installed into a structure of stone, brick, or other material. Similar to indoor hearth products, outdoor hearth products can serve a variety of purposes including heating, decoration, lighting, or some combination of the three.

Figure 6: Example of outdoor hearth product (fire table/pit).

Source: Star Fire Direct 2018.

2.2 Scope

The Statewide CASE Team proposes the same scope of coverage as defined in the U.S. DOE NOPR with some modification to the vented fireplaces, inserts, and stoves category. A proposed Title 20 Standard for hearth products should include coverage for the following product categories:

- Vented fireplaces, inserts, and stoves;
    - Gas fireplaces heaters[2]; and
    - Decorative gas fireplaces
- Unvented fireplaces, inserts, and stoves;
- Vented gas logs;
- Unvented gas logs; and
- Outdoor products.

Unvented, indoor heaters of any kind are banned in California under the California Health and Safety Code, and therefore the Statewide CASE Team assumes there are no savings associated with these products. For clarity and to ensure full compliance, the Statewide CASE Team is still proposing to include these products in Title 20 to explicitly state that they are banned for sale by existing code (CA HSC 1998).

2.3 Applications

Both indoor and outdoor hearth products are designed for use in residential and commercial applications. Fireplaces, inserts, and stoves are usually used indoors, while hearth products used outdoors may include fire pits, inserts, and fireplaces.

[2] Gas fireplaces heaters are the only category of products for which the Statewide CASE Team recommends an efficiency standard. For all other products, the Statewide CASE Team only recommends a design standard.

2.4 Product Design

2.4.1 Ignition systems

This section describes the different ignition systems available for use in hearth products.

2.4.1.1 Standing Pilot

Standing pilot lights (also known as continuous pilot lights) are pilot lights that, once operating, remain lit until manually interrupted (NRCan 2017b). They are designed such that a gas line terminates to a small burner, whose flame lights a thermocouple. A thermocouple is a device that can generate electricity directly from heat. The end of the thermocouple that produces electricity is connected to a valve in the gas line. When the pilot light goes out, the lack of electricity from the thermocouple closes the gas valve to prevent gas leakage into a home (Professional Heating & Air 2014).

2.4.1.2 Intermittent Pilot

Intermittent pilot ignitions (IPI), also known as electronic ignitions, are systems that require a switch, remote control, or toggle of some sort to start when the product is off (My Gas Fireplace Repair 2017). They remain ignited only while the main burner is in operation and are automatically extinguished when the main burner is off (NRCan 2017b). Intermittent pilots involve both a spark ignition component and a sensor. When the sensor receives a signal that heat is needed, an electric solenoid valve opens to release gas to the pilot while the spark ignition component sparks to light the gas. As soon as the gas is lit, another electric solenoid opens to allow gas from the main burner to flow (Ward Burner Systems 2004).

2.4.1.3 On-Demand Pilot

On-demand pilots are designed such that once operating, they remain ignited for a specific period of time after operation of the main burner. They automatically shut off after a specified period of time when no operation of the main burner has occurred (NRCan 2017b).

3. Standards Proposal Overview

The Statewide CASE Team proposes a design standard for hearth products which bans the use of standing pilot lights, as well as an efficiency standard for gas fireplace heaters which requires a minimum Fireplace Efficiency (FE)[3] level of 75 percent. Currently in the U.S., there is neither a design standard nor an efficiency standard in place for hearth products. However, Canada has subjected gas fireplaces to similar standards as explained in Section 5.11.4. The Statewide CASE Team's analysis shows this proposed standard will result in significant natural gas savings and will be cost-effective. Additionally, the standard will have significant environmental benefits by reducing the carbon dioxide released as a result of using hearth products. A summary of the Statewide CASE Team proposal is shown in Table 1.

[3] As defined in CAN/CSA-P.4.1-15. The FE metric is included in Appendix D.

Table 1: Summary of Proposal

Topic	Description
Description of Standards Proposal	The Statewide CASE Team proposes a design standard which bans standing pilot lights in all hearth products. Additionally, the Statewide CASE Team proposes that gas fireplace heater products test to the CAN/CSA-P.4.1-15 test procedure and comply with the 75 percent FE level.
Technical Feasibility	Over 60 percent of the market already complies with the design standard and all product categories have a comparable option that incorporates an intermittent pilot light. Additionally, over three percent of the gas fireplace heater market already has an FE level equal to or greater than 75 percent.
Energy Savings and Demand Reduction	Eliminating standing pilot lights in all products along with requiring an FE level of 75 percent for gas fireplace heaters will yield first-year statewide savings of 154,129 MM British thermal units (Btu)/year and stock turnover savings of 2,213,231 MMBtu.
Environmental Impacts and Benefits	This proposal will yield first-year statewide savings of 9,274 metric tons of carbon dioxide equivalent (MTCO2e) per year and a total of 123,835 MTCO2e after stock turnover in 2033. These figures are based on the projected carbon intensity of the California electricity supply over the coming years (see Section 5.6.1).
Economic Analysis	This proposal will lead to significant cost savings for consumers with $19.3 million in first-year savings and over $238 million net present value (NPV) after stock turnover in 2033. Additionally, on a shipment weighted basis, there is a lifecycle benefit-to-cost (B/C) ratio of 4.35.
Consumer Acceptance	There are currently no Title 20 Standards in place for hearth products. However, there is already a ban on standing pilot lights for hearth manufacturers under Title 24, Part 6 for low-rise residential new construction, additions, and alterations. Additionally, there are already FE regulations in place in Canada. Many manufacturers sell products to both Canada and the U.S. so they should be relatively familiar with an FE standard.
Other Regulatory Considerations	The U.S. DOE withdrew their federal rulemaking on hearth products in March 2017, effectively removing any federal preemption concerns. Additionally, Title 24, Part 6 bans standing pilot lights for hearth products in low-rise residential new construction, additions, and alterations. This proposal will cover all products not already covered in Title 24. Unvented hearth products are banned by the Health and Safety Code but are covered here to highlight their ban in existing code (CA HSC 1998). Energy savings from unvented products are not included in this analysis.

4. Proposed Standards and Recommendations

4.1 Proposal Description

4.1.1 Design Standard

The Statewide CASE Team recommends the Energy Commission adopt a design standard to prohibit the use of standing pilot lights in hearth products, which is equivalent to efficiency level (EL) 1 in the U.S. DOE analysis presented in the NOPR. The Statewide CASE Team also proposes

to prohibit controls that provide any means of operating the product with a continuous pilot, either as a default or as an option when installed.

Standing pilot lights have been banned from numerous other appliances in California (including fan-type central furnaces, household cooking appliances,[4] pool heaters, and spa heaters) due to their high standby mode energy consumption (CEC 2014). Standing pilot lights are also banned in fireplaces, decorative gas appliances, and gas logs included in new construction, additions, and alterations of low-rise residential buildings under Title 24, Part 6, which has been factored into this analysis (CEC 2015). Expanding the standing pilot ban to all hearth products will result in significant natural gas savings once the standard goes into effect. The details regarding the potential savings are outlined in Section 5.4.6.

4.1.2 Efficiency Standard

In addition to the design standard, the Statewide CASE Team also recommends an efficiency requirement of 75 percent FE for the operating efficiency of gas fireplace heaters. Since there is currently no U.S. DOE test procedure for hearth products, the Statewide CASE Team recommends referencing the CAN/CSA-P.4.1-15 test procedure from the Canadian Standards Association (CSA) Group (CSA 2015). The CSA Standard applies to vented gas fireplaces but not to any of the other product categories outlined in Section 2.2. Thus, decorative gas fireplaces; unvented fireplaces, inserts, and stoves; gas log sets; and outdoor products do not fall under the proposed efficiency standard.

British Columbia recently enacted efficiency regulations for gas fireplaces to have a minimum FE of 50 percent. These requirements are discussed further in Section 5.11.4.

The Statewide CASE Team's proposed code changes will create a new section within Title 20, Section 1605.3: State Standards for Non-Federally-Regulated Appliances.

4.2 Proposal History

The California Building Code addresses hearth product standards in Title 24, Part 6 which states that continuous burning pilot lights in the installation of fireplaces, decorative gas appliances, and gas logs are prohibited in low-rise residential new construction (CEC 2015). This effectively eliminates any savings from installations of hearth products in new construction and has been accounted for in this analysis. Title 24, Part 6 also addresses standing pilot lights in fireplaces, decorative gas appliances, and gas logs for additions and alterations. This analysis assumes most installations would not trigger the building code to require compliance with these sections, thus the Statewide CASE Team has covered all products to ensure standing pilot lights are eliminated from all hearth products. Additionally, unvented products have been banned in California under the Health and Safety Code (CA HSC 1998).

With the withdrawal of the federal rulemaking on energy conservation standards for hearth products, there are no federal preemption concerns for the regulation of hearth products in California. More information on this rulemaking can be found in Section 5.11.1.

To date, there have not been any hearth product standards developed as part of the Title 20 Appliance Efficiency Regulations in California.

[4] Excludes appliances without an electrical supply voltage connection and those in which each pilot consumes less than 150 Btu /hour.

4.3 Proposed Changes to the Title 20 Code Language

The proposed changes to the Title 20 standards are provided below. Changes to the 2017 standards are marked with underlining (new language) and ~~strikethroughs~~ (deletions).

4.3.1 Proposed Definitions

The Statewide CASE Team proposes that the Energy Commission adopt the following definitions in a new "Hearth Products" subsection to Title 20 Section 1602 "Definitions." Some definitions are adapted from Title 24.

"Decorative gas fireplace" means a gas fireplace, insert, or stove that is intended primarily to burn with an aesthetically pleasing flame with minimal heat being directed towards the room side of the appliance.

