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# Survey of Hearth Products in U.S. Homes

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Energy Efficiency Standards Group

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## Table of Contents

Abstract.....	5
1 Introduction .....	6
1.1 Background.....	6
1.2 Scope .....	7
1.3 Existing data sources .....	8
1.3.1 Surveys .....	8
1.3.1.1 RECS 2009.....	8
1.3.1.2 AHS 2013 .....	9
1.3.1.3 Houck 2010, HPBA 2016, and other studies .....	9
1.3.2 Metered Studies .....	10
1.3.2.1 Hayden 1996, 1997.....	10
1.3.2.2 ETO 2015 .....	10
1.3.2.3 GRI 1997 .....	10
1.3.2.4 Elnakat 2016.....	10
1.3.3 Other Sources .....	11
1.3.3.1 CCHT 2010.....	11
1.3.3.2 HPBA 2013 .....	11
1.3.3.3 DOE 2015 and other .....	11
2 Methods .....	12
2.1 Survey Development and Data Collection .....	12
2.1.1 Survey Design .....	13
2.1.2 Data Collection (Amazon Mechanical Turk) .....	14
2.2 Data Screening Process .....	14
2.3 Data Analysis.....	19
2.3.1 Weighting Analysis .....	19
2.3.2 Weighting Evaluation.....	21

2.3.3	Determination of Hearth Product Type.....	24
2.3.4	Determination of Main Burner Operating Hours .....	25
2.3.5	Estimation of Standing Pilot Operating Hours .....	26
2.3.6	Determination of Ignition System Type .....	27
2.3.7	Estimation of energy use .....	27
3	Results .....	29
3.1	Hearth Product Characteristics .....	29
3.2	Hearth Product Usage.....	38
3.3	Repair and Maintenance .....	44
4	Discussion.....	47
4.1	Hearth Products Pilot (Ignition) System.....	47
4.1.1	Hearth Pilot System Distribution by Hearth Products Type .....	47
4.1.2	Hearth Pilot System Usage by Hearth Products Type.....	48
4.1.3	Impact of Hearth Products Features on Pilot Usage .....	49
4.1.4	Impact of Hearth Products Age on Pilot Usage .....	51
4.1.5	Impact of Main Heating Appliance on Hearth Product Usage.....	52
4.1.6	Impact of Decorative Aspect on Operating Hours .....	53
4.1.7	Estimated Energy Use .....	55
4.1.8	Vented vs Unvented Standing Pilot Use .....	57
4.2	Comparisons to Past Studies and Data Sources.....	59
4.2.1	Hearth Products Users General Comparisons .....	59
4.2.1.1	Demographics.....	59
4.2.1.2	General Heating System Characteristics.....	60
4.2.2	Distribution of Hearth Product Types .....	62
4.2.3	Hearth Product Fuel Types .....	62
4.2.4	Standing Pilot Usage .....	63
4.2.5	Main Burner Usage.....	64
4.2.6	Primary Utility of Hearth Products .....	65
4.2.7	Estimated Energy Use .....	65
5	Conclusions.....	66
6	Acknowledgments .....	68
7	References.....	68
	Appendix A: Residential Hearth Products Research Study.....	71

# Abstract

There are over 7 million gas-fired fireplaces currently installed in US households. On an annual basis, these use substantial energy. However, the details of the fireplace energy use and the factors that influence it are currently not well understood. Fireplaces are a type of hearth product, which is a product category that primarily consists of fireplaces, stoves, and gas log sets. For the purpose of this study, the fuels used in hearth products are primarily natural gas, propane, or electricity. They may be vented or unvented. This study reports the results of a web survey of 2,100 respondents in the United States performed in February 2016. The responses were cleaned and weighted using the raking method to form a nationally representative population. The reported data include hearth product characteristics, usage information, and repair and maintenance practices. The hearth product characteristics include the hearth product type, fuel type, ignition system type, features, venting, and installation details. The usage information includes seasonal usage of the main burner and standing pilot (if present), daily usage, and the primary utility (whether decorative or for heating). These raw data are further processed and combined with values from the literature to estimate the annual operating hours and energy use and to assess how these are impacted by the hearth product type, features, age, and the main heating appliance, if present. Based on the survey responses, the estimated average annual hours of usage was 234 for the main burner, and 4,593 for the standing pilot. The results presented provide the most comprehensive data regarding hearth products in the United States published to date. These new data allow for an improved understanding of hearth products' energy use, which in turn may facilitate the development of more informed analyses, and ultimately more efficient hearth products and reduced energy use. These new data also provide insight into topics not previously studied, such as the effect of hearth product features on energy use.

Keywords: Hearth Product; Fireplace; Survey; Usage; Energy; Data

# 1 Introduction

## 1.1 Background

In 2013, households in the United States used 5.05 quadrillion British thermal units (quads) on space heating. Of this, 3.62 quads was natural gas or propane, and 0.40 was electric<sup>1</sup>, which are the most common hearth product fuels. For many space heating appliances, such as central furnaces, the energy use is relatively well understood. This is not the case for hearth products, which is a product class that consists of gas-fired or electric fireplaces, gas log sets, stoves, and outdoor units. According to the 2015 US Department of Energy (DOE) Energy Conservation Standard Notice of Proposed Rulemaking for hearth products (DOE NOPR 2015), the total annual energy use (AEU) of hearth products in the United States is estimated to be approximately 0.1 quads<sup>2</sup>, which amounts to approximately \$1 billion in energy costs annually<sup>3</sup>. While this is a relatively small portion of the total space heating AEU and annual energy costs, it is still substantial. Note that for the purposes of this study references to fireplace refer to gas-fired or electric fireplaces, and hearth products as defined in section 1.2.

A few metering studies of fireplaces and energy use have been conducted, however, none are nationally representative of the United States, the majority are outdated with respect to the evolving technology in fireplaces, and all have limited sample sizes. While there are some relatively recent nationally representative surveys that include information on fireplaces, these do not give comprehensive information on their energy use<sup>4</sup>. This gap is especially problematic with respect to hearth product standing pilot use, as there are no nationally representative studies to date on pilot AEU of hearth products in the United States that the authors could identify. The focus in the relevant literature has been on fireplaces, which make up the majority of the hearth product category, but are substantially different from other hearth product types. Hearth products have undergone significant technological advances since the previous studies were conducted, and there is little understanding of how these design changes affect energy use.

This study began with a literature review with the purpose of identifying past efforts to determine hearth products' energy use in the United States, reviewing available data relevant to energy use estimation, and identifying knowledge gaps in the existing literature. This review found that, although there are over 7 million<sup>5</sup> households in the United States with hearth products, the

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<sup>1</sup> AEO 2015 Table A4

<sup>2</sup> See section III.A of the NOPR at: <https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0010>

<sup>3</sup> AEO 2015 Table A3, 2013, Residential

<sup>4</sup> See section 1.3 for more details

<sup>5</sup> See section 1.3.1

existing literature covering hearth products and their energy use is limited and often does not contain key usage or product data critical to developing accurate energy use estimates across a comprehensive range of U.S. consumers. As previously mentioned, the available information is often outdated, specific to a given region, or otherwise limited in scope. This lack of data impedes quantifying the national AEU of these appliances.

Whether providing heat or displaying a fire for decorative purposes, hearth products consume substantial amounts of energy when in use. When the hearth product is not in use, pilot lights and other components, when present, also use energy, and this usage may be considerable on an annual or lifetime basis. The total amount of energy consumed depends greatly on the mode of the household's hearth product usage, such as how often or for how long with each use main burners or pilots are used. The technology and details of the hearth product unit and installation, such as the pilot type, burner efficiency, flue details, or presence of features such as remote or thermostatic controls may also have a substantial effect. In an effort to supplement the available data regarding hearth products and their use, the authors launched a nationwide online consumer survey regarding residential hearth products.

## 1.2 Scope

For the purposes of this study, a hearth product is a gas-fired or electrical appliance that displays a fire or a flame pattern. These units may be vented or unvented. Hearth product types are fireplaces or fireplace inserts, gas log sets that are typically inserted into an existing empty hearth, freestanding stoves, or outdoor units. Their primary purpose may be decorative or for space heating, or some combination of the two. The term "hearth product" does not include patio heaters or gas lamps, or products with a primary function of cooking or providing lighting. Ignition systems in hearth products are typically either standing pilots where the pilot flame is continuously lit unless turned off by the user, intermittent pilots where the pilot is lit only when there is a call for heat and then automatically extinguished, or there is no pilot and, instead, the main burner is lit using a match or similar tool.

This survey was designed with the objectives of characterizing ownership and usage, especially with respect to the presence or absence of a pilot light, and collecting data useful for determining the AEU over all hearth product types in residential settings. These data include information on the characteristics of the hearth product stock, which can be used to supplement available manufacturer data; consumer behavior regarding hearth products usage, which is currently limited; and repair and maintenance, which is also limited. The data collection is targeted around hearth product pilot energy use but is also designed to include data that may be of use in additional contexts. Table 1.1 summarizes the items of interest with respect to hearth products.



**Table 1.1 Items of interest in hearth product survey**

<b>Product Characteristics</b>	<b>Consumer Behavior</b>	<b>Repair and Maintenance</b>
Product Type*	Pilot Usage	Average Cost
Fuel Type	Main Burner Usage	Frequency
Pilot Type	Decorative Aspect	Type
Product Features	Seasonal Usage	
Age and Installation details		

\*Type can be fireplace or insert, gas log sets (combined with fireplaces for this study), stove, or outdoor units

## 1.3 Existing data sources

While much of the specific data required to accurately characterize hearth products' AEU in the United States does not exist, several sources have published information on hearth product ownership and use. The majority are either market surveys or metering studies. This section gives further details on all sources the authors were able to identify.

### 1.3.1 Surveys

#### 1.3.1.1 RECS 2009

The U.S. Department of Energy's (DOE's) Energy Information Administration (EIA) conducts the Residential Energy Consumption Survey (RECS) which collects energy-related data for a nationally representative sample of occupied primary housing units in the United States. The survey is conducted every four years, with the most recent one reporting data collected in 2009.

The 2009 edition of RECS is the most recent published version as of this writing, and collected energy characteristics, product usage patterns, and household demographic data from 12,083 housing units. These units were statistically selected to represent the 113.6 million primary, occupied households found in the United States (RECS 2009). Of these, 768 housing units representing over 7 million households have been identified as having fireplaces, both vented and

unvented.<sup>6</sup> RECS also provides the total AEU for space heating for a given household on an aggregated basis. However, RECS only asks respondents about their fireplaces, and so the applicability toward other hearth product types such as gas log sets, stoves, or outdoor units is not clear. Additionally, the portion of AEU attributable to the fireplace only is not identified. RECS 2015 became available after this report was completed. The results of that survey show an increase of approximately 10% in gas fireplace ownership.

### 1.3.1.2 AHS 2013

The American Housing Survey (AHS) is a national housing survey sponsored by the Department of Housing and Urban Development, conducted by the U.S. Census Bureau and published every two years since 1973. The survey provides a current and continuous series of data of selected housing (including general housing data, housing quality and equipment, and so on) and demographic characteristics. The most recent survey (AHS 2013) was deployed in 2013 and included more than 80,000 samples taken on a nationwide basis providing information on ownership only. This survey presents no information on consumer behavior or energy use.

### 1.3.1.3 Houck 2010, HPBA 2016, and other studies

Houck (2010) published a report on residential decorative gas fireplace usage characteristics which quantified the fraction of decorative fireplaces and described decorative and overall fireplace use. In 2014 he published a series of articles in *Hearth and Home* magazine which contained some relevant demographic and other data (Houck 2014). Lawrence Berkeley National Laboratory (LBNL) is also aware of several other studies, including two prepared for the Energy Trust of Oregon (ETO) in 2009 and 2013 as well as several previous consumer surveys initiated by the Hearth, Patio and Barbecue Association (HPBA)<sup>7,8,9,10</sup>. Additionally, in 2016 HPBA published a survey documenting hearth product ownership and fuel types.<sup>11</sup>

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<sup>6</sup> The set of criteria used to determine the hearth product owners in the RECS 2009 is listed in Table 2.5.

<sup>7</sup> NFO World Group, 2003, HPBA Fireplace and Freestanding Stove Usage and Attitude Study 2002 (with follow-up), report to Hearth, Patio and Barbecue Association, Arlington, VA.

<sup>8</sup> DHM Group, 2005, 2004 Consumer Attitude and Usage Survey, report to Hearth, Patio and Barbecue Association, Arlington, VA.

<sup>9</sup> TNS Global Market Research, 2006 Fireplace/Freestanding Stove Lifestyle Usage and Attitude Study, report to Hearth, Patio and Barbecue Association, Arlington, VA.

<sup>10</sup> TNS Global Market Research, 2008 Fireplace/Freestanding Stove Lifestyle Usage and Attitude Study, report to Hearth, Patio and Barbecue Association, Arlington, VA.

<sup>11</sup> Hearth, Patio and Barbecue Association, 2016 Hearth Ownership and Market Potential Study, Arlington, VA.

## 1.3.2 Metered Studies

### 1.3.2.1 Hayden 1996, 1997

A.C.S Hayden (1996) presented a conference paper with measured data from households showing the actual use of fireplaces and pilot lights in homes in Canada. This paper included information on how people used pilot lights when not using the hearth product main burner. In 1997 an article based on this information was published (Hayden 1997).

### 1.3.2.2 ETO 2015

ETO (2015) published a field monitoring study of 43 homes in Oregon from February to April 2014. The study focused on examining the different usages among more energy efficient and baseline models in homes with more than 5 hours per week of fireplace usage and did not monitor standing pilot usage.

### 1.3.2.3 GRI 1997

The Gas Research Institute (GRI) in 1997 published a study analyzing hearth product operation using utility data from 118 households in the United States and Canada (GRI 1997). The study contains data on hearth product main burner usage disaggregated by type, including fireplace, gas log set, insert, and stove. The heating season gas usage is presented, as well as the standing pilot hourly consumption, and monthly average consumption. Additionally, demographic data, load profiles, main heating appliance impact, and other information relevant to these products' energy use is presented.

### 1.3.2.4 Elnakat 2016

Elnakat, A. and Gomez, J. D. (2016), published a journal article examining the results of a large metering study on fireplace energy use. From 2011-2013 data from 365,190 single-family homes in San Antonio, Texas, in the US were collected and analyzed. The results showed that homes with fireplaces used 23.7 MMBTU during the winter months, and homes without fireplaces used 18.1 MMBTU during the same period. This study is particularly interesting given the sheer amount of metered data. With accurate values for the efficiency of both the fireplace stock and main heating appliance stock it would be possible to compare the results from Elnakat 2016 with this study, however at this time the authors are not aware of reliable estimates for these efficiency values, particularly for fireplaces.

### 1.3.3 Other Sources

#### 1.3.3.1 CCHT 2010

The Canadian Center for Housing Technology (CCHT) in 2010 published measured test data quantifying the effect of fireplace pilot light heat on furnace use in test houses (CCHT 2010). This is currently the only publicly available study regarding the impact of a pilot light on furnace usage.

#### 1.3.3.2 HPBA 2013

HPBA publishes U.S. hearth product shipment data on their website. In addition, HPBA collected information on hearth product shipments from 1998-2013 (HPBA 2013). These data disaggregate hearth products by type, and includes electric hearth product shipments from 2008 to 2013.

#### 1.3.3.3 DOE 2015 and other

A final source of information with respect to hearth products is from the US DOE. The technical support document (DOE TSD 2015) and notice of proposed rulemaking (DOE NOPR 2015) provide information derived from representative unit teardowns, and the model database is sourced to provide comprehensive market information. Natural Resources Canada (NRCAN) maintains a similar model database; however, that database is composed of Canadian units that have substantially different features, different intended uses in some cases, and are subject to different regulations. For these reasons the NRCAN database is not used in this study or the TSD published by DOE. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI)<sup>12</sup> and the California Energy Commission (CEC)<sup>13</sup> also have similar heating appliance databases, however seem to have recently consolidated or retired their hearth heater categories. AHRI does not have any units in its hearth heater category as of 2016, there is currently no hearth heater category. In June 2016 CEC only had 11 models in the hearth heater database which is now not present, however as of this writing 397 entries of the gas space heater database mention fireplace. These are referred to in the database as wall furnaces or room heaters, but further inspection shows that many of these are fireplaces.

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<sup>12</sup> <https://www.ahridirectory.org/ahridirectory/pages/home.aspx>

<sup>13</sup> <http://energy.ca.gov/appliances/>

## 2 Methods

This study focuses on obtaining new data derived from nationally representative survey responses regarding hearth product characteristics, usage, and maintenance and repair. The first part of this section describes the Amazon Mechanical Turk (AMT) online survey platform used in this study, as well as the survey design and its deployment. The second part of the methods section focuses on data quality analysis. The third and final part of this section describes the post-data collection processing, which includes weighting analysis and demographics comparison and the approaches used to evaluate the data.

### 2.1 Survey Development and Data Collection

Amazon.com started AMT in 2005 as an online crowd-sourcing tool designed to allow “requesters” to post Human Intelligence Tasks (HITs) and “workers” to participate in HITs of their interest in exchange for monetary compensation. There are more than 500,000 global users of AMT; of these users, more than half are from the United States, which provides a large and diverse subject pool for U.S.-based research. Although some doubts remain about the quality of surveys collected by AMT, it has gained popularity among social scientists as a means of collecting experimental data. Several studies also have developed algorithms to screen the results and determine the quality of the responses based on users’ behavioral traces, which enable requesters to control for higher quality responses (Kittur et al., 2008; Rzeszotarski et al., 2011). Additionally, concerns have been expressed over the omission of certain demographic groups in online surveys. However, Paolacci et al. (2010) demonstrated that the population of AMT is “at least as representative of the U.S. population as traditional subject pools,” and Gosling et al. (2004) concluded that online surveys have been shown to be “relatively diverse with respect to gender, socioeconomic status, geographic region, and age...and are consistent with findings from traditional methods.” Furthermore, Ipeirotis (2010) showed that the geographical distribution and race composition of workers generally match those of internet users. However, when compared with the general U.S. demographics, they found that AMT workers are on average younger, more typically female, and have higher education levels and fewer children than the U.S. population. These demographics are not representative of the general population, but all relevant demographic groups are still present, albeit with lower frequencies of occurrence. Therefore, weighting online panel data has become a common way to adjust survey results to more closely represent the general population.

### 2.1.1 Survey Design

The *Residential Hearth Products Research Study* included in Appendix A was designed for use with AMT. The survey was broken into four sections. The first section (section A) included 19 questions and was designed to gather data regarding the survey respondent’s hearth product characteristics and features. The second section of the survey (section B) included 7 questions that were designed to gather data regarding the respondent’s usage of their hearth product. The third section (section C) consisted of 8 questions and was designed to gather data regarding the repair and maintenance of their hearth product. Lastly, the fourth section (section D) consisted of 13 questions and was designed to focus on the respondent’s demographic characteristics. The questions presented in the demographic section of the survey were based on the demographic questions found in RECS, as the RECS data are used as the reference sample for weighting the responses received from the survey. The demographic and home characteristic questions included questions on: gender, ethnicity, race, education, occupants by age, combined annual household income, home-ownership versus home rental, location (both State and zip code), and type of home<sup>14</sup>. The survey parameters are shown in Table 2.1.

**Table 2.1 Hearth Products Survey Sections**

<b>Parameters</b>	<b>Related Survey Questions</b>
Product Class Saturations	Hearth Product Type
	Fuel Type
	Features
Behavior	Frequency of use
	Pilot light use
Repair and Maintenance	Repair and Maintenance incidents and cost
Connection to other surveys	Demographics of the respondent and home characteristics

<sup>14</sup> Types of home include: Single-Family Detached, Single-Family Attached, Apartment building with 2-4 units, Apartment building with 5 or more units, Mobile Home, and Other.

## 2.1.2 Data Collection (Amazon Mechanical Turk)

Using AMT, the *Residential Hearth Products Research Study* was launched with the goal of collecting 2,100 responses. Before data collection could start, the survey design and protocol were carefully reviewed and approved by the LBNL Institutional Review Board. The survey was first launched as a pilot to test and identify any errors. For the preliminary test survey, the target number of responses was 100. This survey was launched on February 18th, 2016 and was completed in approximately one day. The actual survey (hereafter referred to as the “main survey”) was launched with a target number of 2,000 responses. This survey was launched on February 25th, 2016 and was completed in 7 days. The main survey was almost identical to the preliminary survey, excepting some typographical errors found in the test round. The sample size was selected to achieve a statistically representative distribution of the appliances. A survey of 2,000 respondents would achieve a 99% confidence level with a  $\pm 3\%$  confidence interval based on the U.S. household population.

Both the preliminary survey and the main survey were launched with a respondent reward of \$2.00 per survey. Table 2.2 shows the payment per survey respondent, the number of responses received, and the number of survey responses we found to be useful for continued analysis.

**Table 2.2 Survey Characteristics**

<b>Survey</b>	<b>Payment Per Respondent</b>	<b>Number of Respondents</b>	<b>Final Sample</b>
Test	\$2.00	100	63
Main	\$2.00	2,000	1,500
<b>Total</b>	-	<b>2,100</b>	<b>1,563</b>

## 2.2 Data Screening Process

A number of steps were taken to ensure that only reliable responses were selected for the analysis. Below is a brief summary of the types of responses controlled for during the initial data screening process. Responses that fit into any of these categories were not included in the data analysis because of an increased concern of errors in these samples. Table 2.3 goes into further detail regarding criteria for establishing responses as inconsistent. Table 2.4 lists the criteria and the number of responses identified under the listed criteria; note that a response may fall under multiple criteria, with 25% of flagged responses having multiple rejection criteria.

- Questionable Responses

- Respondents who responded incorrectly to either of the “cheater” questions in Section A or D. The cheater questions are listed below.
  - Who is the current president of the U. S.?
  - What material are wine bottles typically made from?
- The sum of the number of people in household by age did not match the total number of people reported.
- Inconsistencies found in Section D when comparing zip codes and selected state of residence.
- Survey response time: Respondents who responded fast enough that it was unlikely they had fully read the questions were not selected. Respondents who completed the survey in less than 300 seconds were excluded.
- Duplicate Responses: Respondents who participated in both the test survey launch and the main survey launch. Both responses were excluded. Both were excluded instead of only the second one to try and maintain the highest level of data quality possible.
- Maintenance or Repair Inconsistencies
  - Selected no repair task but indicated a frequency of repair
  - Selected no repair task but indicated frequency of repair as other
  - Test survey only: Reported maintenance cost too high, greater than \$5,000.
- Housing or hearth product age: Hearth products or houses that were reported installed before 1900 were considered unrealistically old and were not selected.
- Other Inconsistencies
  - Respondents who participated in the test launch of the survey were considered questionable if they gave responses greater than or equal to \$1,000 when asked to provide costs of maintenance or costs of repair.
  - Respondents whose answers were conflicting when compared with one another. Below are examples of the 11 comparisons throughout the survey where a respondent could provide conflicting answers. (See Table 2.3 for further explanation of comparisons.)

