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Cost-Effectiveness Analysis of Alternative Woodstove New Source Performance Standards

Prepared for:

Hearth, Patio and Barbecue Association

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This report was prepared by NERA Economic Consulting ("NERA") on behalf of the Hearth, Patio and Barbecue Association ("HPBA"). The analyses described in this report use information collected and developed by HPBA experts as well as information from public sources. The NERA project team worked with the HPBA experts to review the information, but NERA makes no representation as to its accuracy.

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I. Executive Summary

This study evaluates the cost-effectiveness of increasingly stringent particulate matter emissions standards for woodstoves. Using detailed information on compliance costs and economic assessments consistent with EPA guidelines for economic analysis, we have developed estimates of the incremental cost per ton for three alternative new source performance standards (NSPS).

1. Step I standard of 4.5 grams per hour (g/h);

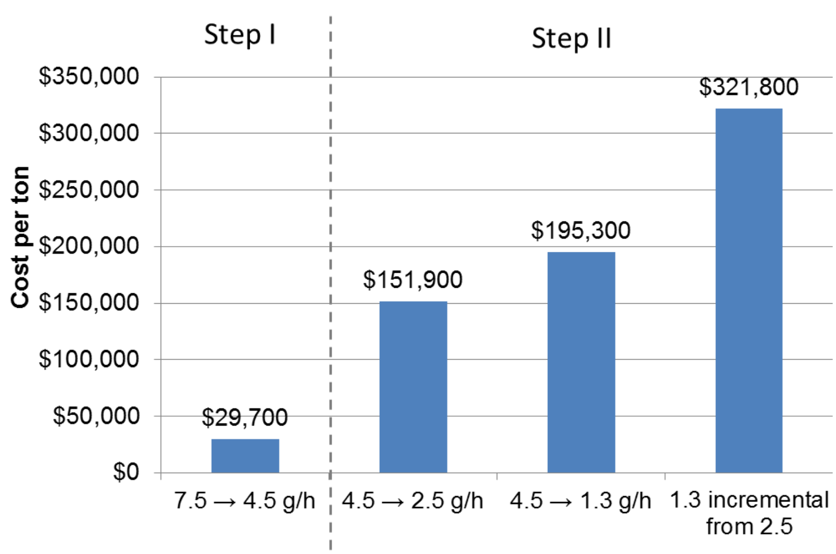
2. Step II standard of 2.5 g/h; and

3. Step II standard of 1.3 g/h.

We have developed estimates of the annualized costs and annual emission reduction benefits of these three alternative standards for an illustrative production year using detailed engineering cost and other information for the three standards developed by an industry expert and peer reviewed by a group of industry experts, as explained in appendices to this report. We also use information provided by the U.S. Environmental Protection Agency (EPA) in its recent proposed rulemaking.

Figure E-1 summarizes the results of our analysis. These results show that the two Step II standards are much less cost-effective than the Step I standard of 4.5 g/h. The cost per ton for the Step I standard of 4.5 g/h is $29,700 per ton, compared to $151,900 per ton for the Step II standard of 2.5 g/h or $195,300 per ton for a Step II standard of 1.3 g/h. Comparing the Step II options, a standard of 1.3 g/h is particularly costly relative to emission gains over a 2.5 g/h standard, resulting in an incremental cost per ton of $321,800 per ton.

Figure E-1. Cost-Effectiveness of Alternative Woodstove NSPS



Source: NERA calculations as explained in text

As noted, these results are based on cost and related information developed by an industry expert and peer reviewed by industry experts. We use sensitivity analysis to assess the implications of changing uncertain estimates used to calculate costs and annual emission reductions, including the underlying compliance cost information and the price elasticity of demand. Although the specific estimates of dollars per ton change under the sensitivity cases, none of the sensitivity cases modifies our basic conclusion that the Step I standard of 4.5 g/h is much more cost-effective than the Step II standards.

I. Introduction

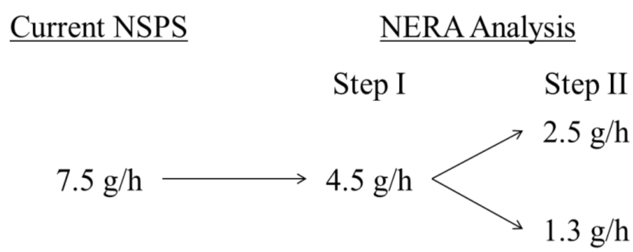
This report evaluates the cost-effectiveness of alternative particulate matter (PM) emission standards for new non-catalytic woodstoves. Consistent with economic principles and guidance provided by the U.S. Environmental Protection Agency (EPA) and the Office of Management and Budget (OMB), we focus on the incremental cost-effectiveness of increasingly stringent emission standards. That is, we compare the added annual costs and annual emission reduction gains as the emission standard is assumed to be increasingly stringent. Throughout the remainder of this report, we use "woodstoves" or "stoves" to refer to non-catalytic woodstoves.

A. Background on Woodstove Emission Standards and Study Objectives

The current NSPS for woodstoves (EPA 1988) require new non-catalytic woodstoves to meet a standard of 7.5 grams of particulate matter emissions per hour (g/h). The EPA on February 3, 2014 proposed new source performance standards (NSPS) for several types of wood heaters, including woodstoves (EPA 2014a).

We consider two potential additional "Steps" of increasingly stringent NSPS for woodstoves – a Step I standard of 4.5 g/h and a Step II standard of either 2.5 g/h or 1.3 g/h.

Figure 1. Alternative Woodstove Particulate Matter Emission Standards in NERA Analysis



The objective of this report is to evaluate these potential woodstove standards in terms of their incremental cost-effectiveness as measured by dollars per ton of particulate matter emissions reduced.

Note that the alternative standards would directly affect only new woodstoves. But the NSPS would have an indirect effect on emissions from existing stoves because of market effects. In particular, as discussed below, price increases for new stoves due to compliance with more stringent NSPS affect the scrappage rates of existing stoves and thus the overall annual emissions of new and existing stoves. The stock of stoves in the U.S. is composed of "certified" woodstoves that meet the current NSPS and a large number of "non-certified" woodstoves sold prior to the current NSPS that have higher particulate matter emission rates.

B. Overview of Methodology

There are five major elements in our cost-effectiveness methodology.

1. Estimate the annualized compliance costs per stove (unit cost) under different NSPS;

2. Determine the effects on new woodstove prices and sales of different NSPS;

3. Determine the effects on annual emissions (emission reductions) of different NSPS;

4. Determine the cost-effectiveness of different NSPS; and

5. Determine the incremental cost-effectiveness of different NSPS.

The following are brief summaries of these five elements of our calculations.

1. Unit Compliance Costs

We first estimate the annualized per-stove compliance costs associated with each alternative NSPS. Compliance costs represent the cost of modifying existing woodstove models and individual units to meet a specific emissions standard. We use detailed estimates of compliance cost components—including capital costs per model, other fixed costs per model, and variable costs per unit—developed by an industry expert and peer reviewed by a group of expert reviewers. Appendix A provides the detailed compliance cost estimates and summarizes the methodology used to develop and validate the estimates. This information represents the best source of data on the likely compliance costs to meet standards of different stringencies. We converted the costs per model to costs per stove based on assumptions on the annualization period and the average units sold per model.

It is, however, important to note some caveats regarding the data in Appendix A. As noted there, compliance costs may be understated due to potential changes in EPA certification testing methods and the way compliance with the standard is determined. The compliance costs estimates were developed based on current certification requirements, but EPA has proposed a more stringent compliance algorithm which we understand would increase NSPS compliance costs.

2. Woodstove Price and Sales Effects

The social costs of alternative NSPS depend in part on how the market for new woodstoves would respond to the added costs related to the emissions standards. We first determine baseline woodstove prices and sales using current market prices (described in Appendix B) and historical sales data. We then use estimates of per unit compliance costs to estimate the increase in woodstove prices under alternative NSPS.

These price changes in turn affect woodstove sales, an effect measured by the price elasticity of demand (i.e., the percentage decrease in sales due to a one percent increase in price). We use an estimate of the price elasticity of -1.6, based upon an EPA study. The price increase and the price elasticity estimate are used to estimate the change in new woodstove sales due to a given NSPS.

The reduction in woodstove sales affects the social costs in two ways. First, compliance costs are reduced (relative to unchanged sales quantity) because the "lost sales" do not incur compliance costs. But secondly, consumers who choose not to purchase a woodstove because of the higher prices experience a loss or cost, referred to in economic analyses as a "consumer surplus deadweight loss." We take into account this loss as a part of the social cost of alternative NSPS.

3. Emissions Reductions

We develop estimates of the changes in annual emissions due to the various NSPS. The estimates are based upon changes in annual emissions relative to a baseline assuming the current number of woodstove sales and their emissions. We identify three sources of changes in annual emissions.

1. *Demand effect.* The reduction in new woodstove sales would lead to a reduction in annual emissions from new stoves relative to what they would be in the baseline. This effect leads to emission reduction benefits.

2. *Compliance effect.* The reduced emission rate for new stoves also would lead to a reduction in annual emissions from new stoves relative to what they would be in the baseline. This effect leads to emission reduction benefits.

3. *Scrappage effect*. Higher new stove prices would result in a change in the scrappage rate for existing stoves; put another way, some of the reduction in new stove sales would be accompanied by an increase in the number of existing stoves (for the stoves that would have been replacement stoves). The scrappage effect would lead to greater annual emissions from the existing stoves than in the baseline. This effect leads to an offset for the annual emission reduction benefits.

Our estimates of emission reduction benefits for a given NSPS take into account all three of these effects.

4. Cost-Effectiveness Calculations

We calculate cost-effectiveness as the social cost per ton of emissions reductions ($/ton) for each of the alternative emission standards. The initial cost-effectiveness estimates are developed relative to the baseline NSPS of 7.5 g/h for the Step I NSPS of 4.5 g/h and relative to 4.5 g/h for the two alternative Step II NSPS.

5. Incremental Cost-Effectiveness Calculations

EPA guidelines for developing economic analyses note the importance of determining the incremental effects of increasingly stringent regulatory alternatives. In this case, we consider the incremental annual cost-effectiveness of the three NSPS standards, 4.5 g/h for Step I (relative to the baseline conditions), 2.5 g/h for Step II (relative to the 4.5 g/h Step I standard), and also 1.3 g/h for Step II (relative to the 2.5 g/h Step 2 standard).

These incremental annual cost-effectiveness values provide an indication of the additional "bang for the buck" obtained as the NSPS is made more stringent. We can use this information along with information on annual emission reductions achievable under the various standards to develop a "marginal cost curve" that shows the additional annual emission reductions achievable and the cost per ton of these additional tons as the potential standard is made more stringent.

C. Caveats

Empirical estimates in this study are based upon the best available data on costs and emissions. Please note the following technical caveats.

1. Costs may be understated because, as discussed below and in Appendix A, they do not reflect EPA's proposed changes to certification testing methods. The proposed methods would raise certification testing costs relative to levels assumed for cost estimation in this analysis.

2. Emission reductions from tighter standards may be overstated because, as discussed in Houck (2012), certification values do not necessarily correlate with actual emissions from in-home appliances. Even if they did, due to the inherent variability when burning wood, the EPA test methods cannot reliably distinguish emissions performance differences in the range of the proposed standards.

D. Organization of This Report

The remainder of this report is organized as follows. Chapter II provides information on the development of the annual cost-effectiveness estimates. Chapter III provides the incremental cost-effectiveness estimates. Both of these chapters are based upon our benchmark estimates of costs and other parameters. Chapter IV provides sensitivity analysis to evaluate how the results of the study would change under different assumptions regarding compliance costs and the price elasticity of demand. Chapter V provides a summary of the principal conclusions.

II. Development of Cost-Effectiveness Estimates

This chapter provides details on the methods we use to develop estimates of the annualized costs and annual emission reductions under the three alternative NSPS. This information is used in the final section to summarize our estimates of the cost-effectiveness of the three emission standards. In this chapter all costs and emission reduction benefits are measured relative to the baseline conditions.

A. Unit Compliance Costs

An industry expert developed detailed information on the potential costs of modifying woodstove models and units to comply with the alternative standards, information that was peer reviewed by a panel of industry experts. This information allows us to calculate the annualized cost per stove to comply with the three standards. This section summarizes the cost estimates and our calculation of per stove compliance costs.

1. Compliance Cost Inputs

Appendix A provides ranges of detailed compliance cost components associated with meeting the three NSPS along with the mid-point of the range for each component; we use the mid-point values in our base analysis and the lower and upper values in our sensitivity analysis. Costs per model and variable cost per unit were estimated for different potential emissions levels, and thus our estimates of compliance costs vary with the stringency of the potential NSPS; this variation is essential for any reasonable comparison of the cost-effectiveness of regulatory alternatives. These cost estimates are based on the current EPA test methods and weighted average procedure for determining compliance with NSPS; Ferguson (in Appendix A) indicates that changing the testing requirements and the more demanding compliance determination algorithm as proposed in EPA (2014a) would raise costs. The development and validation of these cost estimates are discussed in Appendix A.

As noted, in our base case analysis, we use the midpoints of the cost ranges developed in Appendix A and the average of the tooling cost estimates for steel and cast-iron stoves.[1] Table 1 shows the costs per model and the variable cost per unit that are used in this analysis. Note that all costs and prices in this report are in 2013 dollars.

1 Sensitivity cases using the lower and upper costs are presented in Chapter IV of this report.

Table 1. Detailed Compliance Costs for NERA Analysis

	7.5 to 4.5	4.5 to 2.5	4.5 to 1.3	2.5 to 1.3
R&D / engineering	$93,000	$151,250	$198,000	$176,000
Tooling	$33,475	$42,675	$48,575	$33,825
Purchasing	$4,000	$4,000	$6,000	$5,400
Testing	$6,000	$9,000	$12,500	$12,500
Equip and integration	$2,500	$3,000	$5,000	$5,000
Facilities	$0	$5,000	$8,000	$8,000
Certification	$22,400	$24,400	$36,875	$35,900
Roll-out	$120,350	$148,850	$217,100	$183,350
Total costs per model	$281,725	$388,175	$532,050	$459,975
Variable costs per unit	$59	$93	$148	$78

Source: Appendix A and NERA calculations as explained in text.

2. Compliance Cost per Stove

The cost information includes information on the costs per model to modify stove models to meet the alternative standards as well as the additional variable cost per stove. The information on costs per model from Table 1 is used along with information on indirect costs and variable costs to develop compliance costs per stove. The calculation of compliance costs per stove is shown in Table 2.

Table 2. Compliance Costs Per Stove

	7.5 to 4.5	4.5 to 2.5	4.5 to 1.3	2.5 to 1.3
Total costs per model	$281,725	$388,175	$532,050	$459,975
Annualized (10 years)	$40,111	$55,267	$75,752	$65,490
Per unit (800 units)	$50	$69	$95	$82
Variable costs per unit	$59	$93	$148	$78
Subtotal per unit	$109	$162	$242	$159
Indirect costs (35%)	$38	$57	$85	$56
Total costs per unit	$147	$219	$327	$215

Source: Appendix A and NERA calculations as explained in text.

The costs per model in Table 2 reflect costs that would apply to production in a number of years, and thus it is necessary to determine the costs that would be relevant for a single year of production. Ferguson (Appendix E) surveys woodstove manufacturers and reports that the largest average number of years that models remain in production in his sample was about 10 years (with the average of all surveyed manufacture 8.3 years). We annualize the model costs over 10 years using a 7 percent real annual discount rate. Annualized model costs are then divided by 800 annual stove sales per model and summed with variable costs per unit.[2] Finally, we add 35

[2] Historical sales data from Houck (2011) shown in Figure 2 and the 2010 HPBA Enhanced Certified Heater Database (EPA 2014c) suggest average annual sales per model of about 800 (roughly 100,000 sales divided by 125 non-catalytic stove models).

percent indirect costs to capture costs anywhere in the supply chain that were not directly estimated in Appendix A.[3]

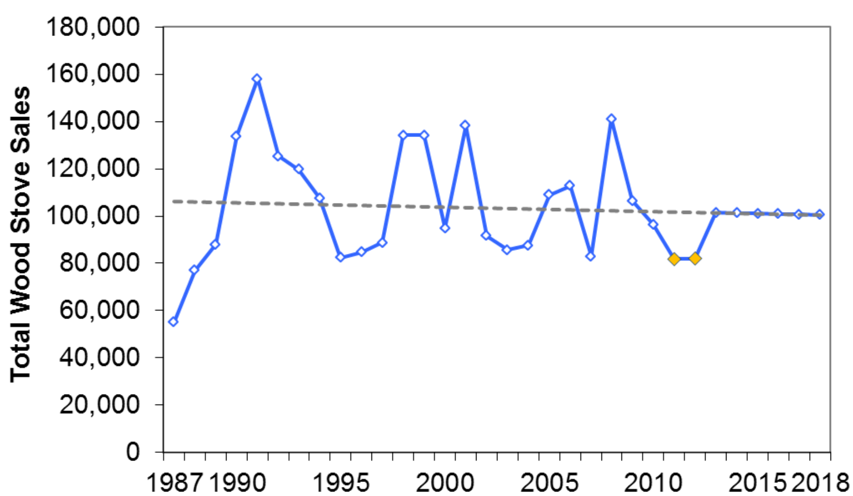
B. Sales, Prices, and Total Costs

The *total* compliance cost depends in part on the number of stoves that are actually sold, i.e., the sales of stoves if the relevant standard were in place. The number of woodstove sales, in turn, is a market outcome based upon changes in stove prices and consumers' willingness to pay for new woodstoves as reflected in the price elasticity of demand. In this section, we present baseline sales and price estimates for the average stove in an illustrative future year. We then estimate the impact of alternative NSPS on stove prices and sales and calculate the total cost of each potential standard net of any expected changes in sales.

1. Baseline Sales by Emissions Category

Figure 2 shows catalytic and non-catalytic woodstove sales using historical data from Houck (2011) and HPBA. A trend line based on 1987-2012 data gives projected 2018 sales of about 100,000 woodstoves. Using model counts from HPBA's 2010 Enhanced Certified Heater Database (EPA 2014c), we estimate that 88 percent of total woodstove sales are non-catalytic. We use the resulting 89,000 projected non-catalytic woodstove sales as our baseline in an illustrative future year.

Figure 2. Projected Catalytic and Non-Catalytic Woodstove Sales



Source: Houck (2011) 1987-2010 historical data; HPBA (2014) shipments data for 2011 and 2012; NERA trend line to 2018.

Various certified woodstoves have emission rates lower than the 7.5 g/h required under the current NSPS (EPA 2013); in cases where a model already would comply with a given standard,

[3] Indirect cost estimates are used in cost analysis of other EPA regulations (e.g. motor vehicle emissions standards). Our analysis does not include a separate markup for manufacturer profit.

it would not incur compliance costs or yield emission reductions as a result of that standard. In order to account for the mix of emission rates among baseline stove sales, we divide sales into four emissions categories using model counts and EPA certification emission rates from Appendix B, a survey of stove manufacturers, distributors, and retailers by Ferguson and Page. Emission rates are "rounded up" (i.e. models between categories are assumed to fall in the higher emissions category) because actual in-home emission rates tend to be higher than lab-determined values (Houck 2012).

1. 7.5 g/h: Test rates greater than 4.5 g/h

2. 4.5 g/h: Test rates greater than 2.5 g/h and less than or equal to 4.5 g/h

3. 2.5 g/h: Test rates greater than 1.3 g/h and less than or equal to 2.5 g/h

4. 1.3 g/h: Test rates less than or equal to 1.3 g/h

Table 3 shows the resulting estimates of baseline sales by emissions category.

Table 3. Baseline Sales by Emissions Category

	7.5 g/h	4.5 g/h	2.5 g/h	1.3 g/h	Total
Percentage of sales	10%	66%	18%	6%	100%
Sales units	9,000	59,000	16,000	5,000	89,000
Sales models	11	74	20	6	111

Source: Total sales based on historical sales data from Houck (2011) and HPBA (2013) and the 2010 HPBA Enhanced Certified Heater Database (EPA 2014c). Sales percentages by emissions category based on pricing survey (Appendix B).

Note: Number of sales models based on assumption of 800 annual sales per woodstove model.

2. Baseline Prices by Emissions Category

A survey of manufacturers, distributors, and retailers by Ferguson and Page (Appendix B) provides estimates of suggested retail prices for catalytic and non-catalytic woodstove models as well as the EPA certification value for emissions rate. We estimate the relationship between prices and EPA-certified emission rates across these models using ordinary least squares (OLS) regression, and we use the predicted values at 7.5, 4.5, 2.5, and 1.3 g/h as the baseline price for our four emissions categories; these predicted values are shown in Table 4.[4] The baseline sales-weighted average unit price based upon these calculations is $1,840.

[4] Note that this analysis does not take into account potential differences in other stove characteristics across the emission categories.

Table 4. Baseline Prices

	7.5 g/h	4.5 g/h	2.5 g/h	1.3 g/h	Total
Baseline price	$1,100	$1,800	$2,200	$2,500	
Baseline sales	9,000	59,000	16,000	5,000	
Weighted average price					$1,840

Source: NERA calculations as explained in text.

3. Price and Sales Methodology

The compliance costs of new emissions standards are presumed to be passed on to consumers through higher prices. Higher prices lead to lower stove sales, an effect we label the "demand effect." The magnitude of this effect for a given emissions standard depends on the compliance cost per unit (presented in Table 2), any retail markup on the compliance cost, and the consumer price elasticity of demand.

a. Retail Price Markup

We use an industry estimate that retailers generally price units to achieve a 40 percent gross margin (Appendix C), which is equivalent to a 67 percent retail markup.[5] We apply this retail markup to the compliance cost of each alternative NSPS. The total increase in the retail stove price caused by a new emissions standard is thus the sum of the unit compliance cost and the retail markup on the compliance cost.

b. Price Elasticity of Demand

Price elasticity of demand is an economic measure of the sensitivity of sales to changes in price. The elasticity is approximately equal to the percent change in sales resulting from a 1 percent increase in the price of a good.

In the absence of more recent estimates, we use the -1.6 elasticity of demand for wood heat from EPA's (1986) regulatory impact analysis. Under this assumption, a 10 percent increase in stove prices would lead to a roughly 16 percent decrease in stove sales. This percentage approximation is unrealistic for large changes in price; for example, a 100 percent increase (doubling) in price would not eliminate the *entire* woodstove market. We instead assume a log-log demand function and constant elasticity of demand,[6] which affects the shape of the demand curve and moderates the sales response to large changes in price. We test the sensitivity of our results to alternative demand elasticities in Chapter IV.

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[5] Gross margin is margin divided by retail price, and retail markup is margin divided by wholesale cost. For example, if total wholesale cost for a unit is $1,200, a retailer would sell it at $2,000 for a 40 percent gross margin ($800/$2,000) or a 67 percent retail markup ($800/$1,200).

[6] A log-log demand function takes the form $\log(Sales) = b_1 - b_2 * \log(Price)$. Assuming constant elasticity of demand ε, the parameter $b_2 = -1 * \varepsilon$ and the parameter b_1 is implied by the baseline sales and average price.

4. Prices and Sales Under Alternative NSPS

This section provides information on effects of the three alternative NSPS on woodstove prices and sales. We assume that the average price increase for a given standard can be developed using estimates of the costs to modify stoves from their baseline emission rates to the standard.

a. Step I: 4.5 g/h Standard

Under an emissions standard for new woodstoves of 4.5 g/h, stoves with baseline emissions rates of 7.5 g/h would have to be modified to comply with the new standard. The price of these units would increase to reflect the unit compliance cost of modifying a 7.5 g/h stove to a 4.5 g/h standard and the 67 percent retail markup on that compliance cost. Table 5 shows that the price of these modified stoves would rise by $246, from $1,100 in the baseline to $1,346 under the NSPS.

Table 5. Price of 7.5 g/h Stoves Modified to Meet 4.5 g/h NSPS

	Compliance Costs	Retail Markup	Price Increase	Original Price	NSPS Price
Modification of 7.5 models	$147	+ $99	= $246	$1,100	$1,346

Source: NERA calculations as explained in text.