"Factory-built fireplace" or "zero clearance fireplace" means a prefabricated fireplace that may be built in conjunction with an attached chimney or flue to be installed as a single entity in a home.

"Fireplace" means a hearth and fire chamber, or similarly prepared place, in which a fire may be made and which is built in conjunction with a flue or chimney.

"Fireplace Efficiency" or "FE" means the metric defined in CAN/CSA-P.4.1 – 15.

"Gas fireplace heater" means a gas fireplace, insert, or stove that simulates a solid fuel fireplace and is intended to be used as a heat source for the space in which it is installed.

"Gas log" means a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs.

"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.

"Insert" means an appliance designed for installation into an existing masonry fireplace.

"Intermittent pilot light" means a pilot light that is automatically ignited when an appliance is called on to operate and which remains continuously ignited during each period of main burner operation. The pilot is automatically extinguished when each main burner operating cycle is completed.

"Masonry fireplace" means a fireplace constructed from non-combustible material that is part of a home's structural design.

"On-demand pilot light" means a pilot light that, once placed into operation, is intended to remain ignited for a predetermined period of time following an automatic or manual operation of the main burner gas valve. The pilot is automatically extinguished when no automatic or manual operation of the main burner gas valve occurs during the predetermined period of time.

"Outdoor product" means a hearth product that is specifically designed for installation and use outdoors.

"Remotely operated pilot (ROP)" means a pilot system that provides the user with a ready means of initiating the automatic ignition and extinguishment of a pilot ignition source. The pilot system includes a device that is external to the gas safety combination control and does not require direct interaction with the gas safety combination control by the user.

"Solid-fuel burning" means a hearth product that burns solid fuel which creates a flame pattern including but not limited to wood, coal, or pellets.

"Standing pilot light" or "continuous pilot light" means a pilot that, once placed in operation, is intended to remain ignited continuously until it is manually interrupted.

"Stove" means a freestanding gas-fired unit used for either heating or decorative purposes.

"Vented hearth product" means a hearth product designed such that the products of combustion are conveyed by a vent or chimney directly to the outside atmosphere.

"Unvented hearth product" means a hearth product designed such that the products of combustion are not conveyed by a vent or chimney directly to the outside atmosphere.

4.3.2 Proposed Test Procedure

The Statewide CASE Team proposes incorporating CSA Group Standard CAN/CSA-P.4.1-15 by reference for the purposes of testing the efficiency of gas fireplace heaters.

4.3.3 Proposed Standard

The standard would reside in Section 1605.3 State Standards for Non-Federally Regulated Appliances.

Hearth Products.

(a) Continuous burning pilot lights or any pilot light that offers the option of continuous operation in hearth products manufactured on or after January 1, 2021, are prohibited.

(b) Gas fireplace heaters manufactured on or after January 1, 2021, are subject to a minimum FE value of 75 percent as tested to CAN/CSA-P.4.1-15.

The calculation for FE is included in Appendix D: FE Metric.

5. Analysis of Proposal

5.1 Scope/Framework

The scope of hearth products subject to this proposed design standard is almost identical to the scope in U.S. DOE's NOPR for hearth product energy conservation standards (U.S. DOE 2015c). The only difference is that the vented fireplaces, inserts, and stoves category is further broken down into decorative gas fireplaces and gas fireplace heaters. See Section 2 for more details regarding covered products. In addition to the design standard for gas fireplace heaters, decorative gas fireplaces, gas logs, and outdoor products, the Statewide CASE Team proposes that the Energy Commission subject all gas fireplace heater products to an efficiency standard with a minimum FE of 75 percent.

5.2 Product Efficiency Opportunities

In crafting their prescriptive requirement, U.S. DOE first considered the following technology options which affect active mode energy consumption:

- Air-to-fuel ratio;
- Burner port design;
- Simulated log design;
- Pan burner media/bead type;

- Reflective walls and/or other components inside the combustion zone;
- Air circulating fan;
- Electronic ignition; and
- Condensing heat exchanger.

After an initial screening analysis, U.S. DOE decided to only pursue a standby mode energy consumption standard, eliminating all the above listed active mode technologies (U.S. DOE 2015c).

However, various jurisdictions in Canada have passed efficiency standards for heating products as explained in Section 5.11.4. Manufacturers indicated to NRCan that there were several methods they would consider to improve the FE including: baffling and flue gas restriction, additional heat exchange surfaces, and ceramic glass (NRCan 2018). Thus, the Statewide CASE Team has proposed an efficiency requirement with the notion that manufacturers could use these improvements to meet the standards.

5.3 Technical Feasibility

5.3.1 Design Standard

As noted in U.S. DOE's analysis, intermittent pilots (i.e., electronic ignitions) are currently commercially available and do not result in adverse impacts on health or safety (U.S. DOE 2015d).

Additionally, U.S. DOE concluded that a prescriptive standard banning standing pilot lights would not lessen the utility or performance of the covered hearth products; all product categories offer comparable products with intermittent pilot lights (U.S. DOE 2015c).

Based on the Hearth, Patio, & Barbecue Association membership,[5] the manufacturers provided in U.S. DOE's analysis,[6] and a general web search, the Statewide CASE Team estimates there are approximately 26 hearth manufacturers based in California and 68 additional hearth manufacturers in the rest of the U.S. and Canada.[7] After doing a survey of the products offered, the Statewide CASE Team found that of the 94 total manufacturers, approximately 1,918[8] products are offered for sale with approximately 70 percent[9] of products meeting the proposed design standard.[10] These results are shown in Table 2.

[5] http://www.hpba.org/Membership/Organization-Search
[6] https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0045
[7] Manufacturer lists from U.S. DOE and HPBA also includes one manufacturer from Denmark and two manufacturers from the United Kingdom.
[8] Estimated from surveying websites and assessing whether the products fall under the scope of this report.
[9] This estimate is conservative as there are some gaps in data due to manufacturer websites not stating which type of pilot light their products use.
[10] Includes match-lit products as these products do not fall under the scope of this report.

Table 2: Hearth Products Offered in California

Hearth product type	Number of California manufacturers	Percentage of products that meet the proposed design standard	Number of additional national manufacturers	Percentage of products that meet the proposed design standard
Vented fireplaces, inserts, and stoves (gas fireplace heaters and decorative gas fireplaces)	3	70%	46	67%
Vented gas logs	5	51%	19	65%
Outdoor products	24	47%	41	76%

Source: Statewide CASE Team Analysis.

As of 2018, the Statewide CASE Team's analysis indicates that in California, over 55 percent of current hearth product stock already utilizes intermittent pilot lights. Detailed numbers are shown in Table 3.

Table 3: 2018 Breakdown of Standing Pilot Lights vs. Intermittent Pilot Lights for Hearth Products in California in 2018

	Stock (all product categories)	Stock market share	Total shipment (all product categories)	Shipments market share
Standing pilot	370,538	45%	24,703	45%
Intermittent pilot	461,838	55%	30,789	55%
Total	832,376	100%	55,492	100%

Source: Statewide CASE Team Analysis;[a] U.S. DOE 2015d.
[a]Based on national shipments from U.S. DOE Technical Support Document (TSD).

Considering that over half of current stock and shipments meet the proposed standard, the Statewide CASE Team has concluded that this proposed design standard is technically feasible for manufacturers.

5.3.2 Efficiency Standard

Improving the overall efficiency of the product does not lessen the utility of the product or result in any adverse health or safety impacts.

Based on the confidential 2018 NRCan study, over three percent of the gas fireplace heater market already meets the 75 percent FE level. A more detailed breakdown of the percentage of products that meet the standard is provided in Table 4.

Table 4: 2018 Breakdown of FE Levels among Gas Fireplace Heaters

FE level	Percent of products (cumulative) that meet the standard[11]
50%	88.2%
55%	75.9%
60%	64.4%
65%	38.5%
70%	16.4%
75%	3.4%

Source: NRCan 2017b.

5.4 Statewide Energy Savings

5.4.1 Per-Unit Energy Savings Methodology

This section describes Statewide CASE Team methodology used to estimate energy and environmental impacts. The Statewide CASE Team calculated the impacts of the proposed code change by comparing non-qualifying products to qualifying products. The results reflected in this report do not currently reflect the recently adopted 2019 Title 24, Part 6 Building Energy Efficiency Standards[12] described further in 5.11.2.

The Statewide CASE Team drew heavily from the U.S. DOE analysis for information regarding per-unit energy consumption, product lifetime, shipments, and cost data by EL. This information was supplemented with information from a confidential Canadian study. The sources for this information are shown in Table 5.

Table 5: Sources Used for Per-Unit Energy Savings Methodology

Data used	Source
Per-unit energy consumption	TSD Chapter 7: Energy Use Analysis,[a] NRCan 2018
Product lifetime	TSD Chapter 8: Life-Cycle Cost and Payback Period Analysis[a]
Shipments	National Impact Analysis (NIA),[b] NRCan 2018
Cost data	NIA,[b] NRCan 2018

Source: [a]U.S. DOE 2015d; [b]U.S. DOE 2015b.

[11] The Statewide CASE Team used the NRCan database as a proxy for shipments.
[12] The 2019 Title 24 Standards have not yet been adopted by the Building Standards Commission as of writing this CASE Report.

The analysis assumes a standard effective year of 2019. In addition, the Statewide CASE Team chose the same scope as U.S. DOE after results showed it would deliver significant, cost-effective savings for California natural gas users.