**Table 2.3 Description of Inconsistent Responses**

Survey Question	Description of Conflicting Response
<i>Comparison 1</i>	
<b>Question 4:</b> <i>what is your hearth product’s primary fuel?</i>	If a respondent replied to question 4 stating that their hearth product’s primary fuel is electricity and responded to question 8 with the response option “My Hearth Product does not use electricity,” their responses were considered conflicting.
<b>Question 8:</b> <i>How does your hearth product use electricity?</i>	



<b>Comparison 2</b>	
<b>Question 8:</b> <i>How does your hearth product use electricity?</i>	<p>If a respondent stated in question 8 that their hearth product uses batteries and responded to question 9 stating that their hearth product does not use batteries, their responses were considered conflicting.</p> <p>Additionally, If a respondent selected an answer in question 8 that suggested their hearth product does not use batteries and proceeded to select a response to question 9 that implied their hearth product does use batteries, their responses were considered conflicting.</p>
<b>Question 9:</b> <i>How often do you replace your hearth product's batteries?</i>	
<b>Comparison 3</b>	
<b>Question 8:</b> <i>How does your hearth product use electricity? (Check all that apply)</i>	<p>As a stand-alone question, question 8 allowed respondents to select more than one of the following responses: "My hearth product is plugged into an electrical outlet or has an electrical connection," "My hearth product uses batteries," "My hearth product does not use electricity," and "I don't know." If a respondent selected "My hearth product is plugged into an electrical outlet or has an electrical connection" and "My hearth product does not use electricity" their responses were considered conflicting. Additionally, if a respondent selected the response option "I don't know" in addition to any of the other responses, their responses were considered conflicting.</p>
<b>Comparison 4</b>	
<b>Question 10:</b> <i>Does your hearth product have the following features? (Check all that apply)</i>	<p>As a stand-alone question, question 10 allowed respondents to select more than one of the following responses: "It has a remote control," "It is controlled by a thermostat," "It has an 'on demand' pilot," "It has a 'cold climate' pilot feature," "It has none of the above," and "I don't know." If a respondent were to select either "It has none of the above" or "I don't know" in addition to selecting any other option, their responses were considered conflicting.</p>
<b>Comparison 5</b>	
<b>Question 10:</b> <i>Does your hearth product have the</i>	<p>If a respondent stated in question 10 that their hearth product has a 'cold climate' feature and responded to question 11</p>

<i>following features? (Check all that apply)</i>	stating that their hearth product does not have a ‘cold climate’ feature, their responses were considered conflicting.
<b>Question 11:</b> <i>How often do you use the cold climate feature, on average?</i>	Additionally, If a respondent selected an answer in question 10 that suggested their hearth product does not have a ‘cold climate’ feature and proceeded to select a response to question 11 that implied their hearth product does have a ‘cold climate’ feature, their responses were considered conflicting.
<b>Comparison 6</b>	
<b>Question 2:</b> <i>How is your hearth product installed?</i>	If a respondent stated that their hearth product was located indoors in question 2 and then selected “outdoor” for their response to question 13, their responses were considered conflicting.
<b>Question 13:</b> <i>What room is your hearth product installed in?</i>	Additionally, If a respondent stated that their hearth product was located outdoors in question 2 and then selected an indoor space for their answer to question 13, their responses were considered conflicting.
<b>Comparison 7</b>	
<b>Question 5:</b> <i>Have you ever used a match or a lighter to operate your hearth product?</i>	If a respondent stated in question 5 that they have never used a match or lighter to operate their hearth product and responded to question 6 stating that they do use a match or lighter to ignite their hearth product, their responses were considered conflicting.
<b>Question 6:</b> <i>Does your hearth product have a 'pilot' button, 'pilot' switch, or 'pilot' knob on the device that you use to start the pilot light?</i>	
<b>Comparison 8</b>	
<b>Question 5:</b> <i>Have you ever used a match or a lighter to operate your hearth product?</i>	If a respondent stated in question 5 that they have used a match or lighter to ignite their hearth product’s pilot light and proceeded to state in question 25 that their hearth product

<p><b>Question 25:</b> <i>Which option best describes how you operate your hearth product's pilot light?</i></p>	<p>does not have a pilot light, their responses were considered conflicting.</p>
<p><b>Comparison 9 (Example only found in the test survey launch)</b></p>	
<p><b>Question 2:</b> <i>How is your hearth product installed?</i></p>	<p>If a respondent stated in question 2 stated that their hearth product is located indoor and proceeded to state in question 23 that their hearth product is not installed in their home, their responses were considered conflicting.</p> <p>Additionally, if a respondent stated in question 2 that their hearth product is located outdoors and proceeded to state in question 23 that their hearth product is installed in their home, their responses were considered conflicting.</p>
<p><b>Question 23:</b> <i>Is there a hearth product installed in your home?</i></p>	
<p><b>Comparison 10 (Example only found in the main survey launch)</b></p>	
<p><b>Question 23:</b> <i>What is your main heating appliance?</i></p>	<p>If a respondent stated in question 23 that their hearth product is their main heating appliance and proceeded to state in question 24 that they have a main heating appliance that is not their hearth product, their responses were considered conflicting.</p> <p>Additionally, If a responded stated in question 23 that their main heating appliance was not their hearth product and proceeded to state in response to question 24 that their hearth product is their main heating appliance, their responses were considered conflicting.</p>
<p><b>Question 24:</b> <i>How often do you turn on your hearth product for heating instead of turning on or adjusting your main heating appliance?</i></p>	
<p><b>Comparison 11 (Example only found in the main survey launch)</b></p>	
<p><b>Questions 27-35:</b> <i>Questions relating to frequency of maintenance and/or frequency of repair</i></p>	<p>If a respondent were to respond to a question about maintenance or repair stating that they had not had the specified type of maintenance or repair and then proceeded to respond that their frequency of maintenance or frequency of repair was anything other than “not applicable,” their responses were considered conflicting.</p>

**Table 2.4. Responses Flagged for Each Criteria**

Screening Criteria	Test and Main Survey Combined
Original number of responses	2,100
Excluded due to “Cheater questions”	50
Time	76
Zip code mismatch with state	62
Sum of people mismatch	136
Duplication	34
Maintenance or repair inconsistencies	119
Housing or hearth product age	82
All other inconsistencies	181
Final number of responses	1563

## 2.3 Data Analysis

### 2.3.1 Weighting Analysis

After screening the raw data, the remaining responses were subjected to a weighting analysis procedure that adjusts the raw data to form a nationally representative sample. Weighting data requires adjusting raw survey results to represent the general population from which the data sample was drawn. In this study, 768 representative sample households that have been identified as hearth product owners in RECS serve as the general population in the weighting process. The RECS hearth products subsample was extracted as detailed in Table 2.5, which shows the criteria, the RECS variables used for that criteria, the number of U.S. households identified by that criteria, and the representative households in the sample.

**Table 2.5 RECS Sampling Criteria**

Variable Criteria	Households	Representative Sample
Gas fireplace as main heating equipment <sup>15</sup>	227,944	22

<sup>15</sup> Type of main space heating equipment used is fireplace (EQUIPM=9) and fuel is natural gas or propane/LPG (FPFUEL=1 or 2).

Gas fireplace as secondary heating equipment <sup>16</sup>	6,263,791	690
Fireplace with other fuel types <sup>17</sup>	477,141	50
Unused fireplaces of all fuel types <sup>18</sup>	39,362	6
Totals	7,008,237	768

The effectiveness of different survey weighting techniques were assessed by Yang et al. (2015). This study specifically compared the cell weighting and raking weighting methods, as defined by a prior study (Kalton and Flores-Cervantes, 2003). The standard cell weighting procedure is to adjust the sample weights so that the sample totals conform to the reference totals on a cell-by-cell basis by applying the ratio of the value in the sample to the general population. Whereas cell weighting forces the sample joint distribution of the auxiliary variables to conform to the population joint distribution, raking operates only on the marginal distributions of the auxiliary variables. Raking is an iterative proportional fitting procedure, requiring a sequence of adjustments so that weights are consistent with reference totals from the marginal distribution of all auxiliary variables. The raking algorithm will continue the iteration until convergence is reached, meaning that all weighted totals conform to the control totals for all the marginal distributions simultaneously.

In Yang et al. 2015, the cell weighting method was found to give better overall performance than the raking method in regards to reducing the mean and maximum absolute error among several product ownership measures. However, a potential disadvantage of cell weighting is that it can introduce great instability in weighting adjustment when the sample size of a number of cells is small. This variance inflation typically occurs when the size of the sample is too small or when there are many cells. Although the RECS hearth product sample is representative of more than 7 million U.S. households, the households are represented by 768 households, which is too few for the cell weighting process as used in previous studies. To illustrate this point, previous studies applied cell weighting using 5 demographic categories. The minimum number of classes in each category is 7, meaning that there are at least  $7^5$  or 16,807 potential demographic combinations, of which the RECS subsample only directly covered less than 5%. Relaxing the criteria to 4 demographic categories leads to at most 32% coverage—still not complete—and also produces a less meaningful fit. Therefore, given the relatively small size of the sample, the cell weighting method was not used, and instead the raking method was performed to estimate weights for each valid response in the AMT survey.

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<sup>16</sup> Fireplace is used for secondary space heating (CHIMNEY=1) and fuel is natural gas or propane/LPG (FPFUEL=1 or 2).

<sup>17</sup> Fireplace is used for secondary space heating (CHIMNEY=1) and fuel is listed as “Other Fuel” (FPFUEL=21).

<sup>18</sup> Unused space heating equipment is fireplace (EQUIPNOHEAT=9).

The AMT survey collected the same household demographic information as RECS, which includes gender, ethnicity, race, and education of the head of the household; Census division in which the household is located; combined annual household income; and occupants by age. In order for the raking algorithm to achieve convergence, it is imperative to examine the following issues closely: (1) the variables selected for raking method, (2) the number and size of the categories of those raking variables, and (3) the magnitude of difference between weighted sample totals in each raking variable and reference totals (Battaglia et al., 2009). Another important criteria regarding raking variable selection is that the raking method is effective only when the variables included exhibit strong associations with the key survey outcome variables. Examining the RECS data, there is a significant correlation between all the household demographics provided and hearth product ownership. For example, household annual income has a strong positive association with hearth product ownership, as well as a householder's education level. The categories of each candidate raking variable should also be examined to see whether the proportion of a certain category is too small. Those small categories in the survey sample or reference totals should be considered for collapsing, if feasible; otherwise they may slow down the convergence, resulting in unreliable weight estimates (Brick et al., 2003) (Battaglia et al., 2009). In this analysis, the lowest and highest two education levels, the highest two income levels, households with more than six occupants, and a householder with multiple races were consolidated to avoid having small categories in the survey sample.

After carefully addressing the three potential issues that might occur during raking variable selection, the raking method was applied to the demographic variables in the order of race, size of the household, ethnicity, gender, census division, education, occupants by age, and household annual income; varying the order was not found to have a substantial impact on the resulting weights. The raking process was iterated until the weight of each response changed by less than a threshold amount of 0.1 %. In our model, it took 51 iterations to reach the required convergence threshold. After the raking method has been successfully applied, it is desirable to evaluate the need for weight trimming, especially in large-scale surveys. The objective of weight trimming is to lower the sampling variability and reduce the mean square error of the key outcome estimates. The general guideline for weight trimming is to eliminate weights that are greater than the median weight plus six times the interquartile range of the entire set of weights (Battaglia et al., 2009). In this analysis, no weight was removed from the final weighting results based on this weight trimming guideline.

### 2.3.2 Weighting Evaluation

As previously mentioned, household demographics were found to be correlated with hearth product ownership in the reference sample. The raking weighting procedure was applied to adjust

the demographic biases inherited in the raw survey data to be representative of the general population of hearth product owners.

Table 2.5 shows a comparison of the demographics distribution found in the raw survey data, the final weighted survey data, and the RECS 2009 data related to hearth product users.

**Table 2.5: Demographic Comparison between Raw and Weighted Data**

Demographics	2009 RECS data - Hearth Product Households (%)	Hearth Products Survey	
		Unweighted (%)	Weighted (%)
<b>Division</b>			
New England	1.72	4.38	1.72
Middle Atlantic	10.44	13.85	10.44
East North Central	12.77	17.41	12.77
West North Central	9.07	4.98	9.07
South Atlantic	26.84	21.69	26.84
East South Central	6.43	5.25	6.43
West South Central	10.28	8.22	10.29
Mountain North	4.28	4.27	4.28
Mountain South	3.19	3.35	3.19
Pacific	14.97	16.60	14.97
<b>Number of Occupants</b>			
1	14.39	8.18	14.39
2	40.26	30.62	40.25
3	15.80	25.42	15.80
4	18.00	21.68	18.00
5	8.60	9.16	8.60
6+	2.95	4.93	2.95

<b>Race</b>			
White	84.23	83.32	84.23
Black	11.12	5.48	11.12
Asian	1.53	6.04	1.53
Other	3.12	5.15	3.12
<b>Distribution by Age*</b>			
Occupant at age <20	40.76	44.94	40.76
Occupant at age 20s	16.93	50.24	16.92
Occupant at age 30s-50s	73.14	76.20	73.14
Occupant at age 60+	33.38	14.06	33.37
<b>Education Level</b>			
No schooling completed + Kindergarten to grade 12	3.26	0.38	3.26
High school diploma or GED	19.32	6.75	19.31
Some college, no degree	20.26	24.37	20.26
Associate's degree	8.49	11.32	8.49
Bachelor's degree	29.57	40.48	29.57
Master's degree	14.18	13.49	14.18
Professional degree + Doctorate	4.92	3.21	4.92
<b>Household Annual Income</b>			
\$0-\$19,000	4.65	5.31	4.65



\$20,000-\$39,000	13.94	16.22	13.94
\$40,000-\$59,000	15.65	20.97	15.65
\$60,000-\$79,000	15.34	19.50	15.34
\$80,000-\$99,000	13.30%	14.19%	13.30%
\$100,000+	37.12%	23.80%	37.11%
<b>Gender</b>			
Female	52.07%	46.26%	52.07%
Male	47.93%	53.74%	47.93%

\*Age Distribution should be interpreted as the proportion of households having occupants at age of each specified range.

As shown in Table 2.5, the weighted distribution across all demographics is closely aligned with the population distribution observed in RECS. This outcome is consistent with our expectation that the raking method would effectively reduce the demographic biases observed in the raw survey data. The Pearson’s chi-square test statistically compares the distribution of each demographic variable between the weighted AMT survey and the reference sample (RECS), and the result suggests that the distribution of proportion in the weighted AMT survey is not significantly different from that in the RECS reference sample across all demographic variables, with a 95% confidence level.

### 2.3.3 Determination of Hearth Product Type

The hearth product types of interest in this study are stoves, outdoor units, and fireplaces and gas log sets. The hearth product type is determined primarily in question 2, which asks about the installation. Freestanding units were determined to be stoves. Outdoor units were identified as being installed outdoors. Fireplaces and gas log sets were disaggregated as those that answered “It is located indoor and installed within the hearth, or in the wall.” to question 2. This study does not further delineate between fireplaces and gas log sets.

### 2.3.4 Determination of Main Burner Operating Hours

The hearth product operating hours were determined for both the heating<sup>19</sup> and non-heating<sup>20</sup> season. This was done by establishing a frequency of use in questions 20 (heating season) and 21 (non-heating season) and establishing average time per use in question 22. It is important to disaggregate between the heating and non-heating season, because most hearth products are used at least partially for heating. Table 2.6 shows how the responses for question 20-22 were applied to calculate the operating hours. Finally, state-level monthly weather data from the National Oceanic and Atmospheric Administration (NOAA) was applied to calculate the length of the heating and non-heating season in each location and applied to generate final operating hour results. Months were identified as being in the heating season if the 10-year average of heating degree days (HDD) measured by NOAA stations in that state was more than 115. If the equivalent cooling degree days (CDD) were more than 115, the month was identified as being in the cooling season. Months with less than 115 HDD or CDD were designated as shoulder months. All of the days in a month identified as heating or non-heating were attributed to that season, and shoulder months were split evenly. Note that this methodology is only applied to users who reported their hearth product usage; users who selected “I don’t know” or “My thermostat controls my hearth product” were not analyzed.

**Table 2.6 Operating Hour Application**

<b>Response</b>	<b>Application</b>
<b>Questions 20 and 21</b>	
5 times or less	2.5 uses per season
A few times a month	2 uses per month
About once or twice a week	4.5 uses per month
More than twice a week	9 uses per month
Every day	30 uses per month
<b>Question 22</b>	
1 hour or less per day	0.5 hours

<sup>19</sup> Definition from survey: The heating season refers to the months that typically are cold enough that heating appliances such as furnaces are typically used. For example, in Atlanta, Georgia this corresponds to the end of October through April.

<sup>20</sup> Definition from survey: The non-heating season refers to the months when no space heating is typically used. For example, in Atlanta, Georgia this corresponds to May through the beginning of October.

More than 1 hour per use, up to 2 hours per use	1.5 hours
More than 2 hours per use, up to 4 hours per use	3 hours
More than 4 hours per use, up to 6 hours per use	5 hours
More than 6 hours per use, up to 12 hours per use	9 hours
More than 12 hours per use	12 hours

### 2.3.5 Estimation of Standing Pilot Operating Hours

The hearth product standing pilot operating hours were determined as per Equation 1. The length of the heating season and non-heating season was determined from NOAA data as previously described in section 2.3.4. Note that the operating hours of the main burner are subtracted from the pilot hours. Although the pilot is typically on during main burner operation, generally these units are rated during active mode with the pilot on; to avoid over-counting AEU, this pilot use is not counted. There is an overshoot of one hour for each cycle of the hearth product applied if the pilot is not left on continuously. This accounts for pilot use of users who generally closely monitor their pilot lights and their use in the non-heating season for users who turn their pilots off in that season. For users in this study who generally closely monitor their pilots, the effect of this overshoot is approximately equivalent to leaving the pilot on for 1 day once a year. This is also a common setting for on-demand units. Based on user responses,  $OH_{MB,HS}$ ,  $OH_{MB,NS}$ ,  $OH_{SP,HS}$ ,  $OH_{SP,NHS}$ , and HPU were estimated.

$$OH_{SP} = OH_{SP,HS} + OH_{SP,NS} - OH_{MB} + \frac{OH_{MB,HS} + OH_{MB,NS}}{HPU} * H_{HS,NS} \quad \text{Eqn. 1}$$

Where:

$OH_{SP}$  = Standing Pilot Annual Operating Hours;

$OH_{SP,HS}$  = Standing Pilot Operating Hours in the heating season, dependent on weather and assigned based on user answer to question 25<sup>21</sup>;

<sup>21</sup> Hours assigned if user answered: "The pilot light is always on", "In the summer I turn off the pilot light", or "I don't adjust my pilot light" and had a pilot light.

$OH_{SP,NS}$  = Standing Pilot Operating Hours in the non-heating season, dependent on weather and assigned based on response to question 25<sup>22</sup>;

$OH_{MB,HS}$  = Annual Main Burner Operating Hours in the heating season as estimated via process described in section 2.3.4;

$OH_{MB,NS}$  = Annual Main Burner Operating Hours in the non-heating season as estimated via process described in section 2.3.4;

HPU = Main burner operating hours per use as reported by user in question 22 and interpreted as per section 2.3.4; and

$H_{HS,NS}$  = Additional standing pilot hours used per main burner use; value assumed equal to 1.

### 2.3.6 Determination of Ignition System Type

As mentioned in section 1.2, the ignition system types of interest are: standing pilot, where the pilot is always on; intermittent pilot, where the pilot is turned on when there is a call for heat; and match lit, where there is no pilot. The hearth product ignition system was determined in questions 5 and 6 for users with gas hearth products, which was determined by selecting “Natural Gas” or “LPG” in question 4. The following lists the various combination of responses and how the ignition system is categorized:

- Respondents who answered “*Yes, I have used a match or lighter to light my hearth product's main burner.*” to question 5 were determined to have match-lit hearth products.
- Respondents who answered “*Yes, I have used a match or lighter to light my hearth product's pilot light.*” to question 5 were determined to have standing pilot hearth products.
- Respondents who indicated *they do not use matches* in question 5 but selected “*Yes, my hearth product has a 'pilot' button, 'pilot' switch, or 'pilot' knob used to start the pilot light.*” for question 6 were also selected as having standing pilots.
- Finally, respondents who selected “*No, my hearth product does not have a 'pilot' button, 'pilot' switch, or 'pilot' knob.*” were determined to have intermittent pilots.
- In addition, because users typically do not interact directly with their intermittent pilots, respondents who *did not use matches* but *did not know how their pilot unit was started* were also determined to have intermittent pilots.

### 2.3.7 Estimation of energy use

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<sup>22</sup> Hours assigned if user answered: “The pilot light is always on” or “I don't adjust my pilot light” and had a pilot light.

The hearth product main burner or standing pilot AEU is determined by applying the operating hours as determined per the process in section 2.3.4 or 2.3.5, respectively, to the input capacity of the component being analyzed. The most comprehensive data sources that this study has identified with respect to United States hearth products are published in DOE TSD 2015. The average values of the standing pilot and main burner input capacity from this source are listed in Table 2.7, along with the values used in this study for energy use estimation. The values shown at the bottom of Table 2.7 that were chosen for this analysis are similar to those from DOE TSD 2015, but differ to reflect the slightly different hearth product grouping in this study. A single value for each category was deemed appropriate, because the energy use estimations are only performed on the entire hearth product population or large sub-groups of it. More precise household level energy use calculations are not a focus and are outside of the scope of this study.

**Table 2.7 Hearth Product Standing Pilot and Main Burner Input Capacities**

		Average Input Capacity (kBTU/hr)	
		Standing Pilot*	Main Burner
<b>DOE TSD 2015</b>			
Vented	Fireplace/Inserts/Stoves	1.0	35
	Log Sets	0.7	35
Unvented	Fireplace/Inserts/Stoves	1.2	30
	Log Sets	0.8	25
N/A	Outdoor Units	1.0	50
<b>Values used in this study</b>			
All Vented Units		1.0	35
All Unvented Units		1.2	30
Outdoor		1.0	50

\*Additionally, GRI 1997 reported that the pilot usage was approximately 0.35 - 2.83 kbtu/hr.

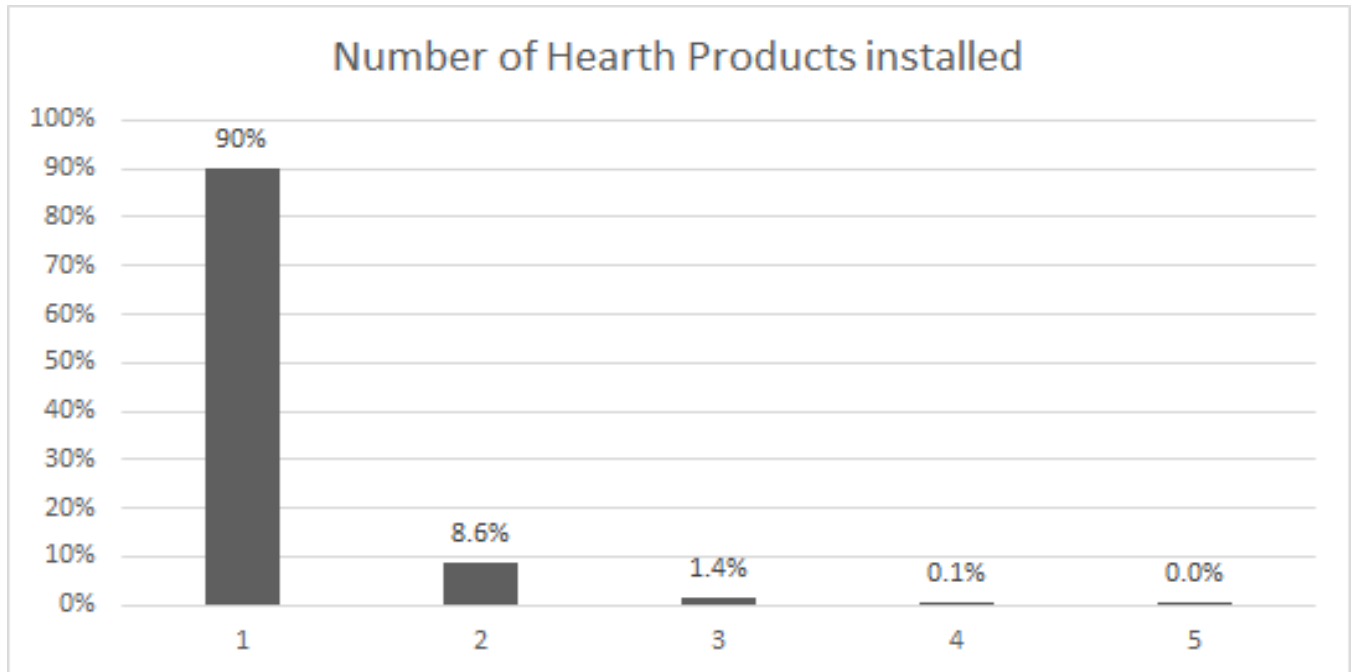
## 3 Results

This section presents the results from this survey. The results are presented according to the survey questions structure: section 3.1 presents the hearth product characteristics, section 3.2 presents hearth product usage, and section 3.3 presents the repair and maintenance results. Each figure includes footnotes detailing the survey question or questions which the data comes from as well as the number of applicable respondents. Results are presented here with minimal interpretation; section 4 of this report provides further analysis of these results.

### 3.1 Hearth Product Characteristics

Determining the specific characteristics of the hearth product or products the survey responder has is essential to interpreting the responses for use in further analysis. There is significant variation in hearth product types and technologies, so usage, maintenance and repair, or other data are most relevant in that specific context. In addition, specifics about the user household, such as geographic location, can greatly affect energy use. Finally, the aggregate characteristics are both useful data and can be more readily compared to data from other sources.

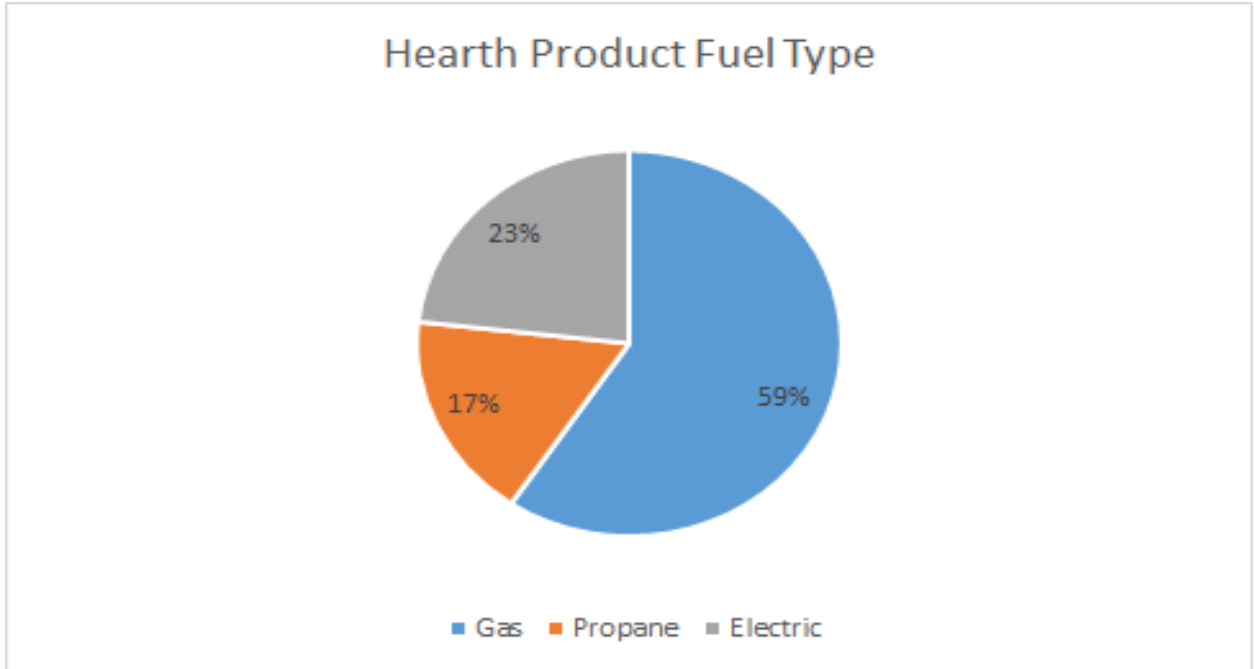
Figure 3.1 shows the number of hearth products respondents reported installed in households where at least one hearth product was installed. Of these households, 90% reported having only one hearth product, 8.6% reported having two hearth products, and 1.5% reported having three or more.