To find the impact of this price change on stove sales, we treat woodstoves as a single market and simultaneously calculate the increase in the average stove price and the resulting decrease in annual sales from the demand effect.[7] The results are shown in Table 6. Average stove prices (averaged across all emission rates) are projected to rise by 2.5 percent and sales are projected to fall by 3.8 percent as a result of the 4.5 g/h standard.

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[7] Note that most stoves already meet a 4.5 g/h emissions standard in the baseline; the unit price for these stoves is unchanged under the 4.5 g/h standard. Note also that information is not available to develop assessments of price effects for stoves differentiated by characteristics other than their emission rates or to consider interactions among different types of stoves.

Table 6. Average Price and Sales under 4.5 g/h NSPS

	Modified 7.5 g/h	4.5 g/h	2.5 g/h	1.3 g/h	Total
NSPS price	$1,346	$1,800	$2,200	$2,500	
Weighted avg NSPS price					$1,886
Impact from baseline ($)					+$46
Impact from baseline (%)					+2.5%
Demand effect	-3,420	N/A	N/A	N/A	
Sales with demand effect	5,580	59,000	16,000	5,000	85,580
Impact from baseline					-3,420
Impact from baseline (%)					-3.8%

Source: NERA calculations as explained in text

Note: "Modified 7.5 g/h" are stoves modified from 7.5 g/h to meet a 4.5 g/h NSPS. The demand effect is assumed to reduce sales of these modified units, which experience an increase in price due to the NSPS.

b. Step II: 2.5 g/h Standard

In Step II, the starting point is no longer baseline conditions but rather a Step I standard of 4.5 g/h (as shown in Table 6). Table 7 shows the price of 4.5 g/h stoves modified to meet a 2.5 g/h emissions standard, and Table 8 shows the resulting average price and sales changes relative to Step I. The average stove price (averaged across all emission rates) is projected to increase by $285 (15.1 percent above Step I), and sales to decrease by over 17,000 units (20 percent below Step I).

Table 7. Price of 4.5 g/h Stoves Modified to Meet 2.5 g/h NSPS

	Compliance Costs	Retail Markup	Price Increase	Original Price	NSPS Price
Modification of 4.5 models	$219	+ $147	= $365	$1,761	$2,126

Source: NERA calculations as explained in text.

Table 8. Average Price and Sales under Step II 2.5 g/h NSPS

	Modified 4.5 g/h	2.5 g/h	1.3 g/h	Total
NSPS price	$2,126	$2,200	$2,500	
Weighted avg NSPS price				$2,171
Impact from baseline ($)				+$285
Impact from baseline (%)				+15.1%
Demand effect	-17,241	N/A	N/A	
Sales with demand effect	47,339	16,000	5,000	68,339
Impact from baseline				-17,241
Impact from baseline (%)				-20.1%

Source: NERA calculations as explained in text.

Note: "Modified 4.5 g/h" are stoves modified from 4.5 g/h to meet a 2.5 g/h NSPS. The demand effect is assumed to reduce sales of these modified units. Price and sales impacts are incremental to the previous standard; in this case, the "baseline" is a Step I standard of 4.5 g/h.

c. Step II – 1.3 g/h Standard

Under a Step II standard of 1.3 g/h, stoves with emissions rates of both 4.5 g/h and 2.5 g/h need to be modified to comply with the new standard. Table 10 shows that these modifications lead to a $506 average stove price increase and a reduction of about 27,000 stove sales – 32 percent of Step I sales.[8]

Table 9. Price of 4.5 and 2.5 g/h Stoves Modified to Meet Step II 1.3 g/h NSPS

	Compliance Costs	Retail Markup	Price Increase	Original Price	NSPS Price
Modification of 4.5 models	$327	+ $219	= $546	$1,761	$2,307
Modification of 2.5 models	$215	+ $144	= $359	$2,200	$2,559

Source: NERA calculations as explained in text.

[8] We assume that sales reductions begin with stoves with higher emission rates (in this case, 4.5 g/h stoves).

Table 10. Average Price and Sales under Step II 1.3 g/h NSPS

	Modified 4.5 g/h	Modified 2.5 g/h	1.3 g/h	Total
NSPS price	$2,307	$2,559	$2,500	
Weighted avg NSPS price				$2,392
Impact from baseline ($)				+$506
Impact from baseline (%)				+26.8%
Demand effect	-27,081	N/A	N/A	
Sales with demand effect	37,498	16,000	5,000	58,498
Impact from baseline				-27,081
Impact from baseline (%)				-31.6%

Source: NERA calculations as explained in text.

Note: "Modified 4.5 g/h" and "Modified 2.5 g/h" are stoves modified from 4.5 and 2.5 g/h to meet a 1.3 g/h NSPS. The demand effect is assumed to reduce sales of modified 4.5 g/h stoves, which experience the largest increase in price due to the NSPS. Price and sales impacts are incremental to the previous standard; in this case, the "baseline" is a Step I standard of 4.5 g/h.

5. Social Cost Methodology

The social cost of alternative NSPS for woodstoves has two components: (1) compliance costs; and (2) consumer surplus deadweight loss. Both components depend upon the market impacts of alternative standards discussed above.

a. Compliance Costs

Compliance costs are calculated after taking into account the reduced sales due to the demand effect. Sales decrease as a result of higher average stove prices under alternative NSPS. Only units that are sold after taking into account the demand effect contribute to compliance costs.

b. Consumer Surplus Deadweight Loss

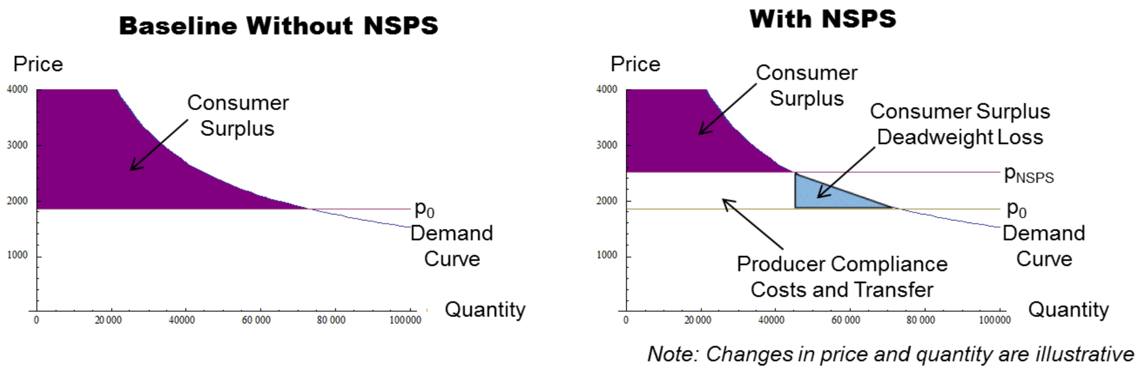
The social costs due to the demand effect include the loss of consumer surplus due to the reduced sales. A consumer would only buy a new woodstove if the value of the stove to that consumer were greater than the stove price. Consumer surplus measures, in this case, the value of stoves to consumers *beyond* the market price they pay.

If, under an alternative NSPS, the price of a stove were to rise to more than the value for a certain customer, then that customer would no longer purchase the stove. Put another way, the customer would receive no "consumer surplus" from the purchase and would spend his/her money on other goods and services. This "lost" sale reduces direct compliance costs due to the NSPS since there would be no costs to modify the stove to comply with NSPS; but the consumer who would otherwise benefit (acquire consumer surplus) from the stove purchase would be worse off. This cost or lost value to consumers who are priced out of the stove market is termed consumer surplus deadweight loss.

In market diagrams like Figure 3, total consumer surplus is the area under the demand curve (which represents consumers' willingness-to-pay) and above purchase expenditures (the rectangle from multiplying price paid by quantity purchased). The shaded triangle represents the loss of value to consumers who would have purchased stoves under baseline conditions, but are priced out of the market when the price of stoves rises to reflect the additional costs of the NSPS.

The importance of consumer surplus deadweight loss is evident when compliance costs are very large; if all consumers were priced out of the stove market by an alternative NSPS, there would be no direct compliance costs associated with the standard. Far from resulting in no social costs, however, this situation would mean that all of the social costs would take the form of lost consumer surplus.[9]

Figure 3. Consumer Surplus Deadweight Loss Diagram



Source: Illustrative results

6. Social Costs Under Alternative NSPS

The tables below show the calculation of compliance costs and consumer surplus deadweight loss under each alternative NSPS. The social cost is the sum of the compliance costs (accounting for the demand effect) and the consumer surplus deadweight loss. These calculations illustrate the importance of modeling market impacts prior to estimating the social cost of regulatory alternatives.

a. Step I – 4.5 g/h Standard

Table 11. Total Compliance Cost of a Step I 4.5 g/h NSPS

	Units	Cost/Unit	Cost
Modify 7.5 without demand effect	9,000	$147	$1,326,040
Modify 7.5 with demand effect	5,580	$147	$822,074

Source: NERA calculations as explained in text.

[9] Note that consumer surplus is reduced for consumers who continue to purchase new stoves when prices increase; but in this case, there is a corresponding transfer to producers and thus no additional net social costs.

Table 12. Consumer Surplus Deadweight Loss Under a Step I 4.5 g/h NSPS

Price impact from baseline ($)	+$46
Price impact from baseline (%)	+2.5%
Sales impact from baseline	-3,420
Sales impact from baseline (%)	-3.8%
Consumer surplus deadweight loss	$77,221

Source: NERA calculations as explained in text.

b. Step II – 2.5 g/h Standard

Table 13. Total Compliance Cost of a Step II 2.5 g/h NSPS

	Units	Cost/Unit	Cost
Modify 4.5 without demand effect	64,580	$219	$14,130,884
Modify 4.5 with demand effect	47,339	$219	$10,358,398

Source: NERA calculations as explained in text.

Table 14. Consumer Surplus Deadweight Loss Under a Step II 2.5 g/h NSPS

Price impact from new baseline ($)	+$285
Price impact from new baseline (%)	+15.1%
Sales impact from new baseline	-17,241
Sales impact from new baseline (%)	-20.1%
Consumer surplus deadweight loss	$2,305,179

Source: NERA calculations as explained in text.

Note: Price and sales impacts are incremental to the previous standard; in this case, the “baseline” is a Step I standard of 4.5 g/h.

c. Step II – 1.3 g/h Standard

Table 15. Total Compliance Cost of a Step II 1.3 g/h NSPS

	Units	Cost/Unit	Cost
Modify 4.5 without demand effect	64,580	$327	$21,114,688
Modify 4.5 with demand effect	37,498	$327	$12,260,309
Modify 2.5 without demand effect	16,000	$215	$3,442,232
Modify 2.5 with demand effect	16,000	$215	$3,442,232
Total without demand effect	80,580	N/A	$24,556,920
Total with demand effect	53,498	N/A	$15,702,541

Source: NERA calculations as explained in text.

Table 16. Consumer Surplus Deadweight Loss Under a Step II 1.3 g/h NSPS

Price impact from new baseline ($)	+$506
Price impact from new baseline (%)	+26.8%
Sales impact from new baseline	-27,081
Sales impact from new baseline (%)	-31.6%
Consumer surplus deadweight loss	$6,151,373

Source: NERA calculations as explained in text.

Note: Price and sales impacts are incremental to the previous standard; in this case, the "baseline" is a Step I standard of 4.5 g/h.

C. Emissions Reductions

This section describes our estimates of the annual particulate matter emission reduction benefits due to the alternative NSPS. The Office of Air Quality and Standards at EPA typically has relied on analysis of annual emission reductions to develop its cost-effectiveness estimates.[10] The emission benefits developed in our report similarly are emission changes in an illustrative year.

1. Baseline Annual Emissions

Emissions benefits are estimated relative to a baseline developed using historical data. We have updated from previous analyses to use EPA (2014b) estimates of the annual emissions per stove for different emission rate categories of certified stoves. We use Houck (2011) to estimate the annual emissions per stove for non-certified woodstoves (summarized in Table 17). These emission rates are all shown in Table 18.

[10] See, e.g., EPA (2012a) Table 3-4 comparing costs and emission reductions for oil and natural gas controls in 2015 and EPA (2012b) Table 1-1 comparing costs and emission reductions for petroleum refinery flare regulations in 2017.

Table 17. Particulate Matter Emissions of In-Use Non-Catalytic Non-Certified Woodstoves, 2010

	Non-certified Cordwood Stoves (Pre '87/'90)
Units	4,344,000
Emissions (tons)	135,000
Emissions (tons/unit)	0.0311

Source: Houck (2011), p. 33

Notes: Non-certified stoves are those that do not meet the current NSPS of 7.5 g/h.

Table 18. Annual PM Emissions per Stove

	7.5 g/h	4.5 g/h	2.5 g/h	1.3 g/h	Non-Cert
Annual emissions (tons/unit)	0.0129	0.0077	0.0042	0.0022	0.0311

Source: Certified stove emissions for 4.5, 2.5, and 1.3 g/h stoves from EPA (2014b), Table 4-3. Tons per unit for 7.5 g/h stoves is the annual emissions for 4.5 g/h stoves scaled up by a factor of 7.5/4.5, consistent with the calculation described in EPA (2014b) p. 4-5. Non-certified stove emissions based on Houck (2011), p. 33.

Applying the EPA estimates of emissions per stove to our baseline sales information, we calculate total annual emissions by stove type in Table 19. The average new woodstove is assumed to have baseline total annual emissions of 651 tons in this illustrative year.

Table 19. Baseline Total Annual Emissions by Stove Type

	7.5 g/h	4.5 g/h	2.5 g/h	1.3 g/h	Total
Units	9,000	59,000	16,000	5,000	89,000
Annual emission rate (tons/unit)	0.0129	0.0077	0.0042	0.0022	0.0073
Annual emissions (tons)	116	456	68	11	651

Source: NERA calculations as explained in text

2. Components of Emissions Reductions

There are three components of annual emissions changes resulting from alternative NSPS.

1. *Demand Effect*: The rise in stove prices causes sales to fall, so fewer units are emitting.

2. *Compliance Effect*: Units converted to comply with alternative NSPS emit less.

3. *Scrappage Effect*: Reduced scrappage of existing units leads to more emissions.

a. Demand Effect

When woodstove prices rise because of compliance costs associated with a new emissions standard, there is a decrease in sales through the demand effect. The demand effect results in fewer units emitting particulate matter than in the baseline conditions (ignoring for the moment the implications of increased prices for new stoves on the scrappage of existing stoves).

b. Compliance Effect

After accounting for the demand effect, some units will be modified to comply with the new emissions standard. The compliance effect is the improved emissions performance of these units that did not comply with the new standard in the baseline and would be sold under the alternative NSPS. If there were no market responses to the compliance cost of alternative NSPS, the compliance effect would be the only change in emissions.

c. Scrappage Effect

Our analysis is focused on emission reductions from modifying new stoves introduced in an illustrative future year; but there is also a large stock of existing woodstoves, many of which are non-certified and thus have emissions substantially greater than the standards being considered. Ferguson and Page (Appendix D) estimate that 40 percent of new stove sales are replacements of existing non-certified stoves; assuming these replaced stoves would be "scrapped" (i.e., taken out of use), these existing stoves would have no emissions. But as a result of price increases for new stoves under alternative NSPS, fewer existing non-certified stoves would be replaced.[11] The increase in emissions from these existing stoves (relative to what they would be if there were no NSPS) is called the "scrappage effect." Scrappage effects are often included in analyses of regulations that affect the price of new products (see, e.g. Goulder et al. 2009 analysis of emission standards for new motor vehicles).

The increase in annual emissions from existing non-certified stoves through the scrappage effect partly offsets the emissions decrease from the demand and compliance effects. Table 18 shows that existing non-certified stoves have an average emission rate several times larger than new stoves.

3. Annual Emissions Reductions under Alternative NSPS

The tables below show the three components of annual emissions change resulting from alternative NSPS in an illustrative future year. For example, Table 20 shows that the Step I demand effect reduces sales of 7.5 g/h units by 3,420; these units had emissions of 0.0129 tons per year in the baseline but are no longer sold and have a "Policy Emission Rate" of 0. There are 5,580 stoves with emissions of 0.0129 tons in the baseline that are now modified to 0.0077 tons per year to comply with the NSPS (the compliance effect). Finally, 1,368 existing, non-certified

[11] Imagine a demand effect in which 10 fewer stoves are sold. Under baseline conditions, 4 of those 10 stoves (40 percent) would have replaced existing non-certified woodstoves that presumably would be scrapped. Those four old stoves are no longer replaced and scrapped, so their emissions are higher under alternative NSPS than in the baseline.

units (40 percent of 3,420) were replaced in the baseline ("Baseline Emission Rate" of 0 tons/unit) but continue to emit 0.0311 tons per unit under the new standard through the scrappage effect.

a. Step I – 4.5 g/h Standard

Table 20. Annual Emissions Impact by Component for Step I 4.5 g/h Standard

	Emissions Impact	Number of Units	Baseline Emission Rate (tons/unit)	Policy Emission Rate (tons/unit)	Emissions Change
Demand effect	-	3,420	0.0129	0	-44
Compliance effect	-	5,580	0.0129	0.0077	-29
Scrappage effect	+	1,368	0	0.0311	+43
Net effect	-				-30

Source: NERA calculations as explained in text.

b. Step II – 2.5 g/h Standard

Table 21. Annual Emissions Impact by Component for Step II 2.5 g/h Standard

	Emissions Impact	Number of Units	Baseline Emission Rate (tons/unit)	Policy Emission Rate (tons/unit)	Emissions Change
Demand effect	-	17,241	0.0077	0	-133
Compliance effect	-	47,339	0.0077	0.0042	-165
Scrappage effect	+	6,896	0	0.0311	+214
Net effect	-				-83

Source: NERA calculations as explained in text.

Notes: Emissions impacts are incremental to the previous standard; in this case, the "Baseline Emissions Rate" is the emissions rate under a Step I standard of 4.5 g/h.

c. Step II – 1.3 g/h Standard

Table 22. Annual Emissions Impact by Component for Step II 1.3 g/h Standard

	Emissions Impact	Number of Units	Baseline Emission Rate (tons/unit)	Policy Emission Rate (tons/unit)	Emissions Change
Demand effect	-	27,081	0.0077	0	-209
Compliance effect (4.5 → 1.3 g/h)	-	37,498	0.0077	0.0022	-207
Compliance effect (2.5 → 1.3 g/h)	-	16,000	0.0042	0.0022	-33
Scrappage effect	+	10,832	0	0.0311	+337
Net effect	-				-112

Source: NERA calculations as explained in text.

Notes: Emissions impacts are incremental to the previous standard; in this case, the "Baseline Emissions Rate" is the emissions rate under a Step I standard of 4.5 g/h.

III. Incremental Cost-Effectiveness

This section summarizes our previous estimates and uses the information to develop *incremental* cost-effectiveness calculations for the three alternative woodstove NSPS. The incremental cost per ton of each alternative is the incremental annualized social costs divided by the incremental annual emissions reductions (both relative to the appropriate baseline). We look at three separate sets of calculations to develop the appropriate incremental cost per ton results.

1. A Step I standard of 4.5 g/h compared to the current (baseline) standard of 7.5 g/h.

2. Step II standards of 2.5 g/h and 1.3 g/h compared to Step I standard of 4.5 g/h.

3. A Step II standard of 1.3 g/h compared to a Step II standard of 2.5 g/h ("1.3 incremental from 2.5").

Note that the calculation of the cost-effectiveness of the 1.3 g/h Step II standard relative to the Step 1 standard of 4.5 g/h is an intermediate calculation; as discussed below, the appropriate beginning point to evaluate the incremental cost-effectiveness of the 1.3 g/h Step II standard is the 2.5 g/h Step II standard, because the 2.5 g/h Step II standard is the next most stringent standard.

A. Sales Impacts and Incremental Social Costs

Table 23 and Figure 4 summarize woodstove sales and incremental annualized social costs under alternative NSPS. Sales fall significantly below baseline levels (89,000 units) under both of the Step II standards; the resulting consumer surplus deadweight loss is 18 percent of social costs under a 2.5 g/h standard and 28 percent of social costs under a 1.3 g/h standard.

Total social costs are much larger under the Step II standards than in Step I because 90 percent of new stoves already comply with the Step I standard. The total annualized cost is about $900,000 for the Step I standard, in contrast to about $12.7 million for the 2.5 g/h Step II standard and about $21.9 million for the 1.3 g/h Step II standard. Note that the incremental annualized social cost for the 1.3 g/h standard relative to the 2.5 g/h Step II standard is $9.2 million ($21.9 million minus $12.7 million).

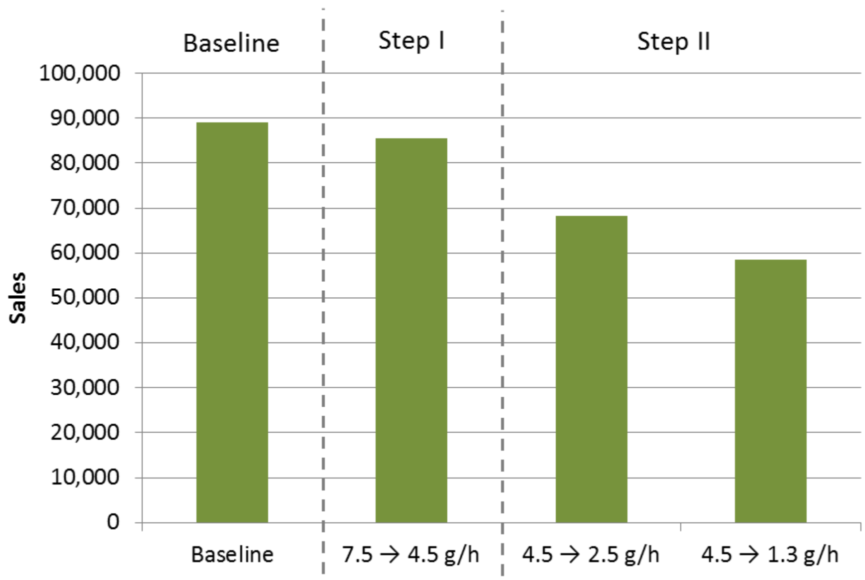
Table 23. Sales and Annualized Social Costs of Alternative NSPS

	STEP I	STEP II		
	7.5 → 4.5 g/h	4.5 → 2.5 g/h	4.5 → 1.3 g/h	1.3 incremental from 2.5
Sales with demand effect	85,600	68,300	58,500	N/A
Social cost				
Compliance cost	$822,000	$10,358,000	$15,703,000	$5,344,000
Consumer surplus deadweight loss	$77,000	$2,305,000	$6,151,000	$3,846,000
Total cost	$899,000	$12,664,000	$21,854,000	$9,190,000

Source: NERA calculations as explained in text.

Notes: Baseline sales are 89,000 units. Total cost may not equal the sum of rows due to independent rounding.

Figure 4. Annual Stove Sales Under Alternative NSPS



Source: NERA calculations as explained in text.

B. Incremental Emission Reductions

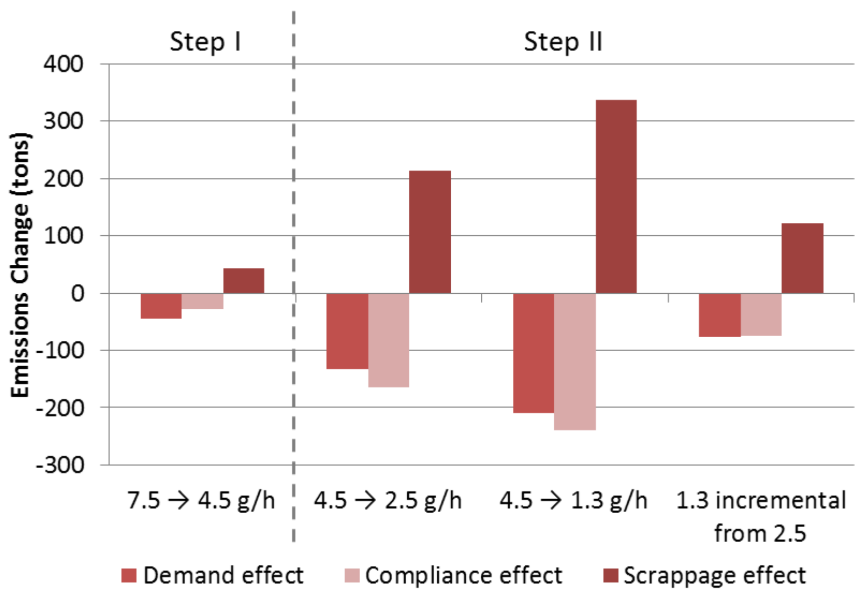
Table 24 and Figure 5 summarize the incremental change in annual particulate matter emissions in the illustrative year under each alternative NSPS. The net result of the demand, compliance, and scrappage effects is an annual reduction of 30 tons of particulate matter in Step I and additional annual reductions of 83 tons or 112 tons under Step II standards of 2.5 or 1.3 g/h (relative to the Step I reductions). Note that setting the Step II standard at 1.3 g/h rather than 2.5 g/h would result in additional annual reductions of about 29 tons. These annual emission reductions are used in our cost-effectiveness calculations.