5.4.1.1 Annual Per-Unit Energy Use Methodology

As described in Section 5.4.1 above, the per-unit energy use was adapted from the U.S. DOE analysis. Non-qualifying products are products that do not meet the proposed standard and qualifying products are products that meet the proposed standard. Based on survey data, tear down analysis, manufacturer literature, and consultant input, U.S. DOE calculated energy consumption for both qualifying and non-qualifying products in each product category (U.S. DOE 2015d). This included calculations for the main burner operating hours, standing pilot light energy consumption, intermittent pilot light energy consumption, and the secondary heating and cooling effects resulting from the use of hearth products (U.S. DOE 2015d). The Statewide CASE Team assumed that the energy consumption values determined in U.S. DOE's analysis were reasonable for products in California. Thus, U.S. DOE values for energy consumption are used throughout the analysis for gas logs and outdoor products. To account for the split between decorative gas fireplaces and gas fireplace heaters, the Statewide CASE Team used data from a confidential NRCan study to recalculate the per-unit energy consumption of decorative gas fireplaces and gas fireplace heaters separately. Similar to U.S. DOE, this included main burner operating hours, standing pilot light energy consumption, intermittent pilot energy consumption, and the secondary heating and cooling effects resulting from the use of hearth products (NRCan 2018). The Statewide CASE Team is also considering conducting additional testing and outreach to gather data around energy consumption of the main burner, energy consumption of the standing pilot light, energy consumption of the intermittent pilot light, and information about hearth product user behavior.

5.4.1.2 Peak Demand Methodology

Peak demand was calculated by multiplying daily electricity use by an assumed load factor. A load factor is the ratio of average annual load to coincident peak load. The Statewide CASE Team obtained end-use load factors through consultations with the Energy Commission. The load factors used in this report were developed by the Energy Commission using an Hourly Energy and Load Model (Brown and Koomey 2002) on 2013 utility-level energy demand data. A complete table of updated values for several end uses is included in Appendix C: Load Factors. For the purposes of this report, the Statewide CASE Team included hearth products in the residential space heating end-use category (see Appendix C: Load Factors) and used the corresponding load factor of zero (0) for hearth products. Thus, this proposed standard does not have any demand reduction benefits.

5.4.2 Summary of Per-Unit Energy Use Impacts

The per-unit energy use for both non-qualifying and qualifying products is shown in Table 6 and Table 7 , respectively. Annual per-unit energy savings are presented in Table 8. The values for gas fireplace heaters accounts for the product meeting both the design and the efficiency standard. Although qualifying products use more electricity than non-qualifying products, their lower natural gas usage outweighs the increased electricity usage, resulting in overall lower energy consumption, as shown in the columns displaying MM (a thousand thousand, or million) Btu usage. The methodology used to calculate these estimates is presented above in Section 5.4.1.

Table 6: Annual Per-Unit Energy Use for Non-Qualifying Products

Product class	Electricity use (kilowatt hours (kWh)/year)	Natural gas use (therms/year)	Peak demand (W)	Total site energy usage (MMBtu)
Vented fireplaces, inserts, and stoves – decorative gas fireplaces	0	64.8	0	6.5
Vented fireplaces, inserts, and stoves – gas fireplace heaters	0	62.7	0	6.3
Vented gas logs	0	31.3	0	3.1
Outdoor	0	39.1	0	3.9

Source: Statewide CASE Team Analysis; U.S. DOE 2015d.

Table 7: Annual Per-Unit Energy Use for Qualifying Products

Product class	Electricity use (kWh/year)	Natural gas use (therms/year)	Peak demand (W)	Total site energy usage (MMBtu)
Vented fireplaces, inserts, and stoves – decorative gas fireplaces	13.6	2.1	0	0.3
Vented fireplaces, inserts, and stoves – gas fireplace heaters	13.6	14.2	0	1.5
Vented gas logs	5.8	2.9	0	0.31
Outdoor	0.2	39.1	0	3.9

Source: Statewide CASE Team Analysis; U.S. DOE 2015d.

Table 8: Annual Per-Unit Energy Savings

Product class	Electricity savings (kWh/year)	Natural gas savings (therms/year)	Peak demand (W)	Total site energy savings (MMBtu)
Vented fireplaces, inserts, and stoves – decorative gas fireplaces	-13.6	62.7	0	6.2

Vented fireplaces, inserts, and stoves – gas fireplace heaters	-13.6	48.6	0	4.8
Vented gas logs	-5.8	28.4	0	2.8
Outdoor	-0.2	0	0	-0.0007

Source: Statewide CASE Team Analysis; U.S. DOE 2015d.

5.4.3 Stock

To estimate stock for hearth products in California, the Statewide CASE Team used shipment data from the U.S. DOE NIA (U.S. DOE 2015b). These numbers were adjusted to California by removing new construction installations, removing match-lit products since they are not in the scope of this proposal, and using the Residential Energy Consumption Survey (RECS) 2009 data to determine how many Californians use hearth products as compared to the nation as a whole (CEC 2015; RECS 2009). Once the shipment numbers were adjusted, they were multiplied by the product lifetime to get an estimate of the stock. Table 9 shows a summary of projected stock data from 2019 (the year the standard would go into effect) until 2033 (the year stock would fully turnover).

Table 9: Hearth Products Stock in California: 2019-2033

Base case year	Stock (total)
2019	841,312
2020	832,291
2021	808,478
2022	796,751
2023	793,951
2024	797,252
2025	812,948
2026	821,636
2027	814,665
2028	800,947
2029	803,570
2030	808,211
2031	800,247
2032	775,472
2033	773,143

Source: Statewide CASE Team Analysis; U.S. DOE 2015b.

5.4.4 Shipments

Similar to stock information, the Statewide CASE Team used U.S. DOE shipment data from the National Impact Analysis (U.S. DOE 2015b). This data was used as a proxy for sales for the design standard proposal and was adjusted to California by removing new construction installations and match-lit products (which are not in the scope of this proposal) and using RECS 2009 data to determine how many Californians use hearth products as compared to the nation as a whole (CEC 2015; RECS 2009). Table 10 shows a summary of projected shipments from 2019 (the year the standard would go into effect) until 2033 (the year stock would fully turnover).

Table 10: Hearth Product Shipments in California: 2019 - 2033

Base case year	Shipments (total)
2019	56,087
2020	55,486
2021	53,899
2022	53,117
2023	52,930
2024	53,150
2025	54,197
2026	54,776
2027	54,311
2028	53,396
2029	53,571
2030	53,881
2031	53,350
2032	51,698
2033	51,543

Source: Statewide CASE Team Analysis; U.S. DOE 2015b.

5.4.5 Current and Future Shipments

Full stock turnover will occur in 2033, assuming a weighted average 15-year lifetime across all product classes and a standard effective year of 2019. Table 11 summarizes stock and shipment for 2019 and 2033 for the purposes of the design standard.

Table 11: California Shipments and Stock

	Annual shipments	Stock
2019 (standards take effect)	56,087	841,312
2033 (after stock turnover)	51,543	773,143

Source: Statewide CASE Team Analysis; U.S. DOE 2015d.

5.4.6 Statewide Energy Use – Non-Standards and Standards Case

In the following section, "non-standards case" is the term used to describe the scenario where no standard is enacted while "standards case" is used to describe the scenario that would occur with a standard in place. Table 12 shows the statewide electricity and natural gas usage for the non-standards case while Table 13 shows the cumulative non-standards case energy usage in MMBtu. As can be seen, the energy use remains relatively constant throughout the lifetime of the product. Alternatively, Table 14 shows the statewide electricity and natural gas usage for the standards case, while Table 15 shows the cumulative standards case energy usage in MMBtu. Table 13 and Table 15 are provided in order to more easily show energy usage since electricity and natural gas are not measured in the same units.

These tables show that with the implementation of a standard, electricity use increases slightly (with more products using intermittent pilots), natural gas usage decreases (with fewer products using excess natural gas from standing pilots), and overall Btu consumption decreases.

Table 12: California Statewide Energy Use by Fuel Type - Non-Standards Case (After Effective Date)

Year	Annual shipments		Stock	
	Electricity use (gigawatt hours (GWh)/year)	Natural gas use (million therms/year)	Electricity use (GWh/year)	Natural gas use (million therms/year)
2019	0.3	2.1	4.5	30.5
2020	0.3	2.0	4.5	30.5
2021	0.3	2.0	4.5	30.5
2022	0.3	1.9	4.5	30.4
2023	0.3	1.9	4.5	30.3
2024	0.3	1.9	4.5	30.2
2025	0.3	2.0	4.4	30.2
2026	0.3	2.0	4.4	30.1
2027	0.3	2.0	4.4	30.1
2028	0.3	2.0	4.4	30.0
2029	0.3	2.0	4.4	30.0
2030	0.3	2.0	4.4	29.9
2031	0.3	2.0	4.4	29.8
2032	0.3	1.9	4.4	29.7
2033	0.3	1.9	4.4	29.5

Source: Statewide CASE Team Analysis.

Table 13: California Statewide Energy Use – Non-Standards Case (After Effective Date)

Year	Shipments	Stock
	Total site energy usage (MMBtu/year)	Total site energy usage (MMBtu/year)
2019	206,623	3,068,618
2020	204,407	3,068,597
2021	198,559	3,062,728
2022	195,679	3,053,979
2023	194,991	3,044,542
2024	195,802	3,035,915
2025	199,657	3,031,144
2026	201,791	3,028,506
2027	200,078	3,024,156
2028	196,709	3,016,437
2029	197,354	3,009,363
2030	198,493	3,003,428
2031	196,538	2,995,537
2032	190,453	2,981,562
2033	189,881	2,967,014

Source: Statewide CASE Team Analysis.

