AMERICAN PUBLIC GAS ASSOCIATION

October 14, 2015

Ms. Brenda Edwards
U.S. Department of Energy, Building Technologies Office, Mailstop EE–2J
1000 Independence Avenue, SW.
Washington, DC 20585–0121

RE: Docket Number EERE–2014–BT–STD–0031

Dear Ms. Edwards:

The American Public Gas Association (APGA) is pleased to submit comments to the U.S. Department of Energy (DOE) in response to the September 14th Notice of Data Availability regarding an analysis of the consumer economics and national impacts of establishing separate standard levels for large and small residential furnaces.

APGA is the national association for publicly-owned natural gas distribution systems. There are approximately 1,000 public gas systems in 37 states and over 700 of these systems are APGA members. Publicly-owned gas systems are not-for-profit, retail distribution entities owned by, and accountable to, the citizens they serve. They include municipal gas distribution systems, public utility districts, county districts, and other public agencies that have natural gas distribution facilities. For more information on APGA and its members, please visit www.apga.org.

A copy of APGA's comments is attached.

Sincerely,

Dave Schryver
Executive Vice President

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Email – dschryver@apga.org

BEFORE THE

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

UNITED STATES DEPARTMENT OF ENERGY

WASHINGTON, D.C.

Docket Number EERE-2014-BT-STD-0031/ RIN NO. 1904-AD20

**COMMENTS OF THE
AMERICAN PUBLIC GAS ASSOCIATION
ON THE NOTICE OF DATA AVAILABILITY**

October 14, 2015

Introduction

The American Public Gas Association (APGA) submits these comments regarding the Notice of Data Availability (NODA) issued in the above-referenced proceeding by the Office of Energy Efficiency and Renewable Energy, Department of Energy (DOE) and published in the Federal Register on September 14, 2015 (80 Fed. Reg. 55038).[1] In the NODA, DOE indicates that it has "completed a provisional analysis of the potential economic impacts and energy savings that could result from promulgating amended energy conservation standards for residential non-weatherized gas furnaces (NWGFs) that include two product classes defined by input capacity …" (*Id.*) DOE asked for "comments, data, and information regarding this analysis" (*id.* at 55045), such comments to be filed by October 14, 2015.

On September 15, 2015, the American Gas Association (AGA) and APGA submitted a data request (Joint Request[2]), noting that filing meaningful comments "is impossible without being provided additional data by DOE underlying and explaining the NODA and the accompanying spreadsheets, and then having a technical analysis to discuss the data." (Joint

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[1] APGA is the national association for publicly-owned natural gas distribution systems. There are approximately 1000 public gas systems in 37 states, and over 700 of these systems are APGA members.

[2] Http://www.regulations.gov/#!docketDetail;dct=FR+PR+N+O+SR;rpp=10;po=0;D=EERE-2014-BT-STD-0031-0168.

Request at 1.[3]) The Joint Request asked DOE for an extension of time to review and analyze the requested data before filing comments.

DOE, without explanation, declined to provide the requested data or the additional time. This refusal to provide the requested data (and time for analysis), in addition to being a violation of the Energy Policy and Conservation Act (EPCA), 42 U.S.C. § 6295,[4] and the Administrative Procedure Act (APA), 5 U.S.C. § 553,[5] also frustrates the stated purpose of the NODA, which is to elicit meaningful comments regarding the NODA analysis. Unfortunately, this lack of transparency regarding the NODA is consistent with the DOE's ongoing lack of transparency in the subject NOPR proceeding and in the preceding Direct Final Rule proceeding (APGA NOPR Comments at 30-34[6]). Notwithstanding DOE's failure to respond to the Joint Request, the Gas Technology Institute (GTI) was able to do a limited "Technical Analysis of Furnace Sizing for the DOE Notice of Data Availability on Residential Furnace Minimum Efficiencies" (GTI NODA Report), which is attached hereto and incorporated by reference (the report, which is

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[3] In addition, the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) submitted a data request on September 15.

[4] *See, e.g., National Resources Defense Council v. Herrington*, 768 F.2d 1355, 1425-1429 (1985). Since we are in the midst of a rulemaking proceeding, it is no excuse for DOE to seek to avoid transparency on the ground that the questions relate to a NODA versus a NOPR.

[5] *See, e.g., Sierra Club v. Costle*, 657 F.2d 298, 397 n.484 (D.C. Cir. 1981) ("In general, factual or methodological information which is critical to a proposed rule should be available *in such a way as to provide an adequate opportunity for comment*.") (emphasis supplied), *rev'd on other grounds sub nom. Ruckelshaus v. Sierra Club*, 463 U.S. 680 (1983); *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 393 and n.67 (D.C. Cir. 1973) ("Obviously a prerequisite to the ability to make meaningful comment is to know the basis upon which the rule is proposed"; "It is not consonant with the purpose of a rule-making proceeding to promulgate rules on the basis of inadequate data, or on data that, critical degree, is known only to the agency"); *Conn. Light and Power Co. v. NRC*, 673 F.2d 525, 530-31 (D.C. Circ. 1982) ("To allow an agency to play hunt the peanut with technical information, hiding or disguising the information that it employs, is to condone a practice in which the agency treats what should be a genuine interchange as mere bureaucratic sport. An agency commits serious procedural error when it fails to reveal portions of the technical basis for a proposed rule in time to allow for meaningful commentary."); *Owner-Operator Independent Drivers Ass'n, Inc. v. FMCSA*, 494 F.3d 188, 201 (D.C. Cir. 2007). As noted in note 4, above, DOE may not escape these notice requirements by arguing that a NODA is not a rulemaking, as we are in the midst of a rulemaking proceeding of which the NODA is a very important part.

[6] Located at EERE-2014-BT-STD-0031-0106.

available at http://www.gastechnology.org/reports_software/Pages/Residential-Furnace-Minimum-Efficiencies.aspx), is denominated by GTI on its website as "21853 Furnace NODA Analysis Task Report 2015-10-14.pdf").

