ACEEE
American Council for an Energy-Efficient Economy
529 14th Street, N. W., Suite 600 Washington, D.C. 20045 202.507.4000 202.429.2248 www.aceee.org

July 10, 2015

U.S. Department of Energy
Buildings Technologies Program
Sent via email: ResFurnaces2014STD0031@ee.doe.gov

Re: Notice of Proposed Rulemaking for Energy Conservation Standards for Residential Furnaces, Docket EERE-2014-BT-STD-0031

We are writing to provide comments from the American Council for an Energy-Efficient Economy (ACEEE), on DOE's Notice of Proposed Rulemaking (NOPR) on efficiency standards for residential furnaces. ACEEE is a non-profit research and education organization founded in 1980 that has been involved in the appliance standards program since its inception. We participated in negotiations leading to the 1987 legislation and subsequent amendments that underlie the program and have been active participants in most DOE appliance standards dockets.

In general we support the DOE proposal but suggest it be modified in several ways. In these comments we:

1. Discuss the DOE proposal and our suggested modifications;
2. Discuss some acceptable alternatives to our preferred set of standards; and
3. Comment on several additional issues raised in the docket.

The DOE Proposal and Suggested Modifications

In the NOPR, DOE proposes a national standard for both non-weatherized furnaces and mobile home furnaces at 92% AFUE. DOE proposes this level based on the many benefits such a standard will provide including energy savings, positive national net present value benefit, positive impacts on consumers, emissions reductions and the estimated monetary value of the emissions reductions.

We recommend five modifications to DOE's analysis and proposed standards:

a. Make the Appendix 8L analysis using new venting technology the primary analysis;
b. Use a "shift" scenario rather than a "rollup" scenario for the main analysis
c. Use the "low fuel switching" scenario for the main analysis
d. Establish a separate product class for small furnaces (tentatively those with an input capacity of 50,000 Btu/hour or less) and leave the standard for these units at 80% AFUE; and
e. Adopt a higher standard of 95% AFUE (TSL 4) for larger furnaces.

Appendix 8L Analysis

In Appendix 8L, DOE analyzes a lower-cost approach for venting a condensing furnace in homes with existing common venting of a non-condensing furnace and a gas water heater. This technology is now being marketed by a major venting manufacturer and our understanding is

that other manufacturers have developed their own products and are getting UL certification. Many products will be widely available long before this new standard takes effect.

Shift vs. Roll-up Scenario

In the NOPR, DOE adopts a "roll up" scenario to characterize future shipments of furnaces. This is an overly conservative scenario and instead a "shift" scenario is much more reasonable in our opinion.

Under the rollup scenario, DOE assumes that every furnace sale in the baseline market share distribution which does not meet the new standard rolls up to exactly meet the new standard. The market share above the new standard remains unchanged. So, for example, since DOE projects that current market share of furnaces above 95% AFUE is under 1%, under the roll up scenario, the agency predicts that market share stays at this level for thirty years. This assumption is clearly wrong. A host of market forces and public policies will foster market share growth for furnaces exceeding any new standard. For example, EPA is likely to revise the Energy Star specification for furnaces so that the AFUE for Energy Star is significantly higher than the minimum AFUE.[1] Many gas utilities will offer incentives for these higher-efficiency furnaces. Furthermore, manufacturers like to offer a range of products (i.e. good, better, best product offerings) to maximize margins and profits. Even if efficiency differences are reduced, manufacturers bundle other value added features (e.g. longer warranties, other non-energy features) with efficiency to distinguish better and best products.

Using a shift scenario has important repercussions for DOE's analysis. National energy savings increase as the share of product exceeding a new standards grows and manufacturer impacts decline since they are able to sell higher margin, value-added products. We strongly urge DOE to modify its analysis to take into account the powerful market and policy drivers that will drive a future distribution of efficiency performance.