Table 14: California Statewide Energy Use by Fuel Type – Standards Case (After Effective Date)

Year	Annual shipments		Stock	
	Electricity use (GWh/year)	Natural gas use (million therms/year)	Electricity use (GWh/year)	Natural gas use (million therms/year)
2019	0.7	0.5	4.9	29.0
2020	0.7	0.5	5.3	27.4
2021	0.7	0.5	5.6	25.9
2022	0.6	0.5	6.0	24.3
2023	0.6	0.5	6.3	22.8
2024	0.6	0.5	6.6	21.2
2025	0.7	0.5	7.0	19.7

2026	0.7	0.5	7.4	18.1
2027	0.7	0.5	7.7	16.6
2028	0.6	0.5	8.1	15.0
2029	0.7	0.5	8.4	13.5
2030	0.7	0.5	8.8	11.9
2031	0.6	0.5	9.1	10.4
2032	0.6	0.5	9.4	8.8
2033	0.6	0.5	9.8	7.2

Source: Statewide CASE Team Analysis.

Table 15: California Statewide Energy Use – Standards Case (After Effective Date)

Year	Shipments	Stock
	Total site energy usage (MMBtu/year)	Total site energy usage (MMBtu/year)
2019	52,493	2,914,489
2020	51,931	2,761,991
2021	50,445	2,608,008
2022	49,713	2,453,293
2023	49,538	2,298,403
2024	49,744	2,143,719
2025	50,724	1,990,014
2026	51,266	1,836,852
2027	50,831	1,683,255
2028	49,975	1,528,801
2029	50,139	1,374,511
2030	50,428	1,220,511
2031	49,931	1,066,014
2032	48,385	909,972
2033	48,240	753,783

Source: Statewide CASE Team Analysis.

5.4.7 Statewide Energy Savings - Methodology

Statewide savings estimates were calculated by applying the per-unit energy savings for the design standard presented in Section 5.4.1.1 to the statewide stock and sales forecast for the design standard presented in Sections 5.4.3 and 5.4.4 of the report.

The difference between the standards and non-standards cases as shown in Section 5.4.6, which ultimately results in overall savings, is shown in Table 16 and Table 17. Table 16 shows the statewide electricity and natural gas savings for the design standards case, while Table 17 shows the statewide energy savings for the standards case in MMBtu.

Table 16: California Statewide Energy Savings by Fuel Type– Standards Case (After Effective Date)

Year	Annual shipments		Stock	
	Electricity savings (GWh/year)	Natural gas savings (million therms/year)	Electricity savings (GWh/year)	Natural gas savings (million therms/year)
2019	-0.7	2.8	-0.7	2.8
2020	-0.7	2.8	-1.4	5.6
2021	-0.7	2.7	-2.0	8.3
2022	-0.6	2.7	-2.7	10.9
2023	-0.6	2.6	-6.3	25.9
2024	-0.6	2.7	-3.9	16.2
2025	-0.7	2.7	-4.6	18.9
2026	-0.7	2.7	-5.3	21.7
2027	-0.7	2.7	-5.9	24.4
2028	-0.6	2.7	-6.6	27.0
2029	-0.7	2.7	-7.2	29.7
2030	-0.7	2.7	-7.9	32.4
2031	-0.6	2.7	-8.5	35.1
2032	-0.6	2.6	-9.2	37.7
2033	-0.6	2.6	-9.8	40.2

Source: Statewide CASE Team Analysis.

Table 17: California Statewide Energy Savings – Standards Case (After Effective Date)

Year	Shipments	Stock
	Total site energy usage (MMBtu/year)	Total site energy usage (MMBtu/year)
2019	154,129	154,129
2020	152,477	306,606
2021	148,114	454,720
2022	145,966	600,686
2023	145,453	746,139
2024	146,057	892,196
2025	148,933	1,041,129
2026	150,525	1,191,654
2027	149,248	1,340,902
2028	146,734	1,487,636
2029	147,215	1,634,851
2030	148,065	1,782,917
2031	146,606	1,929,523
2032	142,067	2,071,590
2033	141,641	2,213,231

Source: Statewide CASE Team Analysis.

5.5 Cost-Effectiveness

This section describes the methodology and approach the Statewide CASE Team used to analyze the economic impacts of the proposed standard.

5.5.1 Incremental Cost

For the design standard proposal, incremental cost is the calculated difference between installation of equipment with a standing pilot and equipment without a standing pilot light. For the efficiency standard proposal, incremental cost is the shipment-weighted cost of improving the efficiency of a gas heater from a range of market FE values (anything less than 75 percent) to an FE of at least 75 percent. The distribution of products among the different FE levels came from a confidential 2018 NRCan study. The results for the design standard presented in Table 18 are derived from the average installed costs in U.S. DOE's analysis by adjusting numbers to 2018 dollars (U.S. DOE 2015d). U.S. DOE calculated this installed cost using retail markups, sales, taxes, installation costs (including labor), overhead, and miscellaneous materials and parts which were obtained through various sources including: RS Means 2013, teardown analysis, and interviews with manufacturers (U.S. DOE 2015d). The U.S. DOE values for annual operating costs were not included in the incremental cost analysis since they are accounted for separately in the Statewide CASE Team Analysis. The results for the efficiency standard presented in Table 18 are derived from a

confidential 2018 NRCan study (NRCan 2018). As shown in the table, vented gas log sets have the highest incremental cost while outdoor products have the lowest incremental cost. The incremental cost for gas fireplace heaters has been split up between the cost of the design standard and the cost of the efficiency standard.

Table 18: Incremental Product Costs

Hearth product category	Incremental cost over baseline (2018 $)
Vented fireplace/insert/stove – decorative gas fireplaces	$100.42
Vented fireplaces, inserts, and stoves – gas fireplace heaters (design standard)	$100.42
Vented fireplaces, inserts, and stoves – gas fireplace heaters (efficiency standard)	$76.97
Vented gas log sets	$162.03
Outdoor	$79.52

Source: Statewide CASE Team Analysis; U.S. DOE 2015d.

The Statewide CASE Team plans to further investigate how the incremental cost of the design standard will evolve over time. A significant body of research suggests that appliance energy efficiency standards do not cause permanent increases in the purchasing price of appliances but rather a short-term increase followed by a long-term decline that can be modeled using an experience curve approach (Dale 2008, Hossain 2011, Van Buskirk *et al* 2014, Weiss 2009). Furthermore, U.S. DOE has created instructional documents for using experience curves to forecast appliance prices when evaluating the cost-effectiveness of energy efficiency standards (U.S. DOE 2011, Woolf 2011). The Statewide CASE Team intends to explore opportunities to use historic price-versus-shipments trends to predict how the costs of standing pilot and non-standing-pilot equipment will evolve before and after the proposed design standard is adopted.

5.5.2 Design Life

To determine product lifetime for hearth products, U.S. DOE used warranty information and the lifetimes of similar appliances to estimate both hearth product and hearth product ignition system lifetimes (U.S. DOE 2015d). In their lifecycle cost analysis, U.S. DOE used a weighted average of 15 years for hearth products and 7.3 years for the ignition system, which were the values used throughout the Statewide CASE Team's analysis (U.S. DOE 2015a). This assumption is in line with other sources for hearth product lifetimes. Total Chimney Care noted that the average life expectancy is between 10 to 15 years for prefabricated fireplaces with a maximum lifetime of 20 to 30 years (Total Chimney Care 2015). Additionally, Total Home Supply estimated gas log lifetimes to be between three and 10 years depending on the use (Total Home Supply 2017). Given limited online information about the lifetime of gas stoves and outdoor products, the Statewide CASE Team is using the information provided in U.S. DOE's analysis.

5.5.3 Lifecycle Cost / Net Benefit

Table 19 presents the per-unit and total lifecycle costs and net benefits of the proposed standard. In this case, the period of analysis is the weighted average product life, 15 years, to account for all

savings that occur until the stock turns over. The cost impacts are presented in present value (PV) and NPV. The energy benefits savings per-unit over the 15-year period are presented for the hearth product classes evaluated, weighted by shipments.

Table 19: Costs and Net Benefits Per-Unit for Qualifying Products

Product class	Product life (years)	Lifecycle costs per-unit (PV)[a]			Lifecycle benefits per-unit (PV)		NPV per-unit
		Incremental cost[b]	Additional cost[c]	Total PV costs	First-year natural gas savings	Total PV benefits	Net natural gas PV benefits
Shipment weighted hearth products	15.0	$135.33	$30.00	$165.33	$619.32	$619.32	$453.99

Source: Statewide CASE Team Analysis; U.S. DOE 2015b.

[a] PV calculated using the Energy Commission's average statewide PV statewide energy rates, and a 3% discount rate (CEC 2017). See Appendix A: Natural Gas Rates for details regarding rates.

[b] Incremental cost is the cost difference between the baseline non-qualifying product and the qualifying product.

[c] Additional cost incurred from the cost of electricity due to increased electricity use and an annualized maintenance cost.

5.6 Environmental Impacts/Benefits

5.6.1 Greenhouse Gases

Table 20 presents the annual and stock greenhouse gas (GHG) savings for the first year the design standard takes effect (2019) through the year of full stock turnover (2033). The estimated annual statewide GHG savings is 9,274 $MTCO_2e$ the first year the design standard is in effect and 7,925 $MTCO_2e$ after full stock turnover in 2033, with stock GHG savings reaching 123,835 $MTCO_2e$ in year 2033. The Statewide CASE Team calculated the avoided GHG emissions from the adoption of the design standard assuming an emissions rate varying by year, in accordance with California's projected emissions factors as outlined in the 2017 update to the California Air Resources Board (CARB) scoping plan to meet the 2033 greenhouse gas targets (CARB 2017).