Discussion

DOE states that the NODA analysis proceeds on the basis of the "same analytical framework" as the Notice of Proposed Rulemaking (NOPR) published in this proceeding on March 12, 2015 (*see* 80 Fed. Reg. 13120), *i.e.*, using a life-cycle cost (LCC) analysis premised on random selection of homes using Oracle's Crystal Ball software (NODA, 80 Fed. Reg at 55039-040; *see id.* at 55040-041). DOE indicates in the NODA that it made several updates regarding the data used in the model and corrected a "bug" in the LCC analysis in the NOPR. It does not disclose in the NODA what the "bug" was that it corrected, and it has refused to answer the Joint Request related to that issue (or anything else).

Since DOE used "the same analytical framework" in the NODA as in the NOPR, it has made the same fundamental errors that were identified in the July 10, 2015 comments of APGA (APGA NOPR Comments at 12-39) and the accompanying report of the Gas Technology Institute (GTI NOPR Report, *passim*) in the NOPR proceeding. These errors include (i) reliance on random assignment rather than economic decision making to establish the homes that would be impacted by the proposed rule; (ii) reliance on a flawed fuel switching analysis that inappropriately ignores the more granular American Home Comfort Study data showing that tolerable payback periods are a function of income and are dominated by large numbers of very low tolerable payback periods with small numbers of much larger payback periods, the effect of which is to undermine DOE's use of a single switching payback value of 3.5 years; and (iii) reliance on inappropriate and/or inaccurate input data.[7] The net effect of correcting these errors was to turn the positive LCC savings reported in the NOPR to negative LCC savings, rendering the proposed condensing standard rule untenable (APGA NOPR Comments at 12-30).

In the NODA, DOE has ignored the furnace assignment and fuel switching flaws in its modeling approach, and instead used its NOPR LCC model, with a few data updates, an

[7] As discussed below, DOE has corrected several of the input errors in the NODA.

unexplained "bug" correction, and a lower denominator (discussed below) to show that if certain furnace sizes are exempted from the single condensing standard (i.e., purchasers of small furnaces are permitted to buy either a condensing or non-condensing furnace), the average LCC savings increase, the number of consumers experiencing a net cost decreases, and the percentage of consumers switching to an alternate fuel decreases (NODA, 80 Fed. Reg. at 55042-043). While these changes would be positive from the consumer standpoint if premised on sustainable, verifiable data, they are not based on such data; the LCC savings and other numbers shown in the tables in Section III of the NODA are without a foundation given the significant flaws in the DOE's LCC Crystal Ball model and in the input data that has not been corrected. It is imperative that DOE first correct the LCC model to address the problems identified in the GTI NOPR Report (i) to determine if a single condensing standard can be economically justified (the data indicates otherwise) and (ii), if the answer to question (i) were in the affirmative, to then determine the effect of exempting various furnace sizes (including furnaces larger than 65,000 Btu/hour, which was the unexplained cap used in the NODA[8]).

One significant change that DOE did make in the NODA, vis-à-vis the NOPR, is that it changed the denominator in the LCC savings calculation, with the result being that the LCC savings numbers (versus the savings themselves) are inflated in the NODA versus what was shown in the NOPR. If the NODA analysis is calculated on the same basis as the NOPR analysis (or vice versa), the LCC savings associated with a single standard approach in both the NODA and the NOPR decline substantially.[9] DOE provides no rationale for its decision to change the manner in which LCC savings are measured, thereby rendering the NOPR and NODA LCC data a misleading apples-to-oranges comparison; rather, it simply states that "DOE believes that showing a direct comparison with the NOPR results would not serve the purposes of the NODA

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[8] APGA believes, based on informal discussions with its members in different regions of the country, that for a furnace-size exception to have the desired effect on fuel switching, it would have to include furnaces with an input of at least 95,000 Btu/hour.

[9] GTI NODA Report at Section 3.1, Table 3. For example, the putative LCC savings shown in the NOPR for the 92% TSL were $305 (80 Fed. Reg. at 13122), whereas in the NODA it is $425 despite making updates that drove the NOPR savings down (80 Fed. Reg. at 55043). If the NOPR denominator is used in the NODA calculations, the LCC savings for the 92% TSL drop from $305 (in the NOPR) to $225; if, on the other hand, the NODA denominator is used in the NOPR calculations, the LCC savings for the 92% TSL drop from $520 (per the NOPR) to $425.

analysis." (NODA, 80 Fed. Reg. at 55042.) APGA respectfully disagrees, as the change in methodology sows confusion rather clarification, by suggesting, incorrectly, that LCC savings are enhanced in the NODA, when in point of fact the opposite is true, with or without a furnace-size exception.[10]

Another disappointing feature of the NODA is DOE's failure to address the fact that what the corrected LCC data, in combination with the data provided by AHRI on furnace sales (which DOE properly included in the NODA analysis), show is that the furnace market is functioning properly *without a rule*. Consumers that should be purchasing condensing furnaces because it makes economic sense are purchasing such furnaces in huge numbers;[11] and consumers that would be ill-served economically by purchasing a condensing furnace largely are not buying them (APGA NOPR Comments at 34-37). Thus, the market failures that a furnace rule should be designed to address do not exist; rather, they will only exist if a rule is finalized that eliminates the non-condensing furnace option from the market place. While exempting small furnaces will diminish the number of market failures that would otherwise accompany a single standard rule,[12] a single standard rule with a small furnace exemption will nonetheless promote unnecessary market failures, in contravention of the Energy Policy Conservation Act (EPCA).

