May 2014

Assessment of EPA Economic Analyses for Proposed Wood Heater New Source Performance Standards

Prepared for:

Hearth, Patio and Barbecue Association

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Executive Summary

This report provides an economic assessment of the U.S. Environmental Protection Agency's ("EPA" or "Agency") analyses underlying the proposed New Source Performance Standards ("NSPS") for wood heaters, which EPA issued in the *Federal Register* in February 2014. We evaluate EPA's cost-effectiveness analysis (dollars per ton of emission reduction), industry impact analysis, and economic impact analysis. We do not assess EPA's monetized benefit estimates or its comparisons between costs and monetized benefits.

We focus on a methodological evaluation of EPA's cost-effectiveness analysis—in particular, the extent to which EPA follows guidance it has provided for developing such analysis in its *Guidelines for Preparing Economic Analyses* (EPA 2010)—rather than on a detailed evaluation of their specific estimates of costs and emissions reduction benefits. The current version of the EPA *Guidelines* reflects decades of input and review from numerous experts and stakeholders. It provides sound and detailed instruction on preparing accurate and useful analyses of environmental regulations. We note the lack of any quantitative assessment of impacts of the NSPS on the industry and the overall economy.

A. Summary of Relevant Guidance from EPA *Guidelines*

The EPA Guidelines provide a template for performing an economic assessment of potential new regulations, including a cost-effectiveness analysis as well as industry impact and economy-wide impact analysis.

1. Major Elements of an Appropriate Cost-Effectiveness Analysis

As a basic rule for environmental policy proposals, the EPA *Guidelines* instruct Agency staff to specify several regulatory options, including at least one option less stringent than the Agency's proposal and at least one option more stringent than the Agency's proposal. Stringency parameters can take various forms, including compliance timeline, tight or loose standards, and scope of regulated industries or areas.

Moreover, the EPA *Guidelines* instruct Agency staff to develop incremental analyses among the regulatory options. For example, analyses related to air emissions should show not only the total costs, total emission reductions, and total cost-effectiveness for each regulatory option, but also the incremental costs, incremental emission reductions, and incremental cost-effectiveness for increasingly stringent options relative to the next less stringent option. For each stringency level, incremental analyses provide useful information on what society must additionally pay (in the form of incremental costs) for what society would additionally gain (in the form of incremental environmental effects) relative to the next less stringent option. In other words, incremental analyses allow decision-makers and the general public to understand which regulatory option has the most "bang for the buck." An analysis with few regulatory options and no clear comparisons among them does not provide much useful information for decision-making.

The EPA *Guidelines* also provide guidance on basic requirements for accurately evaluating social costs, environmental effects, and social benefits (i.e., the monetized value of

environmental effects to society). The *Guidelines* note that compliance cost estimates should be specific to the stringency level of each regulatory option. They also discuss the importance of market analyses that evaluate the impacts of regulatory options on product prices and sales quantities. In general, environmental regulations tend to impose costs on product manufacturers, which lead to higher product prices for consumers and lower sales quantities. Any analysis that does not account for changes in sales quantity due to the regulation would not have accurate estimates of social costs, environmental effects, and social benefits.

For an analysis like the wood heater NSPS, it is also necessary to consider the extent to which changes in new appliance sales would affect scrappage of existing appliances and implications for net emission reductions from the regulation. In addition, the *Guidelines* instruct Agency staff to evaluate how changes in product prices and sales quantities lead to changes in social welfare in the relevant markets, which economists measure as changes in consumer and producer surplus. These social welfare measures capture both compliance costs and any social costs associated with lost sales; the cost of foregone sales (called deadweight loss) can be a significant component of total costs.

2. Industry Impact and Economy-Wide Impact Assessments

Economic assessments should provide indications of the potential impacts of regulatory requirements on the regulated industry. Industry impact analyses provide estimates of changes in jobs, closures, startups, and other indicators of business activity within the industries directly affected by the regulation.

Economic impact analyses provide estimates of changes in the broader economy, including changes in industries that provide inputs to the affected industries as well as changes from the purchase of goods and services by individual employees within the affected industries. These impacts are typically expressed in terms of changes in jobs, Gross Domestic Product ("GDP"), personal labor income, and taxes for the United States or the particular area of interest. The EPA *Guidelines* also provide detailed instructions on proper techniques for conducting such analyses.

B. Summary of Methodological Assessment

Table E-1 summarizes our assessment of EPA's analyses for the proposed wood heater NSPS relative to the proper methodologies as prescribed in the *Guidelines*. The table contains seven rows for seven key elements of an appropriate incremental cost-effectiveness analysis, as well as one row each for industry impact analysis and economic impact analysis.

As shown in the table, EPA did not comply with the basic rule to specify a broad range of regulatory options, with some options less stringent than the proposed regulatory approach and others more stringent. Instead, EPA provides estimates only for its proposed approach and an alternative approach that has the same initial and final standards for all categories of wood heater. EPA's alternative approach differs from the proposed approach only by setting an intermediate standard and adjusting the regulatory timeline slightly (as discussed in the main body of this report). Clearly, a regulatory analysis that evaluates only two options that differ only slightly from each other does not provide a useful basis for a careful evaluation of alternatives.

Moreover, the combinations of various appliance categories in EPA's analyses and combinations of various time periods for cost and environmental calculations further limit the usefulness of the information for informed implications for decision-making.

Table E-1. Assessment of EPA Analyses for Proposed Wood Heater NSPS Relative to EPA *Guidelines for Preparing Economic Analyses*

	EPA Performed for Proposed Wood Heater NSPS?	
Incremental Cost-Effectiveness Analysis		
1. Specify several options (at least one less stringent and one more stringent than proposal)	**No**	No option more stringent than Proposal; only difference between Proposal and Alt. is timing
2. Develop compliance cost estimates based on stringency	**No**	No dependence on stringency for most costs
3. Develop emission reduction estimates based on stringency	**Yes, but…**	No accounting for large emission uncertainty
4. Incorporate market impacts into cost and emission reduction estimates	**No**	No demand, scrappage, or cons. surplus effects
5. Calculate incremental costs (least to most stringent)	**No**	No incremental analysis for decision-making
6. Calculate incremental emission reductions (least to most stringent)	**No**	No incremental analysis for decision-making
7. Calculate incremental cost-effectiveness (least to most stringent)	**No**	No incremental analysis for decision-making
Industry Impact Analysis	**No**	No estimates of industry jobs, closures, etc.
Economic Impact Analysis	**No**	No estimates of economy-wide jobs, GDP, etc.