Table 20: Greenhouse Gas Savings 2019 - 2033

Year	Annual GHG savings (MTCO2e/year)	Stock GHG savings (MTCO2e/year)
2019	9,274	9,274
2020	9,102	18,304
2021	8,762	26,900
2022	8,529	35,100
2023	8,395	43,065
2024	8,309	50,756
2025	8,465	59,179

2026	8,549	67,682
2027	8,474	76,132
2028	8,326	84,408
2029	8,250	91,622
2030	8,297	99,908
2031	8,213	108,095
2032	7,962	116,103
2033	7,925	123,835

Source: Statewide CASE Team Analysis.

5.6.2 Indoor or Outdoor Air Quality

This proposed measure is estimated to reduce total criteria pollutant emissions in California by 289,100 pounds (lbs) per year in 2033 as shown in Table 21 with an estimated value of $2.8 million. Criteria pollutant emission factors for California electricity generation – Nitrogen Oxides (NOx) and Reactive Organic Gases (ROG), Sulfur Oxides (SOx) and fine particulates under 2.5 micrometers (PM2.5) – were calculated per megawatt-hour (MWh) based on California Air Resources Board data of emission rates by power plant type and expected generation mix (CARB 2010). Criteria pollutant emission factors for natural gas combustion – NOx and carbon monoxide (CO)—were calculated per MMBtu based on U.S. Environmental Protection Agency's AP-42: Compilation of Air Emissions Factors for External Combustion Sources. Because natural gas-fired hearth products were not included in AP-42, the Statewide CASE Team chose the general "Natural Gas Combustion" category as a proxy for criteria pollutant emissions for hearth products (U.S. EPA 1998). The monetization of these criteria pollutant emission rate data times the dollar per ton value of these reductions based on Carl Moyer values where available, and San Joaquin Valley Unified Air Pollution Control District (UAPCD) "BACT" (best available controls technology) thresholds for SOx. These dollar per ton values vary significantly for fine particulates, as discussed in Appendix E: Criteria Pollutant Emissions and Monetization (CARB 2011a, CARB 2013a, San Joaquin Valley UAPCD). Because this measure results in increased electricity use, the values associated with electricity usage are negative. However, the savings from natural gas more than accounts for the increased emissions associated with electricity, and the result is overall improved air quality.

Table 21: Estimated California Criteria Pollutant Reduction Benefits (lbs/year) in 2033

	Type of pollutant	Reduced emissions lbs/year	Carl Moyer $/ton (2018)	Monetization
Criteria Pollutants Associated with Electricity	ROG	-270	$20,781	-$2,805
	NO_x	-921	$29,161	-$13,426
	SO_x	-97	$21,781	-$1,054
	PM2.5	-398	$415,627	-$82,701
Subtotal		**-1,700**		**-$100,000**

Criteria Pollutants Associated with Natural Gas	NO_x	203,964	$29,161	$2,973,857
	CO	86,793	$357	$15,496
Subtotal		**290,800**		**$2,989,400**
Total		**289,100**		**$2,889,400**

Source: Statewide CASE Team Analysis.

5.6.3 Hazardous Materials

Most gas fireplaces with intermittent pilots include a battery backup system in order to light the pilot if the power goes out. Several sources indicate that the backup systems generally use either two D-batteries or four AA-batteries (The Hearth Shop 2014, The Heatilator 2015). The use case for these battery systems occurs when there is a power outage and the user simultaneously desires to use their hearth product. The battery is then used to create enough of a spark to ignite the pilot light and allow the hearth product to continue to run on natural gas. Thus, given the small amount of energy required and the relatively rare use case, the Statewide CASE Team assumes that the batteries included as a backup will discharge due to limited shelf life before they discharge due to use by the user. Assuming the user does not use rechargeable batteries, the average shelf life of D- and AA-batteries is about 11 years (Energizer 2019). In a worst-case scenario, the user replaces the batteries after about 11 years and then also disposes the batteries when the hearth product is replaced after 15 years. This means that there are potentially four D-batteries or eight AA-batteries disposed of over the hearth product lifetime of 15 years. Due to the chemicals inside,[13] batteries can be hazardous to the environment if not disposed of properly. If disposed of in a landfill, the corroding chemicals can leach into the soil and enter the water supply (Seattlepi 2019). However, there are programs that exist to recycle batteries and prevent environmental damage.

5.7 Impact on California's Economy

Table 22 presents the total lifecycle costs and benefits for the design standards case. The first-year shipments in 2019 have a NPV of $19.2 million while the stock turnover yields over $238 million by 2033.

[13] The chemicals vary by battery chemistry but can include cadmium, lead, mercury, nickel, lithium, and electrolytes.

Table 22: Statewide Total Lifecycle Costs and Benefits for Standards Case[a]

Product class	Lifecycle B/C ratio[b]	NPV ($)[c]	
		First-year shipments ($ million)	Stock turnover[d] ($)
Hearth products (shipment weighted average)	4.35	19.3	238,641,394

Source: Statewide CASE Team Analysis.

[a] The analysis does not include cost savings associated with embedded energy savings.

[b] Total PV benefits divided by total PV costs. Positive value indicates a reduced total cost of ownership over the life of the appliance.

[c] It should be noted that while the proposed standard is cost-effective, it may be more cost-effective if using alternative rate structures. For example, marginal utility rates may more accurately reflect what customers save on utility bills as result of the standard.

[d] Stock turnover NPV is calculated by taking the sum of the NPVs for the products purchased each year following the standard's effective date through the stock turnover year (i.e. the NPV of "turning over" the whole stock of less efficient products that were in use at the effective date to more efficient products, plus any additional non-replacement units due to market growth, if applicable). For example, for a standard effective in 2015 applying to a product with a five year design life, the NPV of the products purchased in the fifth year (2019) includes lifecycle cost and benefits through 2024, and therefore, so does the Stock turnover NPV.

5.8 Consumer Utility/Acceptance

There are currently no design or efficiency standards for hearth products in the U.S. However, hearth manufacturers and installers must comply with the current ban on standing pilot lights for new construction under Title 24, Part 6. Thus, manufacturers and installers should be familiar with the need to comply with regulations in California around the standing pilot light ban.

While the U.S. does not have any hearth product regulations, Canada has recently enacted both design and efficiency requirements similar to those proposed here (as explained in Section 5.11.3). Many manufacturers sell products in both Canada and the U.S; thus, the expectation is that they will generally be prepared for the proposed California standard.

5.9 Manufacturer Structure and Supply Chain Timelines

Based on calls to local suppliers, the Statewide CASE Team found that most local suppliers sell hearth products directly to consumers and subsequently perform home installation. Suppliers report occasional sales to contractors for installation in new homes. However, local suppliers most often act as both retailer and installer for these types of products.

NRCan noted that manufacturers said that FE improvements would likely require significant redesign and retesting but the Statewide CASE Team believes the timeline for the proposed standard gives manufacturers enough time to prepare for implementation due to existing regulations in Canada and other design cycles for products.

5.10 Stakeholder Positions

The Statewide CASE Team is aware of three California-based hearth manufacturers who submitted comments in response to the 2015 U.S. DOE rulemaking. Williams Furnace Company wanted U.S. DOE to specify that vented direct heating equipment was not included in the rulemaking because they manufacture vented room heater gas furnaces to simulate solid fuel fireplaces (Williams Furnace Company 2015). However, this proposal would not affect gas furnaces. R.H.

Peterson Company, a manufacturer of vented and unvented gas log sets, argued (among other issues) that the cost of implementing this standard would fall on small businesses in the gas log industry (RH Peterson Company 2015). Finally, Rasmussen Iron Works, Inc., which manufactures gas log sets, argued that gas log sets should not be covered under the proposed U.S. DOE regulation (Rasmussen Iron Works 2015). In the NOPR, U.S. DOE noted that they could not certify that the proposed standard would not have a significant impact on a substantial number of small businesses but declined to adopt any of the alternatives set forth in the regulatory impact analysis. They planned to continue to seek input from small business that would be affected by the rulemaking and planned to consider comments received in the development of the final rule (U.S. DOE 2015c). Additionally, U.S. DOE estimated that the cost of the proposed U.S. DOE standard could disproportionately affect gas log set manufacturers assuming that manufacturers of gas log sets would likely see a greater increase in manufacturer product cost compared to manufacturers of other products. However, overall, U.S. DOE estimated most manufacturers already offer units with electronic ignition systems and that there was limited capital conversion costs to achieve compliance with a new standard (U.S. DOE 2015c).

5.11 Other Regulatory Considerations

5.11.1 Federal Regulatory Background

In February 2015, U.S. DOE released a NOPR on energy conservation standards for hearth products (U.S. DOE 2015c). However, the rulemaking never made it to the final rule stage and was withdrawn in March 2017, removing any federal preemption concerns for California.

5.11.2 California Regulatory Background

There have not been any Title 20 Regulations passed for hearth products. In Title 24, Part 6, there is a provision which bans continuous burning pilot lights in the installation of fireplaces, decorative gas appliances, and gas logs[14] in new construction of low-rise residential buildings as well as additions and alterations (CEC 2015). This eliminates any savings associated with hearth product installation in new construction, which has been appropriately accounted for in this analysis.

The Statewide CASE Team is also aware that the recently adopted Title 24, Part 6 Building Energy Efficiency Standards will prohibit standing pilot lights for fireplaces in new construction, additions, and alterations of all building types starting in January 1, 2020. Savings estimates were not adjusted in this analysis, but can be accounted for post-adoption.

5.11.3 Utility and Other Incentive Programs

The Statewide CASE Team is not aware of any current utility or incentive programs for hearth products.