**Figure 3.1 Number of Hearth Products Installed<sup>23</sup>**

Figure 3.2 shows the breakdown of hearth products by fuel type, with 59% of units using natural gas, 23% electricity, and 17% propane. Note that only gas, propane (liquified propane gas or LPG), and electric appliances were included. This study does not take into account wood, coal, or other fuel types. For comparison, in HPBA 2016 the ratio of gas to electric is approximately 3.1, and here (including gas and propane) it is approximately 3.3. Without more details it is impossible to know how comparable the numbers are, but they seem in relative agreement.

<sup>23</sup> Based on survey Question 1, Number of Respondents = 1563

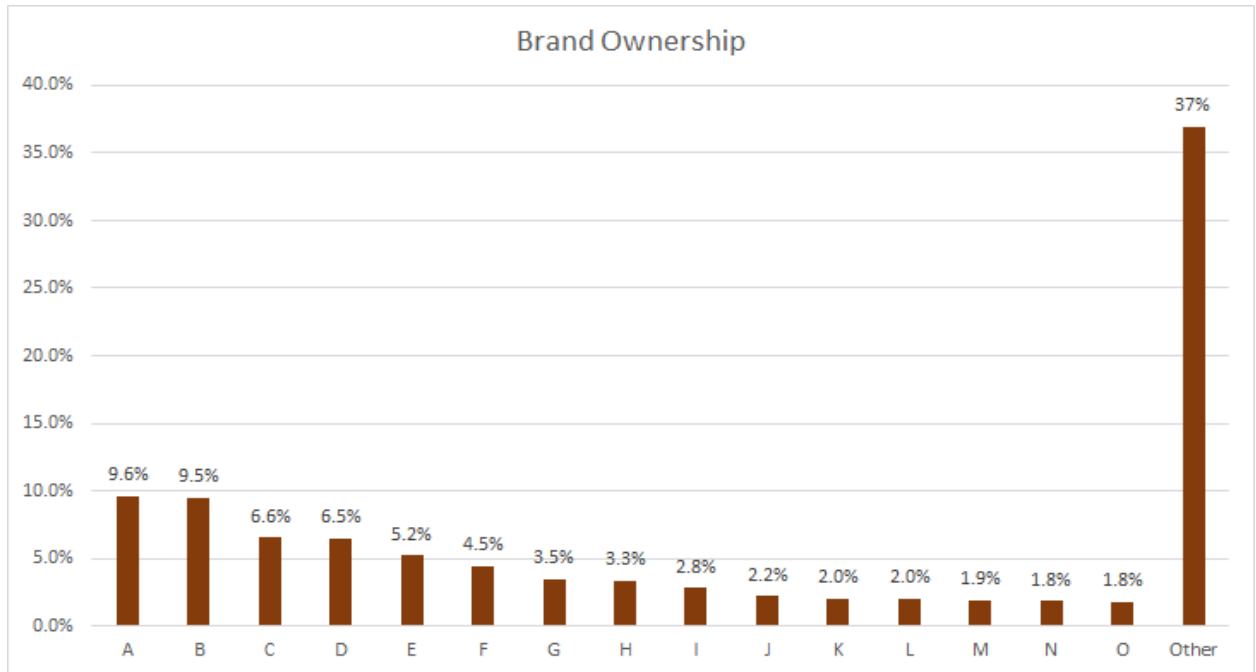


**Figure 3.2 Hearth Product by Fuel Type<sup>24</sup>**

Figure 3.3 depicts the distribution of hearth products by brand. In this chart, the brand names have been removed from the chart to keep the study brand-neutral. In total, 181 brands were represented in the survey. The distribution of these responses was fairly diffuse with the 15 most selected brands representing 63% of the total, and the remaining 37% of respondents selecting one of the remaining 166. There were a total of 750 respondents who answered the brand question, which represents 48% of all survey respondents. The other 52%, or 813 respondents, either selected “I don’t know” or chose not to answer this question. There is a relatively large fraction of non-respondents for this question. One explanation for this is that many respondents may not have been able to easily identify their hearth products’ brand because hearth product branding tends to be more subtle, and often brand names are not prominently displayed. The five brands most often selected by respondents were each used by more than 5% of the population, and cumulatively they accounted for 37% of the hearth products reported overall.

<sup>24</sup> Based on survey Question 4, Number of Respondents = 1502

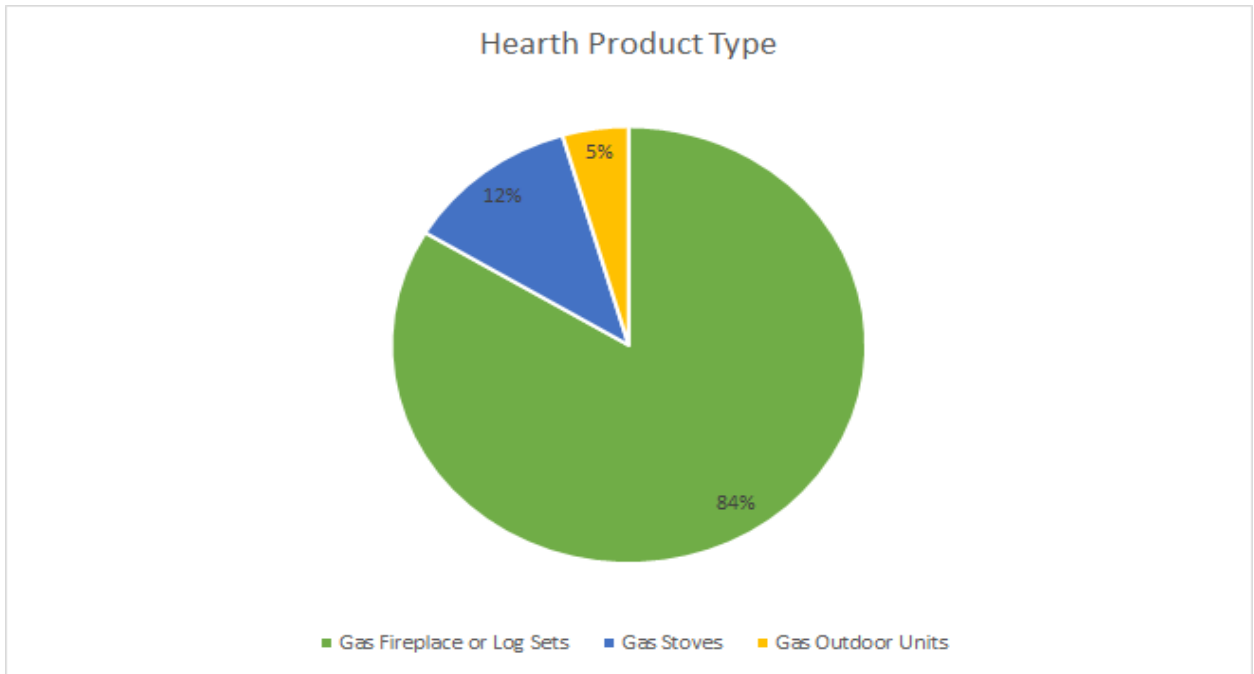




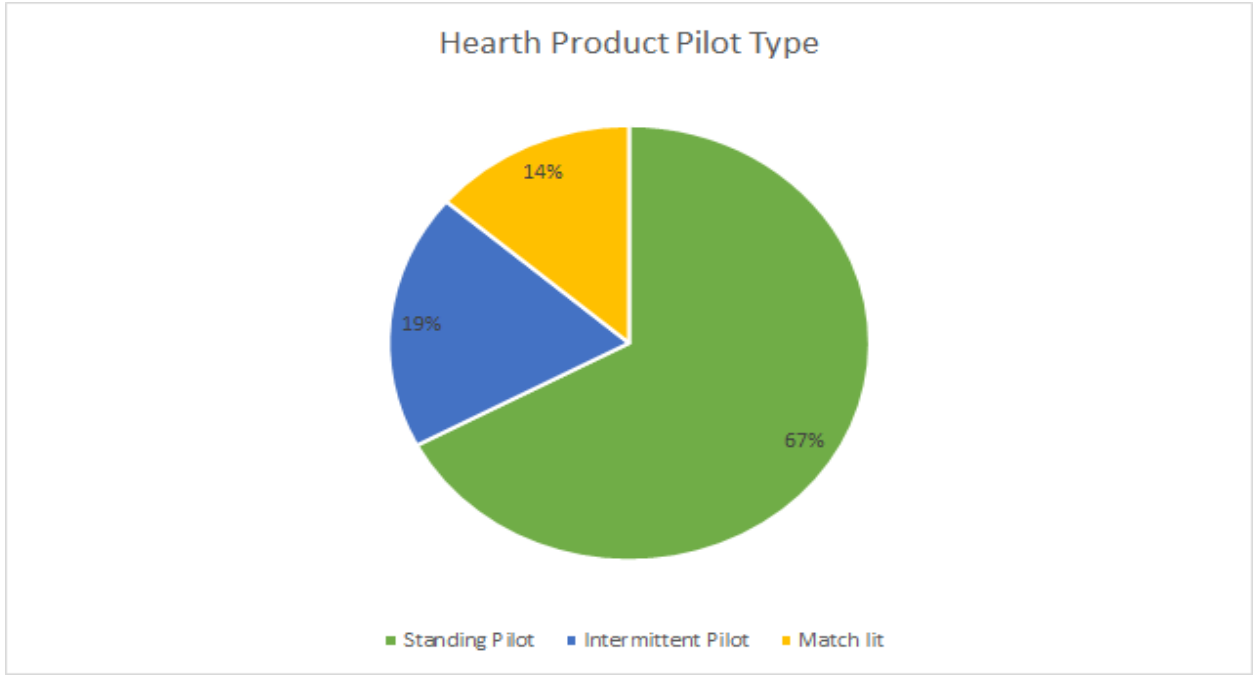
**Figure 3.3 Brand Ownership in Hearth Products<sup>25</sup>**

Figures 3.4 through 3.6 show the reported hearth product type, pilot type, and venting type for gas units. Electric units are excluded from this portion as they do not have pilots or venting and currently are not considered to have different hearth types. Approximately 84% of gas hearth products are fireplaces and gas log sets, while 12% are stoves and 5% are outdoor units. 67% reported have a standing pilot, 19% an intermittent pilot, and 14% match lit. Finally, 69% are vented units, while 31% are unvented.

<sup>25</sup> Based on survey Questions 17 and 18, Number of Respondents = 750



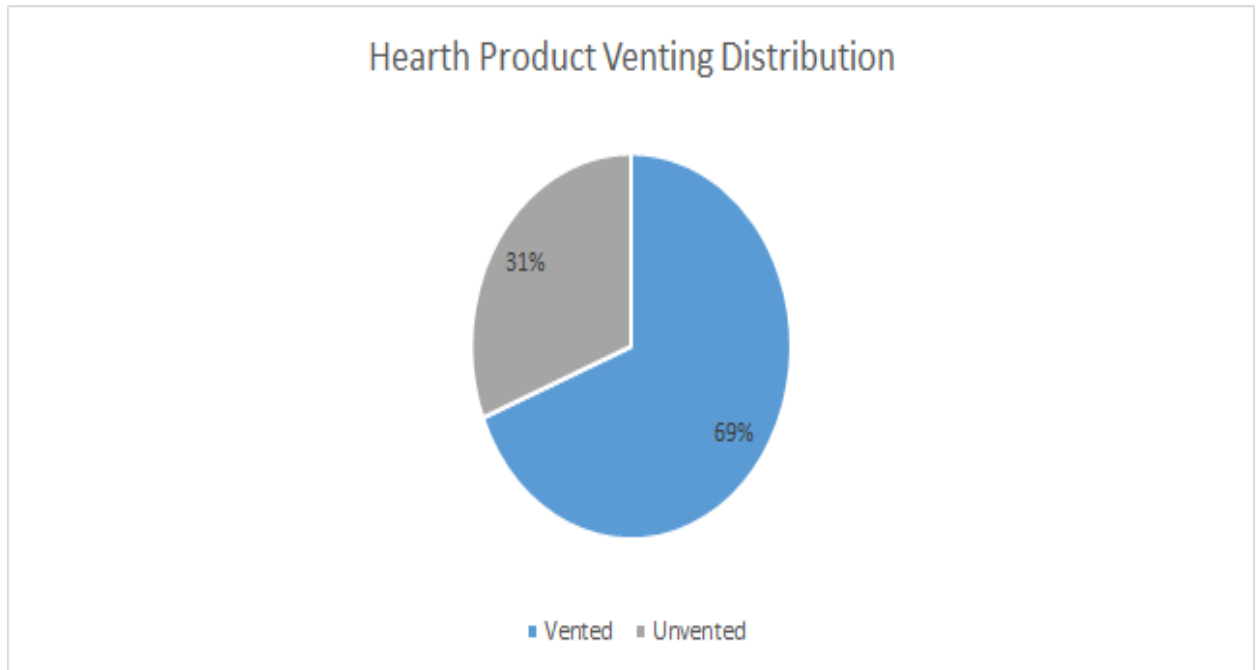
**Figure 3.4 Hearth Product Type<sup>26</sup>**



**Figure 3.5 Hearth Product Ignition System<sup>27</sup>**

<sup>26</sup> Based on survey Questions 2,3, and 4, Number of Respondents =1563

<sup>27</sup> Based on survey Questions 4, 5, and 6, Number of Respondents = 1229



**Figure 3.6 Hearth Product Venting Distribution<sup>28</sup>**

Figure 3.7 shows the hearth product features identified by the survey. The features included in the question were:

**Remote control:** the hearth product can be controlled remotely;

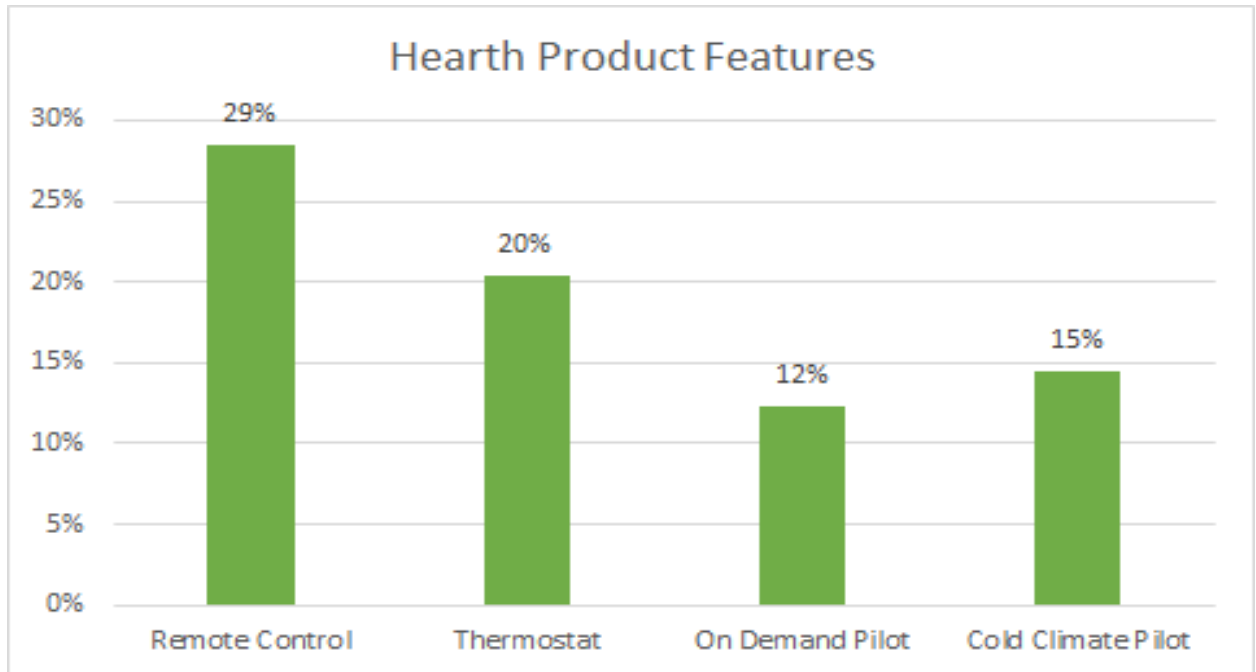
**Thermostat:** the hearth product is connected to a thermostat for the purpose of maintaining a set temperature;

**On-demand pilot:** a standing pilot that can be set to turn off automatically after a set amount of time; and

**Cold climate pilot:** intermittent pilots with the option to convert to standing pilots, intended for use in cold climates.

Approximately 29% of users reported their hearth product having a remote control, while 20%, 12%, and 15% of users reported their hearth product having thermostat connectivity, on-demand pilots, or cold climate pilots, respectively.

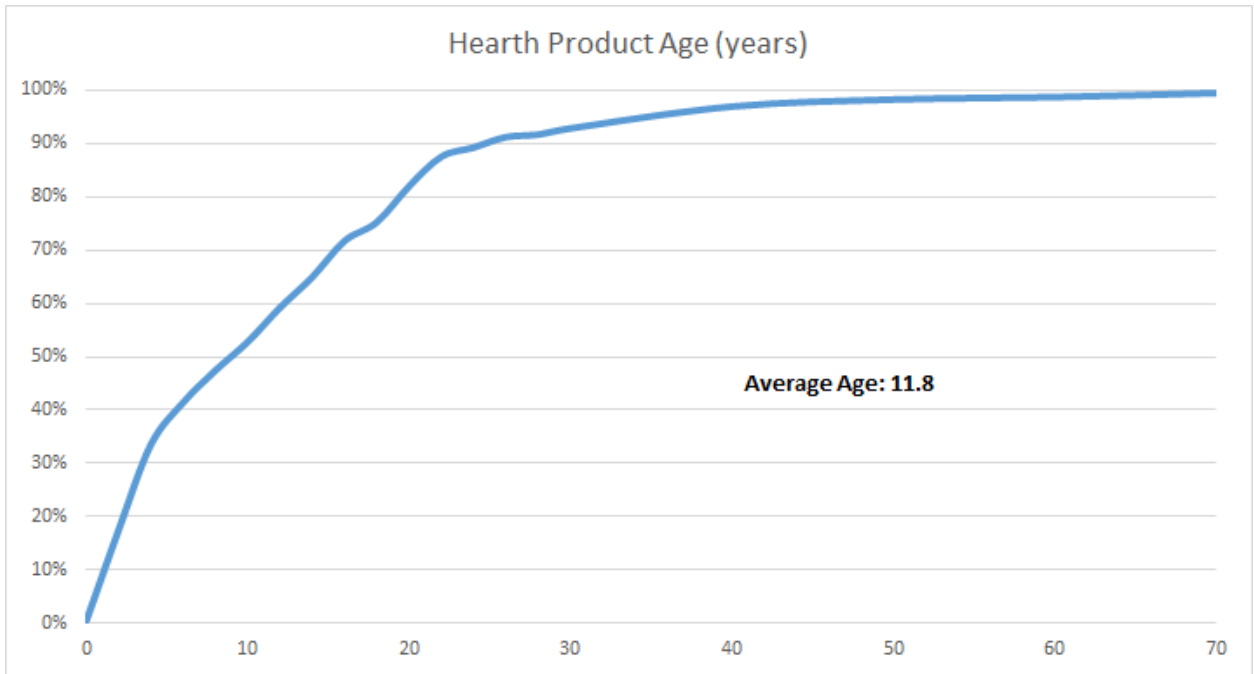
<sup>28</sup> Based on survey Questions 4 and 7, Number of Respondents = 1042



**Figure 3.7 Hearth Product Features<sup>29</sup>**

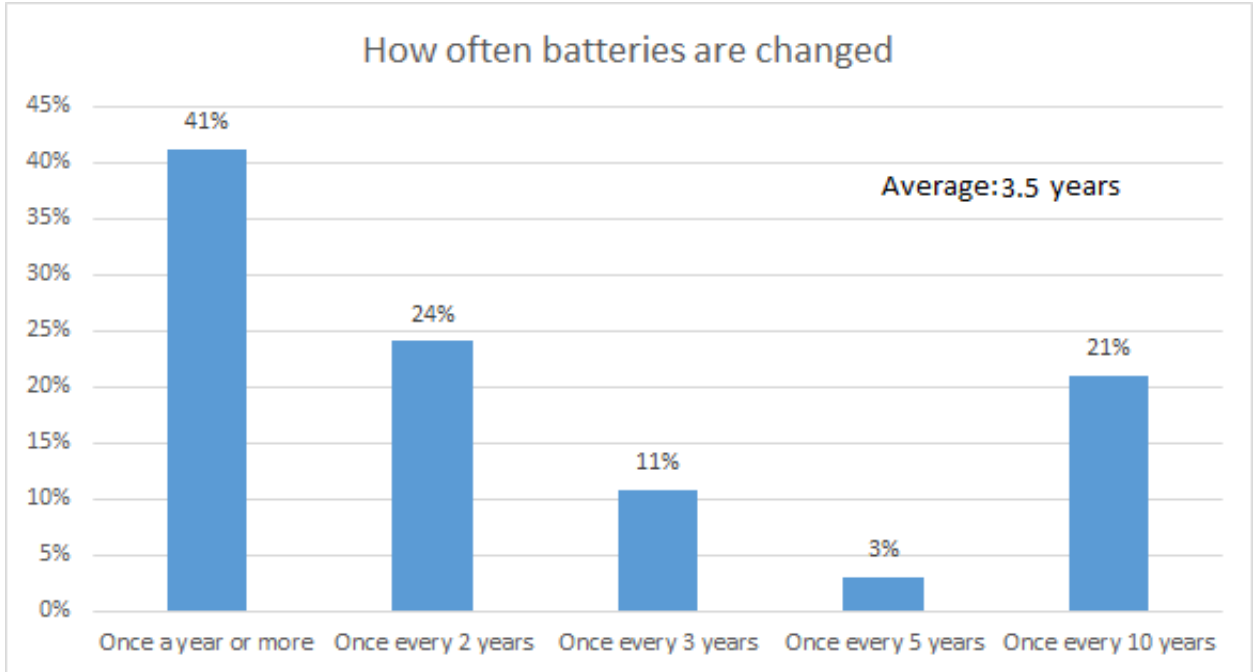
Figure 3.8 shows the reported hearth product age. The figure shows a cumulative distribution of the reported hearth product ages. For example, users in the 80th percentile—those who reported units older than 80% of other users as shown on the vertical axis—reported their units as approximately 20 years old as shown on the horizontal axis. The average reported age was 11.8 years.