Fuel Switching

DOE's fuel switching analysis has a significant impact on the results, reducing the energy savings substantially. We are concerned that DOE's analysis is too sensitive to fuel switching and believe that fewer homeowners and builders will switch fuels than DOE estimates – many decision-makers will not make an investment at the 3.5 year payback threshold that DOE uses. Furthermore, the question facing a furnace purchaser is more complex than how quickly an investment will payback. Rather, they are deciding to switch from one fuel that they have been using and are most likely happy with to another that has a reputation for high bills and, in some areas, greater risk of outages. Therefore, we would expect consumers to have more inertia in their decision making that would cause them to stick with gas furnaces at a greater rate than that which would they would make an energy efficient investment in upgrading their home's insulation or deciding between different efficiency levels of a refrigerator, for instance. This higher threshold is represented by DOE's "low-switching" scenario, for which analysis results

[1] For example, EPA might use the Energy Star Most Efficient criteria for furnaces which requires 97% AFUE and also that the furnace must work as part of a system that provides system status and messaging capabilities (see. http://www.energystar.gov/ia/partners/downloads/most_efficient/2015/Final_ENERGY_STAR_Most_Efficient_2015_Recognition_Criteria_Furnaces.pdf?9966-84de).

are shown in Appendix 10E of the TSD. We recommend that DOE adopt this scenario for the main analysis in the Final Rule.

Furthermore, if DOE adopts our suggestion to base the analysis on new venting technology, the number of households switching fuels to avoid orphaned water heaters will also go down. And if DOE adopts our suggestion for a lower standard for small furnaces, as discussed in the next section, we believe that fuel switching shown in DOE's analysis will have further substantial declines , as a significant number of the households that DOE shows as fuel switching will now be able to purchase an 80% AFUE gas furnace.

Small Capacity Product Class

As noted in DOE's analysis, a significant majority of homes will have lifecycle cost benefits from condensing furnaces but there will be some consumers who find condensing furnaces to have higher lifecycle costs. For example, at TSL 3 (92% AFUE), DOE found that 10% of consumers in the north will experience net costs while in the south this figure is 31% (TSD Table 8.5.2). We think it would be useful to reduce the number of "losers" and suggest that a good way to do this would be to establish two size classes for non-weatherized gas furnaces, one for small furnaces and one for larger furnaces.[2] Homes with smaller furnaces generally have lower heating loads since the homes are either small or well weatherized. We believe that many of the "losers" will have small furnaces and recommend that DOE specifically examine this issue and estimate the economics of different standard levels as a function of furnace input capacity.

Based on an analysis we discuss below, we tentatively recommend that a separate product class be established for furnaces of 50,000 Btu/hour or less and that the standard for these small furnaces remain at AFUE 80%. We believe that the percentage of "winners" will be higher above this size threshold but look to DOE to definitively examine this issue. We also note that if a size threshold is established, most homes in the deep south will be able to use non-condensing furnaces, as, from our analysis, it appears that only a limited number of homes in the deep south need larger furnaces (and we suspect many of these homes will be very large homes with owners having above-average incomes). A size threshold will also affect a more limited number of homes in the north. And a size threshold provides another option for some households with very high installation costs – if they weatherize their home and get the needed capacity below 50,000 Btu/h, they can avoid the extra installation cost of a condensing furnace. Furthermore, a size threshold would not present the potential enforcement challenges associated with regional standards.

To arrive at our 50,000 Btu/h dividing line, we examined data on space heating natural gas consumption by state from the 2009 Residential Energy Consumption Survey (RECS). Using this data as well as data on average heating degree days and design temperature by state, we were able to back out the average heating capacity needed in each state. Our analysis is attached and indicates that in most of the states in the southeast, the average needed furnace capacity is under 20,000 Btu/h. We also examined a more conservative assumption in which we reduced the design temperature in each state by 10 degrees F. Even in this scenario, the

[2] We do not suggest this for mobile home furnaces as the percentage of "losers" for mobile home furnaces is much lower since installation costs are less of an issue with these products. Also, in the deep south, since most new mobile homes already have air conditioners, installing a high-efficiency heat pump may be a better option than installing an air conditioner and a furnace since the incremental costs of a heat pump relative to an air conditioner are modest and heating loads are low.

furnace capacity needed to serve the average home is less than 30,000 Btu/h in all states in the south. Thus our tentative recommendation for a 50,000 Btu/h cutoff looks like it will cover a large majority of homes in the south.