5.11.4 Model Codes and Voluntary Standards

While proposing no marking or labeling requirements for products in California at this time, the Statewide CASE Team is aware of voluntary requirements for products in Canada. Currently, gas fireplaces sold in Canada can voluntarily use the EnerGuide label that displays FE[15] as a percentage; percentage increase directly correlates to higher product energy efficiency (NRCan 2015b).

Since 2003, NRCan has required that all gas fireplaces manufactured in Canada are subject to testing and reporting requirements (NRCan 2017a). Based on data collected from testing and

[14] As defined in Title 24, Part 6.
[15] As defined in CAN/CSA-P.4.1-15

reporting, the Office of Energy Efficiency at NRCan issued a Notice of Intent in March 2017 to adopt minimum efficiency performance standards for gas fireplaces. NRCan differentiates between decorative gas fireplaces and gas fireplace heaters; their notice of intent proposes several efficiency requirements for each. They are considering regulating the types of pilots that can be used in any gas fireplaces as well as requiring gas fireplace heaters to have a minimum FE of 50 percent when tested using CAN/CSA-P.4.1-15. Additionally, they are considering requiring decorative gas fireplaces to draw combustion air directly from outside the building unless intended to be installed as a replacement only with proper markings (NRCan 2017a). Vented decorative gas fireplaces are currently under the scope of the gas-fired equipment safety standard ANSI Z21.50/CSA 2.22-2016 while vented gas fireplace heaters are under the scope of ANSI Z21.88/CSA 2.33-2016 (NRCan 2017a).

Since 2007, British Columbia's Energy Efficiency Standard Regulation has required that any gas fireplace manufactured or sold in the province includes a label from a designated tester that displays the FE rating of the product. British Columbia also developed a voluntary certification called EnerChoice™ in 2010 to help bring awareness to gas fireplace energy performance. It is awarded to the 25 percent most efficient fireplace models in the categories of inserts, freestanding, and zero clearance (Berkhout and Nowell 2016). Subsequently, in March 2018, British Columbia updated standards for gas fireplaces. Gas fireplace heaters[16] manufactured on or after January 1, 2019 must be tested with CAN/CSA P.4.1-15 to have an FE of at least 50 percent which must be stated on a verification label; must not have a standing pilot light; and must have a pilot-on-demand, interrupted, or intermittent pilot ignition system. Decorative gas appliances[17] manufactured on or after January 1, 2019 must have an efficiency label which states the FE rating and must comply with the same pilot light restrictions as fireplace heaters mentioned previously (Ministry of Energy, Mines, and Petroleum Resources of British Columbia 2018). In calculating potential savings for their standard, British Columbia only included savings associated with taking out standing pilot lights and did not include savings associated with meeting the 50 percent FE rating, as at least 94 percent of products in each of their categories already meet this performance level (Berkhout and Nowell 2016).

Additionally, Ontario requires that any gas fireplace manufactured on or after January 1, 2021 must test to CAN/CSA P.4.1-15, must publish the FE in any promotional literature, and must not have a standing pilot light (NRCan 2018).

5.11.5 Compliance

Currently, approximately 65 percent of products on the market meet the proposed design standard and 3 percent of gas fireplace heater products meet the proposed efficiency standard. In addition, each product category has a product currently on the market that meets the proposed standard.

6. Conclusion

The Statewide CASE Team proposes that the Energy Commission adopt a design energy conservation standard which bans standing pilot lights for hearth products. Additionally, the Statewide CASE Team proposes an efficiency standard of 75 percent FE for gas fireplace heaters based on the CAN/CSA-P.4.1-15 test procedure. The data generated from these efforts will help to inform future performance energy conservation standards. Due to U.S. DOE withdrawing their

[16] As defined in the scope of CSA 2.33-2016 and CSA 2.22-2016.
[17] As defined in the scope of CSA 2.33-2016 and CSA 2.22-2016.

energy conservation standard on hearth products in March 2017, these products are eligible for a state level energy conservation standard. For this analysis, the Statewide CASE Team drew heavily on the analysis previously done by U.S. DOE.

The design standard proposed by the Statewide CASE Team will achieve significant, cost-effective, technically feasible energy savings. The first-year statewide savings are estimated at 154,129 MMBtu/year and 2,213,231 MMBtu after stock turnover. This proposal will yield savings of 9,274 MTCO2e per year, and a total of 123,835 MTCO2e total after stock turnover in 2033. The proposed design standard will lead to significant cost savings for consumers, with $19.3 million in first-year savings, and over $238 million NPV after stock turnover in 2033. Finally, on a shipment weighted basis, there is a lifecycle B/C ratio of 4.35.

7. References

1. Berkhout, T. and R. Nowell. 2016. "Gas Fireplaces: Regulatory Proposal." Energy Efficiency Branch, BC Ministry of Energy and Mines. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/energy-efficiency/mem_eesr_ris_gas_fireplaces_september_27_2016.pdf.
2. Brown, R.E. and J.G. Koomey. 2002. "Electricity Use in California: Past Trends and Present Usage Patterns." Energy Policy (also LBNL-47992) 31:849-864.
3. Bulletin, The. 2015. "Ventless fireplaces: How safe are they?" http://www.bendbulletin.com/lifestyle/homeandgarden/3659538-151/ventless-fireplaces-how-safe-are-they.
4. CA HSC (California Health and Safety Code). 1998. CA HSC §19981 as amended by Stats. 1997, Ch. 17, Sec. 67. Effective January 1, 1998. Accessed March 20, 2018. https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=13.&title=&part=3.&chapter=12.&article.
5. CARB (California Air Resources Board). 2010. "Proposed Regulation for a California Renewable Electricity Standard Staff Report: Initial Statement of Reasons Appendix D." http://www.arb.ca.gov/regact/2010/res2010/res10isor.pdf.
6. ____. 2011a. California Air Resources Board. *Appendix C: Cost Effectiveness Calculation Methodology*. http://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/appc_3_10_11.pdf. March 10.
7. ____. 2011b. Emission Reduction Offsets Transaction Cost Summary Report for 2011. http://www.arb.ca.gov/nsr/erco/erco.htm.
8. ____. 2012. *Emission Reduction Offsets Transaction Cost Summary Report for 2012*. http://www.arb.ca.gov/nsr/erco/erco.htm.
9. ____. 2013a. Mail-Out #MSC 13-09. http://www.arb.ca.gov/msprog/mailouts/msc1309/msc1309.pdf. March 25.
10. ____. 2013b. California Air Resources board Quarterly Auction 3, May 2013 – Summary Results Report. www.arb.ca.gov/cc/capandtrade/auction/may-2013/results.pdf.
11. ____. 2014. "First Update to the Climate Change Scoping Plan." May. http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.
12. ____. 2015. "Assembly Bill 32 Overview." http://www.arb.ca.gov/cc/ab32/ab32.htm.
13. ____. 2017. "2017 Scoping Plan Appendix D Pathways." https://www.arb.ca.gov/cc/scopingplan/2030sp_appd_pathways_final.pdf.
14. CEC (California Energy Commission). 2014. "2013 Residential Compliance Manual" http://www.energy.ca.gov/2013publications/CEC-400-2013-001/chapters/04_Building_HVAC_Requirements.pdf.
15. ____. 2015. 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings." http://www.energy.ca.gov/2015publications/CEC-400-2015-037/CEC-400-2015-037-CMF.pdf.

16. ___. 2016. Demand Analysis Office. Communications with M. Tian.

17. ___.2017a. Adopted California Energy Commission Demand Forecast Report 2017-2027. Mid-Case Final Demand Forecast. Form 2.3. Updated January 23, 2017. http://www.energy.ca.gov/2016_energypolicy/documents/2016-12-08_workshop/mid_demand_case.php.

18. ___.2017b. CEC 2017 Revised Baseline Natural Gas Planning Area and Sector Mid Demand Case. Mid-Case Revised Demand Forecast. Form 2.3. Updated February 21, 2018. http://www.energy.ca.gov/2017_energypolicy/documents/2018-02-21_business_meeting/2018-02-21_middemandcase_forecst.php.

19. CSA (Canadian Standards Association). 2015. http://shop.csa.ca/en/canada/performance-test-methods/cancsa-p41-15/invt/27015052015.

20. Dale, L. 2009. "Retrospective Evaluation of Appliance Price Trends." LBNL-3838E. December 3. https://escholarship.org/uc/item/9r72w9qr.

21. Energizer. 2019. "Frequently Asked Questions About Batteries." Accessed February 5, 2019. https://www.energizer.com/about-batteries/battery-faq/lists/battery-faqs/how-long-will-my-em-energizer-em-sub-reg-sub-batteries-last-in-their-packaging.

22. Fireplace Doors Online. 2018. Accessed May 18, 2018. https://www.fireplacedoorsonline.com/learning-center/masonry-fireplace-or-zero-clearance-fireplace.html.

23. Fireside Hearth & Home. 2018a. "Anatomy of a gas fireplace." Accessed March 28, 2018. http://firesidehearth.com/anatomy-gas-fireplace/.

24. ___. 2018b. "Gas Stoves." Accessed March 20, 2018. http://www.fireside.com/Browse/Stoves/Gas-Stoves.aspx.

25. The Fireplace Shop & Grill Center. 2018. Accessed March 20, 2018. http://grillsandfireplaces.com/gas-logs.html.

26. Fleet Plummer. 2014. *Gas Logs: Vented or Vent-Free? How To Tell The Difference, and Decide Which One You Need.* YouTube. Accessed March 28, 2018. https://www.youtube.com/watch?v=niUkweOcZtI.