It is ironic that DOE invokes consumer rationality to justify its conclusion that certain consumers will downsize their furnaces in order to be able to purchase a non-condensing furnace because of the economic burdens associated with a condensing furnace (NODA, 80 Fed. Reg. at 55041), but ignores consumer economics in the key threshold decision of furnace assignment. Once DOE gets the furnace assignment task done correctly (i.e., to reflect rational consumer decision-making), the furnace size issue becomes academic, as it is apparent that there is no basis for a single condensing furnace standard. The market is functioning well without a single

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[10] *E.g., compare* NODA Table III.4 *with* Table 3 in the GTI NODA Report.

[11] As the NODA concedes, "[b]ased on the AHRI shipment data, DOE's estimate of the condensing furnace market share in 2021 increased from 47-percent in the NOPR to 53-percent in the NODA." NODA, 80 Fed. Reg. at 55041, note 12. Regarding the market penetration of condensing furnaces by region in 2050, *see* Figure 37 at Appendix A, page A-57 of the GTI NOPR Report.

[12] This is so because the number of not-impacted consumers increases with an exemption permitting some adversely impacted consumers to purchase non-condensing furnaces.

condensing furnace standard,[13] and hence a single condensing furnace standard, with or without a small furnace exemption, would only cause market dysfunction, albeit in varying degrees.

One of the several ironies of the NODA focus on furnace size is that DOE is ignoring the approach that is required under the statute and that would make the furnace size issue academic. Under the EPCA and outstanding DOE precedent, DOE is required to set a performance standard for condensing and non-condensing furnaces, without regard to size (APGA NOPR Comments at 39-50). DOE has ignored this point in the NODA, choosing to rely on furnace size as the method for ameliorating some of the harsh impacts of a single condensing standard. While, as noted at the outset, an exemption from the single standard based on furnace size would mean that fewer consumers are involuntarily skewered by a single condensing furnace standard, the appropriate answer to the harm that would be created by such a single standard is recognition that separate standards for condensing and non-condensing furnaces are the only lawful response under the EPCA given the facts of this case. Further underscoring the irony of the NODA furnace size approach is that while DOE argues in the NOPR (incorrectly, in APGA's view) that condensing and non-condensing furnaces are not separate product classes (and hence under the EPCA it may not set separate standards for condensing and non-condensing furnaces; 80 Fed. Reg. at 13137-138), the NODA is silent regarding the statutory authority for DOE to create separate product classes based on furnace input capacity.

The GTI NODA Report also identifies other issues raised by the NODA methodology that affect its validity, including the absence of a meaningful correlation between heating load and furnace size;[14] the failure of DOE to consider air-conditioning requirements when sizing furnace;[15] and DOE's reliance on a RECS 2009 data base that does not contain the vital furnace size and heating load information and hence is inadequate to address the furnace AFUE for existing buildings, the existing building loads, or the existing building furnace capacities.[16]

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[13] *See also* AHRI NOPR Comments at 25-35 (located at .EERE-2014-BT-STD-0031-0159).

[14] GTI NODA Report at Section 2.3.

[15] *Id.* at Section 2.2

[16] *Id.* at Section 2.4

Conclusion

APGA respectfully submits that, in order for the NODA analysis to be meaningful (*i.e.*, in order to issue a SNOPR), the DOE first must correct the flaws in its NOPR LCC analysis identified in the GTI NOPR Report and the flaws in the NODA analysis noted in the GTI NODA Report; in addition, DOE must be willing to answer data requests, such as the Joint Request, that seek information necessary to understand more completely the underpinnings of the NODA analysis.

Respectfully submitted,

AMERICAN PUBLIC GAS ASSOCIATION

By: Bert Kalisch
APGA President and CEO

October 14, 2015

the Energy to Lead

gti

GTI-15/0003

TASK REPORT

GTI PROJECT NUMBERS 21853, 21693, and 21754

Technical Analysis of Furnace Sizing for the DOE Notice of Data Availability on Residential Furnace Minimum Efficiencies

Reporting Period:
August 2015 through October 2015

Report Issued:
October 14, 2015

Prepared For:
American Public Gas Association
American Gas Association

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Disclaimer

This information was prepared by Gas Technology Institute ("GTI") for the American Gas Association (AGA) and the American Public Gas Association (APGA).

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Executive Summary

This report attempted to examine DOE's Notice of Data Availability (NODA) furnace sizing methodology and the impact of furnace size on lifecycle cost (LCC) savings for impacted consumers at the national level. Due to limited explanatory information in the NODA LCC model and no technical support document accompanying the NODA, the American Gas Association (AGA) and American Public Gas Association (APGA) submitted NODA-related questions and a request for an extension of the comment period on the NODA to DOE on September 15, 2015. DOE did not provide answers to those questions nor did it extend the comment period, both of which limited the opportunity to conduct scenario analyses of NODA algorithms and assumptions. As a result, lifecycle cost (LCC) savings for consumers impacted by separate standards for large and small furnaces were not able to be determined in this report.

The DOE NODA does not effectively address the methodology issues and shortcomings identified in GTI-15/0002 that resulted in overstated national benefits in the March 2015 Notice of Proposed Rulemaking (NOPR). With this caveat, it is noteworthy that, independent of the furnace-size exemption issue, the DOE NODA analysis shows a significant reduction in average benefits for all trial standard levels (TSLs) compared to the original DOE NOPR analysis, as shown in Table 1.

For the first time in the NODA, DOE used a new segmentation grouping of "impacted furnaces" in the LCC savings calculations. Table 1 shows LCC results used in the NODA (for impacted furnaces) as well as in the NOPR (for all furnaces).

As shown in Table 1, GTI's analysis of the NOPR and NODA shows negative average savings for all single standard TSLs (compared to DOE's findings of positive savings). The single standard results in the NODA do not appreciably alter the overall negative average savings findings in the GTI analysis of the NOPR.

