Using SAS® to Determine the Revenue Impacts From Emerging Products

Mark E. Thompson, Forefront Economics

ABSTRACT

This paper demonstrates the use of SAS to determine the revenue impacts from emerging products. Consumer demand for natural gas fireplaces and logs, collectively referred to as hearth products, has grown significantly since 1990. However, little was known about the actual impact sales of hearth products had on sales of natural gas. In order to determine a marketing and planning strategy, NW Natural, a natural gas distribution company headquartered in Portland, Oregon, requested a rigorous analysis of the expected impact of hearth products on natural gas sales. In order to integrate hearth products in company market and system planning, NW Natural wanted to determine whether natural gas hearth products increased or decreased total home consumption and by how much. Furthermore, NW Natural wished to better understand the home characteristics that might be determinants of gas usage increases or decreases.

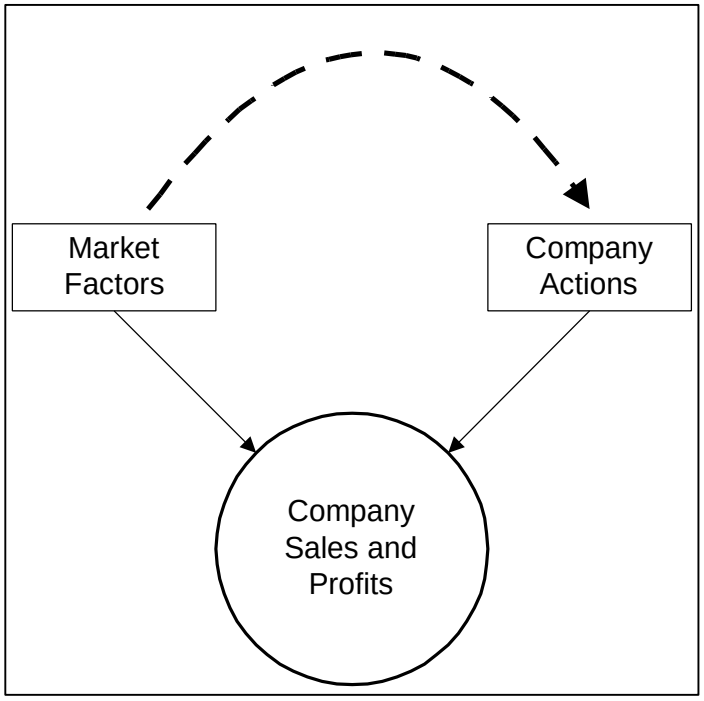
The purpose of this paper is to present the approach and results of research designed to combine customer survey information with monthly billing data to estimate the impact of gas fireplace and logs ownership on annual therm consumption. This paper also discusses how NW Natural has used the analysis to position hearth products in their marketing plan.

INTRODUCTION

Emerging trends often develop in the market place with uncertain impacts on company sales and profitability. Using the simple model shown in Chart 1, company sales and profitability is affected by a variety of influences from both market factors and company actions. It is obviously important to be aware of market factors when making business decisions.