27. The Hearth Shop. 2014. Accessed February 4, 2019. http://hearthshopokc.com/faq.html.

28. The Heatilator. 2015. "Using Your Fireplace or Insert During a Power Outage." January 26. Accessed February 4, 2019. https://www.heatilator.com/Shopping-Tools/Blog/Using-Your-Fireplace-or-Insert-During-a-Power-Outage.aspx.

29. High's Chimney Service. 2018. "The Heat Efficiency of Wood Burning Stoves vs. Gas Stoves." Accessed March 28, 2018. https://www.highschimney.com/heat-efficiency-wood-burning-stoves-gas-stoves/.

30. Hossain, T. M. 2011. "Diffusion and experience curve pricing of new products in the consumer electronics industry," *Journal of Management and Marketing Research* 6. January 2011.

31. Houselogic. 2018. "Ventless Fireplaces: What You Need to Know." Accessed March 20, 2018. https://www.houselogic.com/organize-maintain/home-maintenance-tips/ventless-fireplaces-what-you-need-know/.

32. Merlin Goble Masonry, Inc. 2017. Accessed March 20, 2018. https://www.merlingoblemasonry.com/fireplace_masonry.html.

33. My Gas Fireplace Repair. 2017. "Identifying Gas Fireplace Parts." Accessed March 28, 2018. https://www.mygasfireplacerepair.com/2017/04/identifying-gas-fireplace-parts/.

34. Ministry of Energy, Mines, and Petroleum Resources of British Columbia. 2018. "Energy Efficiency Standards Regulation Amendment." Accessed May 16, 2018. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/energy-efficiency/eesr_amendment_6_regulatory_bulletin_march_7_2018.pdf.

35. Napoleon Fireplaces. 2015. "Fireplaces vs. Fireplace Inserts." Accessed March 20, 2018. http://napoleonfireplaces.com/fireplaces-and-fireplace-inserts/.

36. Nordic Stove & Fireplace Center. 2013. "A Gas Log Set or a Gas Insert – Which is right for me?" Accessed March 28, 2018. http://nordicstoveandfireplace.com/files/photos/gas%20log%20vs%20gas%20insert.pdf.

37. NRCan (Natural Resources Canada). 2015a. "Chapter 3: What to Look For." Accessed March 20, 2018. http://www.nrcan.gc.ca/energy/publications/efficiency/residential/gas-fireplaces/6807.

38. ___. 2015b. "Gas fireplaces – EnerGuide." Accessed March 26, 2018. http://www.nrcan.gc.ca/energy/products/energuide/label/reading/13718.

39. ___. 2017a. "Gas fireplaces." Accessed March 26, 2018. http://www.nrcan.gc.ca/energy/regulations-codes-standards/19682.

40. ___. 2017b. "Gas Fireplaces: Energy Efficiency Regulations." Accessed March 26, 2018. http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6865.

41. ___. 2018. "Market Analysis for Gas Fireplaces." Confidential Study.

42. Pine Lake Stoves. 2014. "Gas Inserts." Accessed March 20, 2018. http://lakestoves.com/gas_inserts.html.

43. Professional Heating & Air. 2014. "What is a Standing Pilot?" Accessed March 28, 2018. http://www.aprofessionalheatingandair.com/blog/what-is-a-standing-pilot/.

44. Rasmussen Iron Works, Inc. 2015. "2015-05-09 Comment response to the notice of proposed rulemaking (NOPR)." Accessed March 28, 2018. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0038.

45. RECS (Residential Energy Consumption Survey). 2009. 2009 RECS Survey Data. https://www.eia.gov/consumption/residential/data/2009/.

46. RH Peterson Company. 2015. "2015-05-11 Comment response to published notice of proposed rulemaking (NOPR)." Accessed March 28, 2018. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0037.

47. San Joaquin Valley UAPCD. 2008. *Final Staff Report:* Update to Rule 2201 Best Available Control Technology (BACT) Cost Effectiveness Thresholds. http://www.valleyair.org/busind/pto/bact/May%202008%20BACT%20cost%20effectiveness%20threshold%20update%20staff%20report.pdf. May 14.

48. Seattlepi. 2019. "What Do Batteries Do to the Environment If Not Properly Recycled?" https://education.seattlepi.com/batteries-environment-not-properly-recycled-3916.html.

49. Star Fire Direct. 2018. Accessed March 20, 2018. https://starfiredirect.com/collections/fire-pits-fire-pit-tables/products/manhattan-concrete-fire-table.

50. Total Chimney Care. 2015. Accessed February 4, 2019. https://www.totalchimneycare.com/why-does-my-prefab-fireplace-need-replacing/.

51. Total Home Supply. 2017. Accessed February 4, 2019. November 26. https://blog.totalhomesupply.com/how-and-when-to-replace-gas-logs/.

52. U.S. Census Bureau, Population Division. 2015. "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014." http://factfinder2.census.gov/bkmk/table/1.0/en/PEP/2014/PEPANNRES/0400000US06.05000.

53. U.S. DOE (United States Department of Energy). 2011. "Using the Experience Curve Approach for Appliance Price Forecasting." https://www1.eere.energy.gov/buildings/appliance_standards/pdfs/experience_curve_appliance_price_forecasting_3-16-11.pdf.

54. ___. 2015a. "Hearth Products Life-Cycle Cost and Payback Period Analysis (hearths_nopr_lcc_2015_01_20)." https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0006.

55. ___. 2015b. "Hearth Products National Impact Analysis (NIA) (hearths_nopr_nia_2015_01_20)." https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0007.

56. ___. 2015c. "Notice of proposed rulemaking and announcement of public meeting." https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0010.

57. ___. 2015d. "2015-01-30 Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products." https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002.

58. ___. 2015e. "2015-03-01 Energy Trust of Oregon Studies: Summary of Gas Fireplace Research. Updated with corrected statistic May 22, 2015." Accessed May 30, 2018. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0046.

59. U.S. DOL (United States Department of Labor). 2018. Bureau of Labor Statistics. *CPI Inflation Calculator*. http://www.bls.gov/data/inflation_calculator.htm.

60. U.S. EPA (United States Environmental Protection Agency). 1998. "AP 42, Fifth Edition, Volume I Chapter 1: External Combustion Sources, Natural Gas Combustion." https://www3.epa.gov/ttn/chief/ap42/ch01/index.html.

61. ___. 2011. "Calculations and References." http://www.epa.gov/cleanenergy/energy-resources/refs.html.

62. Van Buskirk, R. D. *et al*. 2014. "A retrospective investigation of energy efficiency standards: policies may have accelerated long term declines in appliance costs," *Environ. Res. Lett*. 9.

63. Ward Burner Systems. 2004. "Pilots: Standing & Intermittent." Accessed March 28, 2018. http://www.wardburner.com/pilotstypes.html.

64. Weiss, M. 2010. "Analyzing price and efficiency dynamics of large appliances with the experience curve approach," *Energy Policy* 38.

65. Wilkens Contracting Inc. 2015. "Fireplace Anatomy." Accessed March 28, 2018. http://www.wilkens.ca/fireplace-anatomy/.

66. Williams Furnace Company. 2015. "2015-04-13 Comment response to published notice of proposed rulemaking (NOPR) and announcement of public meeting." Accessed March 28, 2018. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0024.

67. Woodland Direct. 2018. "Gas Log FAQs." Accessed March 28, 2018. http://www.woodlanddirect.com/Fireplace-Accessories/Gas-Log-Information/Gas-Log-FAQs.

68. Woolf, T. 2011. "Equipment Price Forecasting in Energy Conservation Standards Analysis." Synapse Energy Economics, Inc. http://www.synapse-energy.com/sites/default/files/SynapseReport.2011-03.ASAP%2BNRDC.Equipment-Price-Forecasting.11-023.pdf

Appendix A: Natural Gas Rates

The natural gas rates used in the analysis presented in this report were derived from projected future prices for the residential sector in the Energy Commission's "Mid-case" projection of the 2018-2030 Demand Forecast (CEC 2017b), which used no discount rate and provided prices in 2016 dollars. The Statewide CASE Team applied a three percent discount rate to future years relative to 2018. Then, the sales weighted average of the three largest natural gas utilities in California was converted to 2018 dollars using an inflation adjustment of 1.03 (U.S. DOL 2018). See the rates by year below in Table 23.

Table 23: Statewide Sales Weighted Average Residential Natural Gas Rates 2018-2033 (PG&E, SCG, and SDG&E - Three Largest California Natural Gas Utilities) in 2018 $/therm Including a 3% Discount Rate

Year	Residential natural gas rate (2018 $/therm)
2018	1.19
2019	1.19
2020	1.17
2021	1.15
2022	1.12
2023	1.10
2024	1.08
2025	1.06
2026	1.04
2027	1.02
2028	0.99
2029	0.98
2030	0.96
2031	0.96
2032	0.94
2033	0.93

Appendix B: Electricity Rates

The electricity rates used in the analysis presented in this report were derived from projected future prices for the residential sector in the Energy Commission's "Mid-case" projection of the 2018-2030 Demand Forecast (CEC 2017a), which used no discount rate and provided prices in 2016 dollars. The Statewide CASE Team applied a three percent discount rate to future years relative to 2018. Then, the sales weighted average of the five largest electric utilities in California was converted to 2018 dollars using an inflation adjustment of 1.03 (U.S. DOL 2018). See the rates by year below in Table 24.