Source: EPA (2010) and NERA assessment of EPA (2014a, b)

The table also shows that EPA did not follow its own *Guidelines* for other key elements of cost-effectiveness analysis. When EPA estimated compliance costs for manufacturing wood heaters to meet lower emission performance standards, the costs per model did not depend on emission performance. Common sense indicates, however, that the costs per model should increase as the emission performance standard tightens. To highlight the problem with costs that do not depend on emission performance, note that it seems to imply that the best strategy would be setting the standard at zero emissions (assuming technological feasibility), because this would maximize emission reductions at the same cost as any other standard. This implication reveals that EPA's cost assumptions are faulty; our intuition rightly tells us that a zero-emission standard should have extremely high costs.

With regard to the emission reduction benefits, the table notes that EPA did not account for the significant uncertainty in emissions. Indeed, Houck (2012) concludes that actual emissions from certified woodstoves bear little correlation with certified emission rates, as discussed in the main body of this report and other materials submitted by the Hearth, Patio and Barbecue Association ("HPBA").

Furthermore, EPA did not perform a market analysis evaluating the potential changes in product prices and sales quantities from the regulation, and therefore its estimates of social costs, emission reductions, and social benefits inaccurately exclude important components related to demand effects, scrappage effects, and consumer surplus effects (as discussed in the main body of this report and as included in our own third-party cost-effectiveness analyses of the woodstove and hydronic heater standards).

EPA also failed to provide incremental information in its cost-effectiveness analysis. Although this information would not be of much usefulness because of the lack of meaningful options, EPA still should have shown the incremental costs, incremental emission reductions, and incremental cost-effectiveness for the "alternative" approach relative to the proposed approach. Without an incremental analysis, the EPA calculations do not provide any insight into "bang for the buck." It is especially difficult to glean useful information from EPA's analyses because the cost-effectiveness results for the proposed and alternative approaches combine costs and emission reductions for multiple regulatory steps (i.e., multiple rounds of tightening the standards over time). The lack of incremental analysis by EPA, either between the proposed and alternative approaches or between increasingly tighter standards, makes it impossible to compare the cost-effectiveness of meaningful alternatives.

The shortcomings in EPA's cost-effectiveness analysis are fatal flaws that make it essentially useless for decision-making. In fact, the errors and omissions are so fundamental that it is not worthwhile for NERA to attempt to develop incremental analyses from the information that EPA provides, because the information itself is not useful.

Finally, the table indicates that EPA did not provide any quantitative estimates of industry impacts or broader economic impacts for either its proposed regulatory approach or the alternative approach. EPA makes some general statements and speculations about these impacts but does not give any direct calculations related to jobs, closures, GDP, or other impact measures.

I. Introduction

This report evaluates the U.S. Environmental Protection Agency's ("EPA" or "Agency") analyses underlying the proposed New Source Performance Standards ("NSPS") for wood-burning residential appliances. EPA issued the proposal in the *Federal Register* in February 2014 (EPA 2014a). The EPA materials also include a regulatory impact analysis (EPA 2014b) and calculations by EPA's consultant, EC/R (e.g., EC/R 2013).

Our assessment concerns three areas of economic analysis: (1) cost-effectiveness analysis (dollars per ton of emission reduction); (2) industry impact analysis; and (3) economic impact analysis. We focus on a methodological assessment of EPA's information. In particular, we compare EPA's analyses with the prescribed methodologies for such analyses in EPA's own *Guidelines for Preparing Economic Analyses* (EPA 2010). We do not assess EPA's monetized benefit estimates or its comparisons between costs and monetized benefits.

The remainder of this section provides background on the EPA proposal and cost-effectiveness analyses, an overview of the EPA *Guidelines*, a summary of the objectives of this assessment, and the organization of the subsequent sections of this report.

A. Background on EPA Proposal and Cost-Effectiveness Analyses

EPA has regulated air emissions from woodstoves since 1988. At that time, EPA set the woodstove NSPS at 7.5 grams of particulate matter ("PM") per hour of operation ("g/h") for non-catalytic woodstove. In the current rulemaking, EPA is proposing to tighten the emission standard for woodstoves and introduce emission performance standards for other types of wood-burning appliance that currently are unregulated, including most pellet stoves as well as hydronic heaters, forced-air furnaces, and masonry heaters.[1] EPA also proposes to modify the testing procedures for emission certification of wood heater models.

This section provides a summary of EPA's proposed regulatory approach, its alternative regulatory approach, and its estimates of costs, emission reductions, and cost-effectiveness.

1. Proposed Standards

As noted above, EPA's proposed NSPS covers several categories of residential wood-burning appliances. Table 1 summarizes the proposed and alternative standards for three major categories: wood and pellet stoves, hydronic heaters, and forced-air furnaces. In the proposed regulatory approach for these appliances, Step 1 standards would begin on the effective date of the final rule, and Step 2 standards would apply five years later. Although EPA refers to "proposed" and "alternative" standards, the final standards only differ in terms of their timing and whether an intermediate level is set. The "alternative" standard would have the same initial

[1] As discussed below, woodstove standards relate to emission rates measured in grams of PM emissions per hour ("g/h"). Standards for hydronic heaters, forced-air furnaces, and masonry heaters relate to emission performance measured in pounds of PM emissions per unit of heat output. We refer to these collectively as emission standards.

and final standards but an intermediate standard as well. In particular for the alternative regulatory approach, Step 1 standards would still begin on the effective date of the final rule, but the Step 2 intermediate standards would apply three years later and the Step 3 standards would apply eight years later (i.e., five years after the Step 2 standards). Masonry heaters, which are not included in the table, would have a constant standard rather than a stepwise implementation.

Table 1. EPA Proposed and Alternative Standards for Wood and Pellet Stoves, Hydronic Heaters, and Forced-Air Furnaces

		Years After Final Rule Publication								
		0	1	2	3	4	5	6	7	8
	Proposal	**Step 1**					**Step 2**			
	Alternative	**Step 1**			**Step 2**					**Step 3**
Wood and pellet stoves	Proposal	4.5					1.3			
(g/h)	Alternative	4.5			2.5					1.3
Hydronic Heaters	Proposal	0.32					0.06			
(lb/MMBtu)	Alternative	0.32			0.15					0.06
Forced-Air Furnaces	Proposal	0.93					0.06			
(lb/MMBtu)	Alternative	0.93			0.15					0.06

Note: Wood and pellet stove standards are measured in grams of PM per hour (g/h), while hydronic heater and forced-air furnace standards are measured in pounds of PM per million Btu of heat output (lb/MMBtu Output).