AFUE 95%

In the NOPR, DOE proposes to adopt TSL 3 (92% AFUE) but notes the many benefits of TSL 4 (95% AFUE). DOE tentatively rejects TSL 4, despite its larger benefits, based on concerns about manufacturer impacts. We recommend that DOE reconsider TSL 4 and believe that this reconsideration will find TSL 4 justified. DOE finds that TSL 4 will result in greater energy savings (4.11 vs. 2.78 quads), greater consumer benefits ($21.5 vs. 16.1 billion at a 3% discount rate, $4.0 vs. 3.1 billion at a 7% discount rate) and greater emissions reductions (e.g. 206 vs 137 MMT of CO_2). If small furnaces are eliminated from the calculations, as we recommend above, we believe the incremental net present value benefits of TSL 4 will be even greater.

We also note that all major manufacturers have 95% AFUE models and our understanding is that these units make up a larger portion of current furnace sales than 92% AFUE models. Table 8I.3.3 of the TSD (page 8I-5) supports this conclusion, showing that 67.5% of current condensing models are at 95% AFUE and 24.4% at 92%. In other words, manufacturers have already incurred a substantial portion of the engineering and design costs necessary to comply with a 95% AFUE standard.

In the NOPR, DOE expresses concerns about the impacts on manufacturers of TSL 4, noting that their required investments will be $88.5 million for TSL 4 vs. $55.0 million for TSL 3, a difference of $33.5 million. This is a relatively modest difference for an industry with a value of roughly $1 billion. Also, if small furnaces remain at 80% AFUE, this difference in capital and conversion costs will go down.

Furthermore, it looks to us that the manufacturer impact analysis treats fuel switching to heat pumps as lost income to manufacturers. The major manufacturers of furnaces and the major manufacturers of heat pumps and furnaces are one and the same. Therefore, a lost furnace sale translates into a gained sale of a heat pump or electric furnace, and will therefore generally not have a negative impact on these manufacturers. But, the NOPR analysis counts the lost sale in the manufacturer impact. This approach is inconsistent with the rest of the NOPR analyses, creating a bias against higher standards. The impacts of increased heat pump and electric furnace sales show up in the lifecycle cost and national impact analysis, but not in the manufacturer impact analysis. In other words, DOE accounts for fuel switching when it reduces the benefits of the standard, but fails to account for the same switching when it reduces the costs. If DOE is to include the impact of fuel switching, it must take a consistent approach across all aspects of the rulemaking analyses.

Finally, by setting a standard for larger furnaces of 95% AFUE, DOE will make up some of the lost energy savings by leaving the standard for small furnaces unchanged, achieving larger national benefits from a revised standard.

Acceptable Alternatives

While we recommend a nationwide standard of 95% AFUE, with an exception for small furnaces, we would not object if DOE were to propose a regional standard based on heating

degree days in order to have a lower required AFUE in the deep south. The economics of condensing furnaces are less compelling in places like Florida, Alabama, Mississippi and Texas and we recognize the political issues of requiring extensive use of condensing furnaces in the deep south. As discussed above, we think an exception for small furnaces would address this issue, but an alternative is to establish a lower regional standard for states with less than 2000 or 3000 heating degree days. The exact cutoff should be based on an economic analysis of states with less than 2000, 2000-3000, 3000-4000 and 4000-5000 heating degree days. However, enforcing a regional standard will be more difficult than enforcing a standard for small-capacity units and thus this is not our preferred option.

Also, as discussed above, we do not recommend a size cutoff for mobile home furnaces. However, if DOE decides to consider such a cutoff, we note that since mobile homes are much smaller than most "stick built" homes, if there is a size cutoff for mobile home furnaces, it would need to be much lower than the size cutoff for non-weatherized furnaces.

Comments on Additional Issues

We are aware that AGA and GTI are submitting a report for the record proposing several substantial changes to DOE's analysis. We have only recently received this report and have not been able to fully review it but wish to provide some preliminary comments for the record. We also recognize that impacts on low-income consumers and fuel switching are significant issues in this docket and we want to provide our thoughts on these issues.