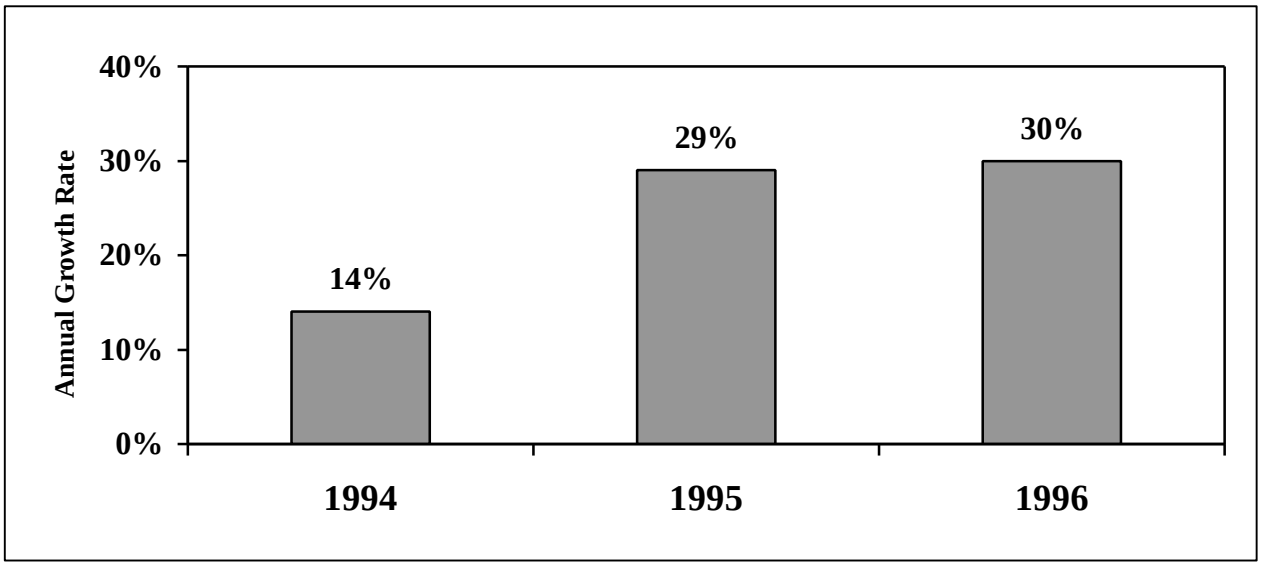
However, much more information is required than just being aware of changes in the market. For effective business planning, decision-makers must also understand how market factors effect company sales and profitability. The research reported in this paper was driven by the objective to understand how a market factor, the increase in sales of gas hearth products, affected sales of natural gas.

Chart 1. External Trends



NW Natural, a distributor of natural gas serving approximately 450,000 customers in Oregon and Washington recognized a developing market trend in the early 1990s. Sales of gas fueled hearth products, fireplaces and log inserts, had been increasing significantly. As shown in Chart 2, sales of gas fueled hearth products in their franchise territory have increased substantially in recent years.

Chart 2. Estimated Growth in Gas Hearth Products Sales
NW Natural Service Territory



NW Natural records of customer purchases of hearth devices served as the frame from which a random sample of 200 gas fireplace and 200 gas log owners was selected. Purchase records were sampled from two of NW Natural's retail outlets located in Portland and Salem, Oregon. Customers who purchased a hearth product from one of these outlets between March 1992 and February 1993 were included in the sample frame. The data required to estimate the econometric model came from two primary sources: NW Natural customer billing records and the customer telephone survey. Monthly billing records from January 1992 through August 1994 were obtained for the sample of 400 owners of hearth devices. Daily weather data were also required to calculate the weather conditions matched to each billing cycle for each customer.

Although NW Natural recognized this emerging trend in the early, the effect of growth in hearth product sales on company sales of natural gas was far less certain. The impact of hearth products on gas sales depended on the existing stock of gas-using appliances and human behavior, the ultimate wildcard. For example, adding a gas fireplace to a home with an existing gas furnace could result in either an increase or decrease in gas usage, depending on behavioral issues. If customers choose to turn down the central furnace and only heat the area affected by the gas fireplace, total gas usage could decline. If, on the other hand, customers use their gas fireplace as a replacement to a wood burning fireplace, usage could be expected to increase.

These examples illustrate the many questions which NW Natural set out to answer through customer research and SAS based modeling of gas consumption. Specifically, the following questions were address through this study:

- What percent of hearth products are installed in homes with gas furnaces and what percent with other heating systems and fuels?
- To what extent do consumers displace other fuels for heat?
- How much do consumers actually use their hearth products?
- Considering all factors simultaneously, what is the impact on sales of gas?

The answers to these questions formed the basis of NW Natural's marketing plan for hearth products.

METHODOLOGY

In this study, a telephone survey of customers who purchased a hearth product was used to directly answer many of the research questions. The impacts on gas sales were determined by the econometric model discussed below. The survey was used to collect appliance ownership, household characteristic, and socioeconomic data. One important feature of the survey was the use of

questions to identify the timing of change in space and water heating equipment and major changes within the household. Knowing the change and the timing of change allowed for a more accurately specified econometric model.