Source: EPA (2014a), pp. 6339 and 6344

As shown in the table above, the proposed approach's Step 1 (beginning on the effective date of the final rule) for wood and pellet stoves (grouped as "room heaters" by EPA) would set the standard at 4.5 grams of PM emissions per hour of operation (g/h), and its Step 2 (five years after the effective date) would tighten the standard to 1.3 g/h (with a temporary allowance for existing certifications under the old NSPS). The alternative approach would have the same initial and final standards, but it would also include an intermediate Step 2 standard of 2.5 g/h that would take effect three years after the effective date of the final rule, and the final standard of 1.3 g/h (labeled Step 3 under the alternative approach) would take effect eight years later.

The table above also shows that hydronic heaters and forced-air furnaces (grouped as "central heaters" by EPA) would have the same schedules under the proposed and alternative regulatory approaches as for wood and pellet stoves. For hydronic heaters, the standard would begin at 0.32 pounds of PM per million Btu of heat output (lb/MMBtu) and would end at 0.06 lb/MMBtu, with a potential intermediate standard of 0.15 lb/MMBtu in the alternative approach. Forced-air furnaces would start with a Step 1 standard of 0.93 lb/MMBtu and then would have the same standards for subsequent steps in the proposed and alternative approaches as hydronic heaters.

2. EPA Analyses and Cost-Effectiveness Results

EPA and its consultants performed various calculations related to compliance costs and emissions reductions for the proposed and alternative regulatory approaches for the various

categories of wood-burning appliance. We focus on the methodology and results they develop to calculate the proposed standard for wood and pellet stoves.

EPA developed baseline projections of appliance shipments based on historical trends. EPA used these shipment projections for calculating both cost and emission reduction estimates. To calculate costs, EPA developed information on design, prototype development, testing, tooling equipment, and other components of manufacturer costs for new products (EPA 2014b, pp. 5-1 to 5-15). These product development costs do not vary with the emission rate or emission performance of the new product, however. To calculate emission reductions, EPA developed baseline emission projections and estimated reductions from tighter emission standards.

EPA allocated costs and emission reductions to specific years based on the compliance schedules for the proposed and alternative regulatory options shown above in Table 1. EPA assumed that capital costs and other fixed costs would be spread over six years for each round of product development (EPA 2014b, pp. 5-9 to 5-10). Certification is required every five years, so certification costs (as well as reporting and recordkeeping costs) continue to the end of the analysis period.[2]

In its summaries of PM emission reductions, EPA shows annual average reductions between 2014 and 2022 based on a single year of wood heater use from each calendar year of appliance production. (For example, 2020 annual reductions are the emission reductions associated with one year's use of heaters produced and sold in 2020.) EPA also calculated cumulative emission reductions based upon an assumption that a given model can be used for 20 production years and that the wood stoves themselves have a lifetime of 20 years (EPA 2014b, p. 4-12). EPA presents results based upon both annual and cumulative emission reductions for stoves produced between 2019 and 2038 for the proposed regulatory approach (or between 2017 and 2041 for the alternative regulatory approach based upon its different regulatory timeline). The following are the cost per ton estimates based upon EPA cost and PM emissions reduction estimates based upon average annual reductions and cumulative reductions.

[2] As noted above, EPA is proposing to modify the testing procedures for emission rate certification of wood heater models. Other materials submitted by HPBA address the cost implications of these modifications.

Table 2. Summary of EPA Cost-Effectiveness Results for Woodstoves: 2010$ per Ton of PM Emission Reduction

	Annual Average	Cumulative
Proposal	$4,098	$471
Alternative	$8,160	$785

Note: Annual average cost-effectiveness for proposed regulatory approach is calculated by NERA based upon stoves produced between 2019 (first year of emission reductions for proposed approach) and 2038 (last year of costs for proposed approach after 20 years of model production); annual average cost-effectiveness for alternative regulatory approach is calculated by NERA based upon stoves produced between 2017 (first year of emission reduction for alternative approach) and 2041 (last year of costs for alternative approach); cumulative cost-effectiveness results are calculated by EC/R for EPA and reflect the final 20 years of stove production for each regulatory option.

Source: EC/R (2013), Tables 3 and 11, and NERA calculations as explained above

Note that EPA's cost-effectiveness values typically are based upon comparing annualized costs and annual emission reductions in a single future year (usually five years after expected promulgation of the final rule).[3] The inclusion of a cumulative assessment is a departure from that standard practice.

B. Overview of EPA *Guidelines*

EPA's *Guidelines for Preparing Economic Analyses* (EPA 2010) serve as the Agency's handbook for sound and accurate evaluation of environmental policies. EPA has prepared several versions of the *Guidelines*. The current version of the EPA *Guidelines* reflects decades of input and review from numerous experts and stakeholders. It provides detailed instruction on evaluation environmental regulations (including retrospective analyses of existing regulations as well as prospective analyses of potential regulations) and presentation of results.

C. Objectives

In this report, we assess EPA's cost-effectiveness analysis, industry impact analysis, and economic impact analysis for the proposed wood heater NSPS relative to EPA's own *Guidelines*. We summarize the prescribed methodologies from the *Guidelines* and compare EPA's analyses for the proposed wood heater NSPS with the prescribed methodologies.

As noted above, EPA also presents estimates of monetized social benefits related to the proposed wood heater NSPS. We do not assess or endorse EPA's health impact modeling, monetization parameters, monetized benefit estimates, or comparisons between estimated costs and monetized benefits.

[3] Examples of prior EPA cost-effectiveness studies prepared by the Office of Air Quality Planning and Standards include the following: EPA (2012a, Table 3-4) compares costs and emission reductions for oil and natural gas controls in 2015; and EPA (2012b) Table 1-1 compares costs and emission reductions for petroleum refinery flare regulations in 2017.

D. Organization

The remainder of this report is organized as follows.