Table 1 National Average LCC Savings for DOE NOPR and NODA LCC Models

TSL (% AFUE)	DOE NOPR Analysis	GTI NOPR Analysis	DOE NODA Analysis	GTI NODA Analysis
	NODA (Impacted Furnaces Only)			
90	$441	-$571	$347	-$592
92	$520	-$417	$425	-$442
95	$507	-$631	$420	-$651
98	$443	-$458	$343	-$475
	NOPR (All Furnaces)			
90	$236	-$215	$163	-$225
92	$305	-$181	$225	-$190
95	$388	-$445	$311	-$462
98	$441	-$447	$341	-$466

In summary, the NODA LCC model did not address the technically flawed random Base Case furnace AFUE assignment methodology, and also includes technically flawed furnace sizing algorithms. Based on the additional scenario analyses summarized in this report, there is no economic justification for the single standard described in the NODA. Due to the lack of requested information from DOE, no comparable LCC analysis for a separate standard level for large and small furnaces could be performed in the time DOE allotted for comments. Further, the RECS database information used by DOE in both the NOPR and NODA does not contain either heating load or furnace capacity information and is inadequate to address the furnace AFUE for existing buildings, existing building loads, or existing building furnace capacities.

1 Background

The U.S. Department of Energy (DOE) issued a notice of data availability (NODA), published in the Federal Register on September 14, 2015, containing a provisional analysis of the potential economic impacts and energy savings that could result from promulgating amended energy conservation standards for residential non-weatherized gas furnaces (NWGFs) that include two product classes defined by input capacity. The NODA does not consider mobile home gas furnaces. In the NODA, DOE outlines a potential alternative furnace efficiency standard that would differentiate between larger furnaces (which would be subject to more stringent minimum efficiency levels) and smaller furnaces (which would be subject to existing minimum efficiency requirements). The NODA analysis estimated impacts for several potential standard level combinations for condensing furnaces and various maximum sizes for non-condensing furnaces.

This task report is a follow-up to GTI-15/0002, "Technical Analysis of DOE Notice of Proposed Rulemaking on Residential Furnace Minimum Efficiencies." The prior GTI-15/0002 report included a comprehensive technical and economic analysis of the original March 2015 NOPR proposal to promulgate a minimum national furnace efficiency of 92% AFUE. The GTI-15/0002 report pointed to significant deficiencies in the NOPR LCC analysis, including:

- A flawed random furnace assignment methodology which deviated from a rational economic decision framework,
- A flawed fuel switching analysis methodology, and
- Use of outdated and lower quality input data.

Addressing these deficiencies and shortcomings, GTI's scenario analyses showed the proposed standard, instead of yielding positive national benefits, would instead result in: 1) negative average lifecycle cost savings and 2) increased primary energy consumption and greenhouse gas emissions (from fuel switching from natural gas to electric options that are less efficient on a primary energy basis). Table 2 provides a recap of the comparison of the NOPR and GTI scenario analysis findings, underscoring the average negative costs, higher proportion of consumers faced with a net cost (27% of the population), and reduced level of consumers who would experience a net benefit (only 17% of the population).

Table 2: Lifecycle Cost and Rulemaking Market Impact

LCC Model	Average Furnace Life-cycle Cost (LCC) Savings	Fraction of Furnace Population (%)		
		Net Cost	No Impact	Net Benefit
DOE NOPR LCC Model	$305	20%	41%	39%
GTI Integrated Scenario Int-5	-$181	27%	57%	17%

2 Furnace Sizing Analysis Methodology

2.1 AGA/APGA Data Request to DOE

Due to limited explanatory information in the NODA LCC model and no technical support document accompanying the NODA, the American Gas Association (AGA) and American Public Gas Association (APGA) submitted NODA-related questions and a request for an extension of the comment period on the NODA to DOE on September 15, 2015. DOE did not provide answers to those questions, nor did it extend the comment period, both of which limited the opportunity to conduct scenario analyses of NODA algorithms and assumptions. As a result, lifecycle cost (LCC) savings for consumers impacted by separate standards for large and small furnaces were not able to be determined in this report. The data requests are summarized below.

2.1.1 NODA LCC Spreadsheet Data Request

The AGA/APGA September 15, 2015, data request sought the following information related to the NODA LCC spreadsheet:

1) An updated version of input spreadsheet "rf_nopr_analysis_inputs_2014-02-06.xlsm" that was released with the NOPR LCC spreadsheet. The input spreadsheet contains key information on the LCC calculations and methodology for:
    - contractor markups
    - implementation of the new AHRI shipment data
    - implementation of the new AEO forecast
    - implementation of the new EIA pricing data
    - implementation of updated NWGF input capacity percentiles
2) Supporting data and detailed descriptions of changes in building shell efficiency calculations in the NODA LCC spreadsheet as mentioned on page 16 of "Res Furnace_NODA_2015-09-04.pdf." This is currently referenced in general terms as "described in the LCC spreadsheet."
3) Supporting data and detailed descriptions of changes in climate indices used to adjust energy use as mentioned on page 16 of "Res Furnace_NODA_2015-09-04.pdf." This is currently referenced in general terms as "described in the LCC spreadsheet."
4) Supporting data and detailed descriptions of the "updated engineering analysis" that is referenced in the "NODA Analysis Update" sheet under the "Prod Price" changes.
5) Clarification as to whether or not changes have been made to the "NWGF Switching" sheet that was omitted from the descriptions of changes in the "NODA Analysis Updates" Sheet of the NODA LCC spreadsheet.

2.1.2 Technical Support Documentation

Information requested in this section of the AGA/APGA data request focuses on descriptions typically included in a DOE technical support document that are needed for a reasonable understanding of changes included in the NODA LCC spreadsheet.

1) Describe the "bug" in the "AFUE Existing" assignment and what was done to correct the bug, with references to specific locations in the NODA LCC spreadsheet.
2) Describe the methodology and rationale for choosing 1.3 vs. 1.7 oversizing factors in the "Furnace & AC Sizing" Sheet of the NODA LCC spreadsheet.