AGA/GTI Analysis

AGA and GTI have just released an analysis that they are providing for the record. We have only just received the analysis and in the time available have not been able to fully review it. However, we recognize that the comment period is closing and therefore we feel a need to put our preliminary views about their analysis in the record.

The AGA/GTI analysis makes four major changes to the DOE analysis and based on these changes, arrives at very different economic results. The four changes are:

1. Factor site-specific economics into whether a house has a condensing or non-condensing furnace in the baseline.
2. Increase the costs of condensing furnaces based on current costs.
3. Increase the market share of condensing furnaces in the base case.
4. Change the fuel switching algorithm to substantially increase the number of homes that fuel switch.

Based on our preliminary review, AGA/GTI may be partly correct on the first issue but substantially overcompensates. We believe that AGA/GTI are incorrect on the other three issues.

On the first issue, AGA/GTI are probably correct that site-specific economics should enter into the decision on what furnace a specific modeled house has in the base case – a condensing furnace is more likely to be installed in a home where condensing is highly cost-effective than in a home where it is clearly not cost-effective. This said, many factors influence the choice of furnace by either the builder, contractor or homeowner and rational economics is only one of these factors. Unfortunately, the AGA/GTI analysis assumes that rational economics always prevail and other factors have no influence. Specifically, as they describe on pages A-16 to A-

18 of their report, they take DOE's data on condensing furnace saturation by state, sort all homes in their dataset by simple payback period, and for each application, assume that only the homes with the lowest simple payback periods install condensing furnaces. This is a wildly unrealistic view of homeowner decision-making, and ignores differences between homeowner, builder and landlord economics. This approach also ignores "green consumers" who upgrade for environmental reasons even though the economics are poor or cases where the economics are altered by utility incentives. Instead, we recommend that the economics of a particular application affect the probability that a condensing furnace will be installed, but that there is still a Monte Carlo simulation based on these varying probabilities.

On the second issue, DOE correctly uses estimated future costs rather than historical costs, since once a standard takes effect, the market share of complying products increases. Due to economies of scale and cost-reduction opportunities during product redesign, after a standard takes effect, costs are generally less than historical costs when efficient products had a substantially lower market share. Furthermore, even though DOE uses projected future costs, DOE has a long history of overestimating these future costs and thus it is more likely that costs will be less than DOE estimates rather than more than DOE estimates. For example, a 2013 ACEEE study compared the projected and actual costs of nine appliance and equipment efficiency standards, finding that across the nine rulemakings, DOE estimated an average increase in manufacturer selling price of $148. On average the actual change in price was a decrease in manufacturer selling price of $12. Looking at the midpoint (median) change, DOE estimated $108 across the nine rulemakings and the actual midpoint was an increase of only $10. All of the nine products' actual incremental costs were less than what DOE estimated. Looked at another way, DOE estimated that the new standards would increase product prices by an average of 35%, but average actual prices did not change after adjusting for inflation. Several alternative analysis approaches were also used and found similar results.[3]

On the third issue, the market share of condensing furnaces has been flat in recent years, as shown by the data AHRI recently provided for the record (e.g. market shares of 47.8%, 47.1%, 47.6% and 48.5% in 2011-2014). DOE projects that the condensing market share will range from 45% in 2021 slowly increasing to 61% in 2050 (TSD p. 10-6). Based on the recent flat trend we would recommend holding the market share steady at 48% throughout the period, which would increase the energy savings of the standard. AGA/GTI instead throw out the 2010-2014 data, claiming they are affected by tax credits, and with the remaining data, mostly pre-2009, find a rising share of condensing furnaces which they project will continue in the future. Since the recent AHRI data shows essentially level condensing market share, it shows that the tax credit had little impact on condensing market share, and therefore the 2010-2013 should not be thrown out.[4]

And on the fourth issue, as discussed above, we believe that DOE has already overestimated the number of consumers that will fuel switch. The AGA/GTI changes exacerbate rather than correct this problem in that AGA/GTI rely even more than DOE on fuel-switching decisions being based on economic factors relative to other factors, with the economic analysis based on consumer self-reports of payback thresholds, a notoriously unreliable type of data (specific

[3] http://aceee.org/research-report/e13d .
[4] The tax credits were for units with 95% AFUE. While they did not affect the size of the condensing market, it appears that they caused increased sales of 95% AFUE units and less sales of AFUE 90% units.

citations provided above under fuel switching). Also, by increasing the cost of condensing furnaces (issue #2), we believe that AGA/GTI spur greater fuel switching than if more reasonable costs were used.

