[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket Number EERE-2014-BT-STD-0031]

RIN 1904-AD20

Energy Conservation Program: Energy Conservation Standards for Residential Furnaces

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Supplemental notice of proposed rulemaking (SNOPR) and announcement of public meeting.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including residential furnaces. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. On March 12, 2015, DOE published in the Federal Register a notice of proposed rulemaking (NOPR), in which DOE proposed amendments to the energy conservation standards for residential non-weatherized gas furnaces and mobile home gas furnaces. In response to the NOPR, DOE received comment expressing concern regarding DOE's proposed approach and encouraging the

Department to examine establishing a separate product class for small furnaces. In response, DOE published a notice of data availability (NODA) in the Federal Register on September 14, 2015 that contained an analysis of a potential product class for small non-weatherized gas furnaces. In this supplemental notice of rulemaking (SNOPR), DOE responds to comments received on the NOPR and NODA and is making a modified proposal regarding amended energy conservation standards for the subject residential furnaces (including a separate small furnaces product class), which supersedes DOE's earlier proposal, as set forth in the March 12, 2015 NOPR. The notice also requests comment on the SNOPR's proposed standards and associated analyses and results. The SNOPR also proposes clarifications to the certification and reporting requirements of standby mode and off mode values for non-weatherized oil furnaces (including mobile home oil furnaces) and electric furnaces, to provide direction on the rounding of standby mode and off mode values, generally, and to clarify the level of precision for the furnace and boiler standards.

DATES: Comments: DOE will accept comments, data, and information regarding this supplemental notice of proposed rulemaking before and after the public meeting, but no later than **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. See section VII, "Public Participation," for details.

Comments regarding the likely competitive impact of the proposed standards should be sent to the Department of Justice contact listed in the **ADDRESSES** section before **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

Meeting: DOE will hold a public meeting on October 17, 2016, from 9:00 a.m. to 5:00 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section VII, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 6E-069, 1000 Independence Avenue, SW, Washington, DC 20585.

Instructions: Any comments submitted must identify the SNOPR on Energy Conservation Standards for Residential Furnaces, and provide docket number EERE-2014-BT-STD-0031 and/or regulatory information number (RIN) 1904-AD20. Comments may be submitted using any of the following methods:

Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.

E-mail: ResFurnaces2014STD0031@ee.doe.gov. Include the docket number and/or RIN in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.

Postal Mail: Mr. John Cymbalsky, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.

Hand Delivery/Courier: Mr. John Cymbalsky, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., Room 6002, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimilies (faxes) will be accepted. For detailed instructions on submitting comments and additional information on the rulemaking process, see section VII of this document ("Public Participation").

Written comments regarding the burden-hour estimates or other aspects of the collection-of-information requirements contained in this proposed rule may be submitted to Office of Energy Efficiency and Renewable Energy through the methods listed above and by e-mail to Chad_S_Whiteman@omb.eop.gov.

EPCA requires the Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. The U.S. Department of Justice Antitrust Division invites input from market participants and other interested persons with views on the likely competitive impact of the proposed standard. Interested persons may contact the Division at energy.standards@usdoj.gov before **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. Please indicate in the "Subject" line of your e-mail the title and Docket Number of this rulemaking notice.

DOCKET: The docket, which includes Federal Register notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at www.regulations.gov. All documents in the docket are listed in the www.regulations.gov index. However, some documents listed in the index may not be publicly available, such as those containing information that is exempt from public disclosure.

The docket webpage can be found at: https://www.regulations.gov/docket?D=EERE-2014-BT-STD-0031. The docket webpage contains simple instructions on how to access all documents, including public comments, in the docket. See section VII, "Public Participation," for further information on how to submit comments through www.regulations.gov.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Appliance and Equipment Standards Staff at (202) 586-6636 or by email: Appliance_Standards_Public_Meetings@ee.doe.gov.

FOR FURTHER INFORMATION CONTACT: Mr. John Cymbalsky, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-1692. E-mail: residential_furnaces_and_boilers@ee.doe.gov.

Mr. Eric Stas or Ms. Johanna Jochum, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-9507 or (202) 287-6307. E-mail: Eric.Stas@hq.doe.gov or Johanna.Jochum@hq.doe.gov.