Table 24. Incremental Change in Annual Emissions of New Stoves Under Alternative NSPS

	STEP I	STEP II		
	7.5 → 4.5 g/h	4.5 → 2.5 g/h	4.5 → 1.3 g/h	1.3 incremental from 2.5
Emissions change (tons)				
Demand effect	-44	-133	-209	-76
Compliance effect	-29	-165	-239	-75
Scrappage effect	+43	+214	+337	+122
Net emissions change (tons)	-30	-83	-112	-29

Source: NERA calculations as explained in text.
Note: Net emissions may not equal the sum of rows due to independent rounding.

Figure 5. Incremental Change in Annual Emissions of New Stoves Under Alternative NSPS



Source: NERA calculations as explained in text.

C. Incremental Cost-Effectiveness

The incremental annual cost-effectiveness results are presented in Table 25 and Figure 6. The Step I standard of 4.5 g/h is most cost-effective at $29,700 per ton. The additional emissions reductions achieved by Step II standards of 2.5 or 1.3 g/h are much more costly ($151,900 and $195,300 per ton, respectively).

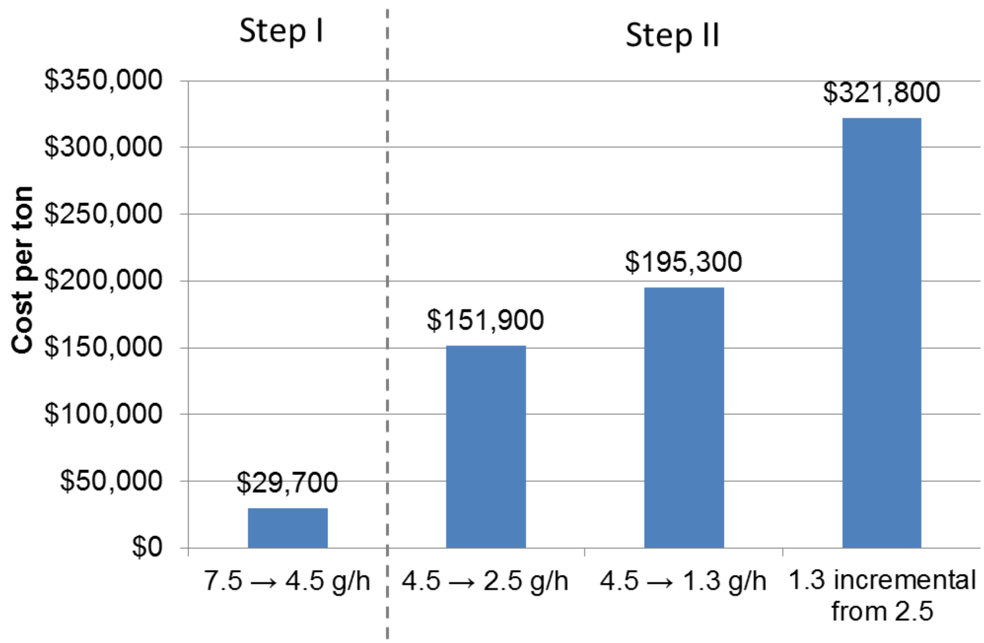
As noted, the appropriate comparison for the 1.3 g/h Step II standard is the incremental cost-effectiveness of 1.3 g/h relative to 2.5 g/h, shown in the final column of Table 25. The additional 29 annual tons of emissions reductions achieved using a Step II standard of 1.3 have an average social cost of $321,800 per ton. This result indicates that the 1.3 g/h standard is significantly more costly than the 2.5 g/h standard in terms of the incremental cost per ton.

Table 25. Incremental Cost-Effectiveness of Alternative NSPS

	STEP I	STEP II		
	7.5 → 4.5 g/h	4.5 → 2.5 g/h	4.5 → 1.3 g/h	1.3 incremental from 2.5
Total social cost	$899,000	$12,664,000	$21,854,000	$9,190,000
Net emissions change (tons)	-30	-83	-112	-29
Cost per ton	$29,700	$151,900	$195,300	$321,800

Source: NERA calculations as explained in text.

Figure 6. Incremental Cost-Effectiveness of Alternative NSPS



Source: NERA calculations as explained in text.

IV. Sensitivity Analyses

The cost-effectiveness results presented thus far can be thought of as "base" case results. They were developed using the available information on compliance costs and woodstove market characteristics provided by industry experts as well as reasonable assumptions and best professional judgment.

Any analyses of future costs and market behavior are subject to some uncertainty. In this chapter we test the robustness of our base case results by accounting for uncertainty in compliance costs and the demand elasticity. We first discuss the role of uncertainty analysis and specifically sensitivity analysis. We then show the sensitivity of our results to alternative assumptions. These sensitivity cases support our finding that the more stringent Step II woodstove emissions standards are much less cost-effective than the Step I standard.

A. Background on Uncertainty Analysis

Economists and policy analysts have long recognized that analyses of costs and market modeling, no matter how careful and thorough, inevitably are subject to some degree of uncertainty. A robust cost-effectiveness analysis will include either a discussion of the major uncertainties or a formal quantitative analysis of uncertainty.

Sensitivity analysis is a widely used approach to considering uncertainty in a quantitative manner in economic analyses (see, e.g., EPA 2010). Sensitivity analysis helps to determine which uncertainties are most critical and whether plausible changes in the parameter values and assumptions could change the conclusions reached using base-case assumptions.

1. Guidelines on the Treatment of Uncertainty in Benefit-Cost Analysis

Guidelines on benefit-cost analysis from EPA and OMB address the importance of uncertainty analysis and the conditions under which quantitative uncertainty analysis should be undertaken.

a. EPA *Guidelines*

EPA's *Guidelines* state that "[E]very analysis should address uncertainties resulting from the choices the analyst has made" (EPA 2010, p. 11-11). EPA stresses the importance of assessing and describing uncertainty in economic analyses and notes that the impact of using alternative assumptions or alternative models can be assessed quantitatively. EPA notes that sensitivity analyses can be useful to assess how a model's output changes as one of its input parameters change (EPA 2010, p. 11-11).

EPA's *Guidelines* also recognize that consideration of all possible uncertainties is not possible or even desirable. As a result, uncertainty analyses should focus on the most critical uncertainties, those most likely to make a material difference to decision makers:

> Because performing an alternative analysis on all the assumptions in an analysis is prohibitively resource intensive, the analyst should focus on the assumptions that have the largest impact on the final results of the particular analysis (EPA 2010, p. 11-11).

b. OMB Guidelines

In its most recent guidance for regulatory agencies, OMB stresses that important uncertainties connected with regulatory decisions need to be analyzed and presented as part of an overall regulatory analysis (OMB 2003).

OMB provides specific guidance on when a quantitative analysis of uncertainty is appropriate. For "major rules" involving "annual economic effects" of $1 billion or more, a formal uncertainty analysis is required. OMB also recommends a rigorous approach to uncertainty in regulations for which "net benefits are close to zero" (OMB 2003).

In other situations (when economic effects are less than $1 billion and net benefits are not close to zero), OMB suggests the following:

> Disclose qualitatively the main uncertainties in each important input to the calculation of benefits and costs. These disclosures should address the uncertainties in the data as well as in the analytical results (OMB 2003).

2. Sensitivity Analysis

Sensitivity analyses help to determine which uncertainties are most critical and whether plausible changes in the parameter values and assumptions could change the overall results and conclusions—in this case, the cost-effectiveness of alternative woodstove emissions standards.

Sensitivity analysis involves varying key input parameters, typically one at a time, over appropriate ranges to determine their effects on net costs (Boardman et al. 2011). Such analyses are often more appropriately termed "partial" sensitivity analysis. "Partial sensitivity is most appropriately applied to what the analyst believes to be the most important and uncertain assumptions" (Boardman et al. 2011, p. 178).

One of the advantages of using sensitivity analysis is its computational ease. It is relatively easy to modify the values of key inputs to see how they affect the results. For each parameter considered, typically "low" and "high" values are tested in addition to the base-case value.

B. Sensitivity Analyses

We evaluated the effects of two major factors that could significantly affect our cost-effectiveness results and that are subject to some degree of uncertainty: [12]

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[12] Our calculations include some assumptions (e.g., number of production years over which capital and fixed costs would be amortized) that seem likely to understate the likely cost per ton.

1. Compliance costs; and

2. Elasticity of demand.

1. Compliance Costs

The specific costs of modifying stoves to meet different emission levels are uncertain. Our base case compliance costs use the midpoint values of detailed compliance cost ranges provided in Appendix A. We use the lower and upper compliance costs as sensitivity cases. The costs per unit in these cases as well as the base case based upon the mid-point values are summarized in Table 26.

Table 26. Cost per Stove for Compliance with Alternative Emissions Standards: Lower, Mid-Point and Upper Values

	7.5 to 4.5	4.5 to 2.5	4.5 to 1.3	2.5 to 1.3
Cost per Stove				
Lower	$93	$147	$246	$142
Mid-point	$147	$219	$327	$215
Upper	$201	$291	$408	$288

Source: NERA calculations as explained in text.

2. Price Elasticity of Demand

The impacts of any significant regulatory action like new woodstove emissions standards also depend in part on the result of market forces and consumer purchase decisions. One key parameter for modeling these impacts is the price elasticity of demand, which describes the responsiveness of sales to changes in price (in this case as a result of new regulatory costs). In our base case analysis, we use an elasticity of demand of -1.6 taken from EPA's 1986 Regulatory Impact Analysis. We performed sensitivity analyses using smaller and greater elasticities of -1.2 and -2. A 10 percent increase in price would lead to a roughly 12 percent decrease in sales with an elasticity of -1.2 and a roughly 20% decrease in sales with an elasticity of -2.

3. Sensitivity Analysis Results

The results of our sensitivity analyses are shown in Table 27. These sensitivity results do not alter the general conclusion that more stringent standards are less cost-effective and that both Step II standards have much higher costs per ton than a Step I standard of 4.5 g/h.

Table 27. Sensitivity of Cost-Effectiveness Results to Alternative Costs and Elasticity of Demand

	Base Case	Lower Costs	Upper Costs	Lower Elasticity	Upper Elasticity
Model Parameters					
Cost Inputs	Mid-point	Lower	Upper	Mid-point	Mid-point
Elasticity of Demand	-1.6	-1.6	-1.6	-1.2	-2.0
Social Cost					
7.5 → 4.5	$899,000	$647,000	$1,096,000	$1,051,000	$688,000
4.5 → 2.5	$12,664,000	$8,959,000	$16,026,000	$13,275,000	$11,939,000
4.5 → 1.3	$21,854,000	$16,783,000	$26,570,000	$22,863,000	$20,700,000
1.3 incremental from 2.5	$9,190,000	$7,824,000	$10,545,000	$9,588,000	$8,761,000
Net Emissions Change (tons)					
7.5 → 4.5	-30	-35	-27	-36	-21
4.5 → 2.5	-83	-123	-51	-118	-51
4.5 → 1.3	-112	-168	-65	-177	-53
1.3 incremental from 2.5	-29	-45	-14	-58	-2
Cost Effectiveness ($/ton)					
7.5 → 4.5	$29,700	$18,700	$40,600	$29,000	$32,700
4.5 → 2.5	$151,900	$73,100	$314,200	$112,100	$234,100
4.5 → 1.3	$195,300	$99,900	$406,900	$129,200	$388,400
1.3 incremental from 2.5	$321,800	$172,200	$737,700	$164,000	$3,823,100

Source: NERA calculations as explained in text.

Note: Parameters differing from base case assumptions are in red.

V. Conclusions

This study has evaluated the cost per ton of increasingly stringent NSPS for woodstoves. Using detailed information on compliance costs and economic methodology consistent with EPA guidelines, we have developed estimates of the incremental cost per ton for three alternative NSPS.

1. Step I standard of 4.5 g/h;
2. Step II standard of 2.5 g/h; and
3. Step II standard of 1.3 g/h.

These results indicate that both Step II NSPS are considerably less cost-effective than the Step I standard of 4.5 g/h. The cost per annual ton for the Step I standard of 4.5 g/h is $29,700 per ton, compared to $151,900 per ton for the Step II standard of 2.5 g/h or $195,300 per ton for a Step II standard of 1.3 g/h. Comparing the Step II options, a standard of 1.3 g/h is particularly costly relative to emission gains over a 2.5 g/h standard, resulting in an incremental cost per ton of $321,800 per ton.

We considered the implications of uncertainties related to compliance costs and the price elasticity of demand. Although the specific estimates change under alternative parameters, none of the sensitivity cases modified our basic conclusion that the Step I standard of 4.5 g/h is much more cost-effective than either of the Step II standards.

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Proposed Wood Heater NSPS Incremental Cost Effectiveness Analyses

Appendix A

Woodstove Cost Modeling

Prepared for the Hearth, Patio & Barbecue Association

By Robert Ferguson

Ferguson, Andors & Company

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I. Introduction and Overview

This appendix describes the methodology for estimating the costs of modifying woodstove models to comply with potential changes to the EPA New Source Performance Standards for woodstoves. The Hearth, Patio & Barbecue Association (HPBA) engaged Robert W. Ferguson, President of Ferguson, Andors & Company to develop the cost estimates and provide them to NERA Economic Consulting for cost-effectiveness analysis. As discussed below, a "bottom-up" approach was used to identify the relevant components of compliance costs and to develop a range of cost estimates for each cost component based on our extensive experience in woodstove development, testing and manufacturing. The cost estimates were focused on mid-sized non-catalytic[1] stove models since those models currently represent the biggest segment of the market. In developing the cost estimates, we incorporated detailed comments from a review panel consisting of ten industry experts. The range of cost estimates resulting from this process are representative of typical manufacturers and typical woodstove models, but actual costs for particular manufacturers could lie outside the range. NERA used the mid-points (averages) of the cost ranges for the cost-effectiveness analysis.

The following subsections of this introductory section provide brief background on Robert Ferguson and the expert reviewers, an overview of the emission rate categories used in the cost-effectiveness analysis, an overview of the cost categories, a summary of the cost estimates, and discussion of omitted costs. The second section of this appendix identifies the components of each cost category and presents tables with the detailed cost estimates. The appendix concludes with a section describing the expert review process. CVs for Robert Ferguson and each of the expert reviewers are included at the end.

A. Background on Robert Ferguson and Expert Reviewers

Robert Ferguson has worked in the wood heater industry for over thirty-three years and is now among the foremost experts in the country for the hearth industry, particularly with regard to product development, testing and manufacturing. He holds a degree in chemical engineering,

[1] Catalytic models implicate all of the same capital, fixed and variable cost elements as non-catalytic models although there are likely to be some differences in the estimated costs for individual cost elements. For example, achieving the proposed Step 1 emission level of 4.5 g/h may require fewer "design, modification and test" cycles for a catalytic model than for a non-catalytic model. Other cost components will be quite similar since these items need to be addressed independent of the technology. This includes elements like engineering, manufacturing and tooling, certification and roll out costs. This is especially true for a model that makes a transition from non-catalytic to catalytic or "hybrid" technology. Variable costs are about equivalent as the non-catalytic technology is replaces by a catalytic element and associated hardware plus the addition of a bypass damper system. Hybrids include most of the components from both technologies and could be expected to have higher incremental variable costs than either technology alone. At the proposed Step 2/3 levels, the cost difference between the technologies narrows. Achieving those proposed levels of emissions performance will implicate a significant investment for most models and most manufacturers regardless of technology.

worked as a senior manager for a major woodstove manufacturer from 1980 to 1990, and founded Ferguson, Andors & Company in 1991. The company provides a full range of product development consulting and regulatory compliance services. Clients include small and large companies from around the world. This extensive experience and unparalleled expertise allowed development of accurate compliance cost estimates that reflect actual input requirements and the diversity of wood stove manufacturers. Mr. Ferguson's CV appears at the end of this appendix.

Ten industry experts were consulted to ensure that the cost estimates were accurate and reflected the wide range of potential costs for woodstove manufacturers. As shown in their CVs appearing at the end of this appendix, the industry experts have many years of experience designing, manufacturing and marketing woodstoves (ranging from 10 years to almost 40 years) and represent small and large companies from throughout the United States and Canada.

For most cost components, the initial estimates were provided to the expert panel for independent review. Their feedback was incorporated into the final cost estimates (preserving the confidentiality of any sensitive business information). For some cost components, however, other industry experts provided assistance in the initial stage developing the cost estimates. Additional information on the expert review process is provided in the final section of this appendix.

B. Overview of Emissions Rate Categories

As discussed in the NERA Report, new wood stoves were divided into four categories based on emission rate for this cost-effectiveness analysis. Two categories relate to current standards, and the other two categories relate to potential new standards. Woodstoves that comply with the current EPA standard of 7.5 g/h but not with the Washington State standard of 4.5 g/h are categorized as 7.5 g/h stoves. Woodstoves that comply with the Washington State standard but would not comply with lower standards are categorized as 4.5 g/h stoves. The two categories for stoves complying with potential new standards are 2.5 g/h stoves and 1.3 g/h stoves.

Consistent with EPA's proposed approach for the new NSPS, the cost-effectiveness analysis assumes that the EPA regulations would be implemented in two steps. It assumes that in the first step, EPA would tighten the wood stove standard from the current level of 7.5 g/h to the Washington State level of 4.5 g/h. In the second step, the analysis evaluates the impacts of tightening the standard further to either 2.5 g/h or 1.3 g/h.

Cost estimates were developed for each of these steps in regulatory implementation. For the first step, the costs of modifying 7.5 g/h stoves to comply with a new 4.5 g/h standard were estimated. For the second step, the costs of modifying 4.5 g/h stoves to comply with new standards of 2.5 g/h or 1.3 g/h were estimated. In addition for the second step, the costs of modifying 2.5 g/h stoves (a segment of the new stove market under baseline conditions) to comply with a new standard of 1.3 g/h were estimated. Costs reflect additional work and materials for technological modifications to improve the emission performance of woodstove models while leaving the other features and design elements of the models unchanged.

C. Overview of Cost Categories

The first step was to identify and catalogue the numerous components of compliance costs to design, manufacture, certify and market modified woodstove models that would be anticipated to achieve compliance with the proposed emission standards. The cost components can be grouped into three categories:

1. *Capital costs per model*. These include costs for research and development (R&D), engineering labor, tooling, equipment, integration, preliminary testing, and other costs to design and manufacture the modified woodstove models. Capital costs per stove model were estimated for each relevant modification (e.g., 7.5 g/h to 4.5 g/h).
2. *Other fixed costs per model*. These include costs for certification testing (EPA and safety listing) and roll-out of the modified products (including store display models and burn programs, brochures, user manuals, training and product discounts while the manufacturer clears inventory). Fixed costs per stove model were estimated for each relevant modification scenario (e.g., 7.5 g/h to 4.5 g/h).
3. *Variable costs per unit*. These include incremental costs for materials associated with the improved emission performance, machining, assembling and inspection labor for each unit produced. Variable costs per unit produced were estimated (in contrast to costs per model as with capital and fixed costs).

Each cost component was estimated as incremental costs for compliance with new emission standards beyond baseline costs that would be incurred for existing models. As noted above, estimates for each cost component typically depend on the modification scenario (e.g., 7.5 g/h to 4.5 g/h), but some cost components have the same estimates for all relevant modifications. Subsequent sections of this appendix present detailed information on the cost estimates by category and modification scenario.

D. Summary of Cost Estimates

The table below presents a summary of the cost estimates for the four relevant modification scenarios. As noted above, a range of estimates for each cost category was developed, and NERA used the mid-point (average) of each range for the cost-effectiveness analysis.

In the table below, the first column for each modification scenario shows the lower end of the cost range, the second column shows the upper end of the cost range, and the third column shows the midpoint of the cost range (the value used by NERA). Capital costs and fixed costs are per model, while variable costs are per unit. The cost estimates are in 2013 dollars. Detailed information on the cost estimates appears in subsequent sections of this appendix.

Table 1. Summary of Cost Estimates

	≤7.5 to ≤ 4.5			≤4.5 to ≤ 2.5		
	Lower	Upper	Midpoint	Lower	Upper	Midpoint
Capital Costs per Model	$94,350	$183,600	$138,975	$153,900	$275,950	$214,925
Fixed Costs per Model	$75,000	$210,000	$142,750	$93,000	$253,500	$173,250
Total Costs per Model	$169,350	$393,600	$281,725	$246,900	$529,450	$388,175
Variable Costs per Unit	$39	$79	$59	$65	$121	$93
	≤4.5 to ≤ 1.3			≤2.5 to ≤ 1.3		
	Lower	Upper	Midpoint	Lower	Upper	Midpoint
Capital Costs per Model	$204,950	$351,200	$278,075	$179,950	$301,500	$240,725
Fixed Costs per Model	$154,200	$353,750	$253,975	$141,000	$297,500	$219,250
Total Costs per Model	$359,150	$704,950	$532,050	$320,950	$599,000	$459,975
Variable Costs per Unit	$118	$177	$148	$48	$107	$78

Note: All Costs are in 2013 dollars.

E. Omitted Costs

The cost estimates **do not** include the impacts of EPA's proposed revisions to the testing requirements or to the algorithm used to determine compliance with Step 2/3 standards. These revisions, if included in the final rule, can only be expected to cause an increase to both development and certification costs over what is reflected.

II. Cost Components

This section provides details on the three categories of costs to modify woodstoves to comply with new standards: (1) capital costs per model; (2) other fixed costs per model; and (3) variable costs per unit. The tables below show the lower and upper ends of the cost estimate ranges for components within each cost category.

A. Capital Costs per Model

Capital costs to modify woodstove models for the four relevant modification scenarios were estimated. Capital costs were divided into three subcategories:

1. *Research and Development (R&D) and Engineering*. This subcategory includes capital costs for product research, product design, prototype construction and extensive in-house testing.
2. *Tooling*. This subcategory includes capital costs for acquiring and installing the machinery to produce the modified woodstoves. As described below, tooling cost estimates for steel stoves and cast iron stoves were developed separately. These two

materials each represent about half of the new stove market, so the average tooling costs for new stoves are the average of the tooling costs for steel stoves and cast iron stoves.

3. *Other capital cost components*. This subcategory includes miscellaneous capital costs, including arranging parts purchases, testing first production models, integrating equipment, and preparing facilities.

The following subsections present detailed information on these subcategories of capital costs.

1. Research and Development (R&D) and Engineering

The following table presents the ranges of cost estimates per model for R&D and engineering costs within the capital cost category. Many of these components would be the same for all modification scenarios (e.g., market research, aesthetic design, and initial prototype design), but the costs of some components would differ significantly by modification scenario (e.g., repeating the design/modify/test cycle until the emission target is met). If manufacturers must reduce the emission rates of their wood stoves by large increments, their costs for designing and testing new wood stove models would increase roughly in proportion.