- Section II describes our assessments related to methodological issues in cost-effectiveness analysis. We summarize the prescribed methodologies for evaluating compliance costs, environmental effects, and cost-effectiveness in the EPA *Guidelines*, and we compare EPA's analyses for the NSPS to the prescribed methodologies.

- Section III describes our assessments related to industry impact analysis and economic impact analysis. We summarize the prescribed methodologies for such analyses in the EPA *Guidelines*, and we compare EPA's analyses for the NSPS to the prescribed methodologies.

- Section IV summarizes our conclusions.

II. Assessments Related to EPA's Cost-Effectiveness Analysis

In this section we summarize prescribed methodologies for cost-effectiveness analysis from the EPA *Guidelines* and compare EPA's analyses for the wood heater NSPS to the prescribed methodologies. The key elements of cost-effectiveness analysis, according to the EPA *Guidelines* and other sources, can be summarized as follows (we have tailored the elements for air emission regulations).

1. Specify several options (at least one less stringent and one more stringent than proposal);

2. Develop compliance cost estimates for the options;

3. Develop emission reduction estimates for the options;

4. Incorporate market impacts into cost and emission reduction estimates;

5. Calculate incremental costs for the options (from least to most stringent);

6. Calculate incremental emission reductions for the options (from least to most stringent); and

7. Calculate incremental cost-effectiveness (from least to most stringent).

Our basic methodology is to summarize each element as reflected in EPA Guidelines and then assess the extent to which EPA's analysis in its wood heater NSPS is consistent with the *Guidelines*.

A. Specify Several Options Differing in Stringency

1. EPA *Guidelines*

The *Guidelines* instruct Agency staff to evaluate a broad range of regulatory options:

> In the context of RIA [regulatory impact analysis], or other analyses of specific regulatory or policy options, CEA [cost-effectiveness analysis] is most informative when several different options are analyzed. The analysis should include at least one option that is less stringent and at least one option that is more stringent than the preferred option (EPA 2010, p 11-5).

The *Guidelines* are echoing analogous instructions from the U.S. Office of Management and Budget's ("OMB") *Circular A-4* to Federal agencies:

> You should carefully consider all appropriate alternatives for the key attributes or provisions of the rule. … Where there is a "continuum" of alternatives for a standard (such as the level of stringency), you generally should analyze at least

> three options: the preferred option; a more stringent option that achieves additional benefits (and presumably costs more) beyond those realized by the preferred option; and a less stringent option that costs less (and presumably generates fewer benefits) than the preferred option (OMB 2003, p. 16).

This basic rule is essential for careful decision-making. If many options are evaluated and their impacts are clearly described, decision-makers and the general public can use information from the analysis to select the best option based on their decision criteria. On the other hand, if few options are evaluated and their impacts are not clearly described, the final selection is less likely to be optimal.

Stringency can be adjusted through various "levers." For example, the set of options related to an air quality regulation could differ in their initial and final emission rate or emission performance standards, their coverage of emission sources, or their geographic scope. The analysis is most useful when options differ in the setting of only one lever at a time. This allows the impacts of that lever to be evaluated in isolation. When regulatory options combine various types of differences, it is difficult or impossible to understand the implications of each difference for decision-making. As noted above, the EPA *Guidelines* note the importance of considering options that differ in terms of stringency.

Specifying a broad range of regulatory options is critical to a meaningful incremental analysis, as discussed further below.

2. EPA Analyses for Proposed Wood Heater NSPS

Contrary to EPA's *Guidelines*, the wood heater analysis presents only two regulatory options: the proposed and alternative approaches. As discussed above, the two approaches have the same initial and final emission standards for wood and pellet stoves, hydronic heaters, and forced-air furnaces. For these appliances, the approaches differ only insofar as the alternative approach would include an intermediate standard and would provide more time for compliance with the final standard. For masonry heaters, EPA proposed a standard and did not evaluate any alternative approach at all.

Also as discussed above, it is unclear whether the alternative approach is less or more stringent than the proposed approach. By providing more time for compliance with the final standard, it would seem to be less stringent than the proposed approach. The extra time and intermediate standard in the alternative approach lead to an additional round of product development, however, and this causes the alternative approach to have higher costs than the proposed approach according to EPA's analysis.

Thus, EPA did not adhere to the basic rule of regulatory analysis, because it did not evaluate a broad range of options with various degrees of stringency (both less stringent and more stringent than the proposed approach). EPA's options differ only slightly in timing; they do not differ in terms of initial or final emission standards, coverage of appliances, or geographic scope. Moreover, each option is actually a package of multiple emission standards that would be

implemented through steps over time; combining them into a single "standard" obscures important differences in cost-effectiveness between the various standards.

B. Develop Option-Specific Compliance Cost Estimates

1. EPA *Guidelines*

In order to meaningfully compare the costs of achieving alternative emission rate standards, cost estimates have to depend in some way on the stringency of the standard. The *Guidelines* note that in proper compliance cost modeling, "Estimates by engineers and other experts are used to produce algorithms that characterize the changes in costs resulting from the adoption of various compliance options" (EPA 2010, p 8-14).

Clearly, cost-effectiveness analysis of multiple regulatory options will be skewed and useless for decision-making if cost estimates do not accurately reflect the specific costs of each option. The most important implication of this rule for the current context is that costs should accurately reflect specific emission standards.

2. EPA Analyses for Proposed Wood Heater NSPS

a. Cost Methodology Issues

As discussed above, EPA estimated compliance costs for the proposed NSPS based on analysis of design, prototype development, testing, tooling equipment, and other components of manufacturer costs for new products (EPA 2014b, pp. 5-1 to 5-15). The cost estimates suffer from a fundamental flaw—the costs do not directly reflect specific emission rates or emission performances.

EPA's cost estimates do account for differences among appliance categories and regulatory approaches in some ways. For example, EPA assumed that previously unregulated appliances, including single burn-rate stoves and forced-air furnaces, would have twice the research and development ("R&D") costs as currently regulated adjustable burn-rate woodstoves in 2013 and 2014 (EPA 2014b, p. 5-6). And since woodstove manufacturers already must comply with NSPS, they would not bear additional costs for certification, reporting, and recordkeeping for the new standards (EPA 2014b, p. 5-9). Additional examples of costs that differ by appliance category, baseline emission rates, or other factors are discussed in EPA (2014b, pp. 5-9 to 5-11).