For further information on how to submit or review public comments, contact the Appliance and Equipment Standards Staff at (202) 586-6636 or by email: Appliance_Standards_Public_Meetings@ee.doe.gov.

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Proposed Rule

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94-163 (42 U.S.C. 6291-6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] These products include non-weatherized gas furnaces (NWGFs) and mobile home gas furnaces (MHGFs), the subject of this rulemaking. (42 U.S.C. 6292(a)(5))

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) EPCA specifically provides that DOE must conduct a second round of energy conservation standards rulemaking for NWGFs and MHGFs. (42 U.S.C. 6295(f)(4)(C)) The statute also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) Once complete, this rulemaking will satisfy both statutory provisions.

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.
[2] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015 (EEIA 2015), Public Law 114-11 (April 30, 2015).

In accordance with these and other statutory provisions discussed in this document, DOE proposes amended energy conservation standards for the subject residential furnaces (i.e., NWGFs and MHGFs). The proposed standards, which are expressed in terms of minimum annual fuel utilization efficiency (AFUE) by certified input capacity and electrical energy consumption, are shown in Table I.1 and Table I.2. These proposed standards, if adopted, would apply to all NWGFs and MHGFs listed in Table I.1 and Table I.2 manufactured in, or imported into, the United States starting on the date 5 years after the publication of the final rule for this rulemaking. For non-weatherized gas furnaces, DOE has also suggested an alternative certified input capcity threshold of 60 kBtu/h for the proposed standard of 80 percent AFUE, and requests public comment on this alternative. Increasing the small furnace threshold reduces the fuel switching impacts relative to the proposed standard (see Table V.3), and has a significantly lower fraction of consumers who would be negatively impacted (see Table V.41). See Section V.C.1 for more discussion on this alternative.

Table I.1 Proposed AFUE Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 6)

Product Class	Certified Input Capacity (kBtu/h)	Proposed Standard: AFUE (%)
Non-Weatherized Gas Furnaces	≤ 55	80.0
	> 55	92.0
Mobile Home Gas Furnaces	All	92.0

Table I.2 Proposed Standby Mode and Off Mode Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Electrical Energy Consumption (TSL 3)

Product Class	Proposed Standby Mode Standard: $P_{W,SB}$ (watts)	Proposed Off Mode Standard: $P_{W,OFF}$ (watts)
Non-Weatherized Gas Furnaces	8.5	8.5
Mobile Home Gas Furnaces	8.5	8.5

A. Benefits and Costs to Consumers

Table I.3 and Table I.4 present DOE's evaluation of the economic impacts of the proposed AFUE standards and standby mode and off mode standards, respectively, on consumers of NWGFs and MHGFs, as measured by the average life-cycle cost (LCC) savings and the simple payback period (PBP).[3] In both cases, the average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of NWGFs and MHGFs, which is estimated to be 21.5 years (see section IV.F.6).

Table I.3 Impacts of Proposed AFUE Energy Conservation Standards on Consumers of Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 6)

Product Class	Average LCC Savings (2015$)	Simple Payback Period (years)
Non-Weatherized Gas Furnaces	692	6.1
Mobile Home Gas Furnaces	1,049	1.7

Table I.4 Impacts of Proposed Standby Mode and Off Mode Energy Conservation Standards on Consumers of Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 3)

Product Class	Average LCC Savings (2015$)	Simple Payback Period (years)
Non-Weatherized Gas Furnaces	19	7.0
Mobile Home Gas Furnaces	19	6.9

Estimates of the combined impact of the proposed AFUE and standby mode and off mode standards on consumers are shown in Table I.5.

[3] The average LCC savings are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of amended or new standards (see section 0). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (see section 0). The AFUE standard results include the projected fuel switching as described in chapter 8 of the SNOPR TSD.

Table I.5 Combined Impacts of Proposed AFUE and Standby Mode and Off Mode Energy Conservation Standards on Consumers of Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Product Class	Average LCC Savings (2015$)	Simple Payback Period (years)
Non-Weatherized Gas Furnaces	411	7.0
Mobile Home Gas Furnaces	1,050	1.9

DOE's analysis of the impacts of the proposed standards on consumers is described in further detail in section IV.F of this document.