Table 1. Capital Costs per Model: R&D and Engineering

R&D/Engineering	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Market/Competitive Product Research	$0	$4,000	$0	$4,000	$0	$4,000	$0	$4,000
Aesthetic Design	$0	$4,000	$0	$4,000	$0	$4,000	$0	$4,000
Initial Prototype Design (with Drawings)	$5,000	$15,000	$5,000	$15,000	$5,000	$15,000	$5,000	$15,000
Initial Prototype Construction	$2,000	$6,000	$2,000	$6,000	$4,000	$7,000	$2,000	$6,000
Baseline Testing on Development Prototype	$6,000	$7,000	$6,000	$7,000	$6,000	$7,000	$6,000	$7,000
Formulate Design Changes - Initial and Subsequent	$1,000	$2,000	$1,000	$2,000	$1,000	$2,000	$1,000	$2,000
Modify Prototype - Initial and Subsequent	$1,000	$1,500	$1,000	$1,500	$1,000	$2,000	$1,000	$2,000
Test Modified Prototype - Initial and Subsequent	$4,000	$6,000	$4,000	$6,000	$4,000	$6,000	$4,000	$6,000
Repeat Design/Modify/Test Cycle Until Emission Target is Met	$30,000	$47,500	$60,000	$100,000	$90,000	$150,000	$80,000	$120,000
Construct 2 Final Prototypes for Cert. Testing (Emissions & Safety)	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000
Confirm Final Prototype Performance	$6,000	$7,000	$10,000	$12,000	$12,000	$15,000	$12,000	$14,000
Safety Test Check	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000
Document Final Design Changes -Engineering Drawings and Part Specs	$5,000	$10,000	$5,000	$10,000	$8,000	$12,000	$8,000	$12,000
Patent Application (for protecting new technology)	$0	$0	$10,000	$15,000	$10,000	$15,000	$10,000	$15,000
R&D/Engineering Total Cost Ranges	$66,000	$120,000	$110,000	$192,500	$147,000	$249,000	$135,000	$217,000

Note: All costs are in 2013 dollars.

2. Tooling

The following table presents the ranges of cost estimates per model for tooling within the capital cost category. As noted above, tooling costs for steel stoves and cast iron stoves were estimated separately. As with R&D and engineering costs, many tooling components have the same costs for all modification scenarios, but some components have higher costs for large increments between the model's current and new emission rates. Tooling costs are higher for cast iron stoves than for steel stoves because of the more complicated processes for cast iron products. As noted above, NERA used the average of steel stove and cast iron stove tooling costs for the cost-effectiveness analysis, because steel stoves and cast iron stoves represent approximately equal fractions of new stove sales. It should be noted that many steel stoves have at least some cast iron components, most often doors, legs and bypass damper parts.

Table 2. Capital Costs per Model: Tooling

Tooling	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Steel Stove								
Translate Engineering Part Drawings into Production Part Drawings	$2,000	$2,400	$2,000	$3,000	$2,000	$4,000	$2,000	$3,000
NC Programming Steel Parts	$1,000	$2,000	$1,500	$2,500	$1,500	$3,000	$1,500	$3,000
NC Programming & Machining Cast Part Negatives & Pour Positives	$0	$4,000	$0	$4,000	$0	$5,000	$0	$4,000
Make Test Parts (Tooling Trials)	$1,000	$2,000	$1,500	$2,500	$2,000	$4,000	$1,500	$2,500
Production Patterns - Cast Iron Parts	$0	$10,000	$0	$10,000	$0	$10,000	$0	$10,000
Machine Sample Parts & Create Machining Specs	$500	$800	$800	$1,000	$800	$1,000	$800	$1,000
Fabricate and Refine Jigs & Fixtures	$2,000	$4,000	$3,000	$5,000	$3,000	$5,000	$3,000	$5,000
Confirm New Part Fit-up	$1,200	$3,000	$1,200	$3,000	$2,000	$3,000	$1,500	$3,000
QA/QC Specs	$2,000	$3,000	$2,000	$3,500	$2,000	$3,500	$2,000	$3,500
Tooling - Steel Stove Total Cost Ranges	$9,700	$31,200	$12,000	$34,500	$13,300	$38,500	$12,300	$35,000
Cast Iron Stove								
Translate Engineering Part Drawings into Production Part Drawings	$2,000	$4,000	$3,000	$5,000	$2,000	$4,000	$2,000	$4,000
NC Programming & Machining Cast Part Negatives & Pour Positives	$8,000	$16,000	$12,000	$20,000	$15,000	$25,000	$8,000	$16,000
NC Programming Steel Parts	$0	$500	$0	$500	$0	$500	$0	$500
Cast or Obtain Sample Parts (Tooling Trials)	$1,000	$2,000	$2,000	$3,200	$1,000	$2,000	$1,000	$2,000
Production Patterns	$15,000	$30,000	$20,000	$40,000	$30,000	$45,000	$15,000	$25,000
Machine Sample Parts & Create Machining Specs	$500	$1,000	$800	$1,200	$1,000	$1,500	$500	$1,000
Fabricate and Refine Jigs & Fixtures	$2,000	$4,000	$3,000	$5,000	$3,000	$4,000	$2,000	$4,000
Confirm New Part Fit-up	$1,500	$3,000	$2,000	$4,000	$2,000	$4,000	$1,500	$3,000
QA/QC Specs	$1,000	$1,500	$1,000	$1,500	$1,000	$1,500	$1,000	$1,500
Tooling - Cast Iron Stove Total Cost Ranges	$31,000	$62,000	$43,800	$80,400	$55,000	$87,500	$31,000	$57,000

Note: All costs are in 2013 dollars.

3. Other Capital Cost Components

The following table presents the ranges of cost estimates per model for other components within the capital cost category. These include arranging parts purchases, testing first production models, integrating equipment, and preparing facilities. Each of these other capital cost components varies depending on the modification scenario. These other capital cost components are small relative to capital costs and fixed costs per model.

Table 3. Capital Costs per Model: Other Components

	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Purchasing								
Specify and Source Parts	$600	$2,400	$600	$2,400	$1,200	$3,200	$1,200	$2,500
Obtain and Qualify Samples	$1,000	$3,000	$1,000	$3,000	$2,000	$4,000	$1,500	$4,000
QA/QC Specs	$400	$600	$400	$600	$600	$1,000	$600	$1,000
Purchased Parts Sourcing Total Cost Ranges	$2,000	$6,000	$2,000	$6,000	$3,800	$8,200	$3,300	$7,500
Test First Production Stoves for Form, Fit, Function & Durability	$4,000	$8,000	$8,000	$10,000	$10,000	$15,000	$10,000	$15,000
Equipment and Integration	$2,000	$3,000	$2,000	$4,000	$4,000	$6,000	$4,000	$6,000
Facilities	$0	$0	$4,000	$6,000	$6,000	$10,000	$6,000	$10,000
Subtotal	$8,000	$17,000	$16,000	$26,000	$23,800	$39,200	$23,300	$38,500

Note: All costs are in 2013 dollars.

4. Summary of Capital Costs per Model

The following table provides a summary of capital costs per model divided into the three subcategories: (1) R&D/engineering; (2) tooling; and (3) other components. For the midpoints of these cost ranges that NERA used in the cost-effectiveness analysis, see **Error! Reference source not found.** above.

Table 4. Capital Costs per Model: Summary

	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
R&D/Engineering	$66,000	$120,000	$110,000	$192,500	$147,000	$249,000	$135,000	$217,000
Tooling								
Steel Stove	$9,700	$31,200	$12,000	$34,500	$13,300	$38,500	$12,300	$35,000
Cast Iron Stove	$31,000	$62,000	$43,800	$80,400	$55,000	$87,500	$31,000	$57,000
Average	$20,350	$46,600	$27,900	$57,450	$34,150	$63,000	$21,650	$46,000
Other Capital Components	$8,000	$17,000	$16,000	$26,000	$23,800	$39,200	$23,300	$38,500
Total Capital Cost Per Model	$94,350	$183,600	$153,900	$275,950	$204,950	$351,200	$179,950	$301,500

Note: All costs are in 2013 dollars.

B. Fixed Costs per Model

The capital costs to modify woodstove models for the four relevant modification scenarios were estimated. Capital costs are divided into two subcategories:

1. *Certification*. This subcategory includes fixed costs for EPA emission rate testing, safety testing, labeling, and related costs.
2. *Roll-out*. This subcategory includes fixed costs for marketing materials (e.g., brochures, training materials, and trade show booths), training costs, display models, and product

obsolescence (including product discounts while manufacturer clears inventory and continuing support for discontinued products).

The following subsections present detailed information on these subcategories of fixed costs.

1. Certification

The following table presents the ranges of cost estimates per model for certification components within the fixed cost category. As with components of capital costs shown above, several elements of the certification process are more costly when the increment between current emission rate and new emission rate is large (partly because of the likely need for multiple rounds of testing for new tighter standards).

Table 5. Fixed Costs per Model: Certification

Certification	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
EPA Testing	$10,000	$12,000	$10,000	$15,000	$15,000	$25,000	$15,000	$25,000
Confirmation Safety Testing or Full Safety Testing	$4,000	$6,000	$4,000	$6,000	$5,000	$8,000	$5,000	$8,000
Shipping of Prototype(s)	$500	$1,000	$500	$1,000	$500	$2,000	$500	$2,000
Personnel at Lab	$1,000	$1,500	$1,000	$1,500	$2,000	$4,000	$2,000	$4,000
Travel Expenses	$1,500	$2,000	$1,500	$2,500	$1,500	$3,000	$1,500	$3,000
Owner's Manual (Revised or New, possibly Bilingual)	$1,500	$3,000	$2,000	$3,000	$2,500	$4,000	$2,000	$3,000
Labeling (Revised or New)	$300	$500	$300	$500	$500	$750	$300	$500
Certification	$18,800	$26,000	$19,300	$29,500	$27,000	$46,750	$26,300	$45,500

Note: All costs are in 2013 dollars.

2. Roll-Out

The following table presents the ranges of cost estimates per model for roll-out components within the fixed cost category. The sets of components within roll-out costs in the table are (1) marketing materials; (2) training; (3) marketing and sales programs; and (4) product obsolescence. The latter two sets of components are large parts of total fixed costs.

Table 6. Fixed Costs per Model: Roll-Out

Roll Out (excludes Owner's Manual and Labeling)	≤7.5 to ≤ 4.5		≤4.5 to ≤ 2.5		≤4.5 to ≤ 1.3		≤2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Marketing Materials								
Brochure: Stand Alone for revisesdproduct	$2,000	$10,000	$2,000	$10,000	$2,000	$10,000	$2,000	$10,000
Training Materials (Rep & Dealer presentations, handouts, etc.)	$2,500	$5,000	$2,500	$5,000	$2,500	$5,000	$2,500	$5,000
Point of Purchase Materials (standup cards, hang tags,etc.)	$2,500	$5,000	$2,500	$5,000	$2,500	$5,000	$2,500	$5,000
Web Site Changes & Development	$1,000	$1,500	$1,000	$1,500	$1,000	$1,500	$1,000	$1,500
Newsletters & Product Updates (Dealer and Rep)	$1,000	$2,000	$1,000	$2,000	$1,000	$2,000	$1,000	$2,000
Press Releases (Trade and Consumer)	$0	$500	$0	$500	$0	$500	$0	$500
Distribution of marketing materials (Printed and electronic)	$1,000	$2,500	$1,000	$2,500	$1,000	$2,500	$1,000	$2,500
National & regional trade show booths	$0	$2,500	$0	$2,500	$0	$2,500	$0	$2,500
Training								
Course Development	$200	$500	$200	$500	$200	$500	$200	$500
Regional Technical Training	$1,000	$5,000	$1,000	$5,000	$3,000	$5,000	$3,000	$5,000
Dealer meetings	$0	$0	$0	$0	$2,500	$5,000	$2,500	$5,000
Rep meetings	$0	$0	$0	$0	$1,500	$2,500	$1,500	$2,500
National & regional trade show costs (shipping and staff costs)	$0	$0	$5,000	$7,000	$10,000	$12,500	$10,000	$12,500
Product, sales and technical training videos:	$0	$5,000	$2,500	$7,500	$2,500	$7,500	$2,500	$7,500
Marketing and Sales Programs								
Display Models (Burn Credits)	$15,000	$50,000	$25,000	$75,000	$50,000	$100,000	$50,000	$75,000
Traveling Display Models	$5,000	$10,000	$5,000	$10,000	$5,000	$10,000	$5,000	$10,000
Coop Advertising	$10,000	$20,000	$10,000	$20,000	$20,000	$40,000	$15,000	$30,000
Launch promotions (dealer & consumer discounts, spiffs)	$5,000	$15,000	$5,000	$15,000	$7,500	$15,000	$5,000	$15,000
Product Obsolescence								
Product Discounts (while manufacturer clears inventory)	$0	$20,000	$0	$25,000	$0	$30,000	$0	$30,000
Unusable WIP/Purchased Parts/Raw Materials:	$0	$10,000	$0	$10,000	$0	$20,000	$0	$10,000
Continuing support for discontinued product (replacement parts)	$10,000	$20,000	$10,000	$20,000	$15,000	$30,000	$10,000	$20,000
Roll-out Total Cost Ranges	$56,200	$184,500	$73,700	$224,000	$127,200	$307,000	$114,700	$252,000

Note: All costs are in 2013 dollars.

3. Summary of Fixed Costs per Model

The following table provides a summary of fixed costs per model divided into the two subcategories: (1) certification; and (2) roll-out. For the midpoints of these cost ranges that NERA used in the cost-effectiveness analysis, see **Error! Reference source not found.** above.

Table 7. Fixed Costs per Model: Summary

	≤ 7.5 to ≤ 4.5		≤ 4.5 to ≤ 2.5		≤ 4.5 to ≤ 1.3		≤ 2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Certification	$18,800	$26,000	$19,300	$29,500	$27,000	$46,750	$26,300	$45,500
Roll-Out	$56,200	$184,500	$73,700	$224,000	$127,200	$307,000	$114,700	$252,000
Total Fixed Cost Per Model	$75,000	$210,500	$93,000	$253,500	$154,200	$353,750	$141,000	$297,500

Note: All costs are in 2013 dollars.

C. Variable Costs per Unit

The following table shows the cost ranges for variable costs per unit produced. Variable costs include materials, labor (machining, assembly, quality assurance / quality control ("QA/QC")), and warranty costs associated with adding new technology and new materials to an otherwise proven design. These estimates reflect variable costs beyond the level for current models. The variable costs increase as the increment between current and new emission rate increases, based on direct experience at Ferguson, Andors & Company with the actual cost impacts on the factory floor. These variable costs per unit have a direct effect on the price of new wood stoves (whereas capital costs and fixed costs per model must be converted into costs per unit, as described in the NERA report). For the mid-points of these cost ranges that NERA used in the cost-effectiveness analysis, see **Error! Reference source not found.** above.

Table 8. Variable Costs per Unit

	≤7.5 to ≤ 4.5		≤4.5 to ≤ 2.5		≤4.5 to ≤ 1.3		≤2.5 to ≤ 1.3	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Materials	$20	$50	$40	$80	$80	$120	$30	$75
Machining	$4	$6	$5	$8	$8	$12	$4	$6
Assembly	$8	$12	$10	$15	$12	$18	$5	$10
QA/QC Inspection, Testing & Monitoring	$5	$8	$5	$8	$8	$12	$4	$6
Warranty	$2	$3	$5	$10	$10	$15	$5	$10
Total Variable Cost Increase Ranges	**$39**	**$79**	**$65**	**$121**	**$118**	**$177**	**$48**	**$107**

Note: All costs are in 2013 dollars.

III. Expert Review Process

This section provides information on the expert review process in which we solicited, received, and incorporated feedback from other industry experts (the "Expert Panel") for estimating the costs of modifying woodstove models to comply with the tighter standards that EPA has proposed.

The Expert Panel was selected to provide both great depth in product development and manufacturing experience and to be representative of a broad range of manufacturers. The identity and background of the members of the Experts Panel is provided at the end of this appendix.

Each Expert Panelist was given a briefing over the telephone, which outlined what was expected of the panelists in detail as well as providing an opportunity for answering any questions. On that call, the panelists were also briefed on the forms that were used to record responses, and the form that was used to document the panelists' backgrounds as industry experts. Panelists agreed to provide specific feedback during this process but as a condition of participating were promised that individual company information would be protected as Confidential Business Information and would not be disclosed as part of this modeling effort.

The Experts Panel was asked to evaluate the cost ranges in the models from the perspective of whether they pass the "reasonableness" test for a typical free-standing woodstove, based on their experience in the industry. The panelists were asked to first consider the "macro" ranges presented for each of the main cost categories, and then consider each item in the breakdown within each category. If a panelist felt that some element of the modeling was not appropriate, they were asked to provide an alternate cost range that they felt was more representative, along with an explanation of their rationale. They were also asked to consider if any significant cost categories or sub-categories had been omitted from the model and to comment if that was the case, and to provide recommended representative cost values for the categories/subcategories in question.

The comments and suggestions ranged from broad to very detailed in nature. In some cases, the comments reflected individual company experience with some of the larger cost items. In other cases, some of the individual values in particular cells in a category in the model were questioned, while at the same time offering support for the aggregated costs in the category. Issues like product development cycle costs, testing costs, and production tooling costs were among the items more commonly addressed. In all cases, each comment or suggestion received was considered on its merits with particular focus on whether it seemed too company-specific or had broader application to the industry.

In evaluating comments, additional weight was appropriately given when similar comments were received from more than one panelist. In the end, expert judgment was used in weighing the comments and to make adjustments to modeled values where needed to insure the modeling was as representative as possible of the industry as a whole. As mentioned previously, in order to maintain confidentiality of company-specific feedback, suggested revisions and comments received from individual panelists are considered as CBI and are not discussed.

IV. Curricula Vitae for Mr. Ferguson and Expert Panelists

The CVs of Mr. Ferguson and members of the Expert Panels are provided below.

HPBA NSPS Economic Modeling Engineering Consultant

Name: Robert W. Ferguson

Total Years in the Hearth Products Industry: 33

Companies and Dates of Affiliation:
Vermont Castings 1980-1990
Ferguson, Andors & Company 1991 - Present

Positions Held and Description of Responsibilities:
Vermont Castings

- Director of Research and Development
  - Responsible for all aspects of product development, product performance and product safety.

Ferguson, Andors & Company

- President
  - Founded Ferguson, Andors & Company in 1991, offering a full range of product development consulting and regulatory compliance services focused on the hearth, patio and barbecue industry. Clients include both small and large companies from around the world. Products developed include solid fuel and gas-burning appliances.
  - Providing HPBA with technical consulting services for the NSPS review/revision process that is now in the proposal stage at EPA.

Significant Accomplishments (include US Patents if applicable):

- Co-inventor for a number of patents related to the hearth product performance and combustion technology.

Trade and Professional Group Affiliations and Positions Held:

- Wood Heating Alliance (HPA/HPBA) Board of Directors
- Hearth Education Foundation Board of Directors/Treasurer
- WHA/HPA Government Affairs Committee Chair
- Represented the manufacturers' interests during the Regulatory Negotiations (RegNeg) that resulted in the current EPA New Source Performance Standards for Wood Heaters.
- ASTM Member, Task Group and Working Group Chairs
  - Chaired or acted as facilitator during the development of the ASTM solid fuel particulate measurement, fireplace PM emissions, wood heater PM emissions, pellet heater PM emissions and partial thermal storage hydronic heater PM emissions test methods. CSA B365 and B415.1 Technical Committee Member.

Other Relevant Information:

- BS Chemical Engineering, Clarkson University, 1972

Expert Panel

A list of the Expert Panelists and their credentials follows.

HPBA NSPS Economic Modeling Review Panelist 1

Name: Dane Harman

Total Years in the Hearth Products Industry: 34

Companies and Dates of Affiliation:
Harman Stove Company 1979- 2007
Hearth & Home Technologies (HHT) 2007 - Present

Positions Held and Description of Responsibilities:
Harman Stove Company
- Founder and President

Hearth & Home Technologies (HHT)
- Vice President of Advanced Technology

Significant Accomplishments (include US Patents if applicable):
- Designed, manufactured and brought over 60 home heating appliances to market. This included an array of wood, coal, gas, pellet and oil burning units.
- Several patents in coal, wood and pellet burning technology.
- Four Vesta Awards.

Trade and Professional Group Affiliations and Positions Held:
- Hearth, Patio & Barbecue Association (HPBA) Board of Directors
- Pellet Fuels Institute Board of Directors

Other Relevant Information:
- Ernst & Young Entrepreneur of the Year, 2007

HPBA NSPS Economic Modeling Review Panelist 2

Name: Alan Atemboski

Total Years in the Hearth Products Industry: 33

Companies and Dates of Affiliation:
Lopi International 1980 - 88
Travis Industries 1988 - current

Positions Held and Description of Responsibilities:

- Welder
- Customer Service Manager
- Q.C. Manager
- Director of Research and Development

Significant Accomplishments (include US Patents if applicable):

- Designed and certified first non-cat stove to meet all burn rates to the Oregon DEQ emissions requirements.
- Designed and certified first wood heater to be less than 0.5 g/h to the current EPA emissions requirements. With tested weighted average efficiencies over 80% using the B-415 with the HHV for the fuel.

	PAT. NO.	Title
1	7,066,170	Apparatuses and methods for balancing combustion air and exhaust gas for use with a direct-vent heater appliance
2	6,871,793	Fire and water display device
3	D502,982	Fire and water display assembly
4	6,602,068	Burner assembly for a gas-burning fireplace
5	6,443,726	Burner assembly for a gas-burning fireplace
6	4,665,889	Stove

Trade and Professional Group Affiliations and Positions Held:

- HPBA NSPS Committees
- CPSC Glass Front Committee

HPBA NSPS Economic Modeling Review Panelist 3

Name: Robert J. Dischner

Total Years in the Hearth Products Industry: 34

Companies and Dates of Affiliation:
Superior Fireplace Company 1978-1996
Lennox Hearth Products 1996-2012

Positions Held and Description of Responsibilities:
Superior Fireplace Company
- Product Manager Fireplace Construction Products
- Market Development Manager
- Director of Sales
- Director of Marketing

Lennox Hearth Products
- Director of Product & Market Planning
- Director of Marketing

Significant Accomplishments (include US Patents if applicable):
- Led product development teams for over 50 new products and product platforms for direct-vent gas fireplaces, B-Vent gas fireplaces, direct-vent gas inserts, wood-burning factory-built fireplaces, EPA-certified wood-burning stoves/inserts/fireplaces, EPA qualified wood-burning fireplaces and catalytic unvented gas fireplaces.

Trade and Professional Group Affiliations and Positions Held:
- Hearth, Patio & Barbecue Association (HPBA) Board of Directors 2002-2008
- HPBA Trade Show Committee 1997-1998
- HPBA Government Affairs Committee 2000-2012
- HPBA Statistics Committee 1999-2000

Other Relevant Information:
- MBA, Marketing, UCLA 1977
- BS, Political Science, UCLA 1973

HPBA NSPS Economic Modeling Review Panelist 4

Name: Paul Williams

Total Years in the Hearth Products Industry: 19

Companies and Dates of Affiliation:
United States Stove Company - 1994 to Present

Positions Held and Description of Responsibilities:
United States Stove Company

- Sales/Customer Service 1994- 2000
- National Sales Manager 2000 – Present
    - I work closely with Manufacturing and Engineering to help develop new products and manage existing. This provides me with detail insight to costing and technologies in use. I also work with state and federal agencies on regulations to make sure our products are compliant. As the Sales Manager, I also work with Marketing and the costing side of promotional material and training, both online and print media. The totality of this available information leads to developing barometers and trends that aid in projections and forecasting to balance budgets and inventories.

Significant Accomplishments (include US Patents if applicable):

- US Patent for first window-mounted Pellet Appliance

Trade and Professional Group Affiliations and Positions Held:

- ASTM Member

Other Relevant Information:

- SER Representative during EPA NSPS SBREFA review
- Worked with SBI to write "NSPS, REVIEW/REVISION AND IMPACT ON OUR COMPANIES", A Manufacturer's Position Paper, June 2010 (SBI and USSC)

HPBA NSPS Economic Modeling Review Panelist 5

Name: Jess Baldwin

Total Years in the Hearth Products Industry: 34
Companies and Dates of Affiliation:
Earth Stove Midwest – 1978 to 1984
The Earth Stove, Inc. – 1984 – 1999
Lennox Hearth Products – 1999 – 2001
Monessen Hearth Systems/Vermont Castings Group – 2001 to present

Positions Held and Description of Responsibilities:
Earth Stove Midwest
- Plant Manager, Product Manager, Marketing Manager - Operations and new product development

The Earth Stove, Inc.
- Eastern Operations Manager, National Sales Manager, Corporate VP – Managed all aspects of sales, marketing and product development.