<sup>29</sup> Based on survey Questions 4 and 10, Number of Respondents =1465



**Figure 3.8 Hearth Product Age<sup>30</sup>**

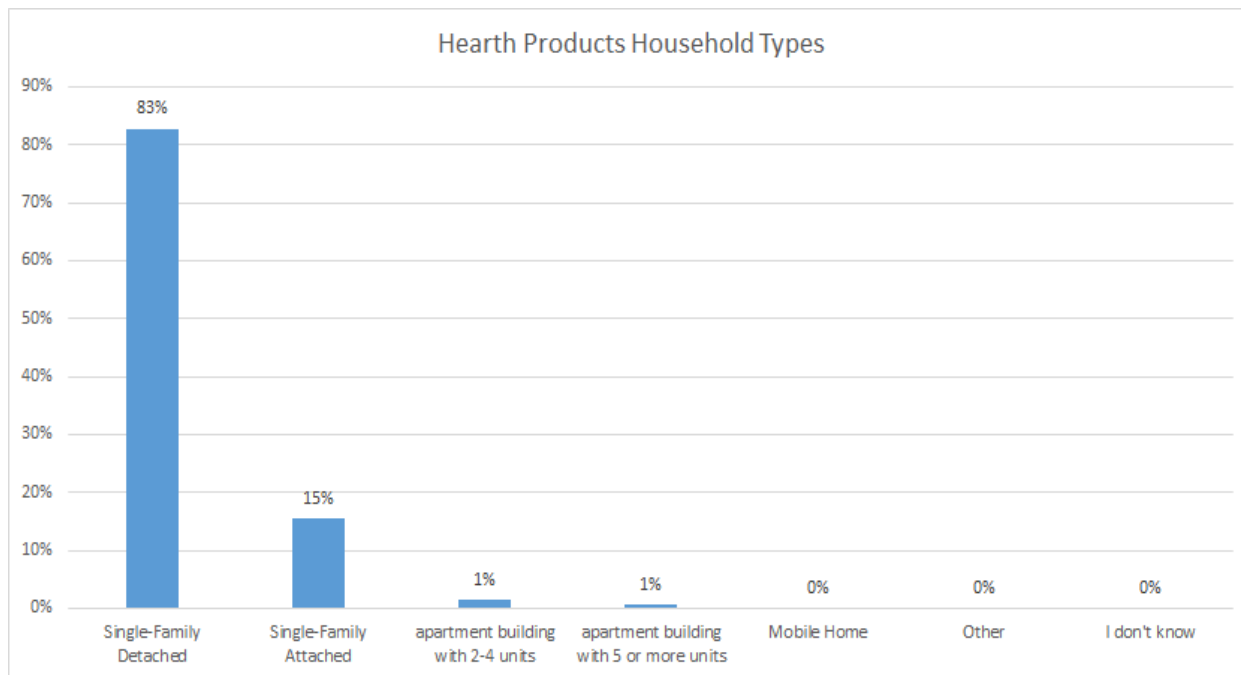
Figure 3.9 shows how often hearth product users reported changing their batteries. As indicated on the chart, the average time is 3.5 years. These responses do not include the 90% of users who indicated that their hearth product does not use batteries. Of these, 43% are plugged in, indicating another source of electricity is present, and 57% are not plugged in.



<sup>30</sup> Based on survey Question 16, Number of Respondents = 1281

### Figure 3.9 Hearth Battery Usage<sup>31</sup>

Figure 3.10 shows the household type. The majority of hearth products are installed in single-family detached homes, and approximately 98% are in single-family homes of all types. In apartments and mobile homes there were more reported stoves than the general population, as 33% of hearth products in these homes were stoves, compared to 12% overall.

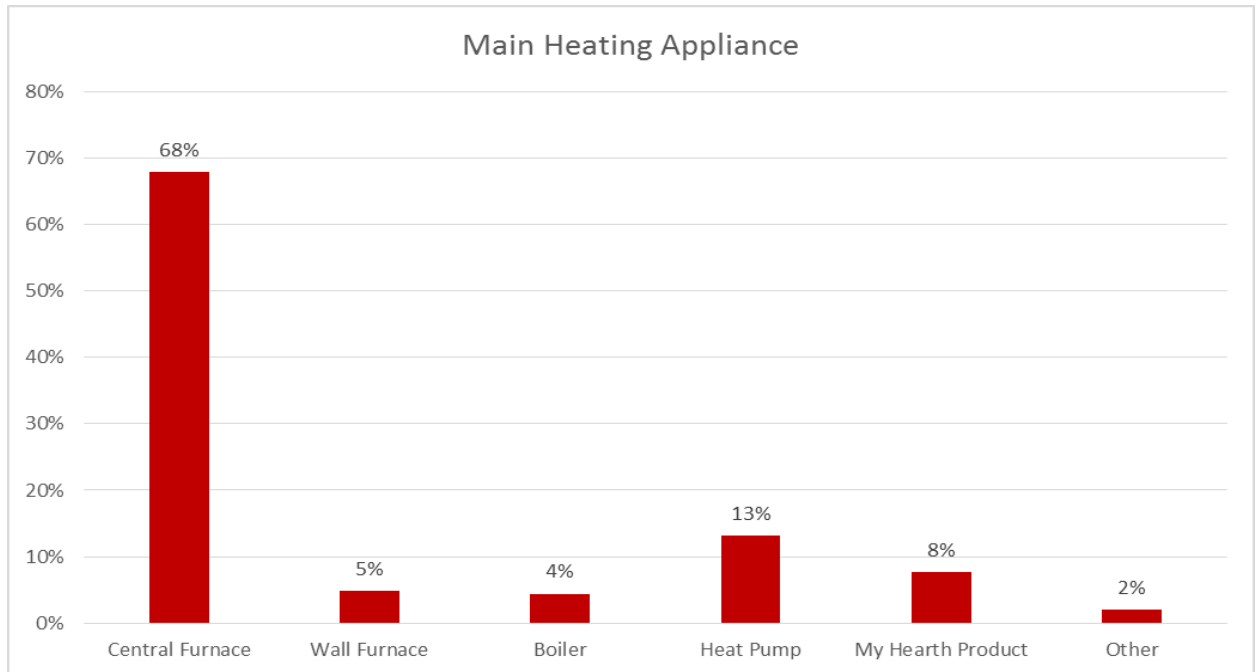


### Figure 3.10 Hearth Product Household Type<sup>32</sup>

Figure 3.11 shows the reported main heating appliance in hearth product installations. The main heating appliance is described as the primary appliance used for heating, such as a central furnace. Most households—68%—have a central furnace as the main heating appliance, and this response makes up the largest category. In other responses, 5% state they have a wall furnace, 4% have a boiler, 13% have a heat pump, 2% have some other appliance, and the remaining 8% use their hearth product as their main heating appliance.

<sup>31</sup> Based on survey Question 9, Number of Respondents = 1481

<sup>32</sup> Based on survey Questions 46, Number of Respondents = 1563



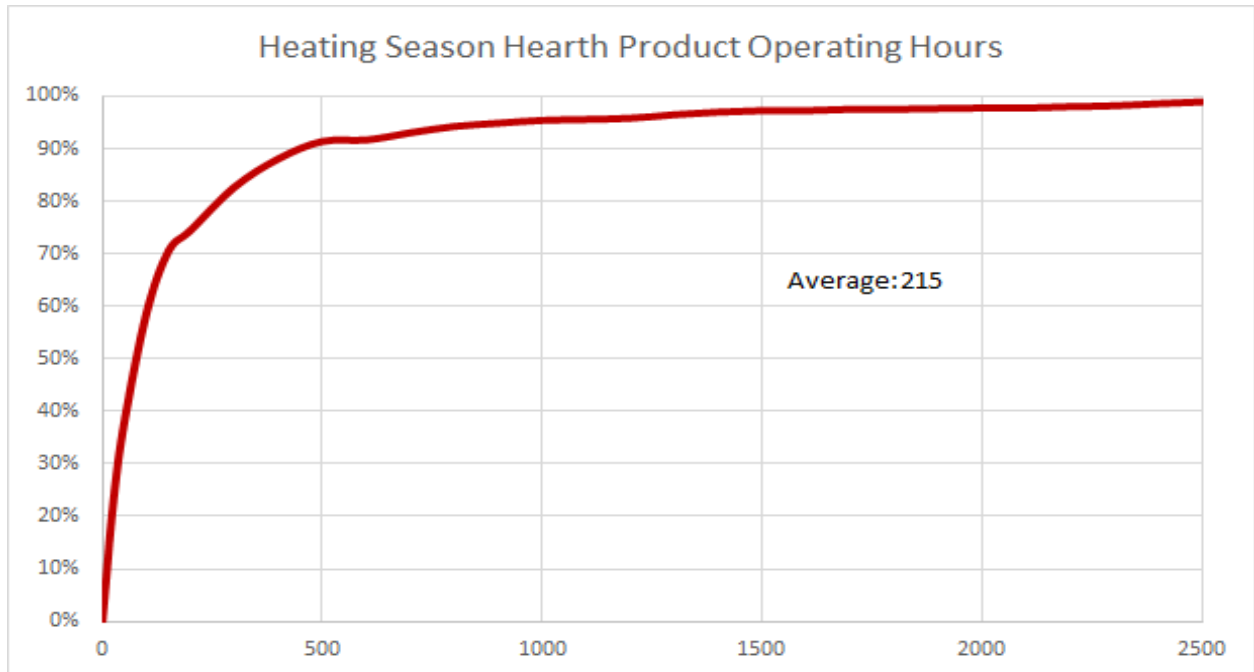
**Figure 3.11 Main Heating Appliance<sup>33</sup>**

## 3.2 Hearth Product Usage

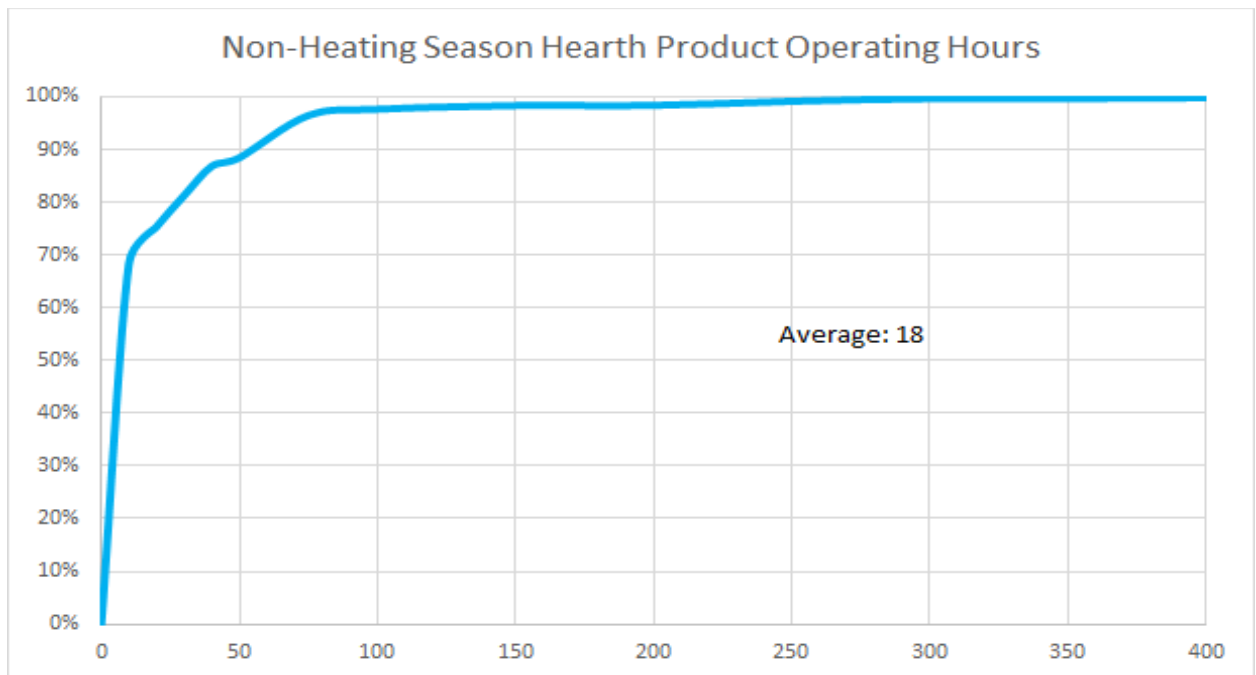
This section presents the results from the household usage portion of the survey. Figures 3.12 and 3.13 show the distribution of respondents' hearth product operating hours in both the heating season and non-heating season as estimated primarily from responses to questions 20, 21, and 22 using the method described in section 2.3.4. In each chart the percentile of the population is shown on the vertical axis and the corresponding operating hours are shown below in the horizontal axis. The average operating hours is also displayed on the chart. Both figures show an approximately Pareto shaped distribution, with 74% and 98% of users using their hearth product for less than 200 hours in the heating and non-heating season, respectively. In the heating season 3% of users reported using their hearth product more than 1,400 hours, and no users reported using their hearth product more than 300 hours in the non-heating season.

The results show that hearth product users tend to use their hearth product more often in the heating season than in the rest of the year. This may highlight hearth products' utility as a heating appliance. These results could also be used to provide insight into the portion of hearth product use that is attributed to heating and the portion that is for decorative purposes.

<sup>33</sup> Based on survey Question 23, Number of Respondents = 1457. Note this question was only present on the general population survey, it was not present in the test survey.



**Figure 3.12** Hearth Product Heating Season Operating Hours<sup>34</sup>



**Figure 3.13** Hearth Product Non-heating season operating hours<sup>35</sup>

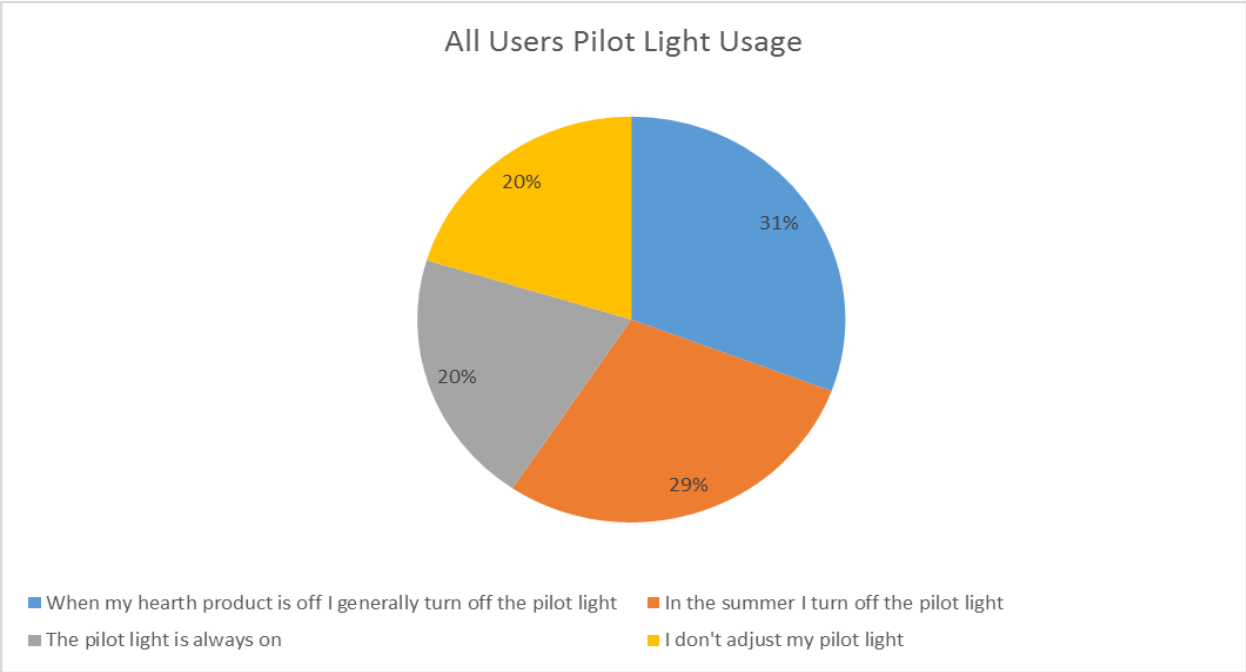
Figure 3.14 shows how respondents reported using their pilot light. Approximately 31% closely monitor their pilot light, and 29% turn off their pilots during the summer, whereas approximately

<sup>34</sup> Based on survey Questions 20, 22, and 37, Number of Respondents = 1531

<sup>35</sup> Based on survey Questions 21, 22, and 37, Number of Respondents = 1525

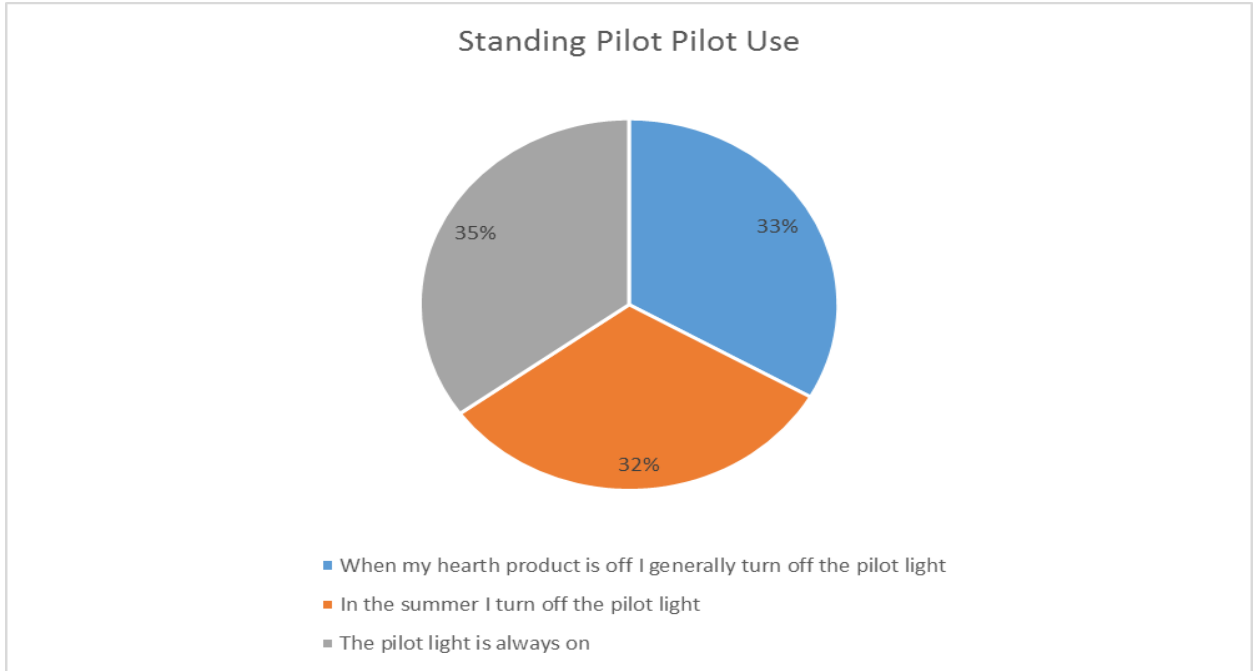


20% leave their pilot on for the entire winter and an additional 20% do not adjust their pilot light. Combining these, the results show that most users (60%) do interact with their pilot light in some way. Note that this analysis includes all users, so standing pilot users and intermittent pilot users with cold climate are included. Figure 3.15 shows a similar breakdown, but only for standing pilot users. In this figure those that indicated they leave their pilots on all year and those that indicated they do not adjust their pilot are combined under “The pilot light is always on”.



**Figure 3.14 Hearth Product Pilot Light Usage (All Users)<sup>36</sup>**

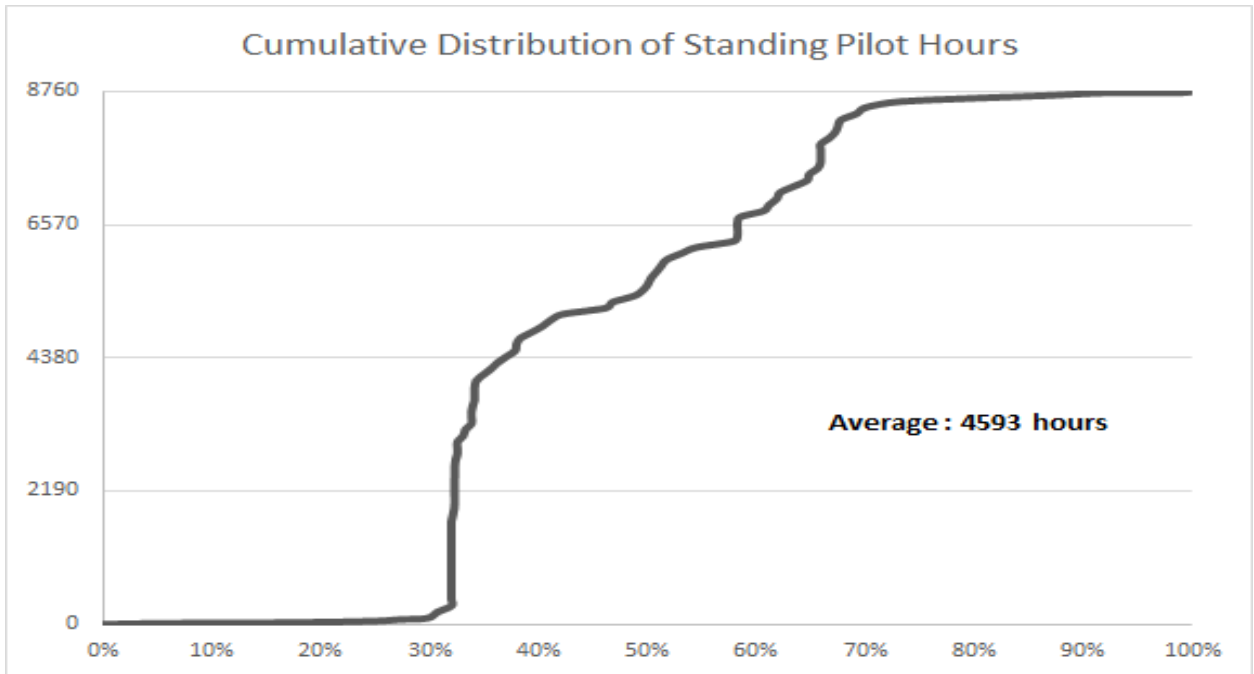
<sup>36</sup> Based on survey Questions 4 and 25, Number of Respondents = 1078



**Figure 3.15 Hearth Product Pilot Light Usage (Standing Pilot Users)<sup>37</sup>**

Figure 3.16 shows the cumulative distribution of standing pilot hours estimates calculated using primarily the responses to question 25 and applying the method in section 2.3.5. The vertical axis shows the estimated hours and the horizontal axis shows the corresponding user percentile. For example, users at the 60th percentile as shown by the 60% on the horizontal axis, who use their pilot light more than 60% of the population, are estimated to have approximately 6,700 standing pilot operating hours as shown on the vertical axis. Overall, this shows that there are three modes of approximately equal size: less than 100 hours, close to 8,760 hours, which is on for the entire year, and from 8,000 to 4,000 hours.

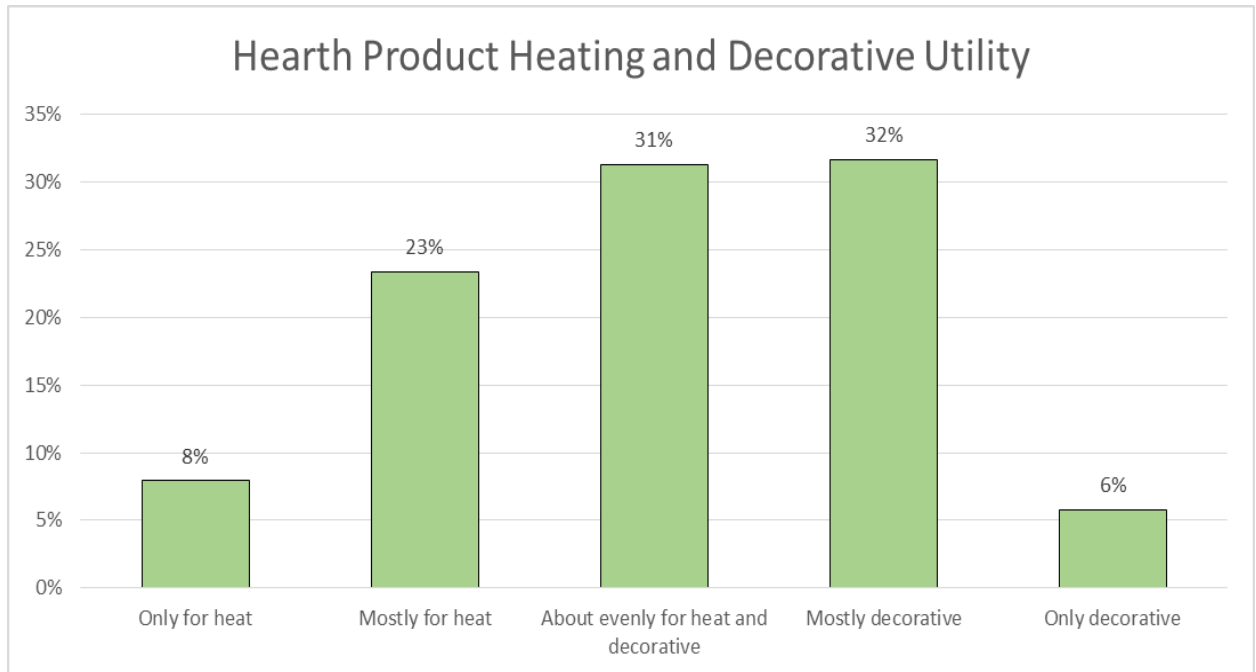
<sup>37</sup> Based on survey Questions 4, 5, 6 and 25, Number of Respondents = 752



**Figure 3.16 Hearth Product Pilot Light Usage (Standing Pilot Users)<sup>38</sup>**

Figure 3.17 shows how respondents reported the utility their hearth product provides. A total of 31% of people view their hearth product about evenly for heat and aesthetics, 32% view their hearth product as mostly decorative, 23% as mostly for heat, 8% as only for heat, and 6% as only decorative. The results show the majority of people, 86%, consider a hearth product some mix of heating and decorative, while 14% consider it either purely for heat or decorative.