Table 24: Statewide Residential Electricity Rates 2018 – 2033 (PG&E, SCE, SDG&E, LADWP and SMUD - 5 Largest California Electric Utilities) in 2018 cents/kWh Including a 3% Discount Rate

Year	Residential electricity rate (2018 cents/kWh)
2018	19.54
2019	19.53
2020	18.82
2021	18.38
2022	17.81
2023	17.35
2024	16.97
2025	16.56
2026	16.10
2027	15.65
2028	15.28
2029	14.84
2030	14.40
2031	13.98
2032	13.57
2033	13.17

Appendix C: Load Factors

Table 25: 2013 Electricity Consumption and Peak Demand for the Top Five Largest California Electric Utilities[a]

Sector & End-Use	Coincident Load		Annual Energy		Load Factor[b]
	MW	% of Total	GWh	% of Total	
Residential					
Cooking	581.4	1%	2833.1	1%	56%
Clothes Dryer	759.4	1%	4419.5	2%	66%
Dishwasher	211.1	0%	2237	1%	121%
Freezer	302.4	1%	2132.1	1%	80%
Miscellaneous	2849.3	5%	23139.9	9%	93%
Multi-Family Water Heater	114.2	0%	1189.4	0%	119%
Pool Heater	33.0	0%	155.6	0%	54%
Pool Pump	769.3	1%	3689.7	1%	55%
Refrigerator	1736.4	3%	13996.2	5%	92%
Solar Water Heat - Back-up	0.0	0%	0.2	0%	63%
Solar Water Heat - Pump	0.8	0%	2.3	0%	31%
Spa Heater	64.9	0%	247.6	0%	44%
Spa Pump	261.5	0%	990.4	0%	43%
Single Family Water Heater	196.5	0%	1709.6	1%	99%
Television	807.2	1%	6003	2%	85%
Waterbed Heater	737.0	1%	12003.7	5%	186%
Clothes Washer	122.2	0%	824.6	0%	77%
Air Conditioning	15739.6	28%	8378.51	3%	6%
Space Heating	0.0	0%	3441.46	1%	0%
Commercial					
Other	3344.8	6%	23762.2	9%	81%
Domestic Hot Water	144.5	0%	675.7	0%	53%
Cooking	94.5	0%	721.9	0%	87%
Office Equipment	263.3	0%	1699.2	1%	74%
Refrigeration	888.4	2%	7872.6	3%	101%
Exterior Lighting	40.9	0%	5909.2	2%	1649%
Interior Lighting	4856.2	9%	30686.2	12%	72%
Ventilation	1787.3	3%	10366.1	4%	66%
Air Conditioning	7714.7	14%	15724.95	6%	23%
Space Heating	0.0	0%	2702.77	1%	0%
Subtotal	19134.6	34%	100120.82	38%	60%

Source: CEC 2016.

[a] The top five largest California Electric Utilities are Pacific Gas & Electric (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison Company (SCE), Sacramento Municipal Utility District (SMUD), and Los Angeles Department of Water and Power (LADWP).

[b] Load Factor is the ratio of average annual load to coincident peak load. The load factors for commercial exterior lighting and residential waterbed heaters are very high because their consumption is mainly off-peak.

Appendix D: FE Metric

As defined in CAN/CSA-P.4.1-15, FE is defined as:

$$FE = \frac{5200\ Effy_{SS,W} Effy_{HS}}{5200\ Effy_{SS,W} + 2.08\ (4600) Effy_{HS} 0.7\ P_F}$$

Resulting in a percentage, where:

5200 = average number of U.S. heating degree-days.

$Effy_{SS,W}$ =

For fireplaces with single-stage controls, $Effy_{SS,W} = Effy_{SS,H}$, where:

a) $Effy_{SS,H} = 100 - L_{L,A} - L_{S,SS,H}$ for all non-condensing fireplaces, where

$L_{L,A=}$ latent heat loss and

$L_{S,SS,H}$=sensible heat loss at steady-state maximum input operation; or

b) $ffy_{SS,H} = 100 - L_{L,A} - L_{S,SS,H} + L_{G,SS,H} - L_{C,SS,H}$,

Where $L_{L,A}$ and $L_{S,SS,H}$ are as defined above,

$L_{G,SS,H}$ = latent heat gain due to condensation at maximum input rate, and

$L_{C,SS,H}$ = steady-state heat loss due to condensate at maximum input rate.

For fireplaces without single-stage controls,

$Effy_{SS,W} = (X_H)(Effy_{SS,H}) + (X_R)(Effy_{SS,R})$, where

X_H = fraction of the heating load at maximum input,

X_R = fraction of the heating load at reduced input,

$Effy_{SS,H}$ is as defined above, and

$Effy_{SS,R}$ =

a) $Effy_{SS,R} = 100 - L_{L,A} - L_{S,SS,R}$ for non-condensing fireplaces without single-stage controls, where

$L_{L,A}$ is as defined above and

$L_{S,SS,R}$ = the sensible heat loss at steady-state reduced input; or

b) $Effy_{SS,R} = 100 - L_{L,A} - L_{S,SS,R} + L_{G,SS,R} - L_{C,SS,R}$ for condensing fireplaces without single-stage controls, where

$L_{L,A}$ and $L_{S,SS,R}$ are as defined above,

$L_{G,SS,R}$ = latent heat gain due to condensation at reduced input rate, and

$L_{C,SS,R}$ = steady-state heat loss due to condensation at minimum input rate.

$Effy_{HS} = 2.08 = \frac{65-15}{24}$ for heating seasonal efficiency for vented gas fireplaces, where

a) 65 = outside air temperature at which home heating fireplaces start operating in degrees Fahrenheit (˚F),

b) -15 = outdoor design temperature for home heating fireplaces in ˚F,

c) 24 = number of hours in a day,

d) 4600 = average number of U.S. non-heating season hours per year, and

e) 0.7 = correction factor to account for pilot contribution.

$P_F = \frac{Q_P}{Q_{IN,H}}$, where

Q_P = the energy input rate;

a) For continuous pilots, Q_P = measured pilot input;

b) For fireplaces with a remotely operated pilot ignition system, Q_P = measured pilot input x 0.5;

c) For fireplaces with an intermittent ignition system that are capable of continuous pilot operation, Q_P = measured pilot input x 0,5;

d) For fireplaces with an on demand pilot ignition system timed for a maximum of 7 days operation, Q_P = measure pilot input x 0.25; and

e) For fireplaces with intermittent ignition systems, $Q_P = 0$.

$Q_{IN,H}$ = the steady-state maximum fuel input rate, determined by multiplying the measured higher heating value of the test gas by the steady-state gas input rate corrected to standard conditions of 60 ˚F (15.6 degrees Celsius (˚C)) and 30 inHg (101.3 kilopascal). Measured values of gas temperature and pressure at the meter and the barometric pressure shall be used to correct the metered gas flow rate to standard conditions.

Source: CSA 2015.

Appendix E: Criteria Pollutant Emissions and Monetization

E.1 Criteria Pollutant Emissions Calculation

To calculate the statewide emissions rate for California, the incremental emissions between CARB's high load and low load power generation forecasts for 2020 were divided by the incremental generation between CARB's high load and low load power generation forecast for 2020. Incremental emissions were calculated based on the delta between California emissions in the high and low generation forecasts divided by the delta of total electricity generated in those two scenarios. This emission rate per MWh is intended to provide a benchmark of emission reductions attributable to energy efficiency measures that could help achieve the low load scenario instead of the high load scenario. While emission rates may change somewhat over time, 2020 was considered a representative year for this measure given it is the first year the standard is in effect.

E.2 Criteria Pollutant Emissions Monetization

Avoided ambient ozone precursor and fine particulate air pollution benefits were monetized based on avoided control costs rather than damage costs due to the availability of emission control cost-effectiveness thresholds, as well as challenges in quantifying a specific value for damages per ton of pollutants.

Two sources of data for cost-effectiveness thresholds were evaluated. The first is Carl Moyer cost-effectiveness thresholds for ozone precursors and fine particulates (CARB 2011a, CARB 2013a and 2013b). The Carl Moyer program has provided incentives for voluntary reductions in criteria pollutant reductions from a variety of mobile combustion sources as well as stationary agricultural pumps that meet specified cost-effectiveness cut-offs.

The second is the San Joaquin Valley UAPCD Best-Available Control Technology ("BACT") cost-effectiveness thresholds study. Pollution reduction technologies that are not yet demonstrated in practice (in which case they are required without a cost-effectiveness evaluation) can be required at new power plants and other sources if technologically feasible and within cost-effectiveness thresholds. San Joaquin Valley UAPCD conducted a state-wide study as the basis for updating their BACT thresholds in 2008.

This CASE Report relies primarily on the Carl Moyer thresholds due to their statewide nature and applicability to combustion sources.[18] In addition, the Carl Moyer fine particulate values for fine particulate apply to combustion sources with specific health impacts, while BACT thresholds include both combustion sources and dust. The Carl Moyer values are somewhat more conservative for ozone precursors than San Joaquin Valley UAPCD BACT thresholds, and significantly higher for fine particulate.[19] The Carl Moyer program does not address SOx, however, thus the San Joaquin BACT thresholds were used for this pollutant.

Price reports for California Emission Reduction Credit (ERC) values (i.e. air pollution credits purchased to offset regulated emission increases) for 2011 and 2012 were also compared to the values selected in this CASE Report. For each pollutant there is a wide range of ERC values per ton that are both higher and lower than the values per ton used in this CASE Report (CARB 2011b,

[18] Further evaluation of the qualitative impacts of combustion fine particulate emissions from power generation and transportation sources may be beneficial.

[19] We note that both the Carl Moyer and San Joaquin Valley UAPCD BACT cost-effectiveness thresholds for fine particulates fall within the wide range of fine particulate ERC trading prices in California in 2011 and 2012.

2012). Due to wide variability and low trading volumes, ERC values were evaluated for comparative purposes only.