Lennox Hearth Products
- Director of Sales Operations, Regional Sales Manager – Managed sales operations, managed Northwest sales team and provided direction and input to engineering on new product development on The Earth Stove and Whitfield brand of pellet, gas and wood burning products.

Monessen Hearth Systems/Vermont Castings Group
- Regional Sales Manager, VP of Sales, VP of Marketing, Merchandising and Product Development – Developed Lexington Forge product line, managed sales force, marketing and new product development. Currently senior vice president of sales and customer service

Trade and Professional Group Affiliations and Positions Held:
- Fiber Fuels Institute – Board Member
- HPBA – Past trade show committee chairman, currently serving on Board of Directors, currently serving on Government Affairs Committee, current chairman of statistics committee.

HPBA NSPS Economic Modeling Review Panelist 6a

Name: Bret Watson

Total Years in the Hearth Products Industry: 20

Companies and Dates of Affiliation:
NHC/HearthStone Home Heating Products: 1994-1998
Jøtul North America: 1998-present

Positions Held and Description of Responsibilities:
HearthStone
- National Sales and Marketing Manager
    - Managed all external and internal sales, marketing and customer service activities supporting a network of 500+ hearth dealers

Jøtul North America:
- President
    - Responsible for p/l and all facets of North American subsidiary business to Jøtul AS Norway

Significant Accomplishments (include US Patents if applicable):
- Jøtul Burner patent
- Jøtul F 50 TL patent
- Best Companies to Work in Maine: Finalist 2006, 2010. Winner 2008
- Various Vesta Design and Technology Awards or Finalists for Jøtul products
- 2009 Governor's Award for Business Excellence – State of Maine

Trade and Professional Group Affiliations and Positions Held:
- Board Member (6 years): Northeast Hearth Patio and Barbeque Assoc.
- Member: Maine Manufacturers Assoc.

HPBA NSPS Economic Modeling Review Panelist 6b

Name: Roger Purinton

Total Years in the Hearth Products Industry: 34

Companies and Dates of Affiliation:
Vermont Castings, Inc. 1979 – 1999
Jøtul North America, Inc. 1999 – Present

Positions Held and Description of Responsibilities:
Vermont Castings

- Began in manufacturing and progressed into R&D department. Started in R&D as Laboratory Technician and concluded as Laboratory Manager / Project Engineer
- Responsible for laboratory testing and product certifications throughout R&D history. The final 10 years involved combustion engineering and design responsibilities.
- In house pre-testing to confirm acceptable EPA particulate emissions performance was typical.

Jøtul North America

- Started as a Project Engineer and currently hold the position of R&D Product Development Manager.
- Oversight of, and responsible for all product projects, both solid fuel and gas. Responsible for all aspects of operational performance, design integrity and design manufacturability.
- Also responsible for maintaining a qualified R&D laboratory capable of in-house product certification activities.
- In house pre-testing for EPA emission conformance is standard.

Significant Accomplishments (include US Patents if applicable):

- Model F 50 TL - Utility Patent Application 12685407: Methods For Operating A Top Loading Wood Fired Appliance Having A Cooperating Top Loading Door and Moveable Baffle.
- Jøtul Burner - Patent 7,004,751: Gas Burner Assemblies, Methods For Assembling, and Gas Fired Appliances Employing Same.

Trade and Professional Group Affiliations and Positions Held:

- Have participated in Technical Working Groups for standards development for both solid fuel and gas technology.

Other Relevant Information:

- Thorough understanding of overall wood heater design and combustion technology. Have worked extensively with both catalytic and non-catalytic combustion technology.
- Comprehensive understanding and experience with the gray iron foundry sand casting process and associated tool making.
- Strong knowledge of steel firebox design and fabrication technology.

HPBA NSPS Economic Modeling Review Panelist 7

Name: Marc-Antoine Cantin

Total Years in the Hearth Products Industry: 14

Companies and Dates of Affiliation:
SBI – Stove Builder International since 1999 - Present

Positions Held and Description of Responsibilities:
Stove Builder International

- President and co-owner of SBI
    - Has overseen all of the company's business development and operations, including product development, marketing, sales, and finances.

Significant Accomplishments (include US Patents if applicable):

- Has helped SBI complete 5 business acquisitions in the Hearth industry between 2002 and 2008.

Trade and Professional Group Affiliations and Positions Held:

- Chairman of the CSA B415.1-10 Standard Committee from 2007 to 2010.
- HPBA Board of Directors
    - Chairman of HPBA in 2010-2011.
    - Member of the Order of Certified Public Accountants, Canada.

Other Relevant Information:

- Holds an accounting and business administration degree from McGill University, Canada.

HPBA NSPS Economic Modeling Review Panelist 8

Name: Cliff Lilley

Total Years in the Hearth Products Industry: 27

Companies and Dates of Affiliation:
Wolf Steel Ltd., since 1989.

Positions Held and Description of Responsibilities:

- Product Engineer
- Director of R&D
- Vice-President of R&D
    - To design and test gas and wood appliances for the hearth industry. List includes vent free gas stoves, inserts and fireplaces, natural vent stoves inserts and fireplaces, both gas and wood, direct vent gas stoves, inserts and fireplaces, wood pellet stoves and inserts, corn pellet furnaces, oil stoves, electric fireplaces as well as outdoor decorative gas appliances.

Significant Accomplishments (include US Patents if applicable):

- Various US and Canadian patents for:
    - gas appliance heat exchangers
    - vent free catalytic doors
    - infra-red gas grill burners
    - electric fireplaces

Trade and Professional Group Affiliations and Positions Held:

- Professional Engineers of Ontario
- ASTM member
- Gas Fitter 2, Province of Ontario

Other Relevant Information:

- Former member of harmonized subcommittee ANSI Z21.50 and Z21.88 and outdoor gas grills
- P.4 subcommittee member for gas fireplace efficiency

HPBA NSPS Economic Modeling Review Panelist 9

Name: Tracy Zomar

Total Years in the Hearth Products Industry: 26

Companies and Dates of Affiliation:
FPI Fireplace Products International Ltd. (Regency Fireplace Products) 1987 - present

Positions Held and Description of Responsibilities:
- Senior VP of Operations – Product Development, Export Sales and Operations (11 years)
- Director of Manufacturing – Operations (5 years)
- Plant Manager – Manufacturing (5 years)
- Supervisor – Assembly line supervisor (2 years)
- Customer Service – Inside Sales, warranty and tech service (1 year)

Other Relevant Information:
- MBA from Simon Fraser University

HPBA NSPS Economic Modeling Review Panelist 10

Name: Charles Page
Total Years in the Hearth Industry: 37 years

Companies and Dates of Affiliation:

- 1977 Jøtul Stoves: Technical Advisor
- 1978 Southport Stoves: Customer Service Manager
- 1979 - 1986 Vermont Castings: Technical Product Manager, R & D Coordinator, New Product Manager & Fireplace Product Manager
- 1987 - 1992 Thermal Energy Storage Systems (TESS Fireplaces): Director of Product Development and President
- 1992 Protech Systems (Ventinox): Vice President of Marketing
- 1993 - present JumpStart Marketing (Business Marketing Consulting): Owner & President
- 1995 - 2010 Harman Stove Company: Northeastern Manufacturers Representative
- 2011- present HomeWarmth Inc.: Northeastern Manufacturers Representative for Industrial Chimney Company

Positions Held and Description of Responsibilities:

- **Kristia Associates** –Jøtul: Wrote and produced the first comprehensive training and repair manual for Jøtul product line of wood burning stoves.
- **Southport Stoves -** As technical director and customer service manager was responsible for development of technical support materials and product training for three brands of European coal and wood stoves – Surdiac, Mørsø and Efel.
- **Vermont Castings –** Held various positions in Research & Development, responsible for obtaining laboratory and code group listings, assisted in the development of many Vermont Castings appliances and related accessories. Provided technical support and product training to dealer network in North America and Europe including writing installation, operations and repair manuals. Marketing functions included forecasting and sales analysis, product planning, new product specs and feasibility analysis, and product launch coordination.
- **Thermal Energy Storage Systems** -Developed new models and a viable product line of modular masonry fireplaces, developed national advertising and marketing programs, established dealer network and consumer direct sales promotions for TESS Inc.
- **Protech Systems** - Developed and implemented new company wide strategic plan. Coordinated all aspects of marketing and sales, including development of dealer and distributor programs, marketing materials, advertising and inquiry tracking systems.
- **Jumpstart Marketing** – Provide a wide range of marketing and advertising service to manufacturers and service companies. Services include market surveys, public relations and advertising, brochures, promotional materials and sales training.
- **Harman Stove Company** - As Northeastern Factory Representative developed strategy to build dealer network throughout New England and New York and increased yearly sales over sixty fold. Wrote marketing materials used nationally. Worked closely with ownership and R&D to develop new products for the retail market. Built a training

facility to educate dealers on installation, troubleshooting and repair of Harman stoves. Provided technical support and marketing assistance to network of 100 dealers.

- **HomeWarmth Inc.** - Northeast sales representative for ICC Chimney – Excel chimney, RSF and Renaissance Fireplaces. Responsible for recruiting dealers in New England, New York and Eastern PA. As liaison between dealers and R&D, responsible for developing many new innovative venting components.

Significant Accomplishments:

- Developed first of its kind high school curriculum on wood heating and alternative energy that received national recognition.

At Vermont Castings:

- Designed and patented system for installing stoves into fireplaces.
- Wrote test standard for domestic hot water heaters in solid fuel burning appliances adopted by ULC.
- Specified and assisted in design of two fireplace inserts with a European manufacturer for the European market.

At TESS:

- Redesigned and patented a system for renovating heat circulating fireplaces.
- Supervised the design and building of state of the art testing laboratory for masonry fireplaces. Used lab to obtain independent lab listings for TESS fireplace models.
- Launched two new fireplace models.

At Harman:

- National Sales Rep for 15 consecutive years.
- Instrumental in making Harman the number one pellet stove line in the US market.
- Assisted in design of several VESTA award winning products.

Trade and Professional Group Affiliations and Positions Held

- Board of Directors – Wood Heating Alliance, 1987 and 1988
- WHA Government Relations Committee, 1987 and 1988
- Member – Fireplace Manufacturer's Caucus (WHA)
- Board of Directors and Treasurer – Hearth Education Foundation – Served on Board for approximately 8 years.
- Secretary for Task Group writing standards for the construction of masonry heaters – American Society for Testing and Materials (ASTM E1602)
- Member of NEHPBA for past 17 years

Proposed Wood Heater NSPS Incremental Cost Effectiveness Analyses

Appendix B

Woodstove Retail Price Survey

Prepared for the Hearth, Patio & Barbecue Association

By Robert Ferguson
Ferguson, Andors & Company

and

Charles Page
JumpStart Marketing.

May 2014

HPBA Wood Stove Pricing Survey

The purpose of the survey was to identify 2012 retail pricing of woodstoves sold by the dominant manufacturers in the hearth industry. The data is used as part of a broader economic analysis to determine the impacts of additional regulation of wood stoves imposed by the proposed New Source Performance Standard. In addition, the survey report outlines some of the other factors that affect the retail price of stoves including styling upgrades and accessories, discounting practices, freight charges, installation costs and taxes. One likely impact of the tighter proposed regulations is increased retail prices for stoves and reduction in the number of available stove models. This could have a devastating effect on wood stove sales when combined with the additional costs associated with installing a wood stove. The cost of the product plus installation represents the true cost to the consumer.

The survey was done by Charles Page, JumpStart Marketing, in conjunction with Ferguson, Andors & Company. Mr. Page has 37 years of industry experience in product development, sales and marketing for various hearth industry manufacturers. Full details on his background are provided in Appendix A.

Survey Methodology & Definition of Terms

The pricing spread sheet was developed from manufacturers' price lists. These were obtained by on-line searches or by contacting and interviewing retailers and distributors or the manufacturers themselves. Other information relating to typical discounts, freight costs and industry practices came from interviews with industry experts in key stove selling areas. All information obtained was logged in spreadsheets by manufacturer and model. A summary of the data collected is presented in Table 1 at the end of this document. Manufacturers and models have been masked. The manufacturers included in the survey represent the majority of the dominant brands on the market, but not all brands. There are some manufacturers who sell primarily through hardware chains or mass merchants and these were not included in the survey. In addition there are other manufacturers who are smaller or more regionally active and have not been included for these reasons. For the purposes of the survey, the Base List Price was considered the same as the Manufacturer's Suggested Retail Price (MSRP) for their base models.

Factors that Affect MSRP Woodstove Pricing

Manufacturers have chosen a variety of stove design strategies to build their product lines. Each company is somewhat different in their approach, but all share the following common goals that have an effect on stove pricing:

1. **Size and heat output of the appliance** to accommodate heating needs of homes in different regions of the country.

2. **Styling related accessories or upgrades** to accommodate a larger group of customers using the same firebox.

3. **Retail price points** to reach different markets of wood stove buying consumers.

4. **Material selection** based on economically achievable manufacturing capabilities.

Here is how these four factors are represented in the MSRP wood stove pricing survey:

1. Size and heat output

For the purposes of defining stove size, the EPA definitions of Usable Firebox Volume (UFV) were used. Using these definitions, a UFV of 1.5 cubic feet or less was considered a small stove, a medium stove had a UFV between 1.5 and 3 cubic feet, and a large stove had a UFV larger than 3 cubic feet.

Using this definition, the greatest number of stove models fall in the medium size range. One could argue that the range is too broad when defining a medium-size stove as there is often a big difference in heating capacity between a 1.6 cubic foot stove and one that has a 2.9 cubic foot firebox. And, the general trend is that larger models are usually more expensive than smaller ones yet both are considered medium-sized stoves for the purposes of the survey. The impact of this cost/size relationship has not been considered as part of the survey analysis.

2. Styling related accessories and upgrades

Cast iron stoves are offered with a paint finish and in some cases with porcelain enamel finishes. In some cases enamel retail prices vary with color. For the purposes of the survey results the least expensive enamel price was used. For example, if green or black enamel were the same price, but red enamel was more expensive, the green enamel price was chosen as the enamel price.

The Base List Price shown for cast iron stoves is for black painted stoves. The Enamel Premium price reflects the least expensive color.

Steel stoves are offered with a variety of styling options. A number of manufacturers have used a modular approach where the stove is "built", in the same way that commercial trucks are built from the ground up. The stove body, doors, pedestals or legs are purchased separately. This approach allows the manufacturer to provide a wide range of looks using the same engine. It also allows to retailer to select which models are right for their markets. The number of combinations of components can be quite large for any given model, so there was a need in the survey to simplify the number of product combinations so that a range of price between the base model and a loaded model could be provided.

For this reason the Base List Price for steel stoves was for a black stove with a black door and pedestal. In most cases this was the least expensive combination of components. In a few cases, where the leg option was cheaper than the pedestal, the leg option was used to determine the Base List Price.

The column entitled With Other Upgrades is for stoves with decorative upgrades which increased the retail price in the same way that enamel finish increases the price of cast iron stoves. These stoves included legs or plated legs when available (rather than pedestals), plated doors or plated door trim, a bottom heat shield if required when using the legs and in one case plated grills because the grill was required to complete the stove. For stoves which did not have leg options, the price of the plated door upgrade was the only accessory included in the With Other Upgrades column.

One manufacturer offered an enamel upgrade for steel stoves, plus legs and door plating that could be used on painted stoves or enamel stove models. In this case the enamel upgrade cost of a stove with a black door was shown in the Enamel Premium column. In the With Other Upgrades column the cost of the painted stove, plus the plated door and plated leg options was used. An assumption was made here that the plated leg and door options would be an alternative to the enamel option and therefore should be priced along with a painted stove to provide a decorative upgrade. No other steel stove manufacturer offered an enamel stove body option. With all other manufacturers the With Other Upgrades column included whatever door plating, trim or leg options (and any required heat shields or adapters) that were available.

Some manufacturers offered additional decorative accessories, such as etched glass, plated grills, warming shelves as well as blower options, but these were not included in the With Other Upgrades column. These additional accessories increase the price of the stove, but were left out because a smaller percentage of stoves are sold with these options.

It is difficult to quantify an exact MSRP price for some stove models given the range of decorative options. A more thorough investigation would determine the most popular accessories and the product line model mix by volume. The base model list prices are more readily identified and assumptions can be made about the percentages of stoves that are sold with enamel or other upgrades with additional research.

3. Retail price points and lower priced models

Many of the dominant manufacturers have developed lower priced models or whole product lines to reach price conscious consumers. Stove prices have risen steadily since the early 70’s and now manufacturers are finding there is a need for value-priced lower end models. These models allow specialty hearth retailers to compete with mass merchants and reach consumers that simply can’t afford or won’t pay for higher end stoves. These stoves generally have fewer features, fewer decorative options, less expensive construction and significantly lower retail prices. In order to more accurately determine an overall “average” retail price based on firebox size only, some estimate of sales volumes of the lower end models would be required.

Manufacturers work hard to create models which are competitively-priced when compared to similar models made by other manufacturers. This is done on a model by model basis, comparing specific heat output, features, styling and price rather than by broad categories. Trying to combine all models by material type or by general size to come up with an average price overlooks the fact that manufacturers are designing products to meet very specific price points. The only way to really assess specific price averages for each size and type of stove would be to know what the model mix is for each manufacturer. That activity is beyond the scope of this survey.

4. Material Selection

One of the factors identified was the material used for construction for each stove model. The four categories identified where steel, cast iron, cast iron and stone and cast iron and steel. These have been consolidated to reflect the major construction material on the pricing spreadsheet. For example, a stove with a steel firebox that is clad in cast iron for aesthetic purposes was grouped with the cast iron stoves. There was no evidence that material alone dictated price. Many steel stoves were priced similarly to corresponding cast iron models of similar size.

Other Factors that affect the retail price of stoves and industry profits

A. Discounting off of MSRP

Discounting off of MSRP is done for a variety of reasons. The industry retailer experts indicated that more than 25% of all stoves are sold at a discount below MSRP. Here is an explanation of why and how wood stoves are discounted:

Factory authorized sales – A typical factory authorized sale is 10% with the discount dollars shared equally between the dealer and the manufacturer. These sales are usually offered for a limited period of time. Some promotions provide for instant savings or money off of MSRP while other promotions offer free accessories rather than appliance discounts.

Factory authorized sales, plus dealer incentives - Some dealers will add additional incentives to factory sales to give them a competitive advantage in their markets. With these extra incentives, combined with manufacturer's discounts, consumer discounts in the 15% - 20% range are typical.

Special event discounts – Some dealers have major sales events once or twice a year where they offer greater than normal discounts. Example: "Christmas in July" sales which are repeated year after year and offer the greatest discounts of the year.

Inventory clearance events – These include steeper discounts for showroom displays, burn models, discontinued models, or slow moving inventory. Discounts can be 30%– 50% or more for selected models.

Major down turns in the market – Retailers have done whatever is necessary to keep their doors open during industry down turns. In some cases this means turning inventory even if they make no profit. To say that the last few years have been difficult for retailers selling wood stoves is an understatement. The market is highly competitive and the market for wood stoves has been soft in most regions of the country.

Generally there is less discounting in more populated urban and suburban areas than in rural areas and this is most likely due to the higher cost of doing business. Also in any given market there is at least one retailer who uses discounts as a competitive advantage. Larger dealers who can take advantage of volume purchases to raise their gross margin above 40%, which is the norm, have the most flexibility to discount, but most choose not to because of the high cost of doing business in the hearth industry.

B. Freight Costs

Most of the bigger manufacturers have regional warehouses or sell through distributors. With regional warehouses, the manufacturer pays the freight to the warehouse and then offers freight discounts to the retailer based on the number of stoves purchased on one invoice. Example: The cost to ship one stove might be $120, 2-3 stoves $90 each, 4-5 stoves $75 and 6 or more stoves $50 per stove. Higher volume dealers are able to take advantage of these types of programs to bring the freight in at $75 - $100 per stove. One manufacturer charges the dealer a percentage of the invoice amount for the stove and related accessories order. This translates into approximately $62 for the least expensive black painted stove to $88 for a higher end enamel stove. In this case, the more expensive the stove (and related accessories invoiced with the stove) the greater the freight cost will be.

The use of distributors has increased, even for some bigger manufacturers as they have recognized the cost benefits as compared to operating their own distribution facilities. Distributors offer the advantage of being able to consolidate multi-brand shipments to individual retailers in their territories. This is a customer service plus for some manufacturers. Distributors handle freight costs in a number of ways. Some have their own trucks and ether provide free freight or reduced freight rates based on dollar volume purchases. In cases where distributors use common carriers for LTL shipments (Less Than Truckload) they will either offer freight discounts based on volume (in some cases 100% of the freight will be paid by the distributor) or the distributor will increase the dealer price of the stove to offset some or all of the freight cost to the dealer.

The dominant manufacturers are evenly split between Eastern and Western US and Western Canada. For these national brands freight is a significant part of their costs. These manufacturers build the cost of shipping to regional warehouses plus the actual warehouse charges into the price of the stove. If the manufacturer is selling through distribution and offers "free" freight based on volume purchases, freight costs are again added to the distributor's price per stove.

The majority of retailers do not pass their freight costs onto consumers directly, but these costs do lower the profit a retailer will make. This is important because the less profit the dealer makes, the less money they have to promote the product, hire and train staff, or discount the stove and still cover their overhead costs. As shipping costs rise, retailers will be forced to pass these costs on to consumers. Any economic analysis should factor in ever-increasing freight costs for both manufacturers and retailers to determine the real cost and pricing for stoves in the future and the resultant impact on stove sales.

C. Installation Costs

When analyzing consumer cost impacts, it is important to look at the cost of typical stove installations. There are two components here – one is the cost of labor which varies depending on the area of the country and income demographics. The second is the price of the materials.

Wood stoves which rely on natural draft require either a masonry chimney which meets building/fire code requirements or a listed prefabricated Class A chimney.

In areas where masonry chimneys are prevalent, a significant number of chimneys simply don't meet current code requirements and, therefore, have to be refurbished and or upgraded with new liners when a new stove is installed. Some older chimneys do not have tile liners that are now required by code, some tile lined chimneys have cracked or deteriorated tile liners, while others have flues which are too large to meet the NFPA flue sizing requirements. The cost for bringing these masonry chimneys into code compliance, even if simply replacing an old stove with a new, can be substantial. Here in New England, typical installation costs to homeowners run from about $500 for a replacement stove in an existing code compliant installation to $1000 to $3000 for an installation that must be upgraded to meet current codes. Retailers and chimney sweeps make a significant amount of money selling and installing chimney liners.

Prefabricated chimneys also can cost the homeowner as much as the stove or more. The retail cost for the chimney materials range from $790 to almost $2300 and this does not include the labor to install them. (See the attached file - Typical Class A Chimney Costs.) Retailers make approximately 50% of the retail price on the installations. It must be determined by the installer whether an existing Class A chimney meets current code requirements and is properly sized or should be replaced.

Venting into either masonry or a prefabricated chimney requires single or double wall connector pipe which can cost the homeowner $50 to as much as $500 depending on the installation needs.

In addition to the venting requirements for installing wood stoves there is the cost of the hearth underneath the stove. This may be required for heat or spark protection or both. Manufactured hearth boards can cost $350 - $500.

The cost of labor to do a stove installation can vary from region to region, but costs are significant and should be factored into any economic evaluation relating to the cost of installing a wood burning stove. Installation trucks, fuel, insurance and training for installers continue to rise. In the Northeast "setting and venting" – delivering, setting the stove in place and connecting the pipe runs from $300 to $500. In urban and suburban areas it can be significantly more.

D. Taxes

Many states have sales taxes which apply to wood stoves and this expense should not be overlooked. Here in the Northeast a 6% sales tax will translate into a $90 to $150 or more per stove.

E. Regional Pricing

Most manufacturers do not have regional pricing. Stove costs can vary, but these are due to increases in freight costs or by distributors who may bump MSRP prices to help offset freight costs to dealers.