3) Describe the methodology used to arrive at the Net Cost percentages included in Tables III.2 and III.3 of "Res Furnace_NODA_2015-09-04.pdf."
4) Describe the methodology/logic of implementing dual standard scenario, and downsizing options.
5) The NODA LCC spreadsheet provides a dropdown box (see cell D23 in the Summary tab of the LCC spreadsheet) that provides options for various Standard Scenarios. The options in the dropdown box include Dual Standard selections for input capacities for small furnaces with thresholds of less than or equal to 70, 75, 80, 85 and 90 kBtus/hr. However, the tables included in the NODA do not include the LCC or the NIA spreadsheet results for these scenarios. Please provide the LCC and NIA spreadsheet results for each of these scenarios in a similar fashion that the other scenario results were presented in the NODA.

2.2 DOE NODA Sizing Methodology

DOE describes its methodology for furnace sizing beginning on page 7B-18 of the NOPR Technical Support Document (TSD). The steps DOE took to assign furnace size in the NODA LCC model appear to be the same as in the NOPR LCC model described in the NOPR TSD as follows:

1) The Department ranked all the RECS housing units in ascending order by size (heating square foot) multiplied by a scaling factor to account for the outdoor design temperature and calculated the percentile rank of each housing unit using the statistical weight of each of the sample records. The scaling factor is given by: $SF_{design,h} = (65 - T_{design,h}) / (65 - 42)$*, where* $SF_{design,h}$ *= heating design scaling factor, and*

$T_{design,h}$ *= average 1 percent ASHRAE design dry bulb temperature (°F) for heating.*

2) The Department constructed percentile tables by input capacity of furnaces based on the historical shipment information and number of models in AHRI Directory (TSD Table 7B.2.13).

3) After selecting a housing unit from the Residential Energy Consumption Survey (RECS) database during each Monte Carlo iteration, DOE noted the size of the selected housing unit and determined the percentile rank from Step 1.

4) To avoid a one-to-one deterministic relation between the housing unit size and input capacity, DOE added a random term to the percentile identified in Step 3 so that the correlation was not perfect. The Department used a normal distribution to characterize the random term. The random term has a mean of zero and a standard deviation of 8 percent.

5) Using the percentile from Step 4, DOE looked up the input capacity from the input capacity percentile table in Step 2.

In the procedure for furnace sizing described in the NOPR TSD, the distribution of furnace input capacity used in Step 2 was used to split the 10 kBtu/hr size bins based on AHRI shipment numbers for the year 2000 in each size bin. As indicated in footnote 6 of the NODA (80 Fed. Reg. 55041), furnaces were binned into 5 kBtu/hr size bins for the NODA analysis. GTI was unable to find any location in the NODA LCC model where the random term described in Step 4 is either generated or used.

Consistent with the steps above, DOE also does not appear to consider the size of an AC system when determining furnace size. Correct furnace fan sizing is important to ensure that the furnace/AC system will provide adequate space conditioning during summer cooling periods in conventional forced air systems with an evaporator coil located adjacent to the furnace. This issue is especially important in warmer climates dominated by cooling demand. Furnace capacity in those cases will not be based on the peak heating load, but on the furnace fan capacity linked to the AC system capacity. As a result, the furnace capacity will often be oversized to maintain adequate delivered air temperature in heating mode based on the fan output. The amount of oversizing varies, but can limit the minimum furnace capacity in those cases to a higher capacity than calculated based on peak heating load. ACCA Manual S acknowledges this application and permits additional oversizing in those cases.

2.3 Furnace Size and Heating Load Analysis Methodology

Furnace size calculated using the above methodology is located in the Furnace & AC Sizing Sheet in Cell D19 for each Crystal Ball trial case. The annual heating load (i.e., furnace output) for each Crystal Ball trial case is located in the Energy Use Sheet in Cell F78. GTI extracted both furnace size and heating load from each trial case for post-processing and analysis using Visual Basic for Application (VBA) code as described in GTI-15/0002 Section 2.1. This permitted an evaluation of the correlation between furnace size and heating load for the 10,000 trial cases in the NODA LCC model.

Figure 1 shows heating load vs. furnace size along with a best fit line for all furnaces, whether impacted by the rule or not. The correlation between heating load and furnace size is weak. Also, the best fit line has an intercept at zero heating load near 75 kBtu/hr. An intercept above zero is expected because even homes with very low heating loads may be expected to install a furnace in the event of infrequent cold weather. The relatively high value of the intercept is consistent with the idea that furnaces are generally oversized for the heating load and that therefore furnace size is only weakly related to heating load, which will tend to make this intercept close to the average furnace size. In this case the average furnace size for all trials is 85.9 kBtu/hr. The lack of a strong relationship between heating load and furnace size may help to explain the lack of a consistent trend in LCC savings with furnace size. To better show the distribution of heating loads within the furnace size bins, Figure 2 and Figure 3 show the distribution of heating loads for a range of kBtu/hr furnace size bins. The distributions overlap substantially, and all of the distributions contain a significant fraction of buildings with very low heating loads.

As noted above in Section 2.2, the DOE sizing methodology does not appear to consider AC requirements when sizing furnaces. Thus, the lack of correlation between heating load and furnace size does not appear to be driven to any meaningful extent by AC size and associated fan requirements.