Concerns About Difficult to Retrofit Homes

Several commenters on the record have expressed concerns about high costs to retrofit condensing furnaces into some houses. While we recognize there are some such homes, from the checking we have done, we believe them to be small in number. We base this on the following observations:

In Canada, national standards require condensing furnaces and there are also similar standards in several provinces. We reached out to Natural Resources Canada, and they reached out to their mortgage agency, and neither has found any significant implementation problems with the Canadian standard. We also checked with the U.S. furnace OEM who might have the largest market share in Canada, and they report essentially no pushback.

Likewise, Great Britain has a national condensing standard (mostly boilers and not furnaces). We checked with several energy efficiency experts there and they reported hearing about few installation problems for condensing systems.

We have also heard particular concerns expressed about the costs to retrofit condensing furnaces in Philadelphia row houses. We reached out to a major weatherization program in Philadelphia about this issue. They have installed many condensing furnaces in Philadelphia row houses, and while they have found some challenges, they have also developed moderate cost solutions to these problems as follows:

Problem: there is no place to vent horizontally directly from the basement either due to:

1. It is below grade;
2. The only available termination location is at a public walkway; or
3. Vent locations are too close to other openings to the building.

They have found the following solutions for these problems:

a. Locate vent at perimeter wall in rear (or piano key area walls) that meets the clearance requirements; create wood frame/finish box to cover the vent - $150 - $200.

b. If no wall area is suitable, run vent/outside air intake up from basement through floor and then out through the wall on first floor. Terminate air intake at first floor location, run flue up exterior wall exposed and terminate above roof line per code; create wood frame/finish box to cover the vent - $250 - $350.

c. If chimney is abandoned, run vent and intake up chimney as chase, terminate at top with suitable cap - $0.

If DOE would like to corroborate these values, contact Liz Robinson, the Executive Director of the Energy Coordinating Agency (ECA) of Philadelphia.

Impacts on Low-Income Consumers

One issue deserving attention is the impact of new furnace standards on low-income households. Low-income households, like other households, will benefit from the energy and life-cycle cost savings of higher efficiency furnaces. However, higher efficiency furnaces cost more and many low-income households are short on capital or access to financing. Regarding this issue we have a few observations.

First, the majority of low-income households are renters and not home owners, and thus in many cases the capital costs will be borne by the owners. As shown in the table below, at household incomes below $50,000 per year, renters outnumber owners. At the second part of the public hearing held on April 13, 2015, DOE's economist showed that the cost of furnace improvements will affect rent prices, but not by the full amount of the cost increase. Since DOE's LCC analysis implicitly assumes that the full cost of furnace efficiency improvements are passed on in rent increases, DOE's LCC estimate underestimates the LCC savings for low income consumers. Because low income families are disproportionately renters, they have higher LCC savings than consumers in general.

Renters and Owners as a Function of Income

	United States			
	Occupied	Owner-	Renter-	Ratio of
	Estimate	Estimate	Estimate	Renter to
Occupied housing units	116,291,033	73,843,861	42,447,172	Owner
HOUSEHOLD INCOME IN THE PAST				
Less than $5,000	3.6%	1.9%	6.4%	3.37
$5,000 to $9,999	4.0%	1.9%	7.6%	4.00
$10,000 to $14,999	5.4%	3.3%	9.0%	2.73
$15,000 to $19,999	5.3%	3.7%	8.1%	2.19
$20,000 to $24,999	5.5%	4.2%	7.8%	1.86
$25,000 to $34,999	10.3%	8.6%	13.3%	1.55
$35,000 to $49,999	13.6%	12.8%	15.1%	1.18
$50,000 to $74,999	17.9%	19.2%	15.7%	0.82
$75,000 to $99,999	11.9%	14.2%	7.8%	0.55
$100,000 to $149,999	12.7%	16.5%	6.0%	0.36
$150,000 or more	9.9%	13.6%	3.3%	0.24
Median household income (dollars)	52,250	66,828	32,831	

Source: All but the last column are 2013 data from the US Census American Community Survey. ACEEE calculated the last column.