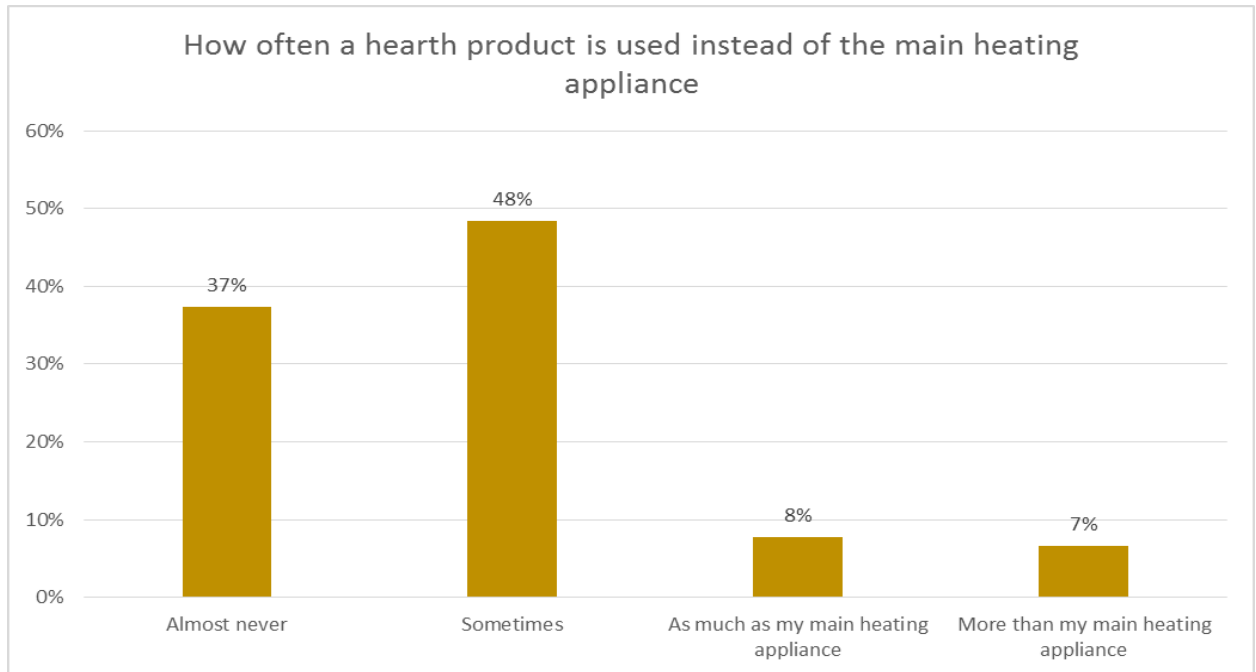
<sup>38</sup> Based on survey Questions 4, 5, 6, 25, and 37, Number of Respondents = 699



**Figure 3.17 Hearth Product Heating and Decorative Utility<sup>39</sup>**

Figure 3.18 shows how often users use their hearth product instead of their main heating appliance. Users whose hearth product is their main heating appliance are excluded from this figure; see Figure 3.11 for that value. The results show that 37% of users almost never use their hearth product instead of the main heating appliance, 48% sometimes use their hearth product instead of their main heating appliance, 8% use them equally, and 7% use their hearth product more than their main heating appliance.

<sup>39</sup> Based on survey Question 26 , Number of Respondents = 1554



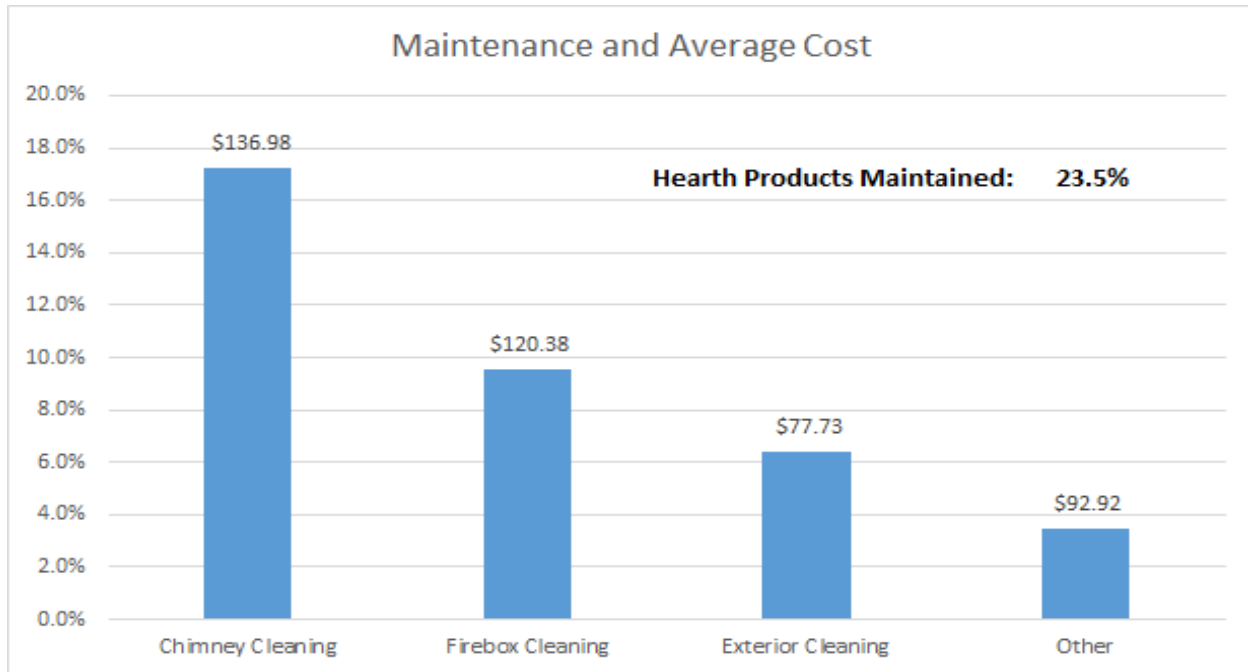
**Figure 3.18 Main heating appliance impact<sup>40</sup>**

### 3.3 Repair and Maintenance

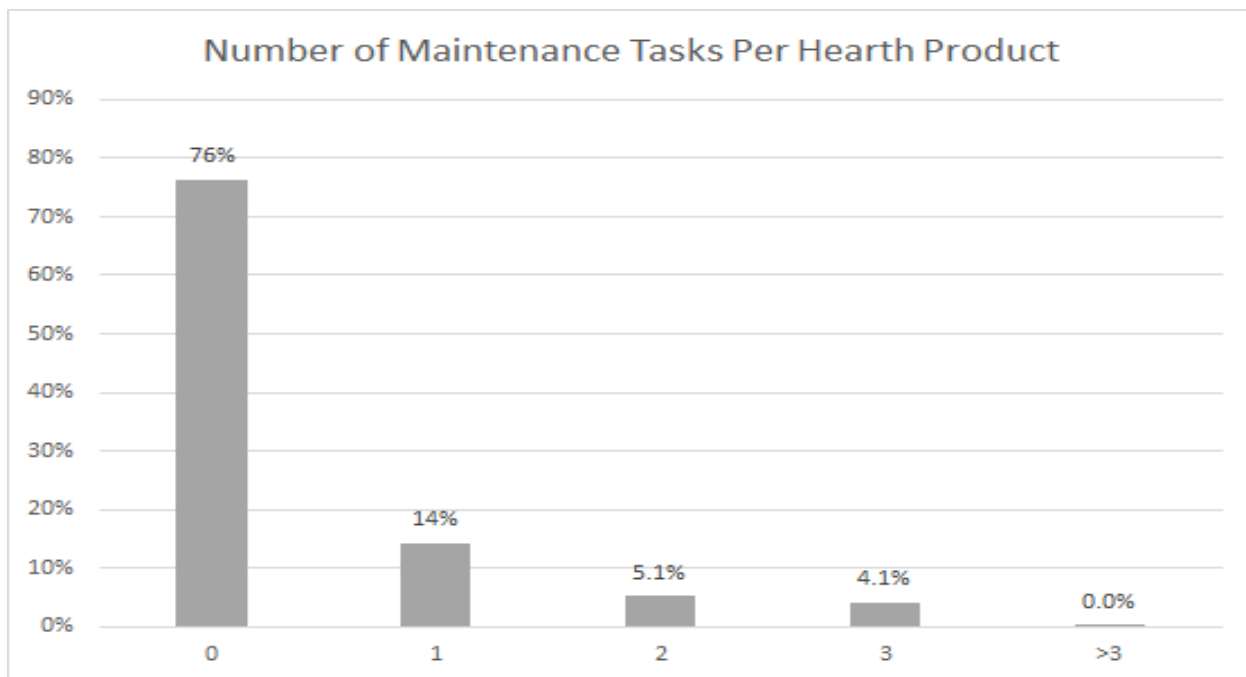
Figure 3.19 shows the average cost and frequency of each task as a percentage of all maintenance, as well as the fraction of users who have had any maintenance done. In this figure and Figure 3.21 the frequency is meant to indicate the fraction of responses indicated the task was performed at any point during the lifetime of the hearth product. Figure 3.20 shows the number of repair or maintenance tasks that respondents reported to have performed on their hearth product over its lifetime. The tasks shown in Figure 3.20 and in Figure 3.22 are derived by summing the tasks owners indicated they had performed in response to Questions 27-30 for maintenance and 31-34 for repair.

Figures 3.21 and 3.22 present the repair results. Figures 3.21 shows the average cost and frequency of each task as a percentage of all repair, as well as the fraction of users who have had any repair done. Figure 3.22 shows the number of repair or repair tasks that respondents reported to have performed on their hearth product over its lifetime.

<sup>40</sup> Based on survey Question 24 , Number of Respondents = 1425



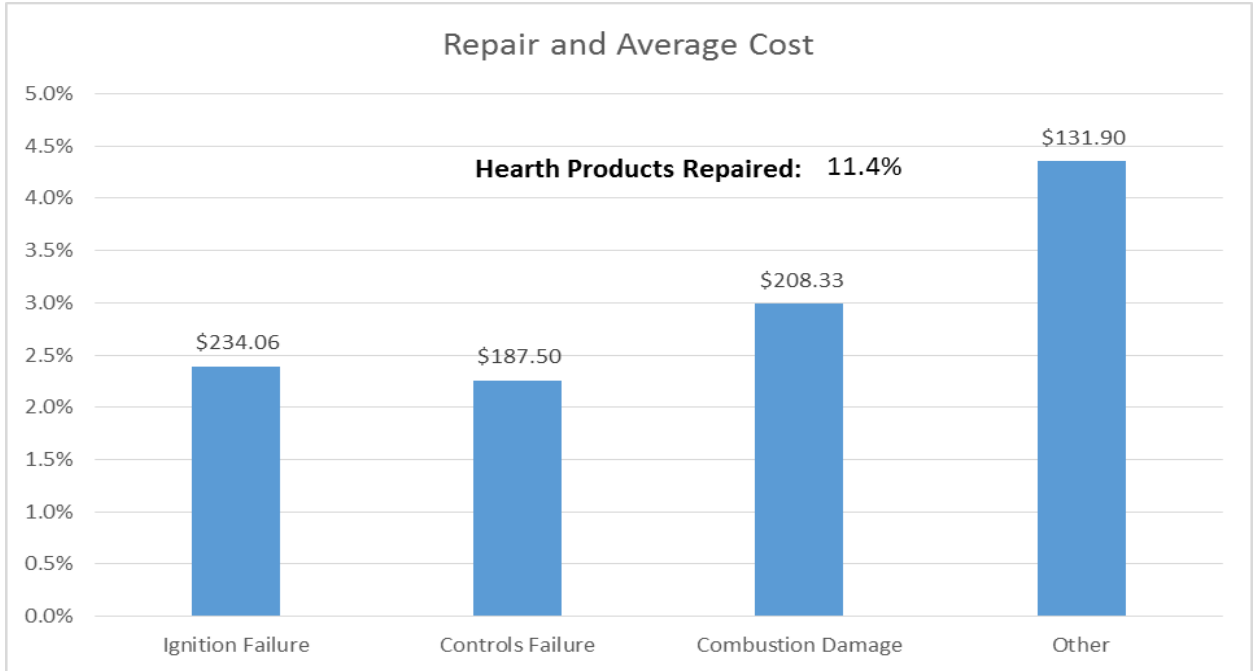
**Figure 3.19** Hearth Product Maintenance Task Frequency and Average Cost<sup>41</sup>



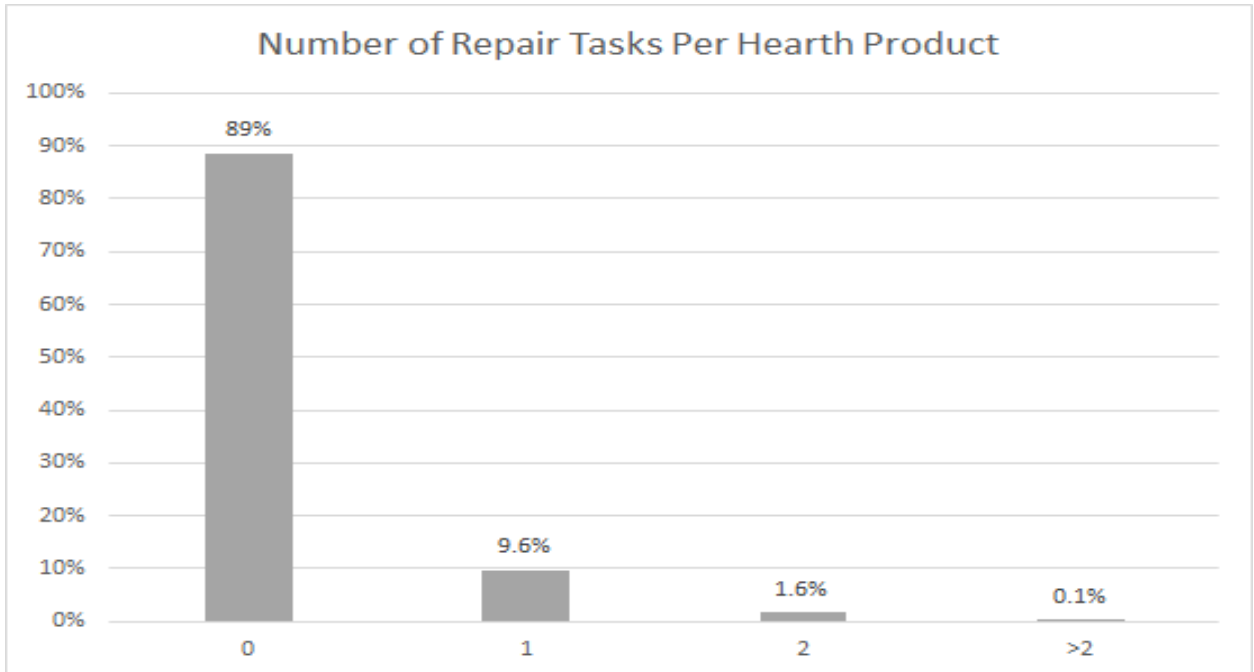
**Figure 3.20** Hearth Product Number of Maintenance Tasks per Hearth Product<sup>42</sup>

<sup>41</sup> Based on survey Questions 27, 28, 29, and 30

<sup>42</sup> Based on survey Questions 27, 28, 29, and 30



**Figure 3.21** Hearth Product Repair Task Frequency and Average Cost<sup>43</sup>



**Figure 3.22** Hearth Product Number of Repair Tasks<sup>44</sup>

<sup>43</sup> Based on survey Questions 31, 32, 33, and 34

<sup>44</sup> Based on survey Questions 31, 32, 33, and 34

## 4 Discussion

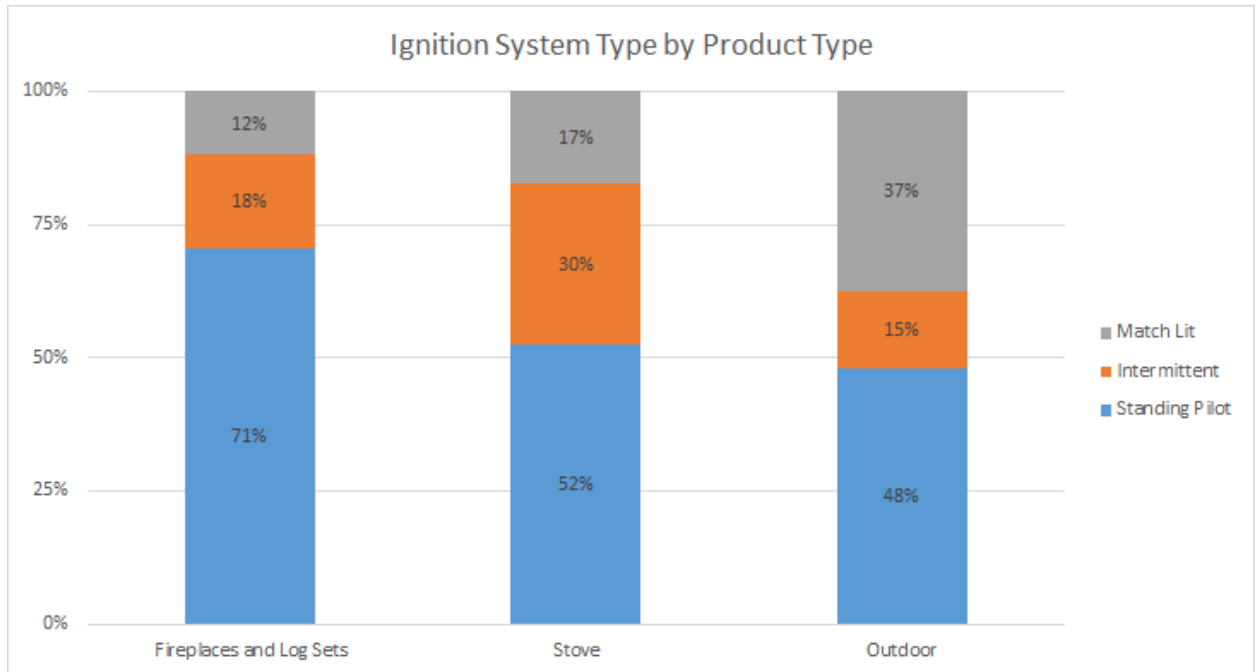
This section presents and discusses further analyses of the results presented in section 3 with a focus on the use of the pilot (ignition) system and energy use. This discussion also compares the key findings with those of other studies in the literature, such as RECS 2009, Houck 2010, Houck 2014, and the metering studies, Hayden 1996, GRI 1997, and ETO 2015. The first part of this section presents additional analyses of the results, and the second part discusses comparisons to other data sources.

### 4.1 Hearth Products Pilot (Ignition) System

#### 4.1.1 Hearth Pilot System Distribution by Hearth Products Type

Figure 4.1 shows the ignition system type for different hearth product types. Fireplaces and log sets show the largest fraction of standing pilots, 71%. While for this study fireplaces and gas log sets were not disaggregated, other sources, including HPBA 2013, DOE TSD 2015, and GRI 1997 indicate that pilot systems are less common on gas log sets and a large portion are match lit. It is therefore likely that a large portion of the 12% match lit as shown in the chart are gas log sets, but at this time it is not possible to disaggregate them. Outdoor units show a larger percentage of match lit units at 37%, as matches are more often used outside of the house. Also present is a larger portion of intermittent pilots for stove units at 30%.



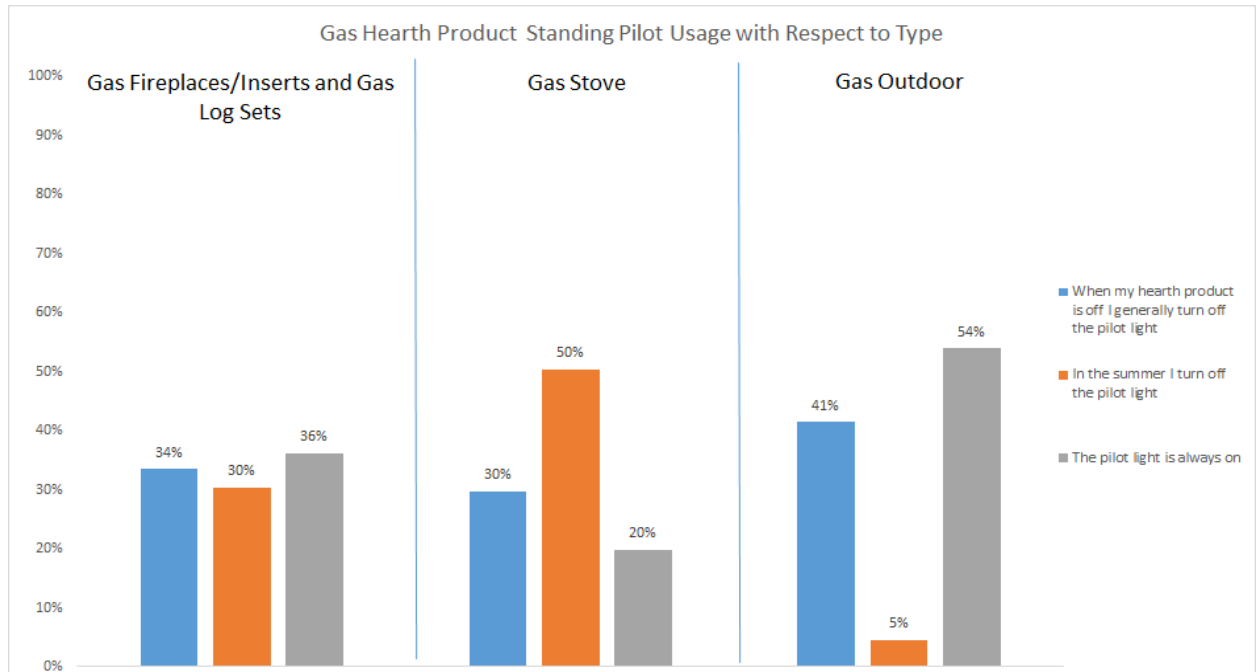


**Figure 4.1 Hearth Product Ignition System Distribution by Hearth Product Type<sup>45</sup>**

#### 4.1.2 Hearth Pilot System Usage by Hearth Products Type

Figure 4.2 shows the use of standing pilot with respect to hearth product type. The methodology is similar to that shown in Figure 3.14 and 3.15. As shown below, pilot usage for gas log sets and fireplaces is split almost evenly between the three modes. In stoves the pilot light is more often turned off during the summer. This may be because freestanding stoves tend to have more exposed pilots due to both their location on the unit and the stove's location in the room and the effect of the heat input from the pilot into the space is more apparent. In contrast, outdoor hearth products are less likely to be turned off only during the summer. This may be expected, as outdoor units are installed outside the house envelope and do not vent heat into the conditioned space as the other types do, so there is less motivation to turn the pilot off in the cooling season compared to the heating season. Additionally, outdoor units may have increased use in the summer, whereas the opposite may be true for other hearth product types due to increased demand for heat.

<sup>45</sup> Based on questions 2,3, 4, 5, and 6, Number of Respondents = 1226



**Figure 4.2 Gas Hearth Product Standing Pilot Usage by Hearth Product Type<sup>46</sup>**

### 4.1.3 Impact of Hearth Products Features on Pilot Usage

Table 4.1 lists how users reported using the hearth product pilots for the general population and with the features listed in question 10 of the survey. Each column shows the fraction of the users who reported having a hearth product with the given feature. The “General Population” column includes all users that own hearth products regardless of pilot type or features as shown previously in Figure 3.14. Each row lists the fraction of users who use their pilot in the listed manner as per question 25 of the survey. For example, the fraction of hearth products users with on-demand pilots who generally turn off their pilot lights is 53%, compared to the general population of users which is 31%.

**Table 4.1 Pilot Usage for Hearth Product Users General Population and with Features**

	General Population	Remote Control	Thermostat	On-Demand	Cold Climate
When my hearth product is off I generally turn off the pilot light	31%	16%	37%	53%	30%
In the summer I turn off the pilot light	29%	42%	39%	27%	32%

<sup>46</sup> Based on questions 2, 3, 4, 5, 6, and 25, Number of Respondents = 824

The pilot light is always on	20%	14%	16%	8%	30%
I don't adjust my pilot light	20%	28%	8%	12%	7%

Table 4.2 lists how users reported using their standing pilots for the general population and with the features listed in question 10 of the survey. This table is similar to Table 4.1 except that it is only for hearth product users with a standing pilot. Each column is the users who reported having a hearth product with the given feature. The “General Population” column includes all users that own hearth products with standing pilots regardless of features and was also presented previously in Figure 3.15. Each row lists the fraction of users who use their standing pilot in the listed manner as per question 25 of the survey. For example, the fraction of hearth products users with on-demand pilots who generally turn off their pilot lights is 52%, compared to the general population of users which is 33%. Note that the “I don’t adjust my pilot light” option has been eliminated in Table 4.2. For the purpose of this analysis that focuses on standing pilots only, respondents who selected “I don’t adjust my pilot light” were combined with those selecting “the pilot light is always on” category because users who have standing pilots and do not adjust the pilot light (but are still able to use their hearth product) most likely have their pilot light always on.