Within each appliance category, however, the cost estimates are simply general costs for product development and do not reflect specific emission rates or emission performances, or differences between appliance categories that have implications for product development challenges and costs. EPA provides most detail on woodstove cost estimates (EPA 2014b, pp. 5-1 to 5-5), but the costs represent development of a generic firebox without any particular components that depend on the emission rate. EPA uses the same costs of the generic firebox for estimating the costs of all woodstove emission rate standards. EPA extrapolates from the firebox information to develop cost estimates for other categories of wood-burning appliance.

The lack of any relationship between compliance costs and specific emission standards raises more questions about how EPA selected these emission standards for the regulation. They seem arbitrary. Indeed, if compliance costs do not depend on emission rate or emission performance, the best strategy would seem to be setting the standard at zero emissions without stepwise implementation (assuming technological feasibility). Common sense strongly suggests, however, that setting a "zero emission" regulation likely would have much higher costs.

As noted above, the difference in costs between the proposed and alternative approach stems from the extended timeline and additional round of product development for the alternative approach. The introduction of the intermediate step in the alternative approach conflates the impact of a longer implementation timeline with the impact of more frequent model development.

b. Specific Cost Parameter and Assumption Issues

In addition to the general methodology issue discussed above, there seem to be several issues with EPA's cost estimates related to specific parameters and assumptions. We discuss three issues: (1) EPA's assumed model lifetime and annualization period; (2) EPA's cost categories; and (3) EPA's doubling of R&D costs in early years for currently unregulated appliance categories.

EPA (2014b, p. 5-7) assumed a model design lifetime of 20 years for wood heaters (i.e., wood heater manufacturers produce units from the same model design for 20 years). It spread annualized capital and other fixed costs over six years (EPA 2014b, p. 5-5). Ferguson (2014) performed a survey of manufacturers in the woodstove industry and gathered data on the design lifetimes of 53 woodstove models. The average over all models in the survey was 8.3 years (Ferguson 2014a, p. 7). Although a few of the models in the survey did indeed have a design lifetime near the length that EPA assumed, the survey results suggest that EPA's assumption is inaccurate as an industry average. Shortening the model design lifetime in EPA's analysis to a more accurate average value, and potentially adjusting the annualization period for capital and other fixed costs, would significantly affect EPA's cost estimates and related calculations.

As noted above, EPA (2014b, pp. 5-2 to 5-13) evaluated various categories of compliance costs for woodstoves and then used the woodstove estimates to extrapolate to other appliance types. Ferguson (2014b, c) has performed comprehensive compliance cost analyses for woodstoves and hydronic heaters, and his cost analyses provide a basis for comparison with EPA's cost analysis. EPA does not address the possibility of variable costs per unit in its analysis, but variable costs are significant in Ferguson's woodstove and hydronic heater cost analyses. Other examples of cost categories that EPA does not address but Ferguson evaluates are training programs on the new models and product obsolescence (such as discounts for manufacturers to clear inventory).

Additionally, EPA does not adequately support the adjustments it makes to account for Step 1 R&D costs. EPA assumes a single round of R&D for Step 1 and Step 2 standards (EPA 2014b, p. 5-6). For technologies that are currently unregulated, EPA accounts for Step 1 costs by doubling two years (2013 and 2014) out of six years of annualized R&D costs; in essence, EPA assumes that R&D costs to meet Step 1 are one third as large (2 divided by 6 years) as R&D

costs to meet Step 2. Given that Step 1 is the least stringent emission standard, it would be reasonable to assume that it has somewhat lower costs than more stringent standards, a presumption borne out by the rigorous cost assessments performed by Mr. Ferguson (a well-recognized industry expert), and peer reviewed by a panel of industry experts (Ferguson 2014b); EPA's particular assumptions, in contrast, appear arbitrary and are still ultimately based on the development costs for a generic firebox without reference to any specific emission rate or emission performance.

C. Develop Option-Specific Emission Reduction Estimates

1. EPA *Guidelines*

Accurate estimation of environmental impacts is critical to develop and evaluate environmental regulations. The *Guidelines* instruct Agency analysts to think carefully about environmental effectiveness: "Does the policy instrument accomplish a measurable environmental goal? Does the policy instrument result in general environmental improvements or emission reductions?" (EPA 2010, p. 4-21). Society should dedicate resources to compliance with the environmental regulation only if this actually improves environmental conditions.

2. EPA Analyses for Proposed Wood Heater NSPS

EPA estimated PM emission reductions from the NSPS based on sales projections, emissions inventory data for residential wood combustion ("RWC"), and factors corresponding to each emission standard (EPA 2014b, pp. 4-1 to 4-15). The alternative approach would achieve slightly more reductions than the proposed approach according to EPA's analysis because of slight differences in the timing of tighter standards. For wood and pellet stoves, for example, the alternative approach would have a tighter standard in the third and fourth years after publication of the final rule (2.5 g/h for the alternative approach compared with 4.5 g/h for the proposed approach). This faster tightening of the standard in the alternative approach offsets the slower timeline for the final standard of 1.3 g/h (which occurs in the eighth year in the alternative approach but the fifth year in the proposed approach).

One of the most significant problems with EPA's emission reduction calculations is the assumption that actual emissions are proportional to certification levels for each model. Houck (2012) performed a careful study of actual emissions from certified woodstoves based on common usage patterns and concluded that actual emissions are not proportional to certification levels. Indeed, Houck (2012) found that actual emissions from certified woodstoves were essentially the same for a wide range of certification levels. Earlier analysis by Curkeet and Ferguson (2010) came to a similar conclusion about the differences between certification levels based on certification testing, which uses dimensional lumber cribs instead of cordwood.

> Our primary conclusion is that the current testing process simply cannot consistently distinguish emissions performance differences of less than 3 to 6 grams per hour. The process is certainly capable of reliably distinguishing between good and bad performance, but it cannot reliably distinguish between "good, better and best" performance (Curkeet and Ferguson 2010, p. 19).

This suggests that EPA's emission reduction estimates are overstated, implying understatement of dollars per ton of emission reduction in the cost-effectiveness analysis and overstatement of potential monetized benefits. Other materials submitted by HPBA elaborate on these studies and their implications.