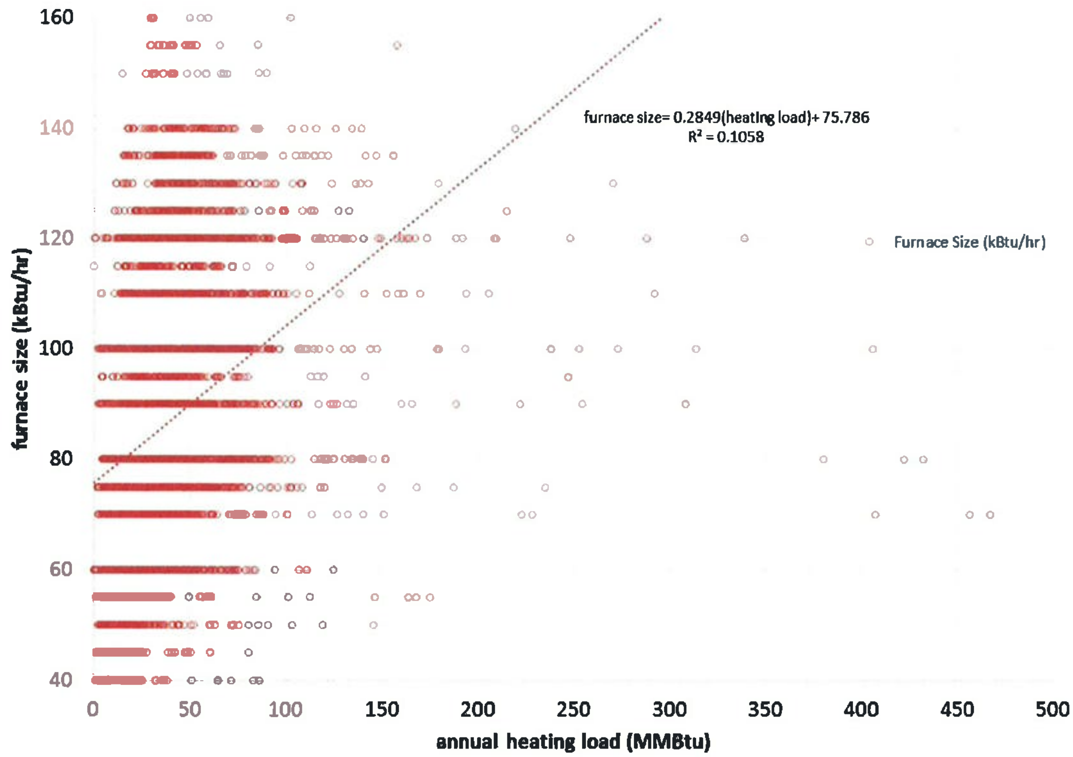

Figure 1: Furnace Size vs. Annual Heating Load

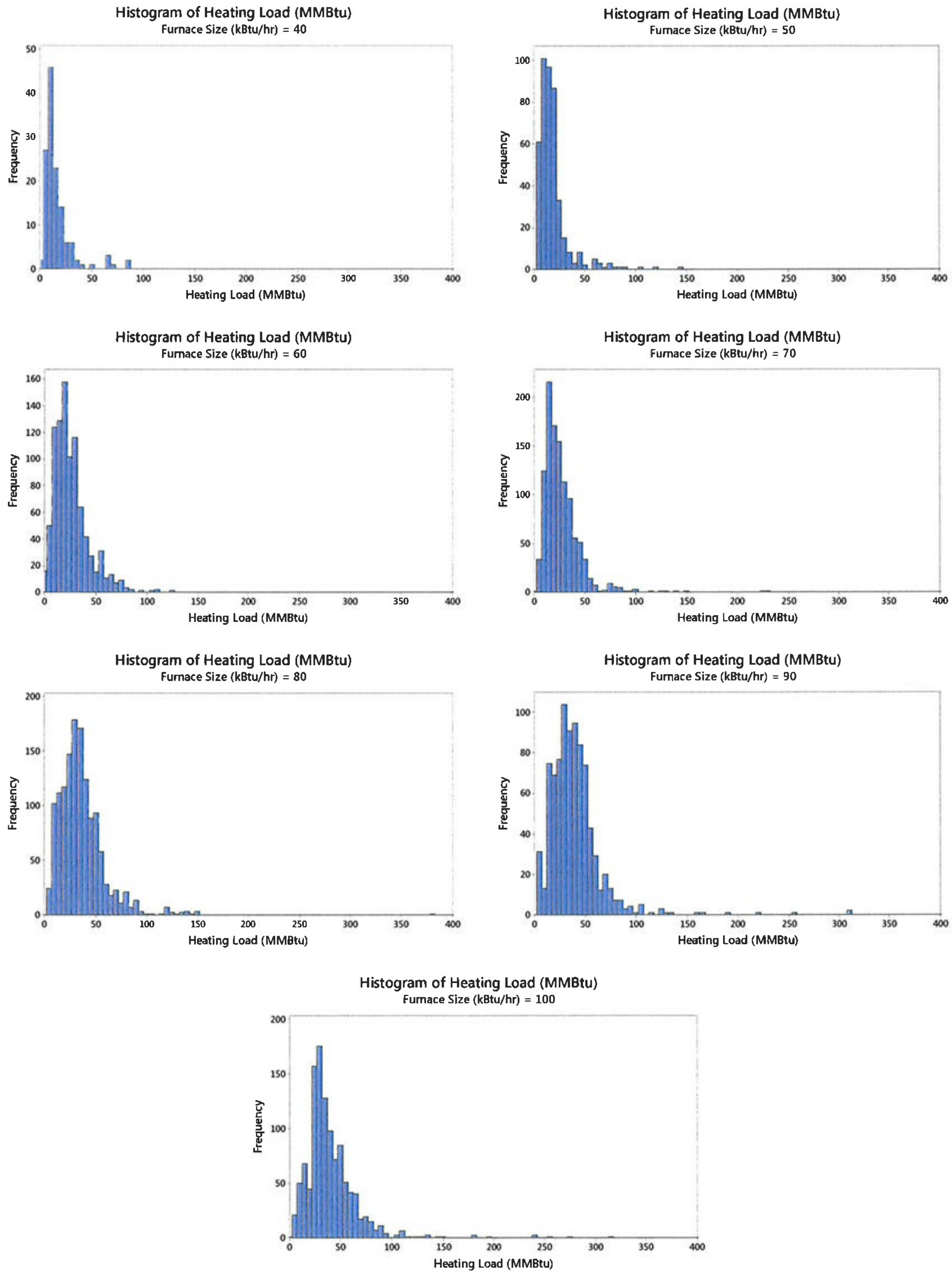

Figure 2: Heating Load Distribution for Selected Furnace Size Bins (40 to 100 kBtu/hr)