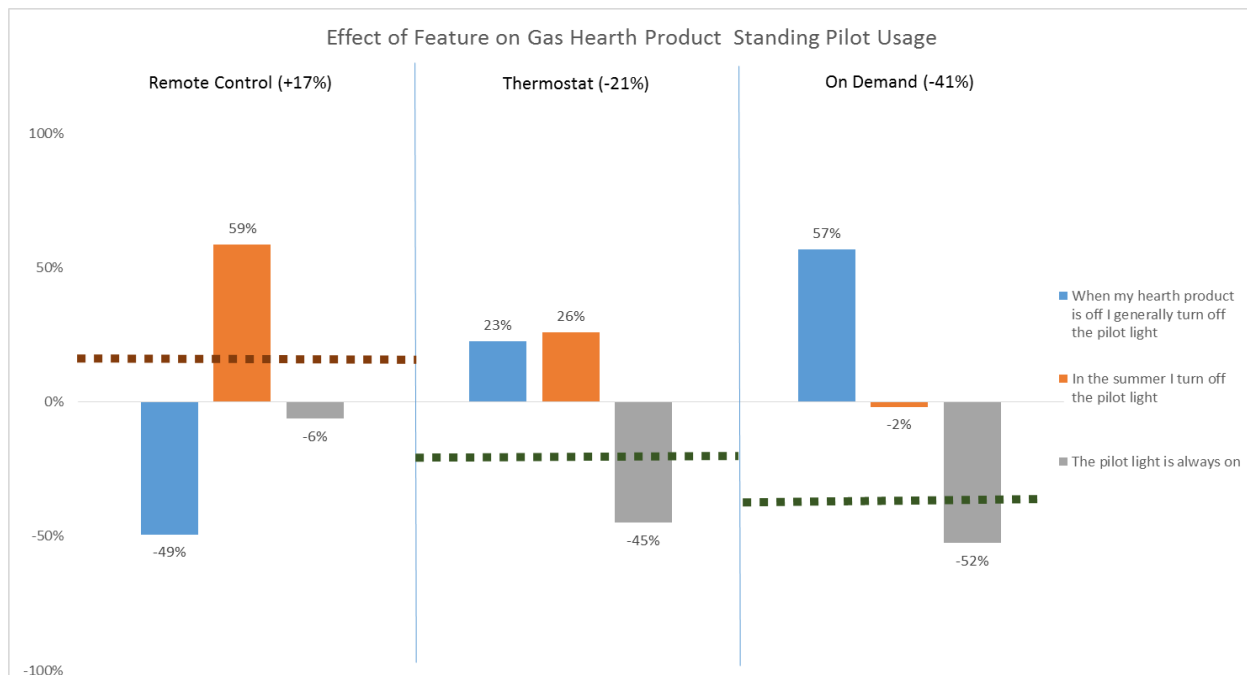
**Table 4.2 Standing Pilot Usage for Hearth Product Users General Population and with Features**

	General Population	Remote Control	Thermostat	On Demand
When my hearth product is off I generally turn off the pilot light	33%	17%	41%	52%
In the summer I turn off the pilot light	32%	50%	40%	31%
The pilot light is always on	35%	33%	19%	17%

Figure 4.3 uses the results of questions 4, 5, 6, 10, and 25 to show the effect of several features on gas hearth products standing pilot usage. For each feature the different modes of use are displayed with each bar representing the fraction of those users who reported using their hearth product in the indicated manner. Figure 4.3 also shows the estimated effects of the different uses on standing pilot operating hours, as calculated via the method in section 2.3.5, parenthetically next to the feature at the top of the figure. The dashed lines superimposed across the bars visually represent this effect. For example, users that responded to this survey with hearth products with remote controls are 49% less likely to closely monitor their hearth products, 6% less likely to

leave their pilot on indefinitely, and 59% more likely to turn their pilot light off in the summer when compared to the general population of users from this survey. These values come from comparing the "general Population" column with the "Remote Control" column in Table 4.2 which shows 17% of users generally turn off their pilot light, 50% of users turn their pilot off in the summer, and 33% of users leave the pilot light always on. The net effect of this on standing pilot hours is an increase of 17% in pilot use.

The data in Figure 4.3 also show that when compared with general hearth product users, users of hearth products with thermostat connectivity are 45% less likely to keep their pilot light always on, and 23% more likely to closely monitor it or 26% more likely to turn it off during the summer resulting overall 21% less pilot use. Finally, users with on demand pilots were 57% more likely than the general population to closely monitor their standing pilot, likely because of use of the on demand feature. These users were also 52% less likely to leave their pilot lights on which resulted in a reduction of pilot operating hours of 41%.



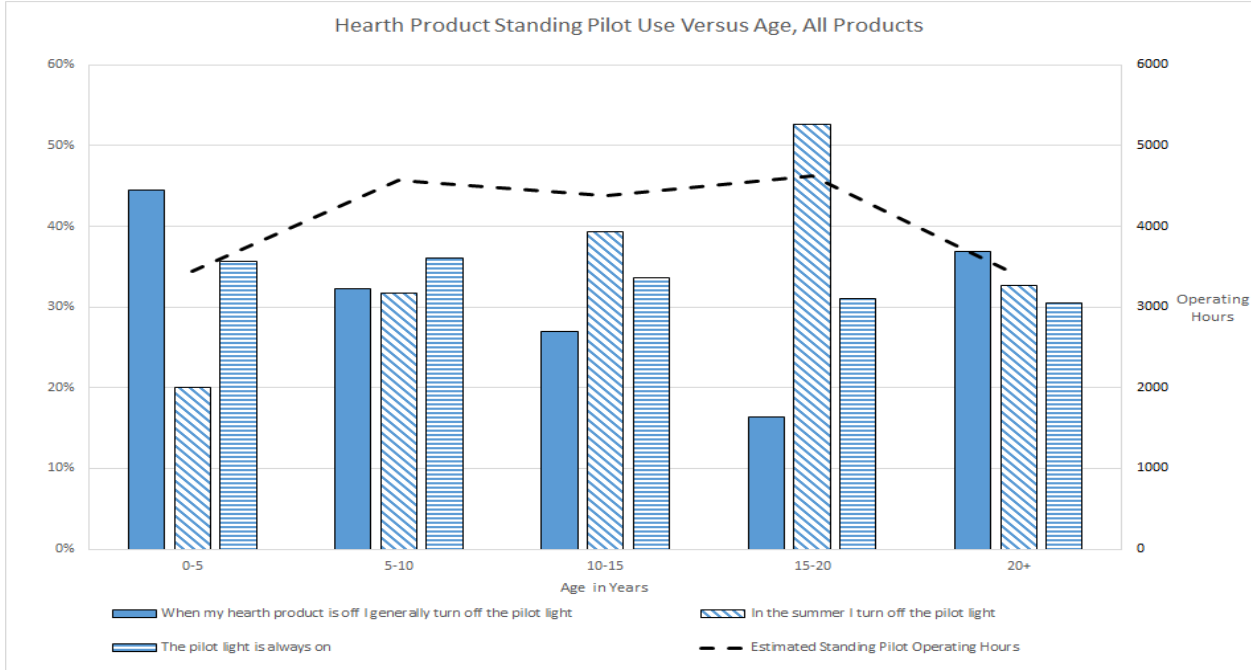
**Figure 4.3 Impact of Hearth Products Features on Standing Pilot Usage<sup>47</sup>**

#### 4.1.4 Impact of Hearth Products Age on Pilot Usage

Figure 4.4 shows reported gas hearth product standing pilot use as a function of age. Survey responses by mode of operation are grouped by age of the hearth product. For each age group,

<sup>47</sup> Based on questions 4, 5, 6, 10, and 25, Number of Respondents =473

the fraction of users who responded in each of the indicated manners is represented by a bar as designated by the legend on the bottom of the chart. Additionally, the dashed line represents the standing pilot operating hours estimated as per section 2.3.5, and labeled on the secondary axis on the right. For example, the distribution of how hearth products less than 5 years old were operated is shown by the three bars over the “0-5” label. Of these, those who generally turned their pilot light off as shown by the solid bar is 44%, the fraction of users with hearth products who turned their pilots off in the summer was 20%, as indicated by the diagonal striped bar, and the fraction who left their pilots on all year was 36%, as shown by the horizontal striped bar. From these modes of operation, the estimated standing pilot operating hours for that group of hearth products is approximately 3,500 as shown by the dashed black line. As shown, standing pilot operating hours appear to be relatively constant within the 3,500 to 4,500 hours range. The age bins are disaggregated for units less than 20 years old and combined for units more than 20 years old because the majority of the stock is from this time period.



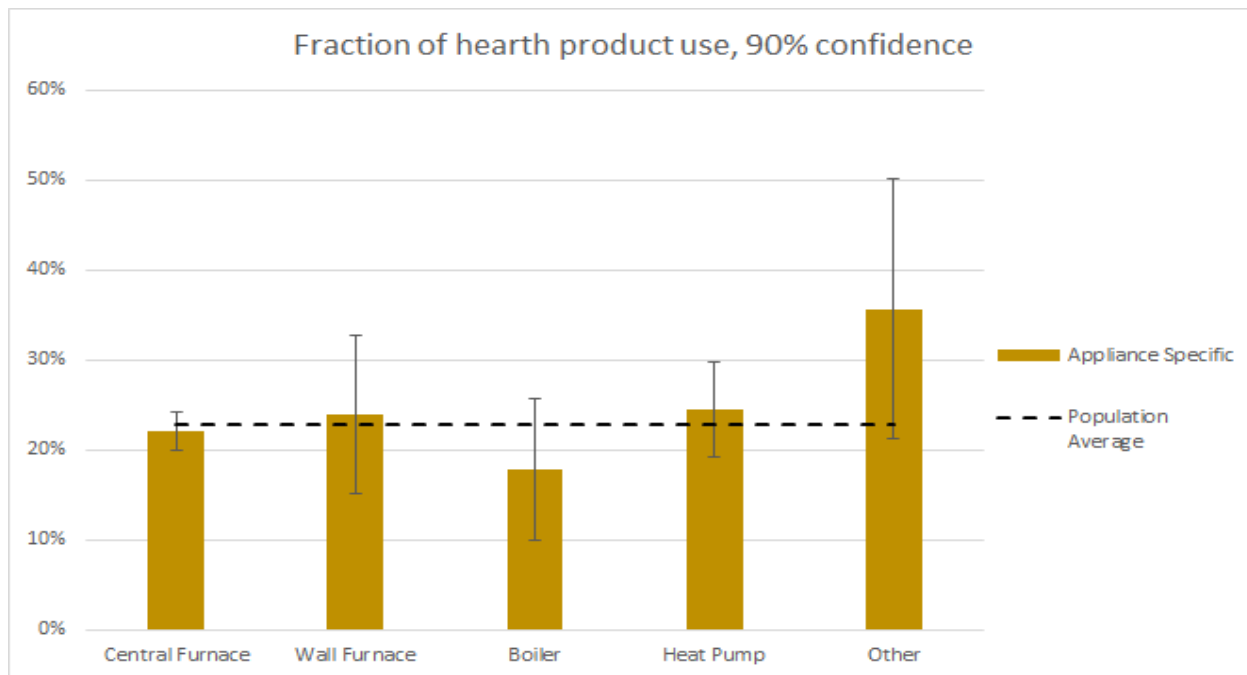
**Figure 4.4 Hearth Product Standing Pilot Use by Age with Operating Hours and On Demand Fraction <sup>48</sup>**

### 4.1.5 Impact of Main Heating Appliance on Hearth Product Usage

Figure 4.5 shows the fraction of time respondents reported using their hearth product instead of their main heating appliance. This value was calculated using the results reported in questions 23

<sup>48</sup> Based on questions 4, 5, 6, 10, 15, 16, and 25, Number of Respondents = 636

and 24. The results from question 24 are interpreted with “Almost Never” interpreted to mean 5% of the heating load is met by the hearth product; “Sometimes” is interpreted as 25%; “As much as my main heating appliance” is interpreted as 50%; and “More than my main heating appliance” is interpreted as 75%. The average response for each group of respondents with each main heating appliance is presented as a bar in Figure 4.5. Also shown on the graph is the total population average and the standard error at 90% confidence. The standard error is shown here to illustrate the effect of sample size on confidence in the results. The sample size varied greatly as the vast majority of units had a central furnace as a main heating appliance, and the sample size of respondents with each of the other appliances was not high enough to show a statistically significant difference. While there are some differences among the absolute reported values, these differences are not significant from the data collected in this study due to the relatively small sample size of some categories. So, the results are inconclusive as to whether the type of main heating appliance has a nimpact on the incidence of the hearth product being used for heat as opposed to the main heating appliance, which was 23% of the time on average for all users.



**Figure 4.5 Incidence of Hearth Product used for Heating by Main Heating Appliance<sup>49</sup>**

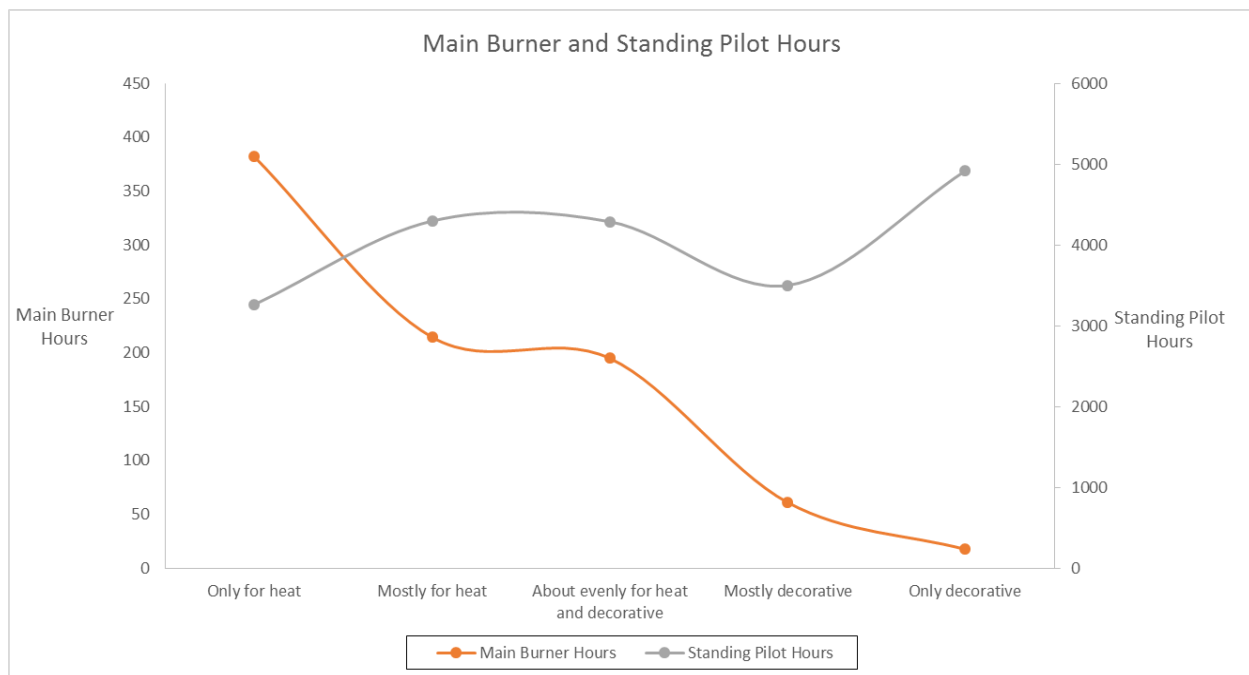
#### 4.1.6 Impact of Decorative Aspect on Operating Hours

Figure 4.6 shows the reported main burner operating hours and estimated standing pilot hours for hearth products. The main burner hours are plotted with respect to the axis on the left, and the

<sup>49</sup> Based on questions 23 and 24, Number of Respondents =1323

standing pilot hours are plotted with respect to the axis on the right. The main burner operating hours are as reported in questions 20, 21, and 22, and the standing pilot operating hours are as reported in question 25. These responses are combined with the decorative aspects as reported in question 26 to produce the information in the figure.

As Figure 4.6 shows, the main burner hours are positively correlated with utility for heat. The average operating hours for “only decorative” units is 17 hours, those used “only for heat” 382 hours, and for all units was the average was 234 hours. The standing pilot hours do not show as clear of a correlation. There are increased standing pilot hours for respondents who reported their hearth product’s use was “Only decorative” due to more of these users leaving their pilot light on at all times. The average for these users was 4,919 hours, while the average for all users was 4,593. This “only decorative” average, which is based on 49 respondents, is significantly higher than the average standing pilot use. However, those who used their hearth product as “Mostly decorative” used it for significantly less hours than the general population average, so there does not seem to be an obvious correlation between standing pilot hours and primary utility, rather only that users who only use their hearth product as decoration have significantly more standing pilot operating hours. Additionally, there were 23 respondents who indicated they had standing pilots on natural gas fueled hearth products with absolutely zero main burner use. Of these, 16 users left their pilot light on.



**Figure 4.6 Hearth Product Main Burner and Standing Pilot Hours<sup>50</sup>**

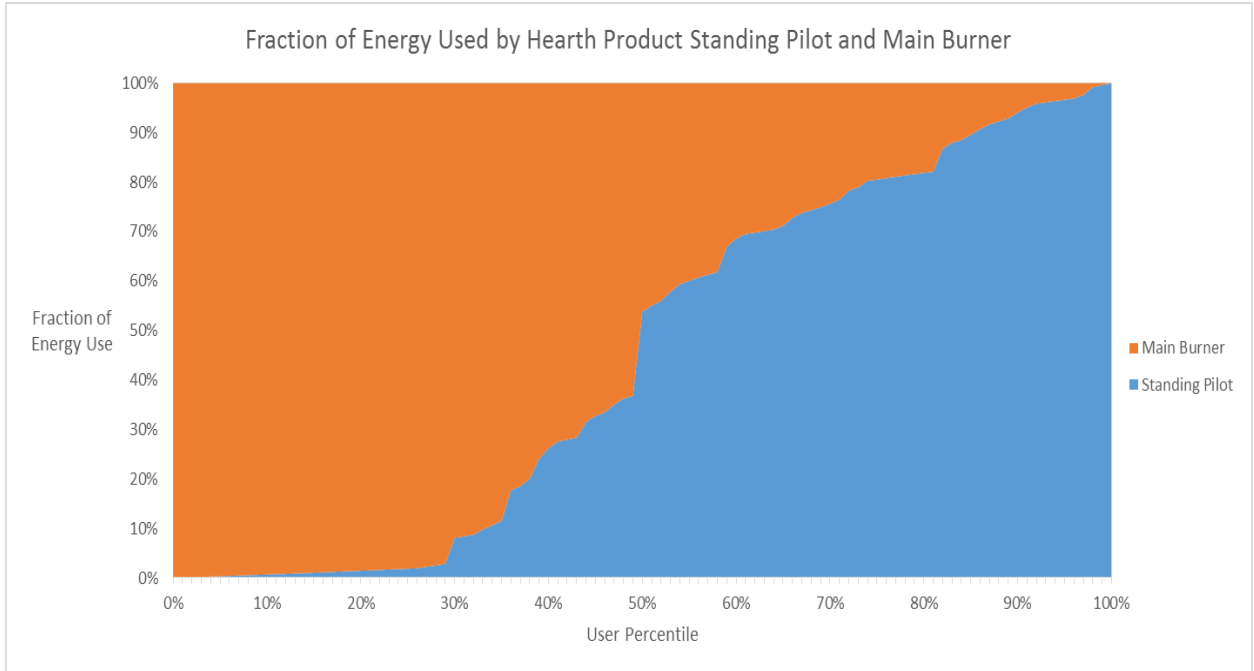
<sup>50</sup> Based on questions 4, 5, 6, 20, 21, 22, 25, 26, and 37, N (main burner hours) = 1554, N (Standing pilot hours) = 752

### 4.1.7 Estimated Energy Use

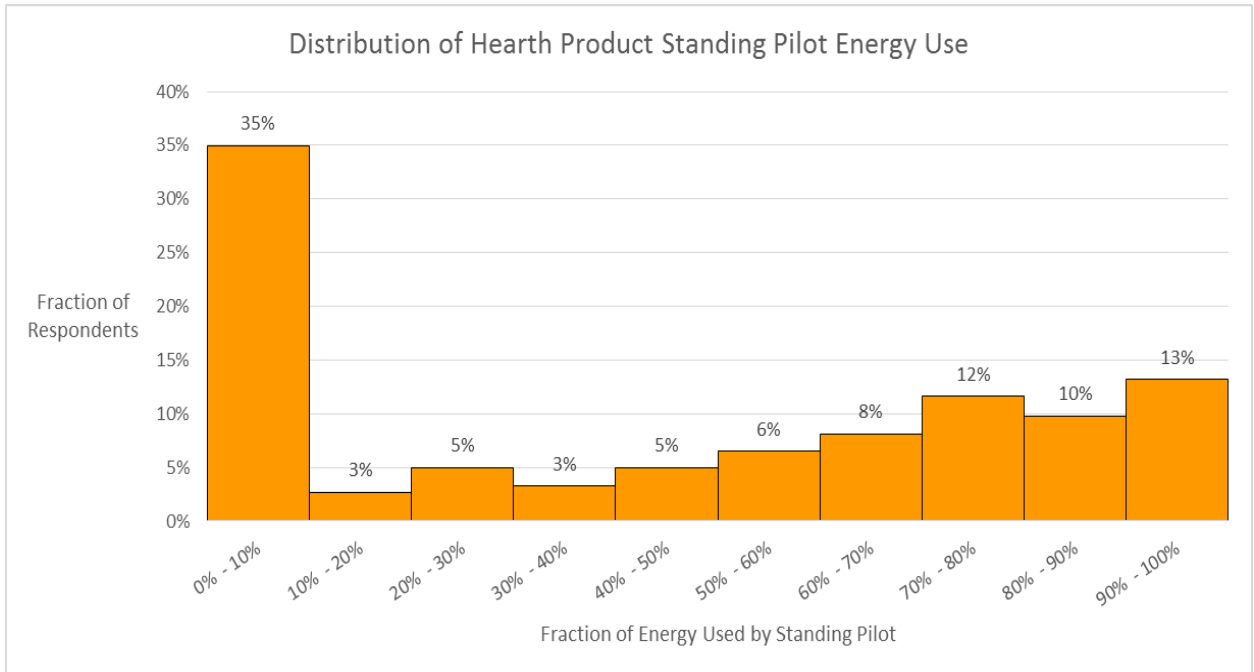
Figures 4.7 and 4.8 give details on estimated hearth product AEU. The values reported in these figures are estimated using the average input capacity for hearth products standing pilots and main burners as discussed in section 2.3.7 and applied to the reported main burner and standing pilot operating hours as shown in section 3.2. Figure 4.7 shows the cumulative distribution of users with respect to the fraction of energy used by the main burner and standing pilot. The top portion represents the fraction of AEU of the main burner, and the bottom represents the standing pilot's energy use. In this figure, the vertical axis shows the percent of the total AEU of each component. The horizontal axis is the user percentile. This figure shows the shape of the distribution to provide a sense of how the population uses their hearth products' main burners and standing pilots. The households on the far left of the graph use little pilot energy, meaning they likely closely monitor their pilot or have an on demand standing pilot. The households on the far right likely leave their standing pilot on year-round and rarely use their main burner.

In Figure 4.8, presents the same data as Figure 4.7 in histogram form. For example, the first bar, labeled "0%-10%" shows the fraction of all respondents (35%) whose standing pilot uses less than 10% of the total hearth product energy. Similarly, for 13% of respondents the standing pilot used 90% or more of the total hearth product energy. These figures taken together show that there is a wide range of AEU profiles driven by both standing pilot and main burner usage. For the users who leave their pilot on year-round, the standing pilot uses significant energy, often more than the main burner. For users who closely monitor their pilot use, their pilot AEU is typically negligible. A total of 35% of users reported their standing pilot used 70% or more of the total energy use, which is consistent with the fraction who leave their standing pilot always on, as shown in Figure 3.16, and have varying levels of main burner use. The estimated total average AEU from the main burner and standing pilot is 13.3 MMBTU.