D. Incorporate Market Impacts into Cost and Emission Reduction Estimates

1. EPA *Guidelines*

The *Guidelines* instruct Agency analysts to evaluate the impacts of environmental regulations on product prices and sales through market analysis:

> While compliance cost models may provide reasonable estimates of the compliance costs of a regulation, they do not incorporate the likely behavioral responses of producers and consumers…if these responses are not taken into account, estimates of social cost are likely to be inaccurate (EPA 2010, p. 8-15).

Subsequent pages of the *Guidelines* provide detailed guidance on empirical methods to estimate changes in product prices and sales. These methods include using estimates of the price elasticity of demand (a measure of the expected change in demand due to a change in price) to calculate impacts on sales quantities. The *Guidelines* (pp. 8-2 to 8-3 and A-3) also discuss the importance of estimating changes in social welfare based on calculation of consumer surplus (the value of purchases to consumers above the price they pay), producer surplus (related to profitability), and deadweight loss (a gap between actual and optimal sales quantities due to government intervention or other causes). The *Guidelines* (pp. 8-2 to 8-4 and 8-15 to 8-16) describe partial equilibrium analysis as a common tool for evaluating price and quantity impacts in a specific market, such as the market for new woodstoves.

2. EPA Analyses for Proposed Wood Heater NSPS

In the documentation underlying the proposed wood heater NSPS, EPA acknowledged the potential importance of market analysis for regulatory evaluations and made some general comments about elasticities and changes in consumer and producer surplus (EPA 2014b, pp. 5-17 to 5-21), but EPA did not develop quantitative estimates. EPA says that developing a partial equilibrium analysis of wood heater markets was too "difficult" (EPA 2014b, p. 5-1) and states:

> We were not able to prepare a full economic analysis of the impacts of this proposal on supply and demand, or the effects of such impacts on emissions (e.g. feedback effect on emissions) (EPA 2014b, p. 5-21).

Thus, EPA's analyses do not incorporate potential changes in product prices, sales quantities, appliance scrappage rates (a consequence of changes in sales quantities), consumer surplus, producer surplus, deadweight loss, or any other type of market impact. The important implications of these deficiencies are discussed below. NERA's cost-effectiveness analyses for woodstoves and hydronic heaters account for these various market effects.

Note that EPA performed a market analysis for its initial woodstove NSPS almost thirty years ago (EPA 1986, Chapter 8). The adoption of hydronic heater standards by several states in the last several years also provides information for market analysis of the impacts of emission regulations, as shown in our own hydronic heater evaluation. In the current rulemaking, EPA does not explain why the current uncertainties or other obstacles to an empirical market analysis are more formidable than earlier.

a. Price Effects

The proposed NSPS would introduce new costs for wood heater appliance manufacturers, and manufacturers would presumably pass some or all of these costs on to consumers in the form of higher product prices. Table 10 of EPA (2014a, p. 6352) shows baseline prices for each wood heater category and compliance costs per unit for the proposed regulatory approach averaged over the long term. For example, the table shows that the incremental cost increase per unit according to EPA would be $24 (3 percent of baseline price) for certified woodstoves, $6,458 (86 percent of baseline price) for hydronic heaters, and $3,262 (more than three times the baseline price) for forced-air furnaces. These large costs per unit relative to baseline price strongly suggest that retail price impacts could be substantial, even based upon EPA's assessments. EPA (2014a, p. 6351) provides some comments on potential price increases, but the price impacts do not flow through into full market impact analysis.

b. Demand Effects

Market analyses typically use elasticity estimates to model the responsiveness of supply and demand to new conditions, including government regulations introducing new costs. The RIA discusses factors influencing elasticity of demand (EPA 2014b, pp. 3-15 to 3-16) and includes a qualitative discussion of possible market reactions based on an illustrative range of elasticities (EPA 2014b, p. 5-20), but EPA did not use any elasticity estimates to calculate changes in sales quantities due to the regulation. EPA (2014a, p. 6351) states: "We did not assume lower projected sales for increased prices because of the uncertainty of other demand factors." In the support documentation, EPA (2014b, pp. 3-15 to 3-16 and 5-25 to 5-26) notes that uncertainty about potential product substitutes, such as electric heating and natural gas appliances, contributes to EPA's inability to estimate the impacts of the regulation on wood heater sales.

The unit cost impacts discussed above (from EPA 2014a, p. 6352) include large impacts relative to baseline prices for some wood heater categories, which could lead to much higher prices and much lower product sales through demand effects. Since emission reduction calculations depend in part on sales estimates, EPA's failure to adjust sales based on cost and price impacts implies that EPA's emission reduction calculations are inaccurate. The emission reduction calculations should also have accounted for scrappage effects, as discussed below.

c. Scrappage Effects

As discussed above, higher prices for wood heaters would lead to lower heater sales. Some of the sales lost through this "demand effect" would have been purchases to replace and scrap old (existing) wood heaters. In other words, some consumers would keep their old heaters longer

because of the higher heater prices caused by the regulation. Thus, existing heaters would operate more and produce more emissions with the regulation than without the regulation. As demonstrated in Houck (2011), old non-certified woodstoves have significantly higher emission rates than new certified woodstoves, and the difference is even greater relative to the potential standards in the proposed regulation.

Estimates of emission reductions from the proposed regulation should factor in the change in emissions from existing heaters due to scrappage effects. EPA's failure to account for scrappage effects is another source of inaccuracy in EPA's emission reduction estimates and cost-effectiveness estimates.

d. Consumer and Producer Surplus Effects

As noted above, analysts evaluate changes in social welfare from government intervention or other causes in terms of changes in consumer surplus, producer surplus, and deadweight loss. To illustrate the potential importance of changes in these social welfare measures, note that a policy that completely eliminated sales of a product would have no direct compliance costs (because no products would be produced) but its total costs would not be zero, because costs in terms of consumer and producer surplus should be calculated as well.

EPA (2014b, pp. 5-17 to 5-21) recognizes that changes in product prices and sales quantities for each category of wood heater could reduce consumer and producer surplus. Since EPA does not calculate market impacts, it does not estimate changes in consumer and producer surplus from the regulation. This is yet another critical shortcoming in EPA's estimates of costs and cost-effectiveness.