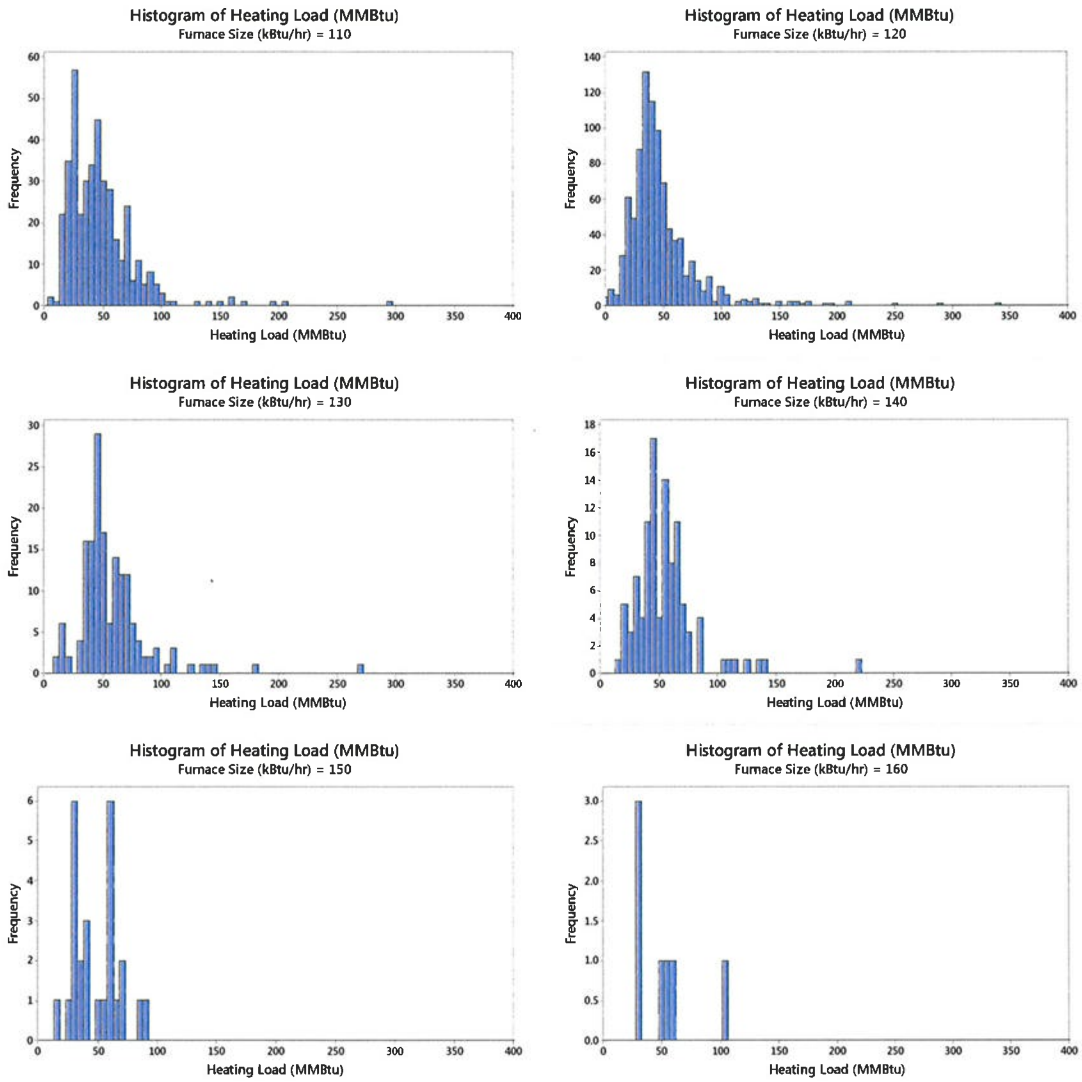

Figure 3: Heating Load Distribution for Selected Furnace Size Bins (110 to 160 kBtu/hr)

2.4 RECS Database Application

In both the NOPR and NODA, DOE derived annual heating load, existing furnace efficiency level, and existing furnace capacity from limited information in the RECS 2009 database. Applicable information in the RECS database includes location, physical size, and gas consumption. Since the RECS database does not include furnace size or annual heating load information, DOE chose to randomly assign existing furnace AFUE and derived the annual heating load from the randomly assigned AFUE. The lack of data in the RECS database on the key values of furnace AFUE and capacity makes it an inadequate source of information for use in the furnace capacity and annual heating load assignments used in the NOPR and NODA, both for the single standard level and for separate standard levels for large and small furnaces evaluated in the NODA. Additional market information is needed for this purpose.

2.5 DOE NODA Furnace Downsizing Methodology

As stated in the NODA, if there is a separate standard for small furnaces, DOE expects that some consumers who would otherwise install a typically-oversized furnace would choose to down-size in order to be able to purchase a non-condensing furnace. For the NODA analysis, DOE identified those sample households that might down-size at the considered small furnace definitions. DOE first determined if a household would install a non-condensing furnace with an input capacity greater than the small furnace size limit without amended standards. In the standards case, DOE assumed that a fraction of such consumers would down-size to the input capacity limit for small furnaces.