Second, since most households will benefit from higher efficiency furnaces, including a clear majority of low-income households, it doesn't make sense to set a lower standard for all just so a few benefit. This leads to our third point -- states and utilities can step in and help low-income owners who lack capital by providing financing. Many states have energy efficiency financing programs and some utilities also have such programs. On-bill-financing can be a particularly attractive strategy and we hope that many of the gas utilities who are expressing concerns about low-income homeowners will provide them with financing if there is not already a state program that does so.

Conclusions

In conclusion, we recommend that DOE refine its analyses to incorporate new venting technologies and a lower rate of fuel switching. With or without these revisions, DOE's analysis supports a 95% AFUE national standard. By establishing a class of small furnaces for which the standard remains at 80%, we believe that DOE could increase the overall net consumer benefits from this standard.

Please let us know if you have any questions about these comments.

Sincerely,

Steven M. Nadel
Executive Director

Harvey M. Sachs
Senior Fellow

Attachment: Analysis of Average Furnace Capacity Needed in the South

Table CE4.9 Household Site End-Use Consumption by Fuel in the South Region, Averages, 2009
Million British Thermal Units (Btu), Final

Housing Unit Characteristics and Energy Usage Indicators	Total Housing Units (millions)	Average Site Energy Consumption (million Btu per household using the fuel & end use)								
		Natural Gas								
		Total	2009 Space Heating	Normalized Space Heating	2021 Space Heating	Avg HDD	Design Temp	Implied Furnace Capacity		2021 but 10 deg colder
								(2009)	(2021)	
Total South	42.1	53.1	38.8							
South Divisions and States										
South Atlantic	22.2	55.9	44.2	42.4	38.6					
Virginia	3.0	64.2	44.5	42.7	38.9	4512	18	14,833	13,498	16,370
Georgia	3.5	64.3	42.3	40.6	36.9	2595	23	21,885	19,916	24,657
Florida	7.0	19.4	14.4	13.9	12.6	741	28	23,066	20,990	26,664
DC, DE, MD, WV	3.4	64.1	52.0	49.9	45.4	4877	14	17,304	15,747	18,850
North Carolina, South Carolina	5.4	54.1	48.3	46.4	42.2	3086	23	20,857	18,980	23,539
East South Central	7.1	55.1	43.7	41.9	38.1					
Tennessee	2.4	57.2	47.5	45.6	41.5	4002	18	17,837	16,231	19,685
Alabama, Kentucky, Mississippi	4.6	53.9	41.6	39.9	36.3	3346	21	17,574	15,992	19,611
West South Central	12.8	49.3	31.2	30.0	27.3					
Texas	8.5	46.2	27.0	25.9	23.6	2302	26	14,624	13,308	16,720
Arkansas, Louisiana, Oklahoma	4.2	56.4	40.6	39.0	35.5	2948	23	18,394	16,738	20,751

Notes:

Data is from 2009 Residential Energy Consumption Survey except for data shaded in yellow which was derived as explained in the notes below.
Normalized space heating is 2009 space heating from RECS times .96, since the TSD indicates that 2009 was 4% colder than average.
Per the TSD, 2021 space heating is 9% below 2009 space heating due to building shell improvements.
Average HDD (heating degree days) is from NOAA.
Design temperature is from ACCA Manual J and is based on eyeballing all of the weather stations in a state and selecting the approximate average.
Furnace capacity calculated for both 2009 and 2021 using the following formula:
Furnace capacity = Avg. site energy consumption in Btu * 80% assumed average current furnace efficiency * (65 - design temp) / (HDD x 24)
2021 but 10 degree colder is a calculation of average capacity if the design temperature is 10 degrees colder than is listed to the left.