E. Calculate Incremental Costs, Incremental Emission Reductions, and Incremental Cost-Effectiveness

1. EPA *Guidelines*

The *Guidelines* instruct Agency staff to perform an incremental analysis of regulatory options by calculating and presenting their incremental costs, incremental environmental effects, and incremental cost-effectiveness relative to the next less stringent option. The *Guidelines* state: "The incremental costs and non-monetary benefit yield of each option, in order of increasing stringency, should be reported" (EPA 2010, p. 11-5).

OMB (2003) also instructs Federal agencies to evaluate options on an incremental basis. OMB (2003, 11) states: "Incremental cost-effectiveness analysis…can help to avoid mistakes that can occur when policy choices are based on average cost-effectiveness." It elaborates on the need for incremental information:

> Whenever you report the benefits and costs of alternative options, you should present both total and incremental benefits and costs. You should present incremental benefits and costs as differences from the corresponding estimates associated with the next less-stringent alternative. [footnote omitted] It is

> important to emphasize that incremental effects are simply differences between successively more stringent alternatives. Results involving a comparison to a "next best" alternative may be especially useful (OMB 2003, p. 16).

For each stringency level, this type of analysis clarifies what society must additionally pay (in the form of incremental costs) for what society would additionally gain (in the form of incremental environmental effects) relative to the next less stringent option. In other words, incremental analyses allow decision-makers and the general public to understand which regulatory option has the most "bang for the buck."

2. EPA Analyses for Proposed Wood Heater NSPS

Contrary to its own *Guidelines* and OMB instructions to Federal agencies, EPA does not evaluate the regulatory options on an incremental basis. EPA simply sums up the cumulative costs for each regulatory option (the proposed approach and the alternative approach), sums up the cumulative emission reductions, and divides the cumulative costs by the cumulative emission reductions to calculate the cost-effectiveness of the proposed approach and the alternative approach for each category of wood-burning appliance.

A proper incremental analysis in this context would clarify differences between the two regulatory options as well as differences between the various emission standards. To clarify differences between the two regulatory options, EPA should have calculated the difference in costs between the proposed and alternative approach, the difference in emission reductions, and the resulting difference in cost-effectiveness. As discussed above, such a comparison would be complicated by EPA's confusing methodology related to the alternative approach. Although the alternative approach would seem to be less onerous than the proposed approach because of its longer timeline to meet the final emission standard, it would have higher costs than the proposed approach according to EPA's analysis because of its additional round of product development.

Even more important than clarifying differences between the two regulatory options, however, would be clarifying differences between the various emission standards. Both the proposed and alternative approaches involve tightening emission standards in steps over several years. Since EPA only reports the average cost-effectiveness of each approach (by dividing cumulative costs by cumulative emission reductions), EPA conflates the various steps together. EPA did not heed OMB's (2003, p. 11) warning to "avoid mistakes that can occur when policy choices are based on average cost-effectiveness."

It is impossible to know from EPA's results the incremental cost-effectiveness of increasingly stringent standards. As noted, this omission stems from the lack of information on how costs would change if the standard were made tighter. NERA performed incremental analysis in line with EPA and OMB guidance, and our results show large differences in cost-effectiveness between the various emission standards for each of these appliance categories.

F. Summary

The following table summarizes our methodological assessment of EPA's cost-effectiveness analysis for the wood heater NSPS. EPA violates a fundamental requirement of regulatory analyses by not evaluating a range of regulatory options. Its compliance cost estimates do not directly reflect emission rate or emission performance stringency, and its emission reduction estimates do not account for the large uncertainty in emissions from in-place appliances as documented by Houck (2012). EPA did not perform a market analysis of important price effects, demand/sales effects, scrappage effects, or consumer/producer surplus effects, and these omissions imply inaccurate cost and emission reduction estimates (in particular, they imply that EPA understated costs and overstated emission reductions). Finally, EPA only calculated average cost-effectiveness for the proposed and alternative regulatory approaches. It did not perform an incremental analysis that would clarify whether additional emission reductions from tighter standards (relative to less tight standards) would make sense based on their additional costs.

Table 3. Assessment of EPA Cost-Effectiveness Analyses for Proposed Wood Heater NSPS Relative to EPA *Guidelines for Preparing Economic Analyses*

	EPA Performed for Proposed Wood Heater NSPS?	
Incremental Cost-Effectiveness Analysis		
1. Specify several options (at least one less stringent and one more stringent than proposal)	**No**	No option more stringent than Proposal; only difference between Proposal and Alt. is timing
2. Develop compliance cost estimates based on stringency	**No**	No dependence on stringency for most costs
3. Develop emission reduction estimates based on stringency	**Yes, but…**	No accounting for large emission uncertainty
4. Incorporate market impacts into cost and emission reduction estimates	**No**	No demand, scrappage, or cons. surplus effects
5. Calculate incremental costs (least to most stringent)	**No**	No incremental analysis for decision-making
6. Calculate incremental emission reductions (least to most stringent)	**No**	No incremental analysis for decision-making
7. Calculate incremental cost-effectiveness (least to most stringent)	**No**	No incremental analysis for decision-making

Source: EPA (2010) and NERA assessment of EPA (2014a, b)

III. Assessments Related to Industry Impact Analysis and Economic Impact Analysis

In this section we summarize prescribed methodologies for industry impact analysis and economic impact analysis from the EPA *Guidelines* and compare EPA's analyses for the wood heater NSPS to the prescribed methodologies. Industry impact analysis relates to impacts on prices, production, profitability, jobs, and closures in the directly affected industries (in this case the wood heater appliance manufacturing and retail industries).

Economic impact analysis takes a broader perspective and relates to impacts on jobs, GDP, and other metrics for all industries and households in the national economy. These analyses help decision-makers and the general public to understand the potential distributional impacts of regulations (i.e., the impacts on particular industries, regions, and demographic groups). Various Federal statutes, orders, and directives call for some form of industry impact analysis and economic impact analysis (EPA 2010, pp. 9-1 to 9-2).

A. Prepare Industry Impact Analysis

1. EPA *Guidelines*

The *Guidelines* (EPA 2010, pp. 9-5 to 9-10) provide detailed instruction to Agency staff on preparation of industry impact analyses. Such analyses should begin with identifying the directly affected industries and developing a profile for each industry under baseline conditions. Using compliance cost information, Agency staff should then develop estimates of changes in product prices and production levels (which would decrease as consumers respond to higher product prices by reducing their demand). These changes in product prices and production levels can have significant impacts on profitability, jobs, closures, and competitiveness (both domestic and international) within the directly affected industries. The *Guidelines* provide background on common modeling approaches for industry impact analysis, including partial equilibrium models (EPA 2010, p. 9-17).