**Figure 4.7 Fraction of Energy Used by Standing Pilot and Main Burner<sup>51</sup>**



**Figure 4.8 Fraction of Energy Used by Standing Pilot<sup>52</sup>**

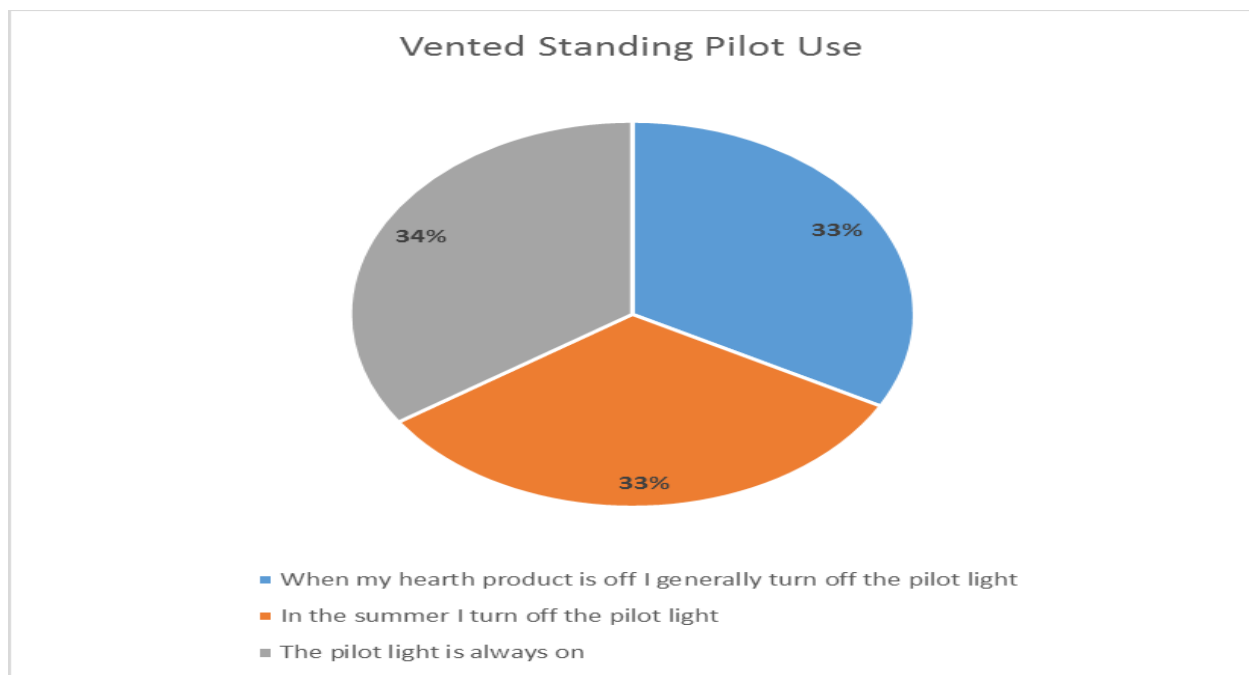
<sup>51</sup> Based on survey Questions 4, 5, 6, 25, and 37, Number of Respondents = 699

<sup>52</sup> Based on survey Questions 4, 5, 6, 25, and 37, Number of Respondents = 699

#### 4.1.8 Vented vs Unvented Standing Pilot Use

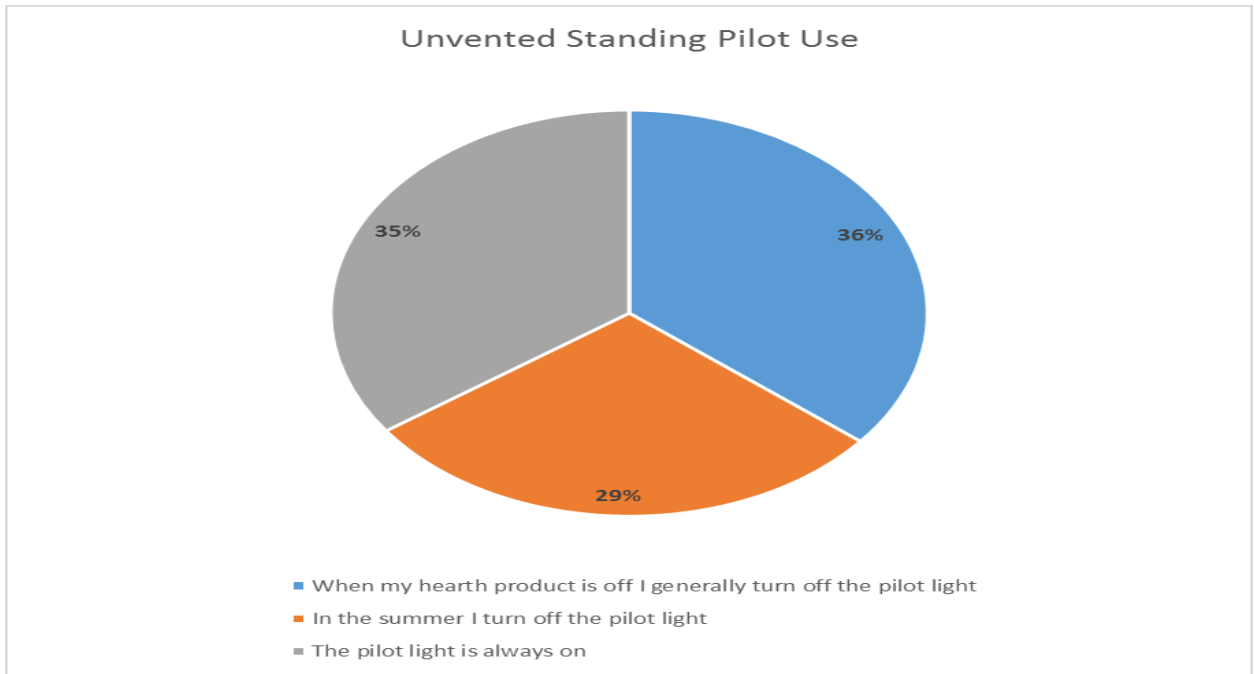
Figure 4.9 and 4.10 show the standing pilot use of vented and unvented hearth products, respectively. These figures are comparable to that previously presented in Figure 3.15 which showed the standing pilot usage for all users. As shown in the figures, the standing pilot use is similar between the vented and unvented population with approximately equal splits between the three modes of operation. The data appears almost identical, especially when taking into account that the unvented sample contains outdoor units, which are rarely turned off during the summer.

Figures 4.11 and 4.12 expand on the data shown in Figure 4.9 and 4.10 and present the calculated reported energy used by the standing pilot of vented and unvented hearth products in both the heating and non-heating season. The standing pilot AEU for vented units was 4.8 MMBTU and for unvented units was 5.4 MMBTU. As shown in Figure 4.11, standing pilots of unvented units used more energy during the heating season. In the non-heating season, as shown in Figure 4.12, the vented and unvented energy use is similar. The data in the figures show that users of vented and unvented units did not report operating their pilots significantly differently, and the resultant energy use is largely the same, particularly in the non-heating season.

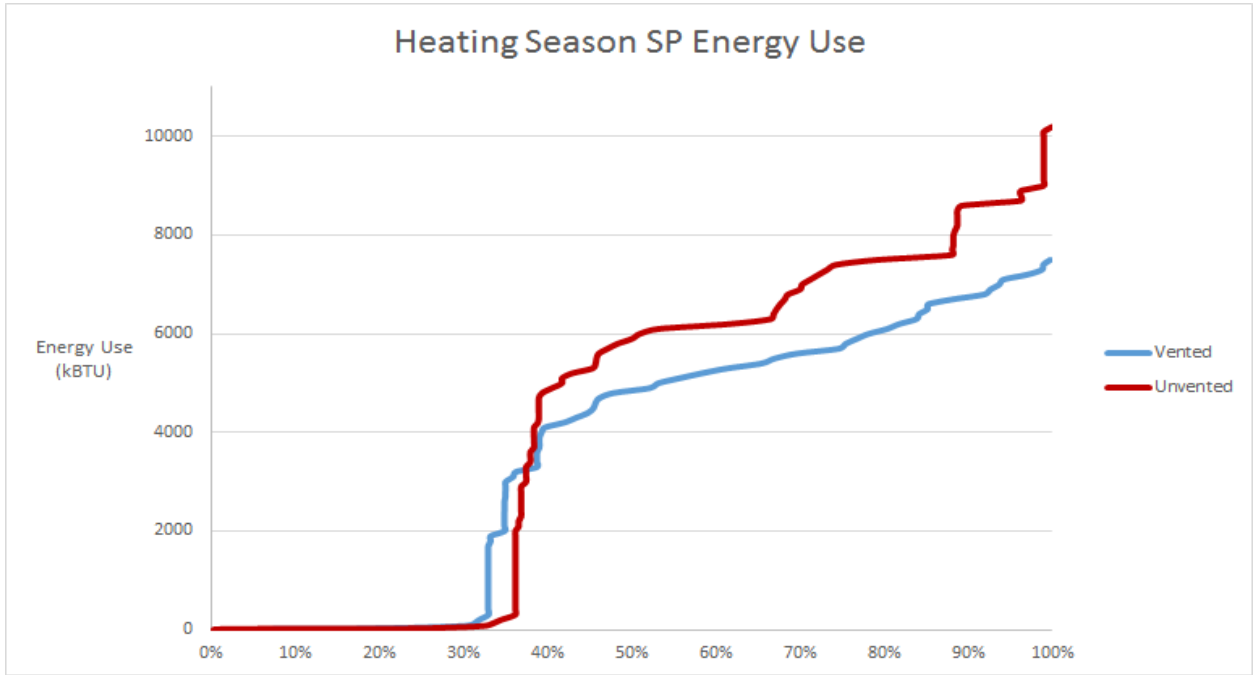


**Figure 4.9 Vented Hearth Product Standing Pilot Use<sup>53</sup>**

<sup>53</sup> Based on survey Questions 4, 5, 6, 7, and 25, Number of Respondents = 521



**Figure 4.10 Unvented Hearth Product Standing Pilot Use<sup>54</sup>**



**Figure 4.11 Cumulative Distribution of Vented Hearth Product Standing Pilot Use<sup>55</sup>**

<sup>54</sup> Based on survey Questions 4, 5, 6, 7, and 25, Number of Respondents = 266

<sup>55</sup> Based on survey Questions 4, 5, 6, 7, and 25, Number of Respondents = 432

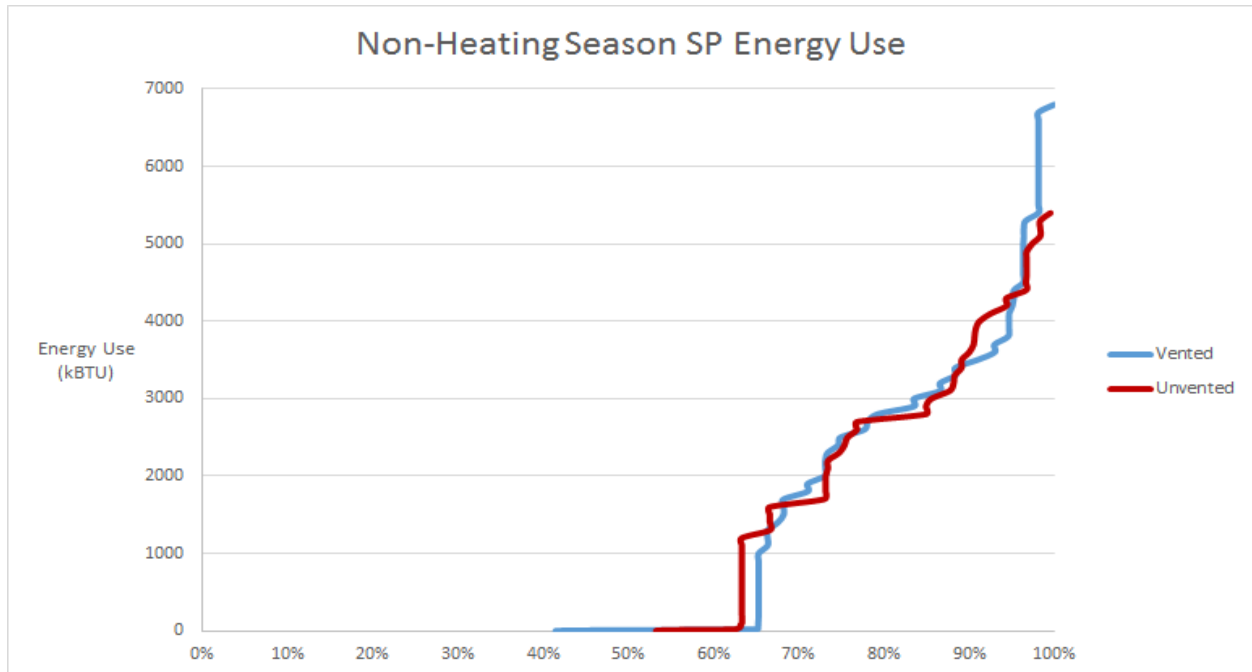


Figure 4.12 Cumulative Distribution of Unvented Heart Product Standing Pilot Use<sup>56</sup>

## 4.2 Comparisons to Past Studies and Data Sources

### 4.2.1 Hearth Products Users General Comparisons

#### 4.2.1.1 Demographics

Table 4.3 compares key demographics for households with at least one hearth product from the available data sources. It should be noted that this study (labeled as LBNL 2017) was weighted towards RECS 2009, as access to the full surveys referenced in Houck 2010 and 2014 could not be obtained. Therefore, the comparison between LBNL 2017 and the Houck studies as well as GRI 1997 are the most informative. As shown, all studies report very similar demographics for hearth product owners in that they are generally in single-family detached homes and, compared to the general population, are more likely to have attended college, are Caucasian, and have higher incomes. This comparison suggests that hearth product demographics have remained consistent relative to the general population over time and that the results from this study are in line with the consensus.

<sup>56</sup> Based on survey Questions 4, 5, 6, 7, and 25, Number of Respondents = 432

**Table 4.3 Hearth Products User Demographics**

	LBNL 2017	Houck 2010 or Houck 2014	RECS 2009	GRI 1997
HP per household	1.12	1.2 (2010)	N/A	1.16 (GRI 1997)
HP in home type - Single family detached homes	81%	80% (2014)	87%	82% (GRI 1997)
Education - Attended College	77%	82% (2014)	77%*	N/A
Income - Average (\$, thousands)	81	76 (2014)	86**	80 (GRI 1997)
Ethnicity - Caucasian	82%	81% (2014)	84%	N/A
Total Sample Size***	1563	N/A	12,083	118

\* 62% of general population attended college

\*\* Average household income for the general population is 56 (\$ thousands, year)

\*\*\* ETO 2015 sample size was 49, Hayden 1997 was 68

#### 4.2.1.2 General Heating System Characteristics

Table 4.4 presents a comparison of the main heating appliances in hearth product households. The percentages represent the household's main heating appliance for households with hearth products installed and average daily use as reported by this study, Houck 2010 and 2014, RECS 2009, and ETO 2015. Note that all of these studies with the exception of RECS are comprised solely of hearth products. The RECS 2009 statistics presented are only for households with fireplaces. Therefore, the weighting differences between sources may explain some of the discrepancy between RECS 2009 and other sources. All sources consistently report that central furnaces are the main heating appliance of approximately 75% of hearth product households, with a relatively diffuse distribution of other main heating appliances. RECS 2009 and this study, both national in scope, approximately match on the fraction of heat pumps, boilers, and other categories. ETO 2015, which was geographically limited to Washington and Oregon only, had substantially fewer of these appliances.

**Table 4.4 Main Heating Appliance in Hearth Product Households**

	LBNL 2017	Houck 2010 or 2014	RECS 2009	ETO 2015

Fireplace	8%	10% (2014)	3%	16%
Furnace (Central or wall)	73%	N/A	73%	75%
Electric Resistance	N/A	N/A	2%	4%
Heat Pump	13%	N/A	15%	3%
Boiler	4%	N/A	5%	1%
Other	2%	N/A	2%	N/A

Table 4.5 presents comparisons of other hearth product characteristics, including the average daily use, the fraction of thermostat controlled units, and the decorative unit operating hours. The average daily use of the hearth product main burner was reported to be between 2.5 to 3.0 hours with the low value from Houck 2014 and the high end of the range from this study. GRI 1997 reported that 6% of hearth products were thermostatically controlled. The equivalent fraction of units installed in 1996 or prior as reported by users in this study is 13%. While there is a substantial difference between the two fractions, this is easily explained by the time period between GRI 1997 and this study, and the difference in the composition of hearth products included, as GRI 1997 was primarily composed of gas log sets. The two studies consistently report that thermostatically controlled units are less common in older units than the general stock, which is shown in Figure 3.7. Additionally, 30% of units less than 5 years old reported being thermostatically controlled. The final row compares units whose use was indicated as “only decorative” as per question 26 with the decorative hours presented in Houck 2010. This shows that the values are relatively close. In general, the values in this table show relatively close agreement with this study and the literature.

**Table 4.5 Hearth Products Use and Characteristics Comparison**

	LBNL 2017	Houck 2010 or 2014	GRI 1997	ETO 2015
Average Daily Use (hours)	3.0	2.5 (2014)	N/A	2.7
Thermostat Controlled (Units >20 years old)	13%	N/A	6%	N/A
Decorative unit annual operating hours	35	37.5 (2014)	N/A	N/A

## 4.2.2 Distribution of Hearth Product Types

Table 4.6 compares the fraction of users who reported having each product type in this survey with percentages derived from DOE TSD 2015, which was based on the AHRI model database and shipment data from HPBA from 2010 through 2013. It is important to note when comparing these values that the data from DOE TSD 2015 is representative of the current distribution of hearth product types as shipped in 2014, whereas LBNL 2017 represents the entire existing stock, including many older models. Additionally, the disaggregation in DOE TSD 2015 combines stoves with fireplaces, and LBNL 2017 combines log sets and fireplaces. For the purposes of comparison, the DOE TSD 2015 values were restructured for comparison with LBNL 2017. Still, only limited comparisons may be made between the sources. As shown in the table, the sources agree on the approximate fraction of fireplaces and log sets. There is a discrepancy in that LBNL 2017 shows more gas stoves and less outdoor units than DOE TSD 2015. This may be due to a difference in the composition of the stock and units shipped in 2014, which may indicate that the ratio of gas fireplaces and log sets to other types has changed since the time period before 2010. HPBA 2016 reported that 86% of those surveyed reported having a fireplace or fireplace insert, and the remaining 14% had stoves. These numbers are hard to compare without knowing how log sets were treated, however the ratio between stoves and fireplaces is similar between both sources.

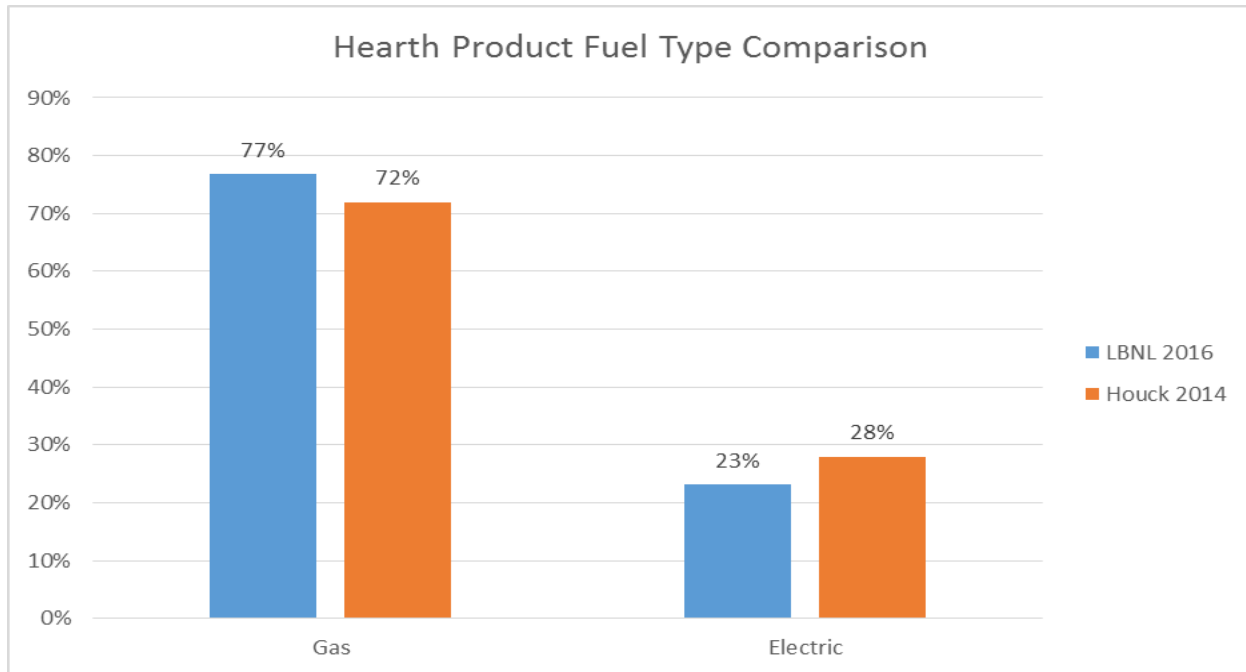
**Table 4.6 Gas Hearth Product Types Comparison**

Hearth Product Types	LBNL 2017	DOE TSD 2015*
Gas Fireplace or Log Sets	84%	78%
Gas Stoves	12%	6%
Gas Outdoor Units	5%	16%

\*These were calculated from the AHRI model database, as DOE TSD 2015 aggregated stoves with fireplaces

## 4.2.3 Hearth Product Fuel Types

Figure 4.13 compares the fuel types reported in this study and in Houck 2014. The values are largely similar; this study and Houck 2014 report 77% and 72% of hearth products being gas-fired and 23% and 28% using electricity, respectively. The values are in agreement, with only a 5% difference between the two values.



**Figure 4.13 Hearth Product Fuel Type Comparison**

#### 4.2.4 Standing Pilot Usage

The results of this study show a substantial difference with a previous field study, Hayden 1997, which was performed in Canada and is to date the only published field metering study performed focused on pilot lights in fireplaces or hearth products. In Hayden 1997, 14 out of the 52 households with substantial fireplace use had almost no pilot use, meaning they extinguished their standing pilots after every use, or did not have standing pilots, meaning they had intermittent pilots or were match lit. Of the remaining 38 fireplaces, 30 of those had their pilots on all year and 8 were turned off during the summer. In addition, the study monitored an additional 16 fireplaces of which 11 had pilots that were on continuously. In the Hayden 1997 study, 60% of pilots were left on continuously, compared to approximately 35% of standing pilots reported left on in this study. Furthermore, in Hayden 1997, 21% of fireplace pilots were closely monitored, compared to 33% in this study. Finally, in Hayden 1997, the remaining 20% consisted of 12% who turned off their pilots in the summer, and 8% whose behavior is unclear but did not leave their pilots on continuously; this is comparable to 32% in this study who reported turning off their pilots during the summer. Likely key factors in this discrepancy are the technology differences both in hearth products and building technology in the 20 years since that study was conducted, demographic and weather differences between the United States and Canada, changes in user behavior, and the difference in hearth product composition between these studies. However, the values found in this study match more closely with DOE TSD 2015, which indicated that 40% of



users left their pilots on year round, 40% turned their pilots off in the summer, and 20% turned their pilots off when not in use, compared to 35%, 32%, and 33%, respectively, in this study.

#### 4.2.5 Main Burner Usage

Table 4.7 compares the estimated main burner hours with other published sources. All comparison sources list either the annual or heating season hours, but not both. However, since the vast majority of operating hours are in the heating season, there is value in comparing the annual and heating season values. As reported in section 3.2 of this study, 8% of total hearth product main burner operating hours was in the non-heating season. Note that these values are for all units in each study. Houck 2010 differentiates between heaters and decorative units, but other sources do not. Also, aside from this study, all of the other studies only covered fireplaces. Two previous studies, RECS 2009 and Houck 2010, report the main burner operating hours for heaters to be 157 annual and 194 heating season hours, respectively. Both sources are based on survey data. ETO 2015, which was based on measured data, reported 17 hours per week during the heating season. Over the course of a typical heating season this corresponds to approximately 421<sup>57</sup> operating hours. The average annual operating hours reported by users from this study is 234. Overall, these studies show a range of main burner operating hours from 75 in Houck 2010 to more than 400 in ETO 2015. This study is near the mean value of these other sources.

**Table 4.7 Average Hearth Product Main Burner Operating Hours**

	Houck 2010**	ETO 2015	RECS 2009*	LBNL 2017
Annual	N/A	N/A	157	234
Heating Season	75 (All) 194 (Heaters Only)	17/week***	N/A	215

\* RECS values were calculated using RECS values and the input capacity values referenced in this study.

\*\* Study reported that all gas hearth products had on average 75 operating hours in the heating season, and decorative had half that. The study also reported 24% of fireplaces being heaters, the rest decorative.

Combining these numbers gives: All fireplaces: 75 hours; decorative: 37.5 hours; heaters: 193.8 hours in the heating season.

\*\*\* Equivalent to 421 hours over the course of a typical heating season.

<sup>57</sup> 17 hours per week applied to average heating season of 4,160 hours as listed in the DOE test procedures for direct heating equipment, a category which used to include hearths, which appears at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix O and 10 CFR 430, subpart B, appendix G. This value is also used in other similar test procedures where heating season hours are used.

## 4.2.6 Primary Utility of Hearth Products

Table 4.8 compares how respondents of this study, ETO 2015, GRI 1997, and Houck 2010 characterized their unit's primary utility, whether as decorative or heating. Houck 2010, which references earlier surveys from 2004-2007 as well as HPBA and manufacturer data, characterized hearth products' utility as mostly decorative, stating that "only 24% of all gas fireplaces are used for heating". This conclusion differs from the results in this study, which indicate that people consider hearth products approximately equally decorative and for heat. ETO 2015 reported hearth products' utility as mostly for heating, with 51 out of 57 (89%) gas fireplace users using their fireplace for heating. It should be noted, however, that the ETO 2015 study was comprised of users who used their fireplace more than 5 hours per week and was used more efficient fireplaces, which may influence the utility. GRI 1997, which was a nationwide study, reported that decorative and heating aspects are considered the primary utility by approximately half of hearth product users, this largely matches the results from this study.