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of industry discounted cash flows from the reference year of the manufacturer impact analysis (MIA) through the end of the analysis period (2016 to 2051). Using a real discount rate of 6.4 percent, DOE estimates that the INPV for manufacturers of NWGFs and MHGFs in the case without amended standards is $1,104.3 million in 2015$. DOE analyzed the impacts of AFUE energy conservation standards and standby mode and off mode energy conservation standards on manufacturers independently. Under the proposed AFUE standards, DOE expects the impacts on INPV to range from -8.0 percent to 3.5 percent, or a change of -$88.0 million to $38.5 million. Under the proposed standby mode and off mode standards, DOE expects impacts on INPV to range from -0.3 percent to 0.5 percent, or a change of -$3.4 million to $5.7 million. Industry conversion costs are expected to total $54.7 million as a result of the proposed standards.

DOE's analysis of the impacts of the proposed standards on manufacturers is described in further detail in section IV.J of this document.

C. National Benefits and Costs[4]

Benefits and costs for the AFUE standards are considered separately from benefits and costs for the standby mode and off mode standards because it was not feasible to develop a single, integrated standard. As discussed in the October 20, 2010 test procedure final rule, DOE concluded that due to the magnitude of the active mode energy consumption as compared to the standby mode and off mode electrical consumption, an integrated metric would not be feasible because the standby and off mode electrical consumption would be a de minimis portion of the overall energy consumption. 75 FR 64621, 64627. Thus, an integrated metric could not be used to effectively regulate the standby mode and off mode energy consumption.

1. AFUE Standards

DOE's analyses indicate that the proposed AFUE energy conservation standards for NWGFs and MHGFs would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated first year of compliance with the amended standards (2022–2051) amount to 2.9 quadrillion British thermal units (Btu), or quads.[5] This represents a savings of 2.3 percent relative to the energy use of

[4] All monetary values in this document are expressed in 2015 dollars and, where appropriate, are discounted to 2016 unless explicitly stated otherwise.

[5] The quantity refers to full-fuel-cycle (FFC) energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (i.e., coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section 0. A quad is equal to 10^{15} Btu.

these products in the case without amended standards (referred to as the "no-new-standards case").

The cumulative net present value (NPV) of total consumer benefits of the proposed AFUE standards for NWGFs and MHGFs ranges from $5.6 billion (at a 7-percent discount rate) to $21.7 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product and installation costs for NWGFs and MHGFs purchased in 2022–2051.

In addition, the proposed AFUE standards for NWGFs and MHGFs are projected to yield significant environmental benefits. DOE estimates that the proposed AFUE standards would result in cumulative emission reductions (over the same period as for energy savings) of 143 million metric tons (Mt)[6] of carbon dioxide (CO_2), 687 thousand tons of nitrogen oxides (NO_X), and 2,777 thousand tons of methane (CH_4).[7] Projected emissions show an increase of 76.8 thousand tons of sulfur dioxide (SO_2), 1.07 thousand tons of nitrous oxide (N_2O), and 0.3 tons of mercury (Hg). The increase is due to projected switching from NWGFs to electric heat pumps and electric furnaces under the proposed standards. Note that the reduction in carbon emissions would be diminished by 18 percent if DOE were to utilize an alternate threshold for small furnaces of less than or equal to 60 kBTU/hr to set its proposed standard of 80 percent AFUE. See Section V.C.1

[6] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.
[7] DOE calculated emissions reductions relative to the no-new-standards case, which includes key assumptions in the Annual Energy Outlook 2015 (AEO 2015) Reference case. AEO 2015 generally represents current legislation and environmental regulations for which implementing regulations were available as of October 31, 2014. At the time when the SNOPR was prepared, AEO 2015 was the most recent available AEO. DOE intends to use AEO 2016 for the final rule.

for more analysis. The cumulative reduction in CO_2 emissions through 2030 amounts to 6.44 Mt, which is equivalent to the emissions resulting from the annual electricity use of 0.88 million homes.

The value of the CO_2 reductions is calculated using a range of values per metric ton (t) of CO_2 (otherwise known as the "Social Cost of Carbon," or SCC) developed by a Federal interagency working group.[8] The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values (see Table I.6), DOE estimates the present monetary value of the CO_2 emissions reduction (not including CO_2 equivalent emissions of other gases with global warming potential) is between $0.8 billion and $12.6 billion, with a value of $4.12 billion using the central SCC case represented by $40.6/t in 2015.