Other issues for industry impact analysis relate to small businesses, small governmental jurisdictions, and small not-for-profit organizations. The *Guidelines* (EPA 2010, pp. 9-14 to 9-15) provide additional guidance on evaluating impacts on these groups.

2. EPA Analyses for Proposed Wood Heater NSPS

Although EPA provides some information related to industry impacts, it essentially performs only a qualitative analysis. It does not present full empirical modeling results for impacts on prices, production, profitability, jobs, closures, competitiveness, or other metrics for the directly affected industries. Instead, EPA simply calculates cost-to-receipts ratios and similar information to draw rough conclusions regarding impacts. These simple calculations do not meet the standards for proper industry impact analyses in the EPA *Guidelines*.

EPA calculates cost-to-receipts ratios in order to "approximate the maximum price increase" from the regulation (EPA 2014b, p. 5-15 to 5-17). This calculation is problematic for several

reasons. First, it does not directly relate to product prices. It seems more than likely that prices for certain wood heater appliances would change by much different amounts that these simple cost-to-receipt calculations imply. Second, the calculations do not account for demand effects and changes in production levels. Instead, the cost-to-receipts ratios erroneously involve baseline production levels. A market analysis would clarify interactions between demand, supply, and product prices, but EPA did not perform a true market analysis for the NSPS. And third, the timing of costs for the cost-to-receipt calculations seems inappropriate for approximating the maximum price impacts. The costs are the annual average for the period from 2014 to 2022. Under the proposed regulatory approach, R&D costs are spread over the six years from 2013 to 2018, and the subsequent years from 2019 to 2022 have much lower testing and certification costs. With such an uneven cost profile in this period, it seems that using the annual average cost from 2014 to 2022 would not accurately represent the maximum price increase. If prices in the first few years reflect costs in those years, using calculations based on average costs from 2014 to 2022 would understate price increases.

In terms of employment impacts, EPA does not perform any empirical modeling for the directly affected industries for the proposed wood heater NSPS. Instead, EPA (2014b, pp. 5-27 to 5-30) cites scholarly articles related to the employment impacts of environmental regulations for unrelated industries. The articles do not provide directly relevant information on the potential employment impacts specifically from the wood heater NSPS on the affected industries.

EPA discusses potential impacts on small businesses and potential mitigation strategies (EPA 2014b, pp. 6-1 to 6-18), but here again the analysis relies on cost-to-receipts ratios and other simple calculations as illustrative estimates. EPA does not perform a thorough empirical analysis based on changes in product prices, production levels, etc., to evaluate potential impacts on small businesses or other groups.

In summary, the information that EPA presents related to industry impacts falls far short of the prescribed methodologies in the *Guidelines* using partial equilibrium analysis (a form of market analysis) and other empirical techniques.[4]

B. Prepare National Economic Impact Analysis

1. EPA *Guidelines*

Economic impact analyses take a broader perspective than industry impact analyses. They go beyond the directly affected industries to evaluate impacts on jobs, GDP, labor income, taxes, and other metrics throughout the entire economy. The geographic scope for a Federal regulatory analysis would typically be the United States, but some contexts may call for economic impact analysis of smaller areas, such as regions, states, counties, or cities. Such analyses track linkages among industries (including sales of intermediate inputs for the production of final products) and consumption patterns for households. The *Guidelines* provide background on common modeling approaches for economic impact analysis, including computable general equilibrium ("CGE")

[4] Other materials submitted by HPBA describe the severe contraction in the woodstove industry, including a large drop in the number of manufacturing companies, following the initial woodstove NSPS in the late 1980s.

models (EPA 2010, p. 9-18). EPA has developed and used a CGE model called EMPAX for several previous regulatory analyses (EPA 2014c).

2. EPA Analyses for Proposed Wood Heater NSPS

EPA did not estimate the regulation's impacts on jobs, GDP, or other metrics for the national economy. As noted above, EPA summarizes scholarly articles on the employment impacts of other environmental regulations (EPA 2014b, pp. 5-27 to 5-30), but these articles do not directly relate to wood heater industries. EPA concludes that "it is inappropriate to utilize their quantitative estimates to estimate the employment impacts from this proposed regulation" (EPA 2014b, p. 5-29). EPA did not use EMPAX or any other CGE model to estimate national economic impacts for the proposed wood heater NSPS.

C. Summary

The following table summarizes our assessment of EPA's industry and economic impact analyses for the wood heater NSPS. Although EPA presents some information related to industry impacts (including cost-to-receipts ratios) and summarizes scholarly articles on the employment impacts of other environmental regulations, EPA did not perform thorough empirical modeling of industry and economic impacts (based on market analysis of price and production changes) described in the *Guidelines*.

Table 4. Assessment of EPA Industry and Economic Impact Analyses for Proposed Wood Heater NSPS Relative to EPA *Guidelines for Preparing Economic Analyses*

	EPA Performed for Proposed Wood Heater NSPS?	
Industry Impact Analysis	**No**	No estimates of industry jobs, closures, etc.
Economic Impact Analysis	**No**	No estimates of economy-wide jobs, GDP, etc.

Source: EPA (2010) and NERA assessment of EPA (2014a, b)

IV. Conclusions

We have assessed EPA's cost-effectiveness analysis, industry impact analysis, and economic impact analysis for the proposed wood heater NSPS against the prescribed methodologies for such analyses in EPA's own *Guidelines for Preparing Economic Analyses* (EPA 2010). We conclude that each EPA analysis has critical shortcomings. For the cost-effectiveness analysis, EPA does not evaluate standards that differ in stringency and thus fails to provide incremental analysis that clarifies the cost-effectiveness of meaningful regulatory alternatives. As a result of these deficiencies, the EPA analysis does not provide critical information to decision-makers and the general public on the cost-effectiveness of regulatory options.

Moreover, EPA did not develop any meaningful empirical estimates of the potential impacts of the proposed regulation on the various industries that would be regulated. This omission is particularly important because the proposed standards are likely to prove extremely costly and disruptive to the industries. Finally, EPA has not assessed the potential economy-wide impacts of these proposed regulations, including impacts on jobs, GDP, or other economic impact metrics using methods described in the *Guidelines*.

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