The equation for the DOE downsizing algorithm is as follows:

$$Downsizing\ Input\ Size = Original\ Furnace\ Size\left(\frac{Downsizing\ Oversize\ Factor}{Original\ Oversize\ Factor}\right) = Original\ Furnace\ Size\left(\frac{1.35}{1.7}\right)$$

Figure 4 shows the flowchart for the NODA furnace downsizing methodology. The NODA downsizing methodology assumes a rational consumer response to a market constraint to protect their economic interests. This rational consumer behavior methodology is inconsistent with the random furnace sizing and baseline furnace efficiency assignment methodology used by DOE elsewhere in the NOPR and NODA. It also fails to account for the selection of furnace size based on AC size and associated fan requirements.

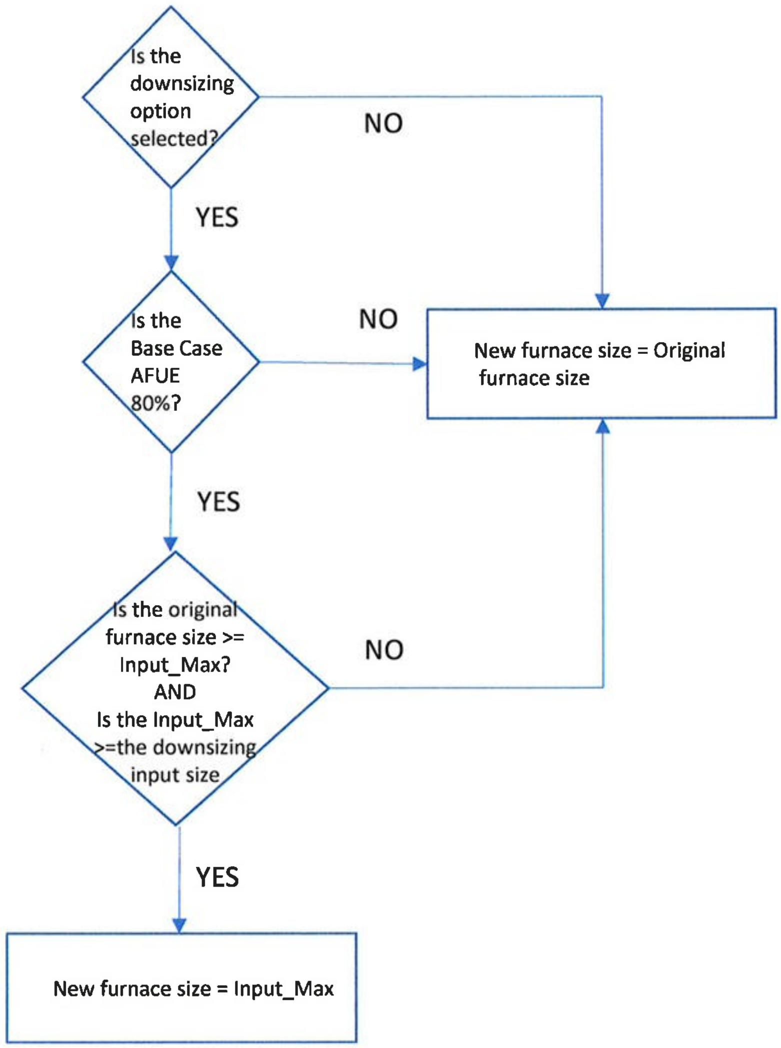

Figure 4 NODA Furnace Down-Sizing Methodology

3 Results

3.1 Incremental changes in the NODA vs. the NOPR LCC Model

The DOE NODA does not effectively address the methodology issues and shortcomings identified in GTI-15/0002 that resulted in overstated LCC savings and national benefits in the March 2015 NOPR. With this caveat, it is noteworthy that, independent of the furnace-size exemption issue, the DOE NODA analysis shows significant reduction in average benefits for all single standard TSLs compared to the original DOE NOPR analysis, as shown in Table 3.

For the first time in the NODA, DOE used a new segmentation grouping of "impacted furnaces" in the LCC savings calculations. In the NODA, the methodology to display average national LCC savings values shifted from an overall average value shown in the NOPR considering all 10,000 trial cases, whether impacted or not, to an average savings value considering only the impacted trial cases. Table 3 shows results for both the NODA (per impacted furnace) as well as the NOPR (per 10,000 furnaces).

Table 3 also summarizes GTI's analysis of the NOPR and NODA. GTI's analysis shows negative average savings for all single standard TSLs in the NODA (compared to DOE's findings of positive savings), and these results are not appreciably different than the overall negative average savings findings in the GTI analysis of the NOPR.

Table 3 National Average LCC Savings for DOE NOPR and NODA LCC Models

TSL (% AFUE)	DOE NOPR Analysis	GTI NOPR Analysis	DOE NODA Analysis	GTI NODA Analysis
	NODA (Impacted Furnaces Only)			
90	$441	-$571	$347	-$592
92	$520	-$417	$425	-$442
95	$507	-$631	$420	-$651
98	$443	-$458	$343	-$475
	NOPR (All Furnaces)			
90	$236	-$215	$163	-$225
92	$305	-$181	$225	-$190
95	$388	-$445	$311	-$462
98	$441	-$447	$341	-$466

3.2 Furnace Size vs. LCC Savings

Due to the lack of requested information from DOE, no comparable LCC analysis for a separate standard level for large and small furnaces could be performed in the time DOE allotted for comments.

4 Conclusions

The DOE NODA LCC model did not address the technically flawed random Base Case furnace AFUE assignment methodology or the technically flawed fuel switching analysis used in the NOPR, and includes technically flawed furnace sizing algorithms. Based on the additional scenario analyses summarized in this report, there is no economic justification for the single standard described in the NODA or the NOPR. Due to the lack of requested information from DOE, no comparable LCC analysis for a separate standard level for large and small furnaces could be performed in the time DOE allotted for comments. Further, the RECS database information used by DOE does not contain either heating load or furnace capacity information and is inadequate to address the furnace AFUE for the existing buildings, the existing building loads, or the existing building furnace capacities.