THE MODEL OF GAS USAGE

The quantity of energy a residence consumes in any given time period can be expressed as a function of that residence's stock of energy using appliances and variables related to the efficiency and use of the appliances. This type of relationship has been referred to as Conditional Demand Analysis (CDA) and includes such variables as weather conditions, household characteristics, including the stock of energy using devices, socioeconomic variables, and the price of energy. Conditional Demand Analysis has been used extensively in the energy industry to model energy consumption for several purposes, including forecasting, estimates of consumption for certain end-uses (e.g. space and water heating), and more recently, estimation of the impact of energy efficiency programs.[1] While many variations exist, the fundamental model can be expressed as:

$$E_{it} = \sum_J f_J(APP_{itj}, ECM_{itj}, BLDG_{itj}, W_{it}, SE_{it}, P_{it}, e_{itj}) \times D_{itj}$$

where:

- i, t, j = household i, time period t, and appliance j,
- E_{it} = energy consumption of household i during period t,
- APP_{itj} = characteristics of energy using appliance j in household i at period t (e.g. the efficiency rating of a forced air furnace),
- ECM_{itj} = energy conservation measures installed at household i during period t affecting appliance j (e.g. ceiling insulation),
- $BLDG_{itj}$ = building characteristics associated with household i during period t and affecting appliance j (e.g. square feet),
- W_{it} = weather conditions during period t and affecting household i,
- SE_{it} = socioeconomic conditions at household i during period t (e.g. income, number of persons),
- P_{it} = price of energy for household i during period t,
- e_{itj} = error term,
- D_{itj} = indicator variable for the presence of appliance j during period t and affecting household i.

Many variants of the theoretical model have been specified depending on research objectives and study design. The model estimated as part of this research is shown in Table 1.

A pooled cross-sectional, time-series data set consisting of approximately 400 homes with monthly data from January 1992 through August 1994 was constructed in SAS from the data sources previously discussed. The variables used in the empirical model are described in Table 1, including a classification of the type of variation in the variable; i.e., cross sectional (between residences), time series (over time), and both.

Space heating requirements were modeled with variables representing the presence of the gas heating device multiplied by heating degree days and square feet (FRHDD, FPHDD, LGHDD). The interaction between space heating appliances was modeled by including interaction variables between homes with gas furnaces and fireplaces (FRFPHDD) and homes with gas furnaces and logs (FRLGHDD). Home weatherization was modeled with an indicator variable set equal to one, for either shell insulation or storm windows (SHELLFR). The impact on space heating requirements from the use of electric (ELECBACK) and wood (WOODBACK) backup was modeled by including indicator variables for each secondary heating source. As with space heating equipment, heating backup and weatherization variables were specified as products of indicator variables, heating degree days, and square feet.

Several end-uses were modeled as products of an indicator variable indicating the presence of the end-use and the number of people in the household. These end-uses include water heating (WTRNP), cooking (COOKNP), and clothes drying (DRYERNP). The presence of a gas barbecue or grill was modeled as the product of an ownership indicator variable and a summer month indicator variable (BBQSUM). Gas spa and pool heaters were included as a simple indicator variable (SPA). Home

[1] Early work with CDA was reported by Parti and Parti, 1980. Since then, many variations have been used, especially in the area of demand side management evaluation. Schiffman (1994) provides an overview and comparison of some of these techniques.

age (AGE), household income (INC), and real gas rates (GPRES91) were also included in the model.

SAS was used (PROC REG) to estimate the model previously described. The t-statistic, to test the hypothesis that the parameter estimate is zero, is shown for all model variables in Table 2. Overall, the model appears to be well specified with a large amount of the variation in therm consumption per day explained (68 percent). The variables of primary importance in this analysis, FPHDD, FRFPHDD, LGHDD, and FRLGHDD are all highly significant and correctly signed. These results present strong evidence of a large and significant interaction between an existing gas furnace and gas fireplaces and logs.