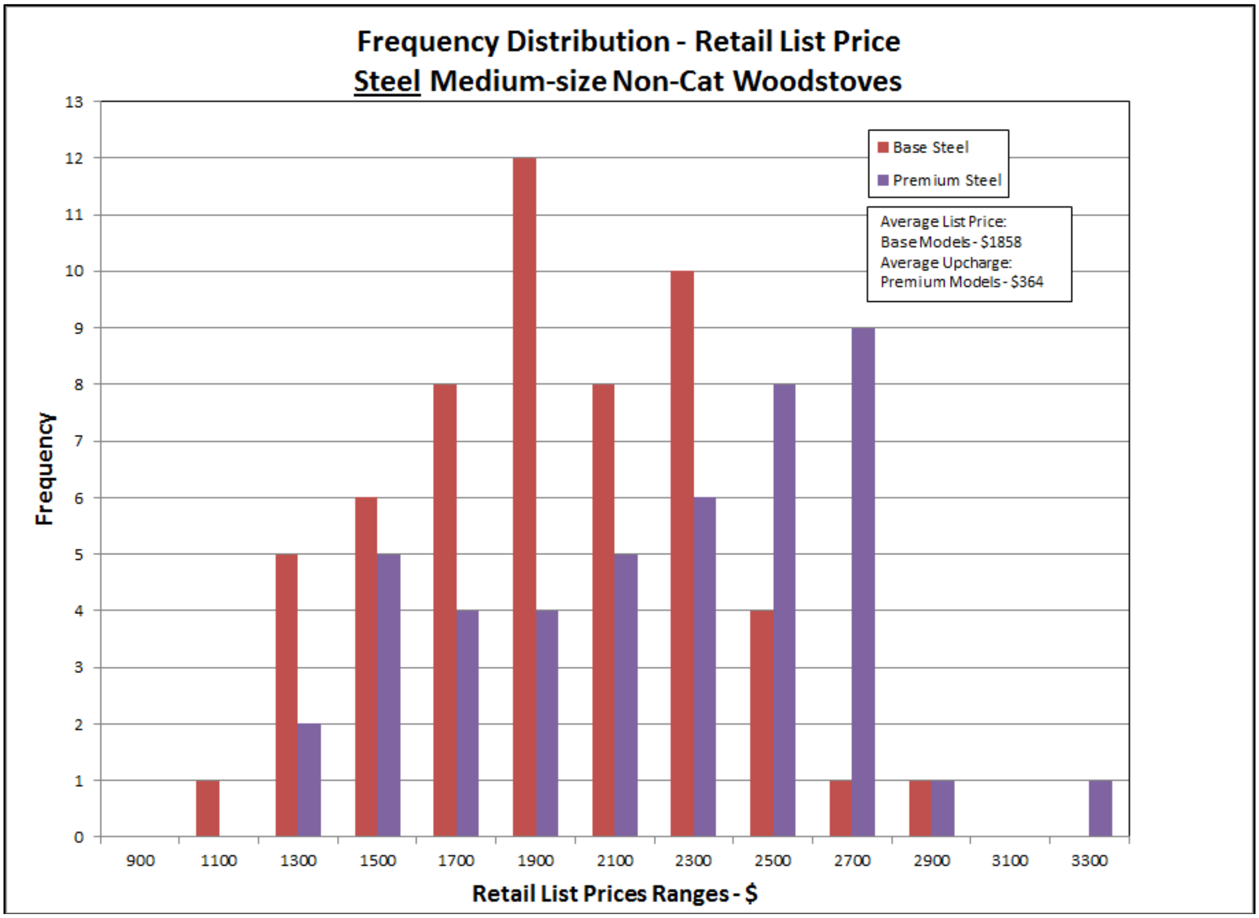
Survey Analyses

The results from the survey have been analyzed in several ways. However, for the purpose of determining retail pricing used in conjunction with other inputs to the broader economic impact analysis that assesses the potential impacts of revisions proposed for the wood heater NSPS, the analyses focused on medium-sized non-cat woodstoves since they represent the majority of models produced and sold. The differences between cast iron and steel were also considered. Price data for large and small models as well as some stone and catalytic models are presented but generally excluded from retail price analyses. The retail pricing used is that for specialty retailers with nationally distributed major brands and where retail pricing was able to be obtained during the surveying.

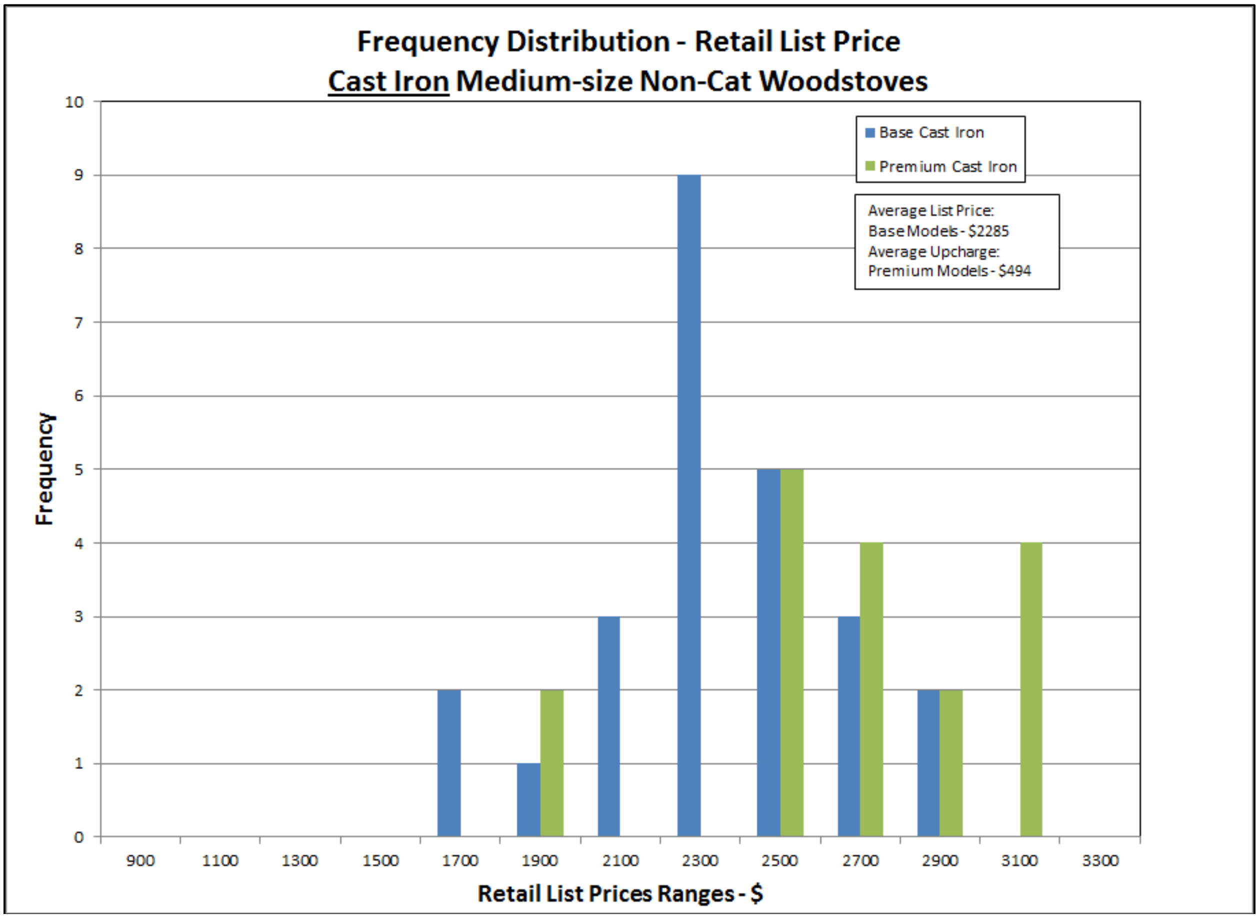
1. Frequency Distribution

The retail price data was analyzed to show the frequency distribution of models in each of a number of discreet price ranges covering the full range from lowest to highest price. Please note that on the charts presented below, the bar represents the frequency from the next lower price to the price below the bar. For example, a bar at $1900 represents the frequency of models with pricing from $1700 to $1900.

Steel Stove Models

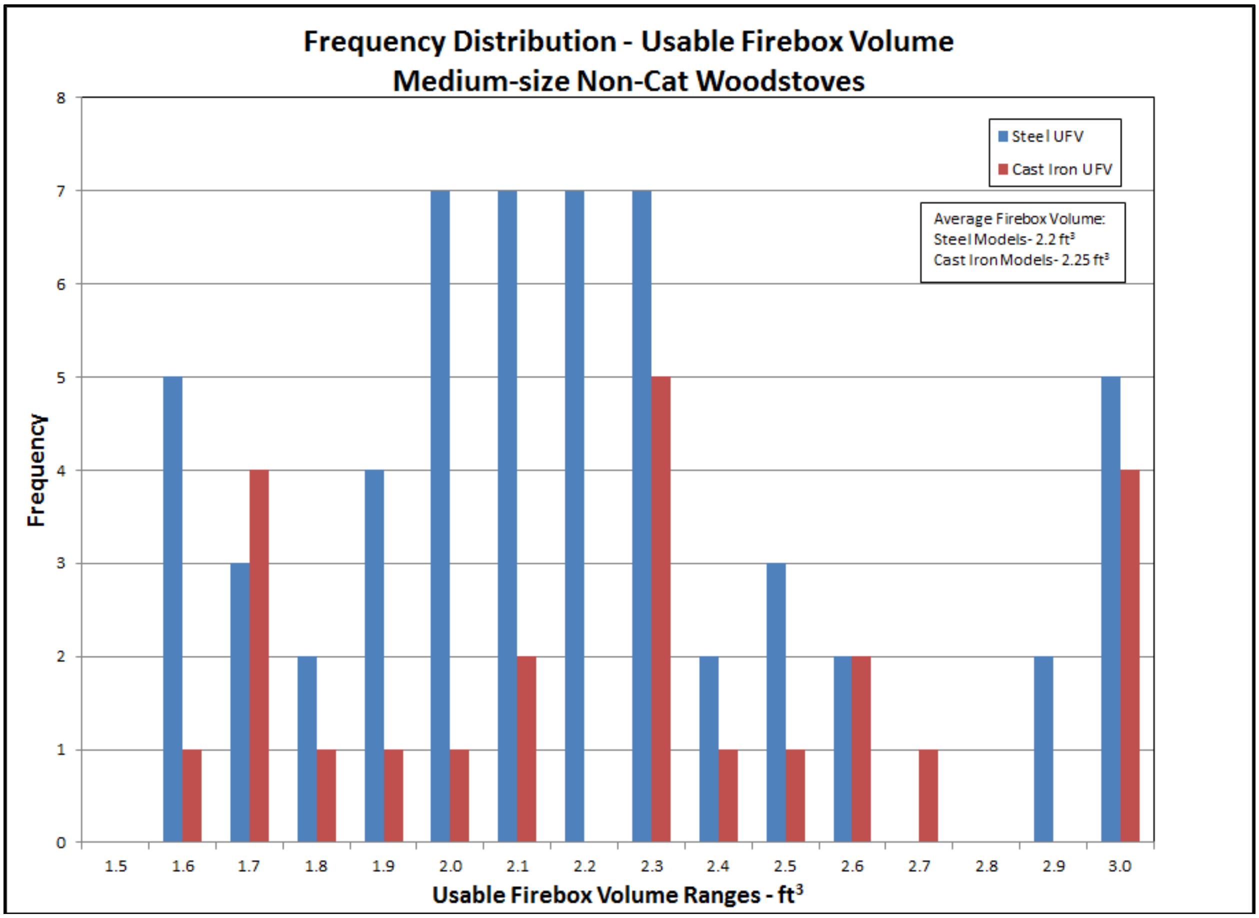


Cast Iron Stove Models



The frequency distribution was also plotted for medium-sized non-cat wood stoves for usable firebox volume.

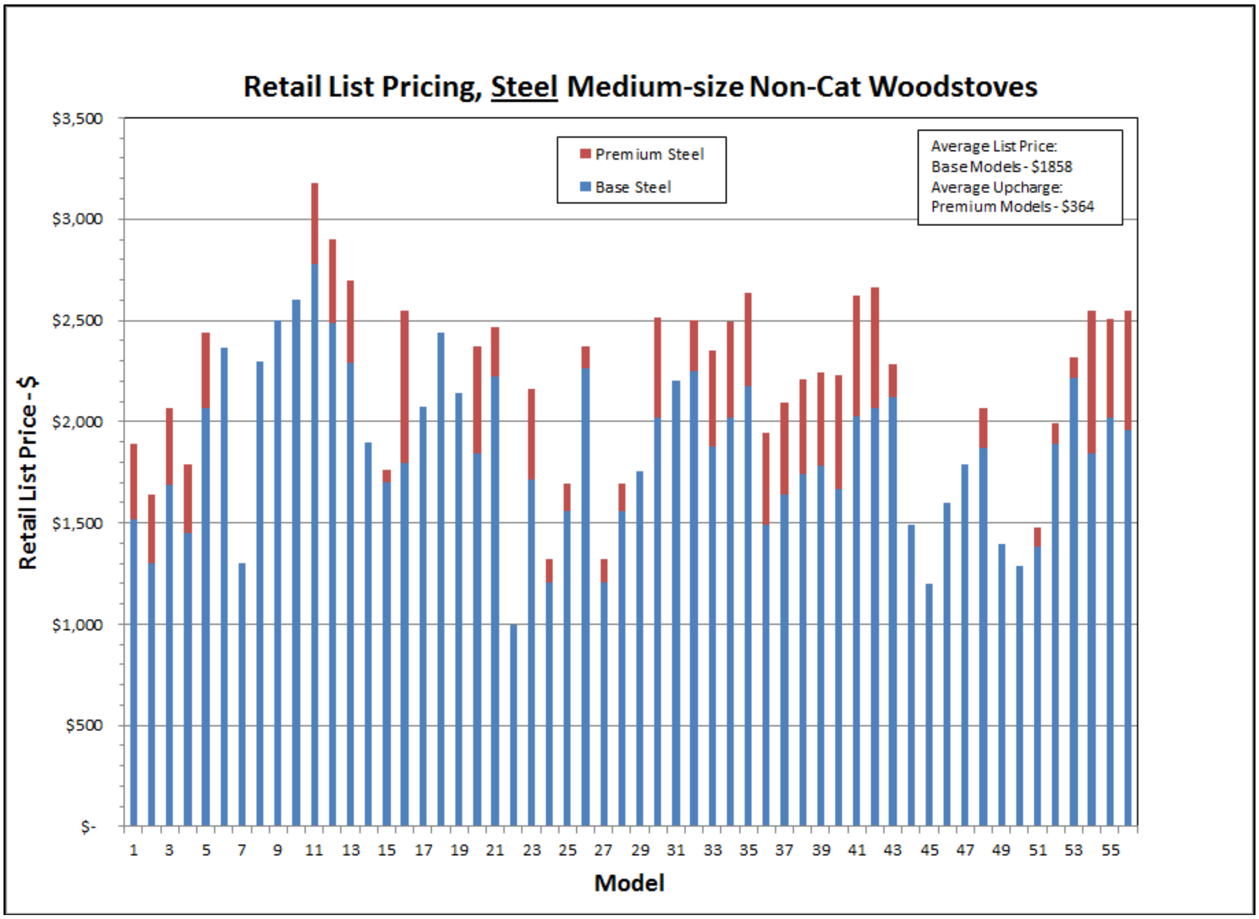
Firebox Volume Frequency



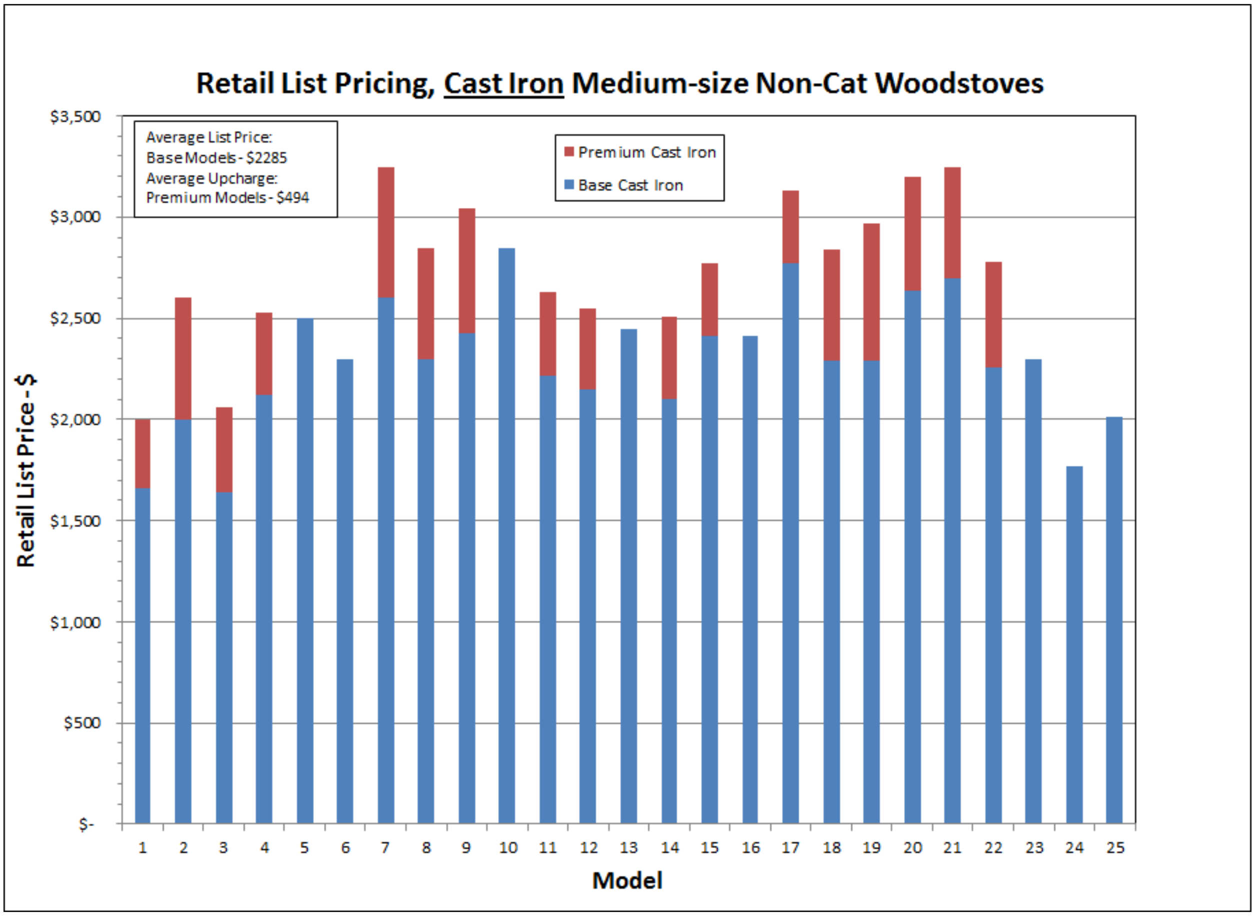
2. Base versus Upgraded Model Pricing

The difference between base model and premium or upgraded pricing was also analyzed, again for medium-sized non-cat models, and also looking at the differences between steel and cast iron.

<u>Steel Models</u>

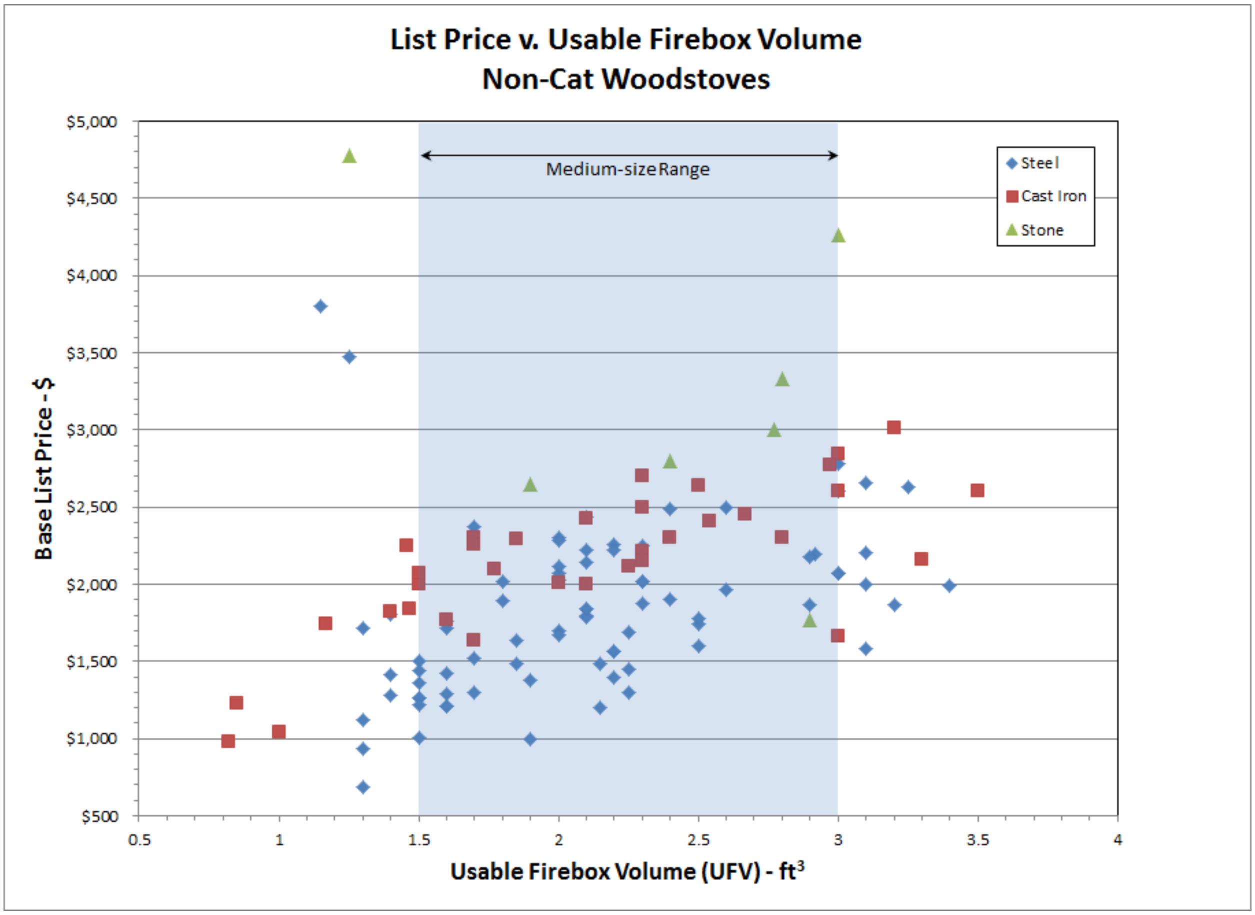


Cast Iron Models



3. Base List Price versus Firebox Volume

The base list price was plotted versus usable firebox volume for all non-cat stove models across the full size range from small to large. This was intended to show the anticipated trend of increasing price with increasing stove size. Of course, there is considerable scatter in the data but it does show the predicted and intuitive general trend. The shaded area indicated the medium-size range.



To determine if the wide range of firebox volumes that comprise the medium-size non-cat models was affecting the average retail price, a secondary analysis was done where the average price for models with firebox volumes within one standard deviation of the mean was calculated. For steel stoves, the average (mean) price for the full range of medium-size models was $1858 and for the mean ± 1SD range, $1851. For cast iron models the average price for the full range was $2285 and for the mean ± 1SD range, $2329. Therefore, the impact of range of firebox volume for medium-size stove pricing was not considered as significant for purposes of this analysis.