DOE estimates the present monetary value of the NO_X emissions reduction to be $0.2 billion at a 7-percent discount rate and $0.5 billion at a 3-percent discount rate.[9] DOE is still investigating appropriate valuation of changes in methane and other

[8] Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Interagency Working Group on Social Cost of Carbon, United States Government (May 2013; revised July 2015) (Available at https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf).

[9] DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis. See section 0 for further discussion. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. Chamber of Commerce, et al. v. EPA, et al., Order in Pending Case, 577 U.S. ___ (2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011), the values would be nearly two-and-a-half times larger.

emissions, and therefore did not include any such values in the analysis for this SNOPR. However, the available evidence indicates that the value of the reduction in methane emissions from the proposed standards would far outweigh the cost associated with the relatively small increase in SO_2, N_2O, and Hg emissions. Consideration of those values would not affect the standards DOE proposes in this SNOPR.

Table I.6 summarizes the economic benefits and costs expected to result from the proposed AFUE standards for NWGFs and MHGFs.

Table I.6 Summary of Economic Benefits and Costs of Proposed AFUE Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 6) *

Category	Present Value (billion 2015$)	Discount Rate
Benefits		
Consumer Operating Cost Savings	10.1	7%
	30.2	3%
CO_2 Reduction (using mean SCC at 5% discount rate)**	0.8	5%
CO_2 Reduction (using mean SCC at 3% discount rate)**	4.1	3%
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	6.7	2.5%
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	12.6	3%
NO_X Reduction †	0.2	7%
	0.5	3%
Total Benefits‡	14.3	7%
	34.8	3%
Costs		
Consumer Incremental Installed Costs	4.4	7%
	8.5	3%
Total Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value‡	9.9	7%
	26.3	3%

* This table presents the costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051. The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically.
** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5 percent, 3 percent, and 2.5 percent. For example, for 2015 emissions, these values are $12.4/t, $40.6/t, and $63.2/t, in 2015$, respectively. The fourth set ($118/t in 2015$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further

out in the tails of the SCC distribution. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011), the values would be nearly two-and-a-half times larger.
‡ Total Benefits for both the 3 percent and 7 percent cases are presented using only the average SCC with 3-percent discount rate ($40.6/t in 2015).

The benefits and costs of the proposed AFUE standards, for NWGFs and MHGFs sold in 2022−2051, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are: (1) the value of the benefits in reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the value of the benefits of CO_2 and NO_X emission reductions, all annualized.[10]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products. The national operating cost savings are measured for the lifetime of NWGFs and MHGFs shipped in 2022–2051 and include savings that accrue from such products after 2051. The benefits associated with reduced carbon emissions achieved as a result of the proposed standards are also calculated based on the lifetime of NWGFs and MHGFs shipped in 2022-2051. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values for

[10] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (e.g., 2020 or 2030), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates, as shown in Table I.6. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year that yields the same present value.

emissions in future years reflect CO_2-emissions impacts that continue through 2300. In addition, the CO_2 reduction is a benefit that accrues globally. As discussed in section IV.L.1, DOE maintains that consideration of global benefits is appropriate because of the global nature of the climate change problem.

Estimates of annualized benefits and costs of the proposed AFUE standards are shown in Table **I.7**. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that has a value of $40.6/metric ton in 2015),[11] the estimated cost of the NWGFs and MHGFs standards proposed in this rule is $500 million per year in increased equipment costs, while the estimated annual benefits are $1,138 million in reduced equipment operating costs, $243 million in CO_2 reductions, and $18.6 million in reduced NO_X emissions. In this case, the net benefit amounts to $900 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that has a value of $40.6/t in 2015, the estimated cost of the proposed NWGFs and MHGFs AFUE standards is $504 million per year in increased equipment costs, while the estimated annual benefits are $1,785 million in reduced operating costs, $243 million in CO_2 reductions, and $29.3 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,553 million per year.

[11] DOE used a 3-percent discount rate because the SCC values for the series used in the calculation were derived using a 3-percent discount rate (see section 0).