**Table 4.8 Fraction of Gas Fireplaces that were Decorative or for Heating**

LBNL 2017*		Houck 2010		ETO 2015		GRI 1997***	
More for heat (%)	46	Heating (%)	20-24	Heating (%)	89	Heating (%)	50
More for aesthetics (%)	54	Decorative (%)	76-80	Decorative** (%)	11	Decorative (%)	50

\* Values presented here are normalized to exclude those who indicated they used their hearth products evenly for heat and for aesthetics. Also note that fireplaces and log sets are aggregated.

\*\* This percentage includes those who "use the fireplace, but for purposes other than heating" and those who do not use their fireplace.

\*\*\*Values presented here are combined and normalized to exclude those who indicated they used their hearth products evenly for heat and for aesthetics. In the original source, 26% selected "Spot heating", "Replace Furnace", and "Cold Weather"; 26% selected "Looks" and "Entertain"; and 48% selected "Looks and Heat".

## 4.2.7 Estimated Energy Use

Table 4.9 shows the average estimated AEU for a hearth product with a standing pilot based on reported values in this survey and presents for comparison results from GRI 1997. Note the previously mentioned differences in each study, including the year performed, differing distribution of hearth product types, and specific items of interest. On average, hearth products in this study used 1.5 MMBTU less than was measured in GRI 1997. One important factor

contributing to this difference, as discussed in section 4.1.3, is the differing technology of the hearth product stock in 1997 compared to 2016. The AEU difference of approximately 10% of the GRI value is relatively small given the differences between the two studies.

**Table 4.9 Comparison of Estimated Annual Energy Use of Hearth Product w/ Standing Pilot**

	Average AEU (MMBTU)
LBNL 2017	13.3
GRI 1997	14.8*

\*Value from summing average monthly use from 2/95-1/96.

## 5 Conclusions

This study was performed to address the scarcity of data regarding hearth product usage in the United States, particularly with respect to the factors that affect hearth product main burner and standing pilot energy use.

This study provides new information about hearth products and also provides updated and United States-specific data. The primary results of the data collection and analysis at this time are the user behavior data, which significantly impact energy use, including the standing pilot hours, main burner hours, and the primary utility. The reported main burner hours for all hearth products was 234, and the standing pilot hours 4,593. The primary utility was reported to be divided approximately equally between products used primarily for decorative and for space-heating purposes. Important related results are the overall estimated AEU of 13.3 MMBTU/year and the identification of the fraction of the population who reported their standing pilots as using a substantial amount of energy, some more energy than their main burners. Understanding the energy use and the installations of the hearth products being operated most inefficiently may enable the development of less wasteful products and usage patterns through relatively simple measures. Other important results include hearth product characteristics and installation parameters as discussed in section 3.1, as well as the effect of such factors as product age and features on energy use, as discussed in section 4.1.

These new data can be used in subsequent analyses to more accurately assess the energy used by hearth products, especially with respect to the different technological options and features that are currently being increasingly adopted in hearth products. Because the data gathered in this study include enough detail to analyze the different technology options separately, the data can be used

to more accurately evaluate both baseline and potential hearth product energy use or model increased adoption of a given feature. These data could also be used to more accurately analyze the effect of more general market shifts, such as increased adoption of stoves in single-family detached homes. Potentially the data could even be of use to manufacturers to better understand customer perceptions of hearth product utility and usage patterns.

## 6 Acknowledgments

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# Appendix A: Residential Hearth Products Research Study

(GP version only)



## Residential Hearth Products Research Study

The Energy Efficiency Group at Lawrence Berkeley National Laboratory (LBNL) would like to invite you to participate in a survey on hearth products in U.S. homes.

Before you proceed with this survey, please make sure that you fulfill the following qualifications:

1. You must reside in the U.S.
2. You must be at least 18 years old.
3. You must have at least one hearth product in your home.

A **hearth product** is a gas-fired or electrical appliance that displays the fire or a flame pattern and provides aesthetics and/or space heating. The term "hearth product" does NOT include patio heaters or gas lamps, or products with a primary function of cooking or providing lighting.

**Hearth products** only include gas-fired and electric fireplaces. **Hearth products** do NOT include oil burning fireplaces or solid fuel burning fireplaces such as: wood, coal, pellets, etc.

In this survey, the term hearth products refer to the following product types:

1. **Fireplaces:** This includes vented or unvented fireplaces, fireplace inserts, stoves, and other similar devices. These products could be located in a fireplace enclosure or could be free standing. Their purpose is decorative, heating, or a combination of the two.
2. **Gas Log Sets:** These consist of a gas burner and feature a structure that looks like burning logs. Gas log sets are typically installed in an existing masonry space and can be vented or unvented.
3. **Outdoor Units:** This includes outdoor gas fireplaces, outdoor gas log sets, burners, and other similar products.

Please see below some pictures of common products covered in this survey:

**Gas Fireplaces**

**Gas Log Sets**





**Outdoor Fireplaces**

**Freestanding Stoves**



The information collected from this survey will help us determine the usage to hearth products by consumers and understand other issues pertaining to costs such as repair and maintenance of the products.

**What you need to do to complete this survey:**

- Answer questions about the hearth product in your home.
- Answer questions about your household's hearth product usage.
- Report the brands and model numbers of hearth product appliances in your home. You can often find this information on the product "nameplate," which is a small

rectangular label usually located inside or on the front or back of the appliance. Your owner's manual may also provide you with the brand and model number.

- Answer demographic questions, such as gender and race.
- Answer all questions in the survey that are applicable to you. Skipping questions may cause your work to be rejected. If applicable, you may choose options such as "I don't know," "I decline to state," or "not applicable."
- Answer all questions in the order they are provided. Answering out of order may cause some invalid responses.

**More information about participating in this survey:**

- It will require approximately 15-25 minutes to complete all of the questions in the survey.
- Within 7 days of the survey being closed, we will review your responses. You will be paid \$2.00 for your completed and accepted survey.
- Your work will not be accepted and you will not be paid if you do not match the qualifications stated above or do not answer all the questions that apply to you.
- If your work is rejected, a negative rating will be applied to your Amazon Mechanical Turk (AMT) account. This could affect your overall rating and might prevent you from taking other AMT HITs requiring a high account rating.
- The data this survey collects about you and your household will be password-protected and only seen by the research team. Only data that has been grouped together with data from others will be published.
- Please be aware that any work performed on Amazon Mechanical Turk can potentially be linked to information about you on your Amazon public profile page, depending on the settings you have for your profile. We will not be accessing any personally identifying information about you that you may have put on your Amazon public profile page.
- At LBNL, the data this survey collects about you and your home will be separated from your Amazon Mechanical Turk worker ID and password protected, and only data that has been grouped together with data from others will be published. Please note, however, that the data you provide may be collected and used by Amazon as per its privacy agreement.
- Should you have any questions related to this survey, you may contact the study Principal Investigator, Alex Lekov, at [ablekov@lbl.gov](mailto:ablekov@lbl.gov) or you may contact us via e-mail at [EESurvey.amz@lbl.gov](mailto:EESurvey.amz@lbl.gov).
- Any questions you have about your rights as a participant will be answered by Berkeley Lab Human Subjects Committee at 510-486-5399.
- A copy of this study information can be obtained from the following webpage: <http://energy.lbl.gov/fsp/>

Participation in this research is voluntary. You have the right to not take part in this survey. If you decide to take this survey, please click "Accept HIT" at the end of this page.

## **BEGINNING OF SURVEY**

**Reminder: Please answer all questions, and please complete the survey questions in order.**

### **A. General Hearth Product Characteristics**

#### **1. How many hearth products are currently installed in your home?**

*Please provide only the total hearth products installed at one time, so if a hearth product was exchanged for a new one, only count this as one.*

- 1
- 2
- 3
- 4
- 5
- More than 5

**For the rest of the survey, if you have more than one hearth product in your home please restrict your answers to the one you use the most.**

---

#### **2. How is your hearth product installed?**

- It is located Indoor and installed within the hearth, or in the wall.



- It is located Indoor and freestanding



- It is located outdoors



**3. If your hearth product is located indoor and installed within the fireplace enclosure, what material is the fireplace enclosure made of? (Select the one that best describes the enclosure if multiple are present)**

*The enclosure is the area where the main flames are located.*

- Not Applicable. My hearth product is NOT located indoor and installed within the fireplace enclosure.
- Masonry (brick or stone)
- Metal
- Other

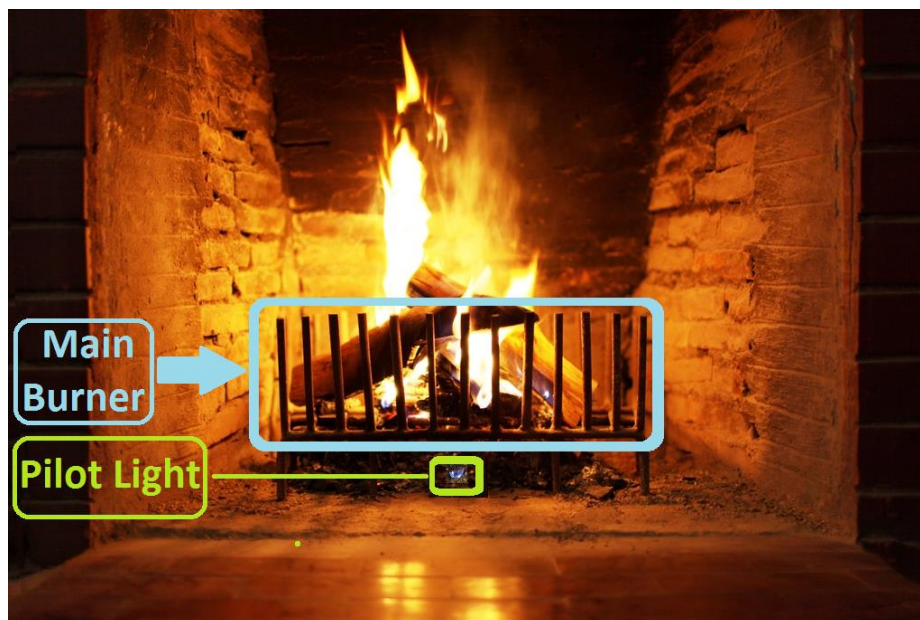
**4. What is your hearth product's primary fuel?**

[Reminder: **Hearth products** only include gas-fired and electric fireplaces. **Hearth products** do NOT include oil burning fireplaces or solid fuel burning fireplaces such as: wood, coal, pellets, etc.]

- Natural Gas (from gas line)
- LPG (Propane)
- Electricity
- I don't know

**5. Have you ever used a match or a lighter to operate your hearth product?**

*To help identify the difference between a pilot light and a main burner, see the below guide using an example hearth product.*



The **pilot light** is a small flame used to light the main flame of the hearth product. You may be able to spot a small flame in the main hearth area that is always on or ignites before the main flame, or it may be underneath or near the main flame. The **Main burner** is the part of the device where the main flame is produced.

- No, I have never used a match or lighter to operate my hearth product.
- Yes, I have used a match or lighter to ignite my hearth product's **pilot light**.
- Yes, I have used a match or lighter to light my hearth product's **main burner**.
- I don't know

Question 5 in the test version of the survey:

**5. Have you ever used a match or a lighter to light your hearth product's pilot light?**

*The pilot light is a small flame used to light the main flame of the hearth product. You may be able to spot a small flame in the main hearth area that is always on or ignites before the main flame, or it may be underneath or near the main flame.*

- No, I have never used a match or lighter to light my hearth product's pilot light.
- Yes, I have used a match or lighter to ignite my hearth product's pilot light.
- I don't know

**6. Does your hearth product have a 'pilot' button, 'pilot' switch, or 'pilot' knob on the device that you use to start the pilot light?**

*This device may be a remote control or panel, or the controls may be on the hearth product itself, and will be labeled "pilot" or similar.*

- Yes, my hearth product has a 'pilot' button, 'pilot' switch, or 'pilot' knob used to start the pilot light.
- Not applicable, I use a match or lighter to ignite my hearth product's pilot.
- No, my hearth product does not have a 'pilot' button, 'pilot' switch, or 'pilot' knob.
- I don't know

**7. Is your hearth product vented or unvented?**

*To help identify whether your unit is vented or unvented, see the below guide using example hearth products.*

Vented units have a chimney or flue to vent combustion gases. This vent may also be in the back behind the unit.



Unvented units do not have a chimney or flue.



- My hearth product is vented
- My hearth product is unvented
- I don't know

**8. How does your hearth product use electricity? (Check all that apply)**

- My hearth product is plugged into an electrical outlet or has an electrical connection
- My hearth product uses batteries
- My hearth product does not use electricity
- I don't know

**9. How often do you replace your hearth product's batteries?**

- Not applicable. My hearth product does NOT use batteries
- Once a year or more
- I replace my batteries once every 2 years
- I replace my batteries once every 3 years
- I replace my batteries once every 5 years
- I replace my batteries once every 10 years
- I don't know

**10. Does your hearth product have the following features? (Check all that apply)**

- It has a remote control
- It is controlled by a thermostat
- It has an 'on demand' pilot  
*An on demand pilot is a pilot that will turn off automatically after a period, but not immediately after the unit is turned off.*
- It has a 'cold climate' pilot feature

*The cold climate feature allows the pilot to function as a standing pilot, which is always on unless turned off by the user.*

- It has none of the above
- I don't know

**11. How often do you use the cold climate feature, on average?**

- Not Applicable. I do not have a 'cold climate' pilot feature
- Every year during the winter, for the whole winter
- Sometimes during the winter
- Rarely during the winter
- Never
- I don't know

**12. Who is the current president of the U.S.?**

- Amana
- Bosch
- Danby
- Emerson
- Empire Comfort
- GE
- Haier
- JennAir
- Kenmore
- Miele
- Obama
- Sanyo
- Tresanti
- Uline
- Viking
- Whirlpool
- I don't know

**13. What room is your hearth product installed in?**

*Reminder: if you have more than one hearth product in your home, please restrict your answers to the one you use the most.*

- Living room
- Bedroom
- Family room or den
- Dining Room



- Office or study room
- Bathroom
- Garage
- Kitchen
- Outdoor
- Hallway
- Attic
- Basement
- Studio

**14. Is there a thermostat in the room this hearth product is installed in?**

- Yes
- No
- I don't know

**15. What year was your house built? (Please provide your best estimate)**

- \_\_\_\_\_
- I don't know

**16. What year was your hearth product installed?**

- Same year as my house was built
- After my house was built: Year \_\_\_\_\_
- I don't know

**17. What is the brand of your hearth product? [dropdown menu]**

- Real Fyre
- Monessen Hearth or Majestic
- FMI
- Vantage Hearth
- American Hearth or White Mountain Hearth
- Marquis Collection
- ProCom
- Heatilator
- Heat & Glo
- Comfort Flame
- Other
- I don't know

**18. If you selected "other" in the previous question (question 17), please fill in the brand of your hearth product below:**

- Brand: \_\_\_\_\_

**19. What is the model of your hearth product? (If you do not know, please write "I don't know")**

- Model: \_\_\_\_\_
- 

## **B. Hearth Product Usage**

**Reminder: If you have more than one hearth product in your home please restrict your answers to the one you use the most.**

**20. Please select the option which best describes how you use your hearth product during the heating season.**

*The heating season refers to the months which typically are cold enough that heating appliances such as furnaces are typically used. For example, in Atlanta, Georgia this corresponds to the end of October through April.*

- 5 times or less
- A few times a month
- About once or twice a week
- More than twice a week
- Every day
- My thermostat controls my hearth product
- I never use my hearth product during the heating season
- I don't know

**21. Please select the option which best describes how you use your hearth product during the non-heating season.**

*The non-heating season refers to the months when no space heating is typically used. For example, in Atlanta, Georgia this corresponds to May through the beginning of October.*

- 5 times or less
- A few times a month
- About once or twice a week
- More than twice a week
- Every day
- My thermostat controls my hearth product
- I never use my hearth product during the non-heating season
- I don't know

**22. When you manually operate your hearth product, please estimate how many hours you typically use your hearth product in one sitting on average.**

- My hearth product is controlled using a thermostat and I never manually operate my heart product
- 1 hour or less per day
- More than 1 hour per use, up to 2 hours per use
- More than 2 hours per use, up to 4 hours per use
- More than 4 hours per use, up to 6 hours per use
- More than 6 hours per use, up to 12 hours per use
- More than 12 hours per use
- I don't know

**23. What is your main heating appliance?**

*A main heating appliance is the primary appliance used to heat the home, some common examples are a furnace, wall furnace, or electric heat pump.*

- Central Furnace
- Wall Furnace
- Boiler
- Heat Pump
- My Hearth Product
- Other
- I don't know

Question 23 in the test version of the survey:

**23. Is there a hearth product installed in your home?**

- Yes
- No
- I don't know

**24. How often do you turn on your hearth product for heating instead of turning on or adjusting your main heating appliance?**

- Almost never
- Sometimes
- As much as my main heating appliance
- More than my main heating appliance
- My hearth product is my main heating appliance
- I don't know

**25. Which option best describes how you operate your hearth product's pilot light?**

*The pilot light is a small flame used to light the main flame of the hearth product. You may be able to spot a small flame in the main hearth area that is always on or ignites before the main flame, or it may be underneath or near the main flame.*

- My hearth product does not have a pilot light
- When my hearth product is off I generally turn off the pilot light
- In the summer I turn off the pilot light
- The pilot light is always on
- I don't adjust my pilot light
- I don't know

Question 25 in the test survey did not include the response option "My hearth product does not have a pilot light."

**26. Do you use your hearth product more for heat or more for decorative purposes?**

- Only for heat
- Mostly for heat
- About evenly for heat and decorative
- Mostly decorative
- Only decorative
- I don't know

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**SECTION C: Repair and Maintenance Costs**

**For questions 27, 28, 29, and 30, please describe any MAINTENANCE (not repair) work done on your hearth product. Please select whether or not you have had the type of maintenance work done, please select the frequency of that maintenance work (select "not applicable" if you have not had this type of maintenance work), and please fill in the cost of maintenance (if applicable).**

*This includes all maintenance which incurs a financial cost, including professional cleanings or any device or chimney/flue servicing, BUT NOT including fuel expenses.*

In the test version of the survey, questions 27, 28, 29, 30 had a fill in the blank option for "Cost per Maintenance Task."

**27. Have you had professional cleaning of your hearth product's venting/chimney?**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Maintenance Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$50</li> <li>● \$51 - \$100</li> <li>● \$101 - \$200</li> <li>● \$201 or more</li> <li>● I don't know</li> </ul>

**28. Have you had professional cleaning of your hearth product's firebox/heart?**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Maintenance Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$50</li> <li>● \$51 - \$100</li> <li>● \$101 - \$200</li> <li>● \$201 or more</li> <li>● I don't know</li> </ul>

**29. Have you had professional cleaning of your hearth product's exterior?**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Maintenance Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$50</li> <li>● \$51 - \$100</li> <li>● \$101 - \$200</li> <li>● \$201 or more</li> <li>● I don't know</li> </ul>

**30. Have you had any other maintenance work done on your hearth product? If yes, please describe the type of maintenance, frequency of maintenance, and cost of maintenance below. (There is space below to describe up to two additional types of MAINTENANCE work)**

<i>Yes or No (dropdown)</i>	<i>Type of Maintenance (fill in the blank)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Maintenance Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>		<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$50</li> <li>● \$51 - \$100</li> <li>● \$101 - \$200</li> <li>● \$201 or more</li> <li>● I don't know</li> </ul>

<i>Yes or No (dropdown)</i>	<i>Type of Maintenance (fill in the blank)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Maintenance Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>		<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$50</li> <li>● \$51 - \$100</li> <li>● \$101 - \$200</li> <li>● \$201 or more</li> <li>● I don't know</li> </ul>

**For questions 31, 32, 33, and 34, please describe any REPAIR (not maintenance) work done on your hearth product. Please select whether or not you have had the type of repair work done, please select the frequency of that repair work (select "not applicable" if you have not had the presented type of repair work), and please fill in the cost of this repair work (if applicable).**

In the test version of the survey, questions 31, 32, 33, and 34 had a fill in the blank option for “Cost per Repair Task.”

**31. Have you had repair work because of ignition failure? (this does not include the pilot light going out)**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Repair Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$150</li> <li>● \$151 - \$300</li> <li>● \$301 - \$500</li> <li>● \$501 - \$1,000</li> <li>● \$1,001 or more</li> <li>● I don't know</li> </ul>

**32. Have you had repair work because of controls failure?**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Repair Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$150</li> <li>● \$151 - \$300</li> <li>● \$301 - \$500</li> <li>● \$501 - \$1,000</li> <li>● \$1,001 or more</li> <li>● I don't know</li> </ul>

**33. Have you had repair work because of damage due to uncontrolled combustion of gasses?**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Repair Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$150</li> <li>● \$151 - \$300</li> <li>● \$301 - \$500</li> <li>● \$501 - \$1,000</li> <li>● \$1,001 or more</li> <li>● I don't know</li> </ul>

**34. Have you had any other repair work done on your hearth product? If yes, please describe the type of repair work, frequency of repair work, and the cost of repair work below. (There is space below to describe up to two additional types of REPAIR work)**

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Repair Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$150</li> <li>● \$151 - \$300</li> <li>● \$301 - \$500</li> <li>● \$501 - \$1,000</li> <li>● \$1,001 or more</li> <li>● I don't know</li> </ul>

<i>Yes or No (dropdown)</i>	<i>Frequency of Maintenance (dropdown)</i>	<i>Cost per Repair Task (dropdown)</i>
<ul style="list-style-type: none"> <li>● Yes</li> <li>● No</li> </ul>	<ul style="list-style-type: none"> <li>● One or more times per year</li> <li>● Once every two years</li> <li>● Once every three to four years</li> <li>● Once every five or more years</li> <li>● Other</li> <li>● Not Applicable</li> </ul>	<ul style="list-style-type: none"> <li>● Not Applicable</li> <li>● \$1 - \$150</li> <li>● \$151 - \$300</li> <li>● \$301 - \$500</li> <li>● \$501 - \$1,000</li> <li>● \$1,001 or more</li> </ul>



		<ul style="list-style-type: none"><li>● I don't know</li></ul>
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**SECTION D: Demographic Questions**

*You **MUST** respond to all questions presented in this section.*

**If you live in more than one home, please restrict your responses in this section to the home where the hearth product is located.**

**35. Do you pay the energy bill for the hearth product (gas, propane, and/or electric), or does someone else?**

- Yes, I pay the bill. Select this option if you split the bill with others.
- No, someone else pays the bill.

**36. Please select which state your home is located in: [drop down menu listing all states in the United States]**

**37. What are the first three digits of the zip code where this home is located?**

- Example: for the zip code "90210", please enter "902"
- Please remember to include leading zeroes: for zip code "07245", please enter "072"

[Zip code:] \_\_\_\_\_

**38. What is your gender?**

- Male
- Female
- Decline to state

**39. Are you Hispanic or Latino?**

- Yes
- No
- Decline to state

**40. What is your race? Please check all that apply:**

- American Indian or Alaska Native

- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White or Caucasian
- Other: Please specify \_\_\_\_\_
- Decline to state

**41. What is your highest education level? [drop down]**

- No schooling completed
- Kindergarten to grade 12 (No Diploma)
- High school diploma or GED
- Some college, no degree
- Associate's degree (for example: AA, AS)
- Bachelor's degree (for example: BA, BS)
- Master's degree (for example: MA, MS, MBA)
- Professional degree (for example: MD, JD)
- Doctorate degree (for example: PhD, EdD)
- Decline to state

**42. How many people live in your home for most of the year (including you)? [drop down]**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

**43. Of the people you included in the total for the previous question, how many people are in the following age categories?**

**[Note: the sum of people listed in the following age categories should equal the total number of people who live in your home (question 42)]**

Number of people in your household younger than 10 [drop down]

- 0

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 10 to 19 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 20 to 29 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 30 to 39 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 40 to 49 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 50 to 59 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more

- I don't know

Number of people in your household who are 60 to 69 years old [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household who are 70 or older [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 or more
- I don't know

Number of people in your household whose ages are unknown or you prefer not to say [drop down]

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

- 8
- 9
- 10 or more
- I don't know

**44. What is your pre-tax combined annual household income?**

- \$0 - \$19,999
- \$20,000-\$39,999 per year
- \$40,000-\$59,999 per year
- \$60,000-\$79,999 per year
- \$80,000-\$99,999 per year
- \$100,000-\$119,999 per year
- \$120,000 or more per year
- Don't know/Decline to state

**45. What material are wine bottles typically made from?**

- Fabric
- Glass
- Rubber
- Tile
- Wood
- I Don't know

**46. What type of home is your hearth product located in?**

- Single-Family Detached (a house detached from any other house)
- Single-Family Attached (a house attached to one or more houses)
- Apartment building with 2-4 units
- Apartment building with 5 or more units
- Mobile Home
- Other: Please specify \_\_\_\_\_
- I Don't know/Decline to state

**47. Is this home owned or rented?**

- Owned or being bought by someone in your household
- Rented
- Occupied without payment of rent
- I don't know/Decline to states

**If you wish, please leave any comments regarding the survey's questions, design, or structure in the comment box below:** \_\_\_\_\_