Only three of the 16 variables in the model are incorrectly signed or statistically insignificant. The existence of electric backup (ELECBACK) does not have a significant impact on the therm consumption of homes heated with gas. Although the t-statistic associated with SHELLFR (shell insulation or storm windows) indicates the parameter is significantly different from zero, it has the wrong sign. The existence of gas barbecues in the summer months (BBQSUM) is also significant and incorrectly signed. An examination of the potential impact of multicollinearity between these and other variables in the model failed to identify any problems affecting the fireplace and logs variables.

Table 1. Description of Variables Used in CDA Model
Dependent Variable is Average Therms per Day

Variable Name	Description	Type of Variation
FRHDD	Gas Furnace Indicator * HDD60 * SQFT	Both
FPHDD	Gas Fireplace Indicator * HDD60 * SQFT	Both
FRFPHDD	Gas Furnace Indicator * FP * HDD60 * SQFT	Both
LGHDD	Gas Logs Indicator * HDD60 * SQFT	Both
FRLGHDD	Gas Furnace Indicator * Logs * HDD60 * SQFT	Both
ELECBACK	Electric Space Heat Backup Indicator * Gas Furnace Indicator * HDD60 * SQFT	Both
WOODBACK	Wood Space Heat Backup Indicator * Gas Furnace Indicator * HDD60 * SQFT	Both
SHELLFR	Shell Insulation-Windows Indicator * Gas Furnace Indicator * HDD60 * SQFT	Both
WTRNP	Gas Water Heating Indicator * Number of People	Both
COOKNP	Gas Cooking Indicator * Number of People	Both
DRYERNP	Gas Dryer Indicator * Number of People	Both
BBQSUM	Gas BBQ * Summer Months (Jun-Sep) Indicator	Both
SPA	Gas Spa or Pool Heater Indicator	Both
AGE	Age of House	Cross Sectional
INC	Household Income	Cross Sectional
GPRES91	NW Natural Residential Rate, Real (1991 base)	Time Series
HDD60 = Heating Degree Days at Base 60; SQFT = Square Feet; FP = Gas Fireplace Indicator, LOGS = Gas Logs Indicator		

Table 2. Estimation Results, Conditional Demand Model
Dependent Variable is Average Therms per Day

Variable Name	t for HO: Parameter = 0	Variable Name	t for HO: Parameter = 0
FRHDD	38.8	WTRNP	17.3
FPHDD	27.0	COOKNP	2.2
FRFPHDD	(15.4)	DRYERNP	2.7
LGHDD	10.3	BBQSUM	(3.4)
FRLGHDD	(5.9)	SPA	4.8
ELECBACK	(0.2)	AGE	2.9
WOODBACK	(7.0)	INC	2.7
SHELLFR	3.0	GPRES91	(3.2)
Overall Results: Observations 4,579 R-Square 68%			

MODEL SIMULATION

The estimated coefficients were used to predict the level of therm usage associated with a variety of scenarios. Assumptions used to simulate annual energy usage for gas appliances are shown in Table 3. Normal heating degree days were obtained from the National Weather Service, while the assumptions for square feet and number of people in the household were derived from the average of the survey results for these variables.

Table 3. Simulation Assumptions

Heating Degree Days, Base 60 (HDD60)	3,300
Square Feet (SQFT)	2,150
Number of People (NP)	2.7

Estimates of space heating impacts, including the impact of fireplace and logs ownership, were developed using the assumptions shown in Table 3. The resulting of these estimate of the impact of hearth products on annual gas sales is shown in Chart 3.

Gas furnaces have an estimated average usage of 657 therm per year. When a gas fireplace is added with an existing gas furnace, the result is 98 therms of additional annual consumption. About 35% of customers who purchased gas fireplaces said they do not use a gas furnace as their primary source of heat. For these types of customers, gas fireplaces contributed an estimated additional 536 therms per year. The interaction between gas fireplaces and furnaces is obviously quite large and accounts for the annual difference of 536 additional therms without a furnace and 98 additional therms with a furnace.

Gas logs, which according to the survey tend to be used for aesthetic reasons and operated less frequently than gas fireplaces, contribute significantly less to annual therm consumption. As shown in Chart 4, gas logs are operated only about one fifth as much as gas fireplaces. When added to a home that uses a gas furnace as their primary source of heat, logs add 65 therms to annual consumption. About 12 percent of the homes with logs said they do not use a gas furnace as their primary heat source. For these homes a gas log increases annual consumption by an estimated 237 therms.

Chart 3. Weather Normalized Annual Gas Usage

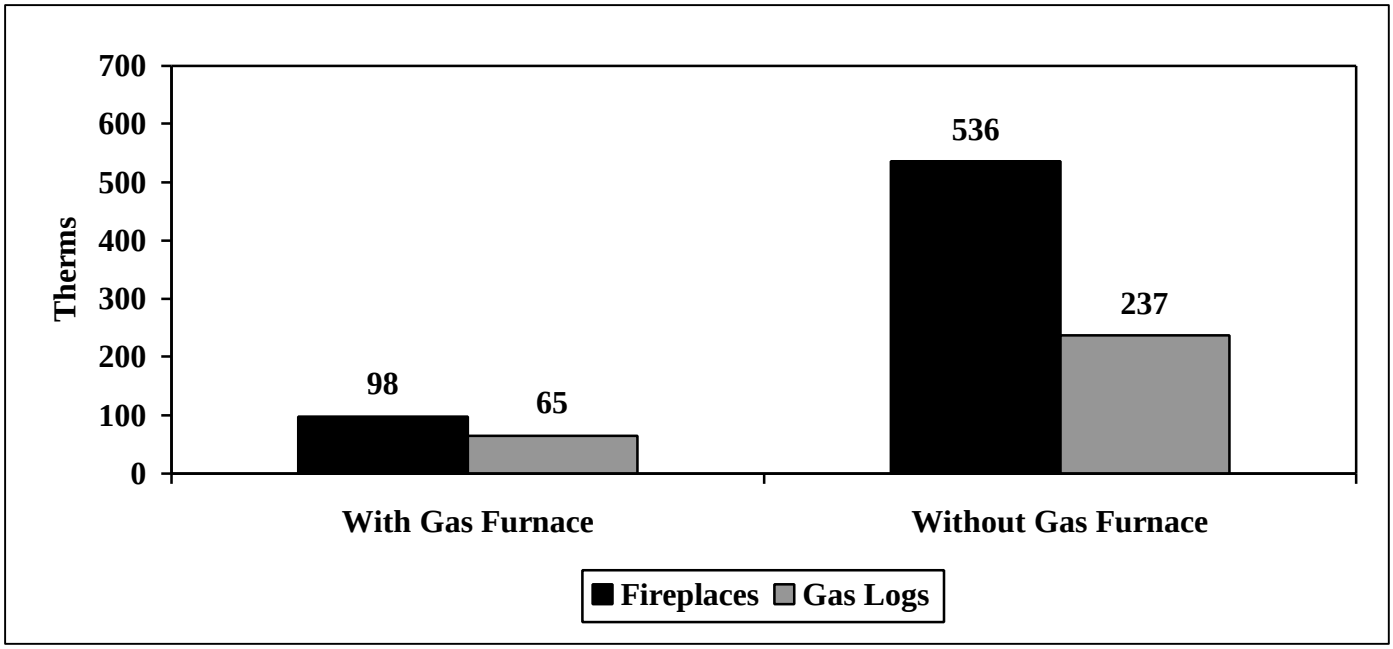
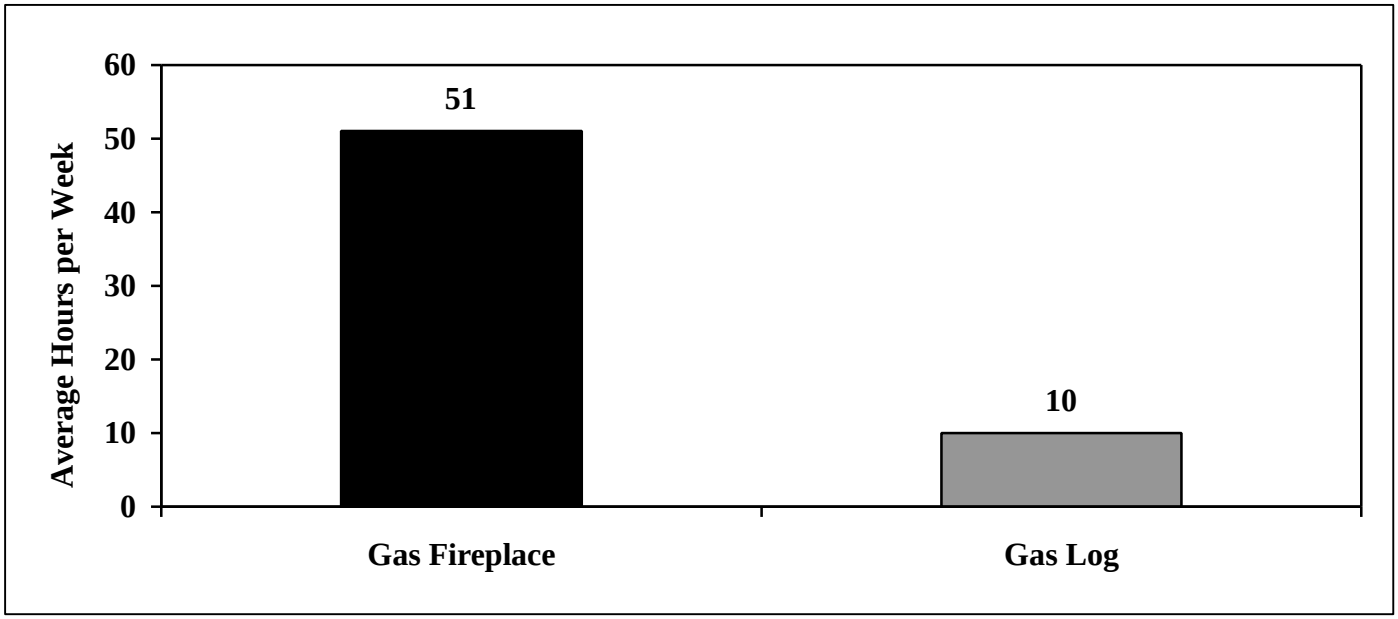


Chart 4. Winter Operating Hours Per Week



The importance of wood as a space heating fuel in the Pacific Northwest is also borne out in the results. Nearly a third of all NW Natural's residential customers use wood for a portion of their space heating needs. As shown in Chart 5, the percentage of households who use wood was even higher among hearth product purchasers (53 percent) before installation of their gas fireplace or gas logs. Those customers who use wood estimated that 26 percent of their space heating needs were met by using wood prior to purchasing a hearth product. After purchasing a hearth product, 75 percent of previous wood users indicated that they no longer have a wood burning device. In other words, 40 percent of all hearth product sales resulted in the elimination of the capability to burn wood. Customers who still own wood burning devices after installing a hearth product estimate that wood contributes 6 percent of their total heating needs. The survey and econometric results provide compelling evidence that hearth products significantly reduce wood use.

Substitution of gas for wood is obviously one of the results of the growth in gas hearth product sales. A review of consumer motivation for purchasing hearth products reveals that this substitution was an important driver in the decision to install a gas hearth product.

Reasons related to wood are mentioned as the primary reason for purchasing a gas hearth product by 55 percent of respondents. Reasons related to comfort are mentioned by 16 percent of respondents as the primary reason for purchasing a gas hearth product. A relatively small percentage said that saving money on heating bills was the primary reason. Several other reasons were also listed; none of which made up more than 5 percent of respondents. Other reasons for purchase mentioned by respondents included appearance, safety, and reduction in pollution.

MARKETING IMPLICATIONS

Based on this study, NW Natural was able to gain a better understanding of factors related to the installation of hearth products, including consumer motivations, impact on gas sales, and impact on supplemental heating fuels. Armed with a greater understanding of the market, NW Natural implemented the following elements of a hearth product market plan:

- Develop relationships with trade allies to promote the sale of hearth products
- Help consumers make informed purchase decisions by providing information on purchase and installation costs, operating costs, and fuel efficiency for the different types of hearth products available on the market.
- Emphasize the advantages of gas over wood.