Table I.7 Annualized Benefits and Costs of Proposed AFUE Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 6)*

	Discount Rate	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7%	1,138	1,007	1,353
	3%	1,785	1,548	2,156
CO_2 Reduction (using mean SCC at 5% discount rate)**	5%	69.7	62.2	80.8
CO_2 Reduction (using mean SCC at 3% discount rate)**	3%	243	217	283
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5%	360	320	418
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3%	742	661	862
NO_X Reduction†	7%	18.6	16.8	47.9
	3%	29.3	26.3	76.8
Total Benefits‡	7% plus CO_2 range	1,226 to 1,899	1,086 to 1,684	1,482 to 2,263
	7%	1,400	1,240	1,684
	3% plus CO_2 range	1,884 to 2,557	1,636 to 2,235	2,315 to 3,096
	3%	2,058	1,791	2,517
Costs				
Consumer Incremental Product Costs	7%	500	554	452
	3%	504	559	460
Net Benefits				
Total‡	7% plus CO_2 range	726 to 1,399	531 to 1,130	1,030 to 1,811
	7%	900	686	1,232
	3% plus CO_2 range	1,380 to 2,052	1,077 to 1,676	1,855 to 2,637
	3%	1,553	1,232	2,057

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051.The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental product costs reflect a medium decline rate in the Primary Estimate, a constant price trend in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in section IV.L.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using four different sets of SCC values. The first three use the average SCC calculated using 5 percent, 3 percent, and 2.5 percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2. for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.
‡ Total Benefits for both the 3 percent and 7 percent cases are presented using only the average SCC with 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

2. Standby Mode and Off Mode Standards

For the proposed standby mode and off mode standards, relative to the case without new standards, the lifetime energy savings for NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated first year of compliance with the new standards (2022−2051) amount to 0.28 quads.[12] This represents a savings of 16 percent relative to the energy use of these products in standby mode and off mode in the case without new standards (referred to as the "no-new-standards case").

The cumulative net present value (NPV) of total consumer benefits of the proposed standby mode and off mode standards for NWGFs and MHGFs ranges from \$1.31 billion (at a 7-percent discount rate) to \$3.96 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for NWGFs and MHGFs purchased in 2022−2051.

[12] The quantity refers to full-fuel-cycle (FFC) energy savings.

In addition, the proposed standby mode and off mode standards for NWGFs and MHGFs are projected to yield significant environmental benefits. DOE estimates that the proposed standby mode and off mode standards would result in cumulative emission reductions (over the same period as for energy savings) of 16.3 Mt of CO_2, 9.17 thousand tons of SO_2, 30.0 thousand tons of NO_X, 72.3 thousand tons of CH_4, 0.192 thousand tons of N_2O, and 0.034 tons of Hg. The cumulative reduction in CO_2 emissions through 2030 amounts to 1.23 Mt, which is equivalent to the emissions resulting from the annual electricity use of 0.169 million homes.

Using discount rates appropriate for each set of SCC values (see Table I.6), DOE estimates the present monetary value of the CO_2 emissions reduction (not including CO_2-equivalent emissions of other gases with global warming potential) is between \$0.098 billion and \$1.454 billion, with a value of \$0.477 billion using the central SCC case represented by \$40.6/t in 2015. DOE also estimates the present monetary value of the NO_X emissions reduction to be \$0.02 billion at a 7-percent discount rate and \$0.05 billion at a 3-percent discount rate.

Table I.8 summarizes the economic benefits and costs expected to result from the proposed standby mode and off mode standards for NWGFs and MHGFs.

Table I.8 Summary of Economic Benefits and Costs of Proposed Standby Mode and Off Mode Energy Conservation Standards for NWGFs and MHGFs (TSL 3)*

Category	Present Value (billion 2015$)	Discount Rate
Benefits		
Consumer Operating Cost Savings	1.7	7%
	4.7	3%
CO_2 Reduction (using mean SCC at 5% discount rate)**	0.1	5%
CO_2 Reduction (using mean SCC at 3% discount rate)**	0.5	3%
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	0.8	2.5%
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	1.5	3%
NO_X Reduction †	0.02	7%
	0.05	3%
Total Benefits‡	2.2	7%
	5.2	3%
Costs		
Consumer Incremental Installed Costs	0.4	7%
	0.7	3%
Total Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value‡	1.8	7