Table 1 – Summary of Retail Pricing Survey Data

HPBA Wood Stove MSRP Survey, Specialty Retailers

Dominant Manufacturers and Brands - Blinded

		Woodstove Specifications				Pricing			
Model Code	Type	Primary Material	Nominal Size	Cu. Ft. Firebox	Emissions g/hr	List Price	Enamel Premium	With Other Upgrades	Upgrade $ Difference
L1	NC	Steel	L	3.10	2.6	$ 2,656	NA	$ 2,796	$ 140
L2	NC	Steel	L	3.10	2.9	$ 1,999	NA	$ 2,466	$ 467
L3	NC	Steel	L	3.25	4.3	$ 2,629	NA	$ 3,057	$ 428
L4	NC	Steel	L	3.10	5.7	$ 1,579	NA		
L5	NC	Steel	L	3.40	3.9	$ 1,989	NA		
L6	NC	Steel	L	3.20	3.5	$ 1,869	NA	$ 1,979	$ 110
L7	NC	Steel	L	3.10	3.2	$ 2,200	NA		
M1	NC	Steel	M	1.70	4.1	$ 1,518	$ 1,888		$ 370
M2	NC	Steel	M	1.70	4.1	$ 1,303	NA	$ 1,637	$ 334
M3	NC	Steel	M	2.25	3.5	$ 1,688	$ 2,068		$ 380
M4	NC	Steel	M	2.25	3.5	$ 1,453	NA	$ 1,787	$ 334
M5	NC	Steel	M	3.00	2.9	$ 2,068	$ 2,438		$ 370
M6	NC	Steel	M	1.70	4.1	$ 2,368	NA		
M7	NC	Steel	M	2.25	3.5	$ 1,299	NA		
M8	NC	Steel	M	2.00	2.6	$ 2,299	NA		
M9	NC	Steel	M	2.60	3.7	$ 2,499	NA		
M10	NC	Steel	M	3.00	1.1	$ 2,599	NA		
M11	NC	Steel	M	3.00	2.3	$ 2,777	NA	$ 3,177	$ 400
M12	NC	Steel	M	2.40	1.1	$ 2,487	NA	$ 2,897	$ 410
M13	NC	Steel	M	2.00	1.1	$ 2,287	NA	$ 2,697	$ 410
M14	NC	Steel	M	2.40	1.1	$ 1,899	NA	$ 1,896	
M15	NC	Steel	M	2.00	1.1	$ 1,699	NA	$ 1,760	$ 61
M16	NC	Steel	M	2.10	3.4	$ 1,796	NA	$ 2,551	$ 755
M17	NC	Steel	M	3.00	3.9	$ 2,075	$ 2,568	$ 2,759	
M18	NC	Steel	M	2.10	3.4	$ 2,436	$ 2,436	$ 2,808	
M19	NC	Steel	M	2.10	3.4	$ 2,138	$ 2,138	$ 2,510	
M20	NC	Steel	M	2.10	3.4	$ 1,842	NA	$ 2,371	$ 529
M21	NC	Steel	M	2.10	3.4	$ 2,223	NA	$ 2,464	$ 241
M22	NC	Steel	M	1.90	4.1	$ 999	NA		
M23	NC	Steel	M	1.60	4.4	$ 1,717	NA	$ 2,162	$ 445
M24	NC	Steel	M	1.60	4.4	$ 1,209	NA	$ 1,323	$ 114
M25	NC	Steel	M	2.20	1.9	$ 1,561	NA	$ 1,694	$ 133
M26	NC	Steel	M	2.20	1.9	$ 2,260	NA	$ 2,372	$ 112
M27	NC	Steel	M	1.60	4.4	$ 1,209	NA	$ 1,323	$ 114
M28	NC	Steel	M	2.20	1.9	$ 1,561	NA	$ 1,694	$ 133
M29	NC	Steel	M	1.60	4.4	$ 1,756	NA		
M30	NC	Steel	M	1.80	2.0	$ 2,021	NA	$ 2,512	$ 491
M31	NC	Steel	M	2.92	3.5	$ 2,199	NA		
M32	NC	Steel	M	2.30	3.4	$ 2,251	$ 2,500		$ 249
M33	NC	Steel	M	2.30	3.4	$ 1,874	NA	$ 2,350	$ 476
M34	NC	Steel	M	2.30	3.4	$ 2,016	NA	$ 2,492	$ 476
M35	NC	Steel	M	2.90	4.2	$ 2,174	NA	$ 2,637	$ 463
M36	NC	Steel	M	1.85	3.3	$ 1,489	NA	$ 1,944	$ 455
M37	NC	Steel	M	1.85	3.3	$ 1,639	NA	$ 2,094	$ 455
M38	NC	Steel	M	2.50	4.5	$ 1,739	NA	$ 2,206	$ 467
M39	NC	Steel	M	2.50	4.5	$ 1,779	NA	$ 2,246	$ 467
M40	NC	Steel	M	2.00	2.5	$ 1,669	NA	$ 2,232	$ 563
M41	NC	Steel	M	2.00	2.5	$ 2,029	NA	$ 2,620	$ 591
M42	NC	Steel	M	2.00	2.5	$ 2,069	NA	$ 2,660	$ 591
M43	NC	Steel	M	2.00	2.5	$ 2,119	NA	$ 2,282	$ 163
M44	NC	Steel	M	2.15	2.7	$ 1,489	NA		
M45	NC	Steel	M	2.15	2.7	$ 1,199	NA		
M46	NC	Steel	M	2.50	3.5	$ 1,599	NA		
M47	NC	Steel	M	2.10	7.5	$ 1,789	NA		
M48	NC	Steel	M	2.90	4.5	$ 1,869	NA	$ 2,069	$ 200
M49	NC	Steel	M	2.20	6.9	$ 1,399	NA		
M50	NC	Steel	M	1.60	5.9	$ 1,289	NA		
M51	NC	Steel	M	1.90	4.4	$ 1,379	NA	$ 1,479	$ 100
M52	NC	Steel	M	1.80	2.7	$ 1,889	NA	$ 1,989	$ 100
M53	NC	Steel	M	2.20	2.7	$ 2,219	NA	$ 2,319	$ 100
M54	NC	Steel	M	2.10	4.2	$ 1,843	NA	$ 2,550	$ 707
M55	NC	Steel	M	2.30	3.6	$ 2,020	NA	$ 2,507	$ 487
M56	NC	Steel	M	2.60	4.1	$ 1,961	NA	$ 2,550	$ 589

Table 1 (Page 2)

		Woodstove Specifications				Pricing			
Model Code	Type	Primary Material	Nominal Size	Cu. Ft. Firebox	Emissions g/hr	List Price	Enamel Premium	With Other Upgrades	Upgrade $ Difference
S1	NC	Steel	S	1.50	2.1	$ 1,499	NA	$ 1,560	$ 61
S2	NC	Steel	S	1.50	2.9	$ 1,358	$ 1,714	$ 2,022	
S3	NC	Steel	S	1.30	3.0	$ 1,719	NA	$ 2,210	$ 491
S4	NC	Steel	S	1.40	3.0	$ 1,802	$ 1,902		$ 100
S5	NC	Steel	S	1.40	3.0	$ 1,412	NA	$ 1,897	$ 485
S6	NC	Steel	S	1.15	2.5	$ 3,799	NA		
S7	NC	Steel	S	1.50	3.8	$ 1,439	NA		
S8	NC	Steel	S	1.30	5.3	$ 1,119	NA		
S9	NC	Steel	S	1.50	4.4	$ 1,259	NA		
S10	NC	Steel	S	1.30	3.3	$ 689	NA		
S11	NC	Steel	S	1.50	4.4	$ 1,009	NA		
S12	NC	Steel	S	1.50	6.2	$ 1,259	NA		
S13	NC	Steel	S	1.30	5.1	$ 939	NA		
S14	NC	Steel	S	1.40	6.0	$ 1,279	NA		
S15	NC	Steel	S	1.50	5.7	$ 1,219	NA	$ 1,319	$ 100
S16	NC	Steel	S	1.25	2.6	$ 3,469	NA		
S17	NC	Steel	S	1.60	1.6	$ 1,419	NA	$ 2,168	$ 749
L8	NC	Cast Iron	L	3.50	2.5	$ 2,599	$ 3,069		$ 470
L9	C/NC	Cast Iron	L	3.20	1.1, 2.3	$ 3,009	$ 3,559		$ 550
L10	C	Cast Iron	L	3.30	1.3	$ 2,160	NA		
M57	NC	Cast Iron	M	3.00	1.5	$ 1,659	$ 1,999		$ 340
M58	NC	Cast Iron	M	2.10	2.0	$ 1,999	$ 2,599		$ 600
M59	NC	Cast Iron	M	1.70	4.1	$ 1,639	$ 2,059		$ 420
M60	NC	Cast Iron	M	2.25	3.5	$ 2,119	$ 2,529		$ 410
M61	NC	Cast Iron	M	2.30	2.3	$ 2,499	NA		
M62	NC	Cast Iron	M	1.70	2.2	$ 2,299	NA		
M63	NC	Cast Iron	M	3.00	2.9	$ 2,599	$ 3,249		$ 650
M64	NC	Cast Iron	M	2.40	3.4	$ 2,299	$ 2,849		$ 550
M65	NC	Cast Iron	M	2.10	3.4	$ 2,425	$ 3,039		$ 614
M66	NC	Cast Iron	M	3.00	3.9	$ 2,847	NA		
M67	NC	Cast Iron	M	2.30	2.4	$ 2,216	$ 2,629		$ 413
M68	NC	Cast Iron	M	2.30	2.4	$ 2,147	$ 2,550		$ 403
M69	NC	Cast Iron	M	2.67	2.8	$ 2,449	NA		
M70	NC	Cast Iron	M	1.77	3.8	$ 2,099	$ 2,509		$ 410
M71	NC	Cast Iron	M	2.54	3.2	$ 2,409	$ 2,769		$ 360
M72	NC	Cast Iron	M	2.54	3.2	$ 2,409	NA		
M73	NC	Cast Iron	M	2.97	4.1	$ 2,769	$ 3,129		$ 360
M74	NC	Cast Iron	M	1.70	4.1	$ 2,289	$ 2,839		$ 550
M75	NC	Cast Iron	M	1.85	3.3	$ 2,289	$ 2,969		$ 680
M76	NC	Cast Iron	M	2.50	4.5	$ 2,639	$ 3,199		$ 560
M77	C/NC	Cast Iron	M	2.30	1.2, 1.5	$ 2,699	$ 3,249		$ 550
M78	NC	Cast Iron	M	1.70	3.4	$ 2,259	$ 2,779		$ 520
M79	NC	Cast Iron	M	2.80	1.3	$ 2,299	NA		
M80	NC	Cast Iron	M	1.60	1.4	$ 1,769	NA		
M81	NC	Cast Iron	M	2.00	1.5	$ 2,009	NA		
S18	NC	Cast Iron	S	1.46	6.8	$ 2,249	$ 2,699		$ 450
S19	NC	Cast Iron	S	1.50	2.7	$ 1,999	$ 2,449		$ 450
S20	NC	Cast Iron	S	1.50	2.9	$ 2,075	$ 2,475		$ 400
S21	NC	Cast Iron	S	1.17	3.8	$ 1,739	$ 2,099		$ 360
S22	NC	Cast Iron	S	0.85	3.0	$ 1,229	NA		
S23	NC	Cast Iron	S	1.47	3.4	$ 1,839	NA		
S24	NC	Cast Iron	S	0.82	5.2	$ 979	NA		
S25	NC	Cast Iron	S	1.40	3.9	$ 1,820	$ 2,185		$ 365
S26	NC	Cast Iron	S	1.00	4.3	$ 1,039	$ 1,419		$ 380
M82	NC	Stone	M	3.00	4.0	$ 4,259	NA		
M83	NC	Stone	M	2.77	2.3	$ 2,999	$ 3,499		$ 500
M84	NC	Stone	M	1.90	2.0	$ 2,649	$ 2,999		$ 350
M85	NC	Stone	M	2.80	3.2	$ 3,329	$ 3,869		$ 540
M86	NC	Stone	M	2.40	2.2	$ 2,799	$ 3,179		$ 380
M87	NC	Stone	M	2.90	1.2	$ 1,769	$ 2,199		$ 430
S27	NC	Stone	S	1.30	3.6	$ 4,779	NA		
M88	C	Cast Iron	M	1.90	1.1	$ 1,629	NA		
M89	C	Cast Iron	M	2.20	1.4	$ 1,889	NA		
S27	C	Cast Iron	S	1.30	2.1	$ 1,889	$ 2,389		$ 500

Proposed Wood Heater NSPS Incremental Cost Effectiveness Analyses

Appendix C

HPBA Hearth Retailer Gross Margin Survey Results

Prepared for the Hearth, Patio & Barbecue Association

By Charles Page

JumpStart Marketing

May 2014

Background

In order to provide a supportable estimate of the typical gross margin for hearth specialty retailers, a survey was conducted by Charles Page of Jumpstart Marketing, Inc. Mr. Page has 37 years of experience that spans the full range of product development, marketing and sales functions across the hearth industry and he is well recognized as a modern hearth industry pioneer and expert.

The results of the survey were provided to NERA Economic Consulting to use in their incremental cost effectiveness analyses for the levels of the standards in the 2014 EPA Wood Heater NSPS proposal.

Summary

A survey of nine appliance manufacturers, five hearth distributors and five factory representatives from throughout the United States in markets where wood burning appliances are sold – the Northeast, the Midwest, Mountain States, Pacific Northwest and California - confirms that the benchmark margin for wood burning appliances is 40% (1.67 multiplier). Over the past 20 years this has become the industry standard and it is true whether the hearth retailer is buying direct from the manufacturer or is buying though a hearth product distributor.

On all price sheets pricing varies depending on the number of appliances purchased. Smaller dealers buying lower quantities would get smaller discounts and make less than a 40% margin – on the low end this would be in the 30% - 35% range, larger dealers purchasing in the highest discount price columns would receive a 40% - 45% margin. All industry experts I spoke with emphasized that most well established retailers are getting a 40% margin or better.

There are a number of reasons why hearth dealers expect and need a 40% margin. While some of the reasons for justification for this margin are related to the costs associated with running a typical brick and mortar store others are specific to the hearth business. Experience has shown that retailers who discount their stoves often are the same retailers who have difficulty paying their bills or maintaining a sustainable business.

Blueprint for Success, *Profit strategies for Specialty Hearth Retailers*[1] outlined various reasons why it is so essential for retailers to maintain a 40% margin. The book is a training guide for retailers and it provides actual Profit & Loss statement from retailers showing why this level of gross profit is required to stay in business and make a profit. Costs have gone up since this book was published in 2003, but the essence of why a 40% margin is so important remains the same today.

Here are some of the hearth specific costs that support the need for this level of margin:

[1] ***Blueprint for Success***, *Profit Strategies for Specialty Hearth Retailers*, Tom Pugh, Jerome Praught and Nancy Sutter, 2003

Specialized Knowledge is required - Selling and servicing hearth appliances requires specialized knowledge which can only be done by hiring experienced people or training competent new personnel. Either the retailer pays more money for experienced employees or they have to absorb the costs of training an inexperienced person. This point cannot be overstated, since retailers are selling products that can create <u>life threatening hazards</u> if they are not installed or used correctly. Public safety is a fundamental responsibility of hearth retailers and one they take very seriously. This specialized knowledge and support is a primary reason why homeowners buy from hearth retailers rather than big box retailers.

Obtaining and maintaining National Fireplace Institute (NFI) Certification – It has become increasingly more important for retailers to have their sales and installation staff certified by NFI. Obtaining certification often requires attending offsite training courses, buying manuals and paying testing fees. Since certifications are offered in three different fuel categories (Wood, Pellet & Gas), the NFI certification process can be expensive for hearth retailers. Maintaining each certification is also costly since NFI certified employees are required to take continuing education classes or retesting every two years.

Homeowner Call Backs – Unlike many consumer goods, stoves often require after-the-sale support in the form of phone consultations and site visits. Woodstoves are natural draft appliances which are prone to field problems such as smoking issues caused by wind interference, house pressurization issues, vent configuration issues, wood moisture content and operator error. Consumers who have recently purchased appliances will not pay for service call charges. They expect problems to be resolved quickly and at no charge. Sometimes these problems are difficult to troubleshoot and require two or more service calls to resolve.

Warranty Repairs - Manufacturers reimburse retailers in a number of ways for warranty work, but rarely is it enough to cover the entire cost of the repair. Manufacturers may only pay $40 or $50 per hour when the cost of labor, plus the service van or truck, costs twice this amount. Some manufactures pay a set amount for each part that needs to be replaced even if the repair takes much more time. Some manufactures only pay shipping one way for the repair part and require the dealer to package and send back the defective part. There are warranty claim forms to fill out and sometimes it takes more than one visit to repair a part and these expenses are rarely paid by the manufacturer. It is rare that a dealership will make money doing warranty work, most lose money and tie up valuable personnel that could be providing tech support to other customers or assisting with stove installations.

Another factor that increases the frequency of warranty repairs is that many manufactures do not have the resources to do extensive life cycle testing on their products before they are launched. Large durable goods manufacturers in other industries do this sort of testing and likely have failure rates far below the rates you see with woodstoves where anything below 1% is considered good. New products or technologies often experience higher warranty claims at the beginning of their product life cycles. Retailers are on the front lines of the warranty process.

High Insurance Costs – Both general liability insurance and workman's comp insurances are high for hearth retailers. Some retailers have had difficulty even finding a company to underwrite their policies. Finding affordable insurance has become more of an issue in the last five years. Insurance companies charge more for stove companies because they are selling and servicing products which can cause house fires if not installed and used properly. In addition workman's comp insurance is higher for companies where installers routinely climb ladders to install chimneys and chimney liners and are also manhandling heavy appliances.

Hearth Shops are seasonal business – It is common for hearth retailers – especially in the Northeast to see no actual profits until the selling season is well under way. The selling season for the Northeast begins in mid-August but many retailers don't break even until sometime in November. Managing cash flow in the offseason is a challenge. Most dealers have lines of credit which are used to pay employees and overhead in the spring and summer months. Discounts on the stoves they sell impacts their ability to pay their bills in a timely fashion that in turn can impact eligibility for those needed lines of credit. If sales are soft in October and November there is no way to make up these lost sales and some years are simply not profitable.

Industry downturns and inventory control – Other industries experience downturns, but the hearth industry particularly affected by fluctuations in the market for wood, pellet and gas appliances. Weather, the price of heating fuels, and political and economic uncertainties all have an effect on appliance sales. Every year retailers must guess how many appliances to buy prior to the selling season plus the model mix. For dealers offering all three types of appliances (gas, wood & pellet), managing and keeping tight control of inventory is extremely difficult. In August of 2013, for example, I questioned 30 retailers in the Northeast as to what was going to "sell" in the upcoming season and not one had any idea. Six weeks later, long after these retailers had purchased stoves in anticipation of the upcoming season, it become clear that pellet stoves where going to be the best sellers. The fact is that specialty retailers don't have sophisticated forecasting systems; they go on gut feel and experience. The distributors and manufactures that they buy from rarely take back unsold inventory so if these appliances don't sell the retailers shoulders the expense of holding this inventory. These retailers try to get rid of excess inventory at the end of the season by discounting these appliances, but if there is no market for them it makes no difference how great the incentives are, they are stuck with them and the attendant sunk costs

Location and how this affects overhead – Hearth retailers often struggle with costs associated with maintaining a retail location especially in suburban and urban areas. The fact is that it is common for retailers to be priced out of the market where costs per square foot make it almost impossible make a profit. In addition labor rates in these more populated areas are higher and competition from other better paying industries is making it difficult to find and afford to keep good people. In these high overhead areas retailers need more than 40% margin to break even.

Conclusions

A review of nine manufacturer's price lists indicated a margin ranges between 35% and 45% depending on the number of units purchased. Interviews with well-established retailers, experienced factory representatives and with the manufactures confirmed that establish hearth retailers generally expect and receive a 40% margin. There are factors specific to the hearth industry and market forces that justify this level of margin in order for the retailer to stay in business and make profit. Hearth retailers require specialized knowledge and experience to be successful. It is a seasonal business and one that is prone to more ups and downs than most retail businesses. A 40% margin helps insure survival and the long range health of the business.

Proposed Wood Heater NSPS Incremental Cost Effectiveness Analyses

Appendix D

HPBA Stove Retailer Survey Results – Woodstove and Pellet Stove Sales Trends

Prepared for the Hearth, Patio & Barbecue Association

By Charles Page

JumpStart Marketing

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Ferguson, Andors & Company

May 2014

Background

In order to provide a supportable estimate of the new stoves sold that are replacements for pre-NSPS (uncertified) models as well as for older NSPS certified models, a retailer survey was conducted was conducted in the spring of 2013 by Charles Page of Jumpstart Marketing, Inc. Mr. Page has 37 years of experience that spans the full range of product development, marketing and sales functions across the hearth industry and he is well recognized as a modern hearth industry pioneer and expert. His CV is included in Appendix A. This survey was limited to the northeastern United States but is felt to be generally representative of nationwide trends since the northeast is one of the primary solid-fuel appliance regions in the country.

The results of the survey were provided to NERA Economic Consulting to use in estimating the impacts of change-outs ("scrappage") in their incremental cost effectiveness analyses for the levels of the standards in the 2014 EPA Wood Heater NSPS proposal.

Hearth Retailer Selection
Retailers were selected for the survey as being representative of New England and New York.

Dealer Criteria

- Dealers had to have in-depth knowledge of the wood and pellet stove sales in their markets spanning over 25 years.
- The interviewees had to be either store owners or key experienced personnel.
- The retailers had to have a significant part of their revenue derived from selling wood and pellet stoves over the last 25 years. Retailers in urban areas where the market is primarily gas fireplaces and gas stoves were not contacted in the survey.

Survey Questions – Wood Stove Sales
For the past 10 years,

1. What percentage of EPA certified woodstoves were sold to people who had never purchased a woodstove before?

2. What percentage of EPA certified woodstove sales have been replacements for non-certified woodstoves (Pre-1988 stoves)?
3. What percentage of EPA certified woodstoves have been replacements for EPA certified stoves?

Survey Questions – Pellet Stove Sales

For the past 10 years,

1. What percentage of pellet stoves were sold to people who were not replacing a woodstove?
2. What percentage of pellet stove sales were replacements for non-certified woodstoves (Pre-1988 stoves)?
3. What percentage of pellet stove sales were replacements for EPA certified wood stoves?

Discussion of Surveying

While most of the interviewees provided answers in round numbers, some found it easier to answer the first question relating to first time buyers, and then to answer the second two questions as a percent of buyers replacing stoves, rather than as a percent of all buyers. In these cases, values for the second two questions were proportionally adjusted so that the totals for the three questions equal 100%.

Retailers were quick to point out that answers were best estimates that summarize purchaser trends in their stores over the last 10 years. During this 10 year period the market has undergone a number of product mix swings as well as ups and downs. In 2008, for example, there was a pellet stove buying frenzy in New England and New York which impacted woodstove sales. Two years later the market had shifted away from pellet stoves and sales were significantly lower in all product categories. The aggregate survey results provide a look at the trends over that past 10 years and should only be considered in that light.

Survey Results

The percentage of new stoves sold to first time buyers, in other words, those not replacing an existing stove ranged from 10 – 80% with a mean of 35% and a median of 30%.