This research formed the foundation of NW Natural's efforts in the hearth product market and has resulted in a comprehensive approach benefiting consumers, trade allies, and NW Natural. Over the next five years the company expects to receive an additional $5 million in revenue from gas sales due to the installation of new hearth products. NW Natural has also received national recognition for their hearth products marketing efforts.

REFERENCES

NW Natural, 1995. Natural Gas Fireplace and Log Study. Market Development Department.

Parti, Michael and C. Parti, 1980. *"The Total and Appliance Specific Conditional Demand for Electricity in the Household Sector"*, The Bell Journal of Economics, 2(1).

Schiffman, Dean A, 1994. *"A Monte Carlo Based Comparison of Techniques for Measuring the Energy Impacts of Demand-Side Management Programs"*, American Council for an Energy Efficient Economy (ACEEE), 1994 Summer Study Proceedings. Vol. l7, p 213-222.

AUTHOR

The author welcomes any questions or comments.

Mark Thompson
Forefront Economics
3800 SW Cedar Hills Blvd., Suite 299
Beaverton, OR 97005
Phone: (503) 626-1657
Fax: (503) 626-6320
E-mail: mark@forecon.com

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Chart 5. Wood Use Among Gas Hearth Product Owners Before and After Installation of a Gas Hearth Product

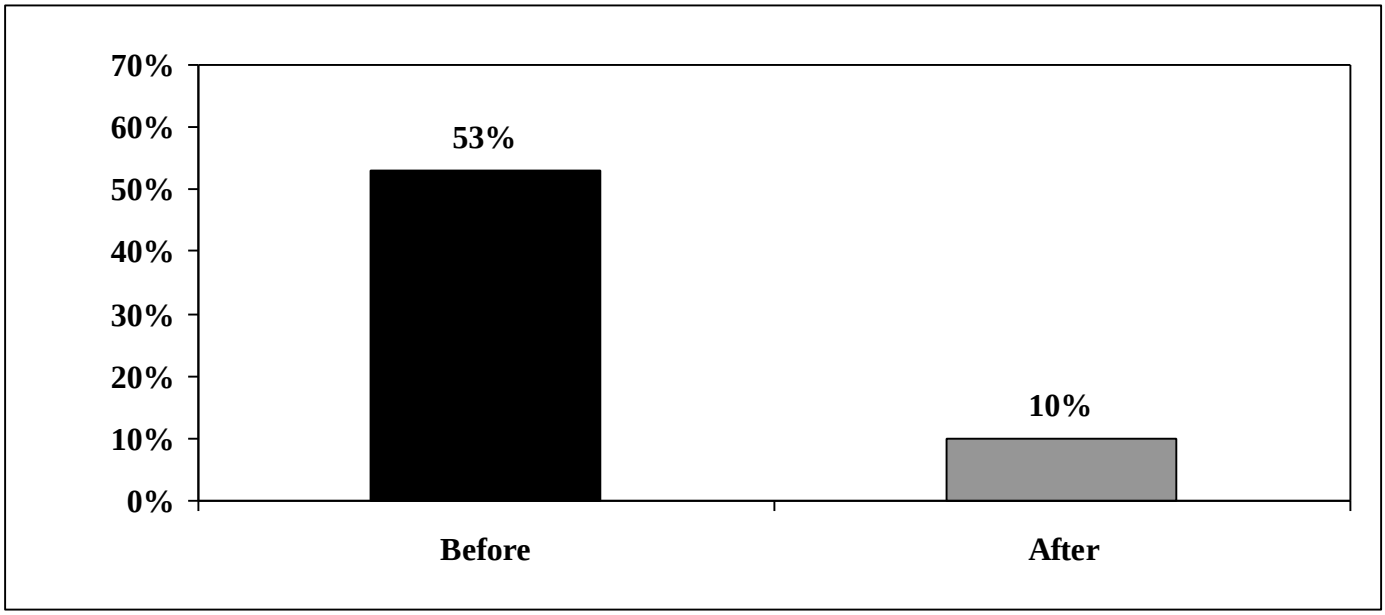

Chart 6. Main Reason For Purchasing a Gas Hearth Product