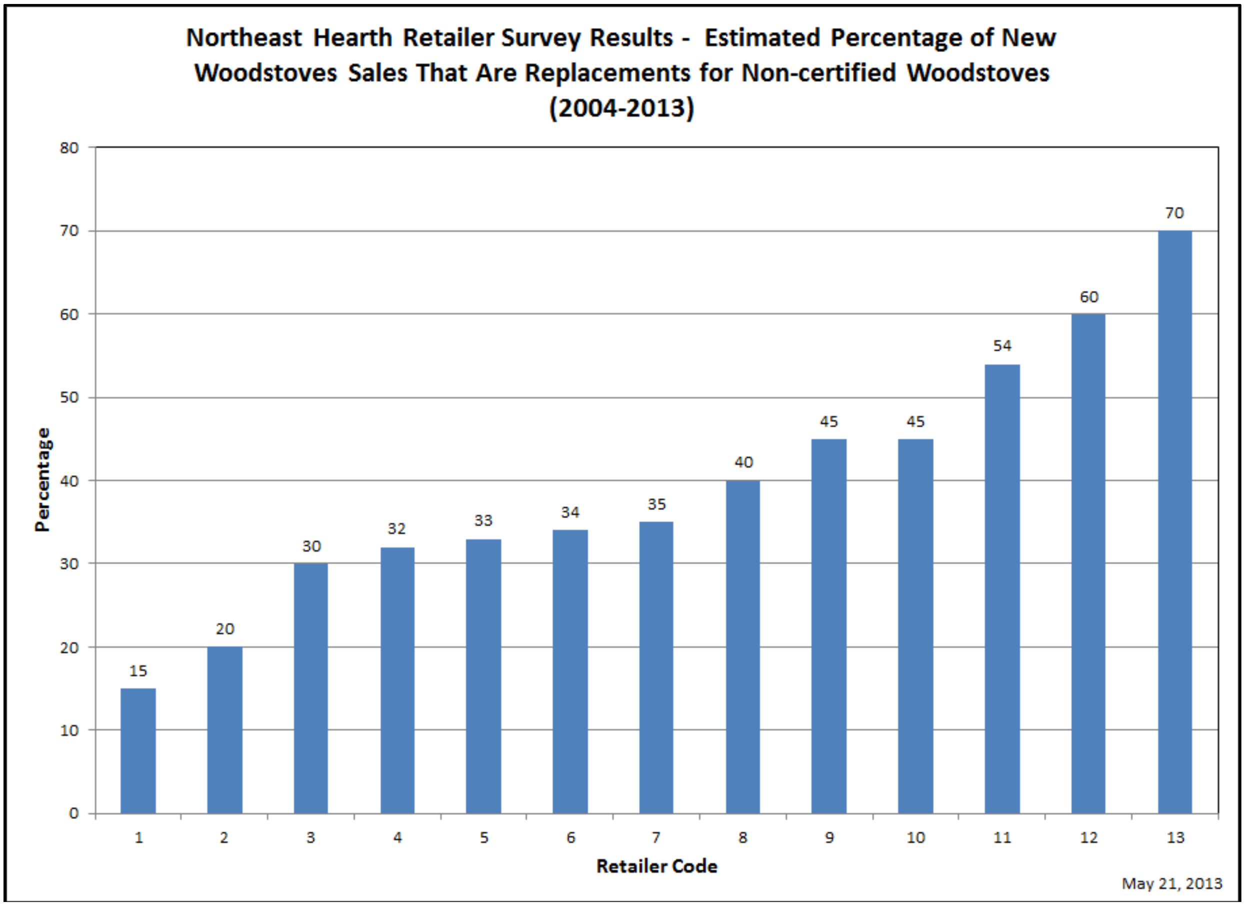
The percentage of new stoves sold that were replacing non-certified (Pre-1988) stoves ranged from 15 – 70% with a mean of 39% and a median of 35%.

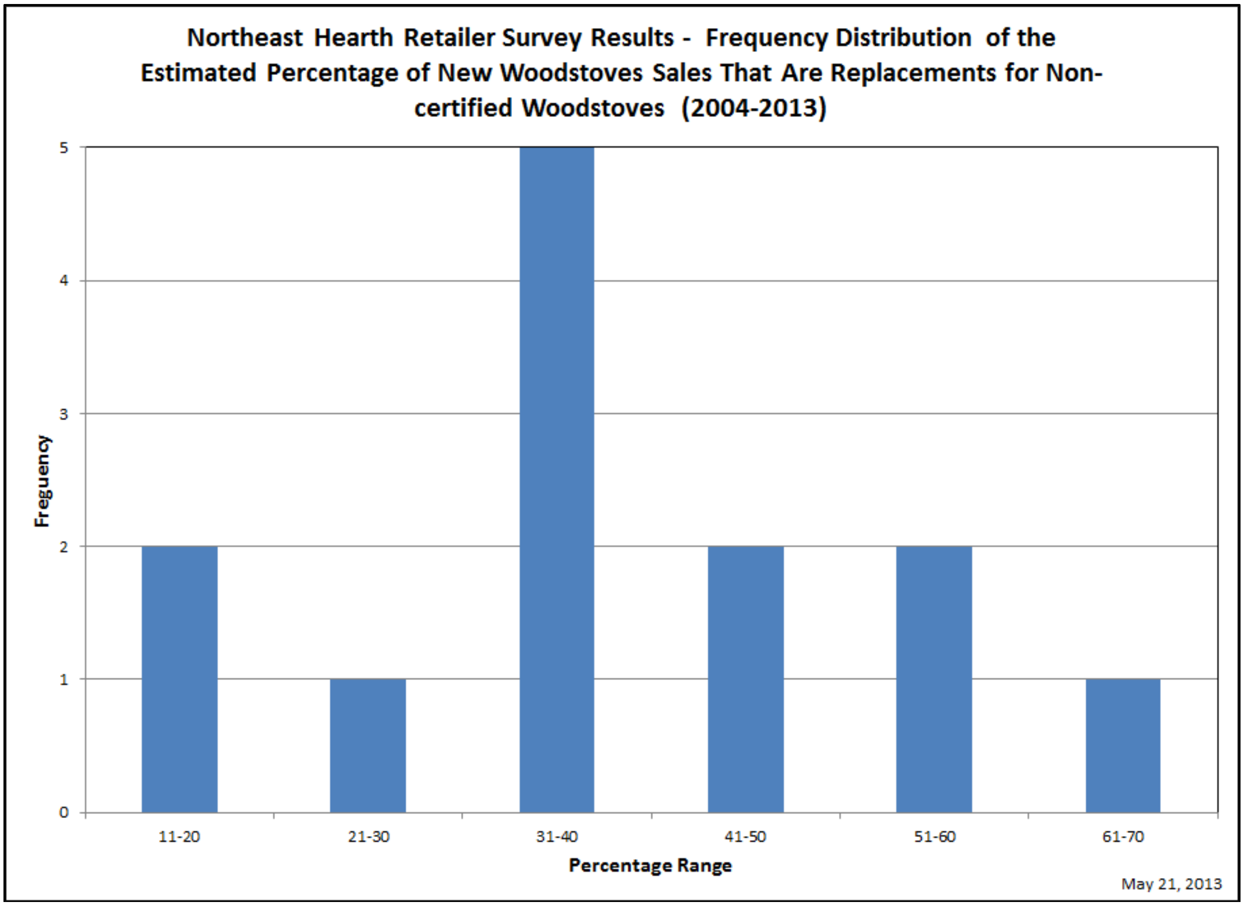
The percentage of new stoves sold that were replacing EPA certified stoves ranged from 5 – 48% with a mean of 25% and a median of 20%. Note: This is a somewhat higher level of replacement of EPA certified stoves than was determined in an earlier survey of 22 retailers that were distributed nationwide and that was conducted by James Houck and reported in "*The Fraction of Freestanding Wood-Fueled Stoves in Current Use That are U.S. EPA Certified Cordwood Stoves and Wood Pellet Stoves"* in July 2011. The difference could be the result of the regional focus of this survey in the northeast or because of the difference and sequence of the questions asked.

Pellet stove results are included in the table below but are not discussed here.

Survey Results

	Woodstoves			Pellet Stoves		
Retailer Code	First Time Buyers	Replacing Non-Cert.	Replacing EPA Cert.	First Time Buyers	Replacing Non-Cert.	Replacing EPA Cert.
1	80	15	5	75	15	10
2	50	20	30	60	30	10
3	67	30	3	67	30	3
4	20	32	48	30	28	42
5	50	33	17	70	24	6
6	15	34	51	30	45	25
7	50	35	15	70	15	15
8	30	40	20	70	15	15
9	10	45	45	80	10	10
10	10	45	45	60	20	20
11	40	54	6	60	20	20
12	10	60	30	20	50	30
13	20	70	10	90	8	2
Mean	35	39	25	60	24	16
Median	30	35	20	67	20	15


Northeast Hearth Retailer Survey Results - Estimated Percentage of New Woodstoves Sales That Are Replacements for Non-certified Woodstoves (2004-2013)
Percentage
80
70
60
50
40
30
20
10
0
15
20
30
32
33
34
35
40
45
45
54
60
70
1
2
3
4
5
6
7
8
9
10
11
12
13
Retailer Code
May 21, 2013


Northeast Hearth Retailer Survey Results - Frequency Distribution of the Estimated Percentage of New Woodstoves Sales That Are Replacements for Non-certified Woodstoves (2004-2013)
Freguency
5
4
3
2
1
0
11-20
21-30
31-40
41-50
51-60
61-70
Percentage Range
May 21, 2013

Proposed Wood Heater NSPS Incremental Cost Effectiveness Analyses

Appendix E

EPA Certified Wood Heater Design Life Assessment

Prepared for the Hearth, Patio & Barbecue Association

By Robert Ferguson

Ferguson, Andors & Company

April 25, 2014

In the NSPS proposal preamble, EPA states that many models developed to meet the current NSPS requirements are still being sold today and that many new models only have had cosmetic changes and still have the same internal working parts (presumably referring to emission reduction technology):

> "To develop estimates of potential unit cost increases, we used major variables including the estimated number of units shipped per year, the costs to develop new models, baseline costs of models, and the schedule by which the proposed revised NSPS would be implemented. Both the number of shipped units and the baseline costs of models were based on data from the Frost & Sullivan report with modifications to address additional appliances or subsets of appliances. The 20-year model design life span and 20- year use/emitting appliance life span are based on actual historical design certification and heater use data. That is, the data show that many models developed for the current 1988 NSPS are still being sold (after 25 years), many ''new'' models still have the same internal working parts with merely exterior cosmetic changes,…."[1]

We find this presumption to be flawed for several reasons. First, many of the models that were offered for sale twenty years ago are no longer in production and many manufacturers on EPA's certified woodstove list are no longer in business (or at least not in the woodstove business). The EPA certified stove database[2] included 790 woodstove models from 91 manufacturers when Hearth, Patio & Barbecue Association (HPBA) undertook the Enhanced EPA Certified Wood Heater Database Project[3] that culminated in February 2010. The HPBA database identified 125 woodstove models actually in production at that time in 2010. Those 125 models were thought to represent well over 90% of all U. S. woodstove sales. The number of manufacturers has also declined appreciably since 1988 although it was hard make an exact count. Of current HPBA manufacturer members, 30 identify themselves as woodstove manufacturers. The data from the Enhanced Database Project alone, when compared with the total number of appliances that have been certified over the now twenty-five year life-span of Subpart AAA program by itself strongly refutes EPA's twenty year design life finding, since the total number of certified models identified as being produced in 2010 (125) is less than 15% or the total certified during the life of the program (790).[4] Speaking in broadly general terms, it is safe to say that the surviving

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[1] 6351 Federal Register /Vol. 79, No. 22 /Monday, February 3, 2014 / Proposed Rules

[2] List of EPA Certified Wood Heaters, http://www.epa.gov/Compliance/resources/publications/monitoring/caa/woodstoves/certifiedwood.pdf

[3] Hearth, Patio and Barbecue Association (HPBA) Enhanced EPA Wood Heater Database - 2/25/2010 Docket ID**:** EPA-HQ-OAR-2009-0734-0266, Agency: Environmental Protection Agency

[4] Unfortunately, some stakeholders continue to rely on the raw EPA certified stove list, and play a "numbers game" by counting any models that had certification scores less than the proposed Step2/3 emission limit. These are meaningless exercises that essentially beg the question for a number of reasons. For example, some models may have been discontinued because of technical problems resulting in unacceptable warranty return rates; others may be previous generations of a frequently upgraded model, so the "count" effectively involves double counting. Concerns like these motivated the exhaustive review which produced the HPBA Enhanced Database. It was intended to inform

manufacturers have continued to add new models, upgrade popular models and retire models over the past 20 years. The new models and upgraded models have included aesthetic and other user feature upgrades but the fact that the upgraded models predominantly needed to be certified/recertified shows that they have also included technology upgrades involving emissions-critical components. In addition, many models were redesigned and re-certified when Washington State imposed their lower emission limits.

Today's woodstoves do contain many of the same "parts" that the first certified stoves included 25 years ago. Besides the necessary four sides, top, bottom and load door including a glass panel, all of today's woodstoves contain a primary air delivery system, a secondary air delivery system and some form of combustion technology. Catalytic models, at a minimum, include a catalytic element, some means to shield the catalyst from flame impingement, and a bypass damper. Typical non-catalytic stoves include an insulated baffle and secondary air tubes. Some other non-catalytic models include a separate secondary combustion chamber, special firebox bricks and a bypass damper. These parts, among numerous others, are the generically designated parts that comprise all the various stove models being produced today.

However, one must look at the specific details before is appropriate to assume that these parts and other emission critical have not evolved over time for many of today's models. In accordance with the current NSPS requirements, changes presumed to affect emissions are codified in the commonly denoted "k-list"[5]. This is a broad list that includes many stove

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this rulemaking proceeding; stakeholders that aren't using it are making misleading arguments that should be ignored.

[5] **40 CFR 60 Subpart AAA—Standards of Performance for New Residential Wood Heaters, §60.533(k)**
§60.533(k)(1) A model line must be recertified whenever any change is made in the design submitted pursuant to §60.533(b)(3) that is presumed to affect the particulate emission rate for that model line. The Administrator may waive this requirement upon written request by the manufacturer, if he determines that the change may not reasonably be anticipated to cause wood heaters in the model line to exceed the applicable emission limits. The granting of such a waiver does not relieve the manufacturer of any compliance obligations under this subpart.
(2) Any change in the indicated tolerances of any of the following components (where such components are applicable) is presumed to affect particulate emissions if that change exceeds ±0.64 cm (±1⁄4 inch) for any **linear** dimension and ±5 percent for any cross-sectional area relating to air introduction systems and catalyst bypass gaps unless other dimensions and cross-sectional areas are previously approved by the Administrator under paragraph (e)(1)(ii) of this section:
(i) Firebox: Dimensions,
(ii) Air introduction systems: Cross-sectional area of restrictive air inlets, outlets, and location, and method of control,
(iii) Baffles: Dimensions and locations,
(iv) Refractory/insulation: Dimensions and location,
(v) Catalyst: Dimensions and location,
(vi) Catalyst bypass mechanism and, for model lines certified to meet the emissions limits in § 60.532(b), catalyst bypass gap tolerances (when bypass mechanism is in closed position): Dimensions, cross-sectional area, and location,
(vii) Flue gas exit: Dimensions and location,
(viii) Door and catalyst bypass gaskets: Dimensions and fit,
(ix) Outer shielding and coverings: Dimensions and location,
(x) Fuel feed system: For wood heaters that are designed primarily to burn wood pellets and other wood heaters equipped with a fuel feed system, the fuel feed rate, auger motor design and power rating, and the angle of the auger to the firebox, and

components. Changes of just about every kind can easily implicate exceeding allowable "k-list" tolerances. Changes to features or accessories like the addition of an ash pan or change in convection air blower, firebox firebrick or insulation or catalyst bypass all implicate revisions that are presumed to affect emissions. And these are in addition to other on-going improvements to the emission control technology that can only be expected to be implemented as manufacturers gain more and more experience in the art and science of combustion technology.

EPA's position also is completely incompatible with the reality that manufacturers have to deal continually with real world issues concerning the profitability and sustainability of their businesses. As such, they are constantly assessing ways to minimize costs and risks, and enhance profitability. These pressures can implicate retirement or significant modification of a model for a number of reasons. For example, a model currently being produced may be having an unacceptable degree of warranty returns, which could lead to a decision to redesign the product. Or a redesign could be motivated by a desire to improve manufacturing efficiency or costs. Or a desire to improve the emissions performance of the model so that its performance was more consistent and predictable could be a motivation. Improving emissions performance to provide a marketing "edge" over a competitor's product is another factor. And there may be other reasons why a manufacturer could launch a product redesign effort for sound business reasons. The point is a simple one: in this business, like any other, innovation is seen by many manufacturers as a prime component of business success.

EPA only revealed the 20-year "design life" assertion when the NSPS proposal was first made public on January 3, 2014. HPBA realized that an industry-wide survey was simply not feasible within the time available and with resource limitations. Instead, a survey of a small number of key manufacturers was conducted and information about 53 specific models was obtained. Some of the models are currently in production and others have been discontinued. One of the manufacturers is the largest woodstove producer in the industry. The others offer a good industry cross-section representing cast-iron and steel stove producers, diverse retail pricing and all forms of distribution. Some models have had as many as four technology upgrades over their lifespans. The results of this survey are at least indicative of industry trends that run counter to the EPA blanket assumption. Manufacturers do modify their emission control technology for various reasons and at various intervals.

By surveying these manufacturers, we have been able to obtain historical information showing the evolution of a number of stove models that have been sold for many years. We were especially interested to know the average "design life" span across full ranges of models from the responding manufacturers. We also requested information about the specific reasons that for any changes.

(xi) Forced air combustion system: For wood heaters so equipped, the location and horsepower of blower motors and the fan blade size.
(3) Any change in the materials used for the following components is presumed to affect emissions:
(i) Refractory/insulation or
(ii) Door and catalyst bypass gaskets.
(4) A change in the make, model, or composition of a catalyst is presumed to affect emissions, unless the change has been approved in advance by the Administrator, based on test data that demonstrate that the replacement catalyst is equivalent to or better than the original catalyst in terms of particulate emission reduction.

The participating manufacturers were given a form that would allow them to track the progression of modifications to models they have produced or are still producing. They were asked to indicate why the changes were made. The tabulated results, coded to protect manufacturer identity as agreed as a condition of participation are provided in Tables 1A and 1B.

Table 1A

Stove Technology Life Cycle													
Mfr. Code	**Model Line Code**	**Beg Mfg (mon-yr)**	**End Mfg (mon-yr)**	**Technology Life (yrs)**	**grams/hr**	**Improve Reliability**	**Cost Savings**	**Improve Emissions**	**Market Demand Requirement**	**Improve Manufacturability**	**Warranty Reduction**	**Improve Performance**
A	1	Jul-07	Jan-16	8.4	2.1			x	x	x		x
A	1	Jan-02	Jul-07	5.4	2.0	x		x				
A	1	Mar-90	Dec-01	11.7	3.6	x		x				
A	1	Jan-87	Jan-90	3.1	6.1			x				x
A	2	Jul-09	Jan-16	6.5	2.0			x	x	x		x
A	2	Mar-01	Jul-09	8.3	1.3	x		x				
A	2	Feb-90	Mar-01	11.1	2.1	x		x				
A	2	Jan-87	Jan-90	3.1	6.5			x				x
A	3	Oct-06	Jan-16	9.2	1.1			x	x	x		x
A	3	Apr-02	Oct-06	4.5	1.2	x		x				
A	3	Dec-94	Mar-01	6.3	1.1	x		x				
A	3	Mar-90	Oct-94	4.6	4.0			x				x
A	4	May-09	Jan-16	6.7	2.3			x	x	x		x
A	4	May-02	May-09	7.0	4.2			x				x
A	5	Jan-10	Jan-16	6.0	3.5			x	x	x		x
A	5	Jun-03	Jan-10	6.6	4.2			x				x
A	6	Aug-09	Jan-16	6.4	1.1			x	x	x		x
A	6	Aug-01	Aug-09	8.0	1.3	x		x				
A	6	Apr-90	Jul-01	11.3	2.1	x		x				
A	7	Sep-11	Jan-16	4.3	4.2			x	x	x		x
A	7	Jul-02	Aug-11	9.1	3.1			x				x
A	8	Aug-11	Jan-16	4.4	4.3			x	x	x		x
A	8	Nov-04	Jul-11	6.7	2.0	x		x				
A	8	Jan-93	Apr-03	10.2	2.7	x		x				
Mfr. A Average				**7.0**								
B	1	Jul-92	Jan-94	1.5	6.5			x				
B	2	Jul-92	Jan-94	1.5	7.0			x				
B	3	Jul-92	Jan-94	1.5	3.2			x				
B	4	Jul-93	Current	25.0	4.1			x		x		x
B	5	Jul-93	Current	25.0	3.5			x		x		x
B	6	Jul-93	Current	25.0	2.9			x		x		x
B	7	Jul-04	May-06	1.8	4.5				x			
B	8	Mar-01	Current	14.0	5.4	x		x				x
B	9	Aug-03	Aug-03	0.0	4.9			x	x			x
B	9	Sep-04	Current	11.0	7.1							x
B	10	Sep-08	Current	10.0	7.2				x			
B	11	Nov-08	Current	10.0	2.4				x			
B	12	Dec-10	Current	5.0	2.1		x	x	x	x		x
B	13	Jul-09	Current	10.0	3.9	x			x	x	x	
B	14	Jul-09	Current	10.0	3.6	x			x	x	x	
B	15	Jul-12	Current	5.0	2.6			x	x			x
Mfr. B Average				**9.8**								

Table 1B

C	1	1988	1998	10.0	3.0							
C	2	1988	1994	6.0	3.3							
C	3	1989	1993	4.0	3.7			x	x			x
C	4	1989	1993	4.0	3.7			x	x			x
C	5	2008	Current	10.0	3.1			x	x			x
C	6	2006	Current	10.0	5.9			x	x			x
C	7	2004	Current	10.0	1.5			x	x			x
C	8	2005	Current	10.0	1.6				x			
C	9	1990	1996	6.0	3.0							
C	10	1990	Jun-05	15.0	3.8							
C	11	2011	Current	5.0	5.4				x			
C	12	2008	Current	10.0	4.6				x			
C	13	2010	Current	10.0	3.7				x			
C	14	2008	Current	10.0	1.1				x			
C	15	2011	Current	5.0	1.9				x			
C	16	2013	Current	5.0	3.2				x			
C	17	2013	Current	5.0	2.5				x			
C	18	2012	Current	5.0	3.9				x			
C	19	2011	Current	5.0	4.0				x			
C	20	2012	Current	5.0	3.6				x			
C	20	2011	2012	5.0	3.8				x			
C	21	2011	Current	5.0	3.2				x			
C	22	2014	Current	5.0	3.2			x	x			x
C	23	2013	Current	5.0	3.1				x			
C	24	2013	Current	5.0	1.8				x			
C	25	2007	Current	10.0	3.6							
Mfr. C Average				**7.1**								
D	1	Dec-08	Dec-18	10.0	4.5			x	x			
D	1	Dec-07	Dec-08	1.0	7.5							
D	2	Sep-00	Sep-15	15.0	3.8			x	x			
D	2	Mar-96	Sep-00	4.5	7.2							
D	3	Sep-11	Sep-16	5.0	3.4			x	x			
D	3	Jul-94	Sep-11	17.1	5.2							
D	4	Jun-03	May-18	14.9	3.2	x					x	x
D	4	May-99	Jun-03	4.1	3.0							
D	5	Mar-04	Mar-19	15.0	4.1			x				
D	5	May-99	Mar-04	4.9	4.4							
Mfr. D Average				**9.2**								

It should be noted that for models currently in production, it was assumed that eligible EPA certificates would be renewed up to 3 months before the effective date of the revised NSPS meaning design life was extended to the end date of any renewable certificate.

For the surveyed manufacturers, the number of years that models remain in production without "k-list" revisions ranged from less than 1 to 25 years. The average for the 53 models was 8.3 years. For the largest manufacturer, the average design life was 7 years. For the other manufacturers, the range was from just over 7 years to just under 10 years.

Reasons for the combustion technology modifications included all seven categories on the survey form. These are ranked here in order according to the survey results with counts in parentheses.

1. Improve Emissions (44)
2. Market Demand Requirement (40)
3. Improve Performance (29)
4. Improve Reliability (14)
5. Improve Manufacturability (14)
6. Warranty Reduction (3)
7. Cost Savings (1)

Improving emissions, meeting market demand requirements (including responding to competitive pressure) and improving overall performance and product reliability (customer satisfaction) were most common reasons given for revising and upgrading models over time.

Conclusions

This survey cannot categorically define the average “design life” for all models across all wood heater manufacturers but is does clearly show that the combustion technology that manufacturers employ in their products has hardly been static for the past 25 years as asserted by EPA in the NSPS proposal. While some manufacturers have left some models unchanged through several EPA certificate renewal cycles, technology has indeed continued to evolve and many other models have been through multiple revision cycles including new certifications as technological improvements have been implemented. Customers and competitors help drive the need to keep products fresh in the marketplace including showing improvements in performance. While emissions performance may not be a factor that heavily influences all consumer purchasing decisions, some manufacturers do use emission performance in their marketing as a point of differentiation between their products and those from their competitors. And product differentiation is an important factor when trying to gain market share and retailer floor space. This motivation has driven the largest manufacturer to a commitment to constant improvement in emission performance as well as overall performance and that has resulted in regular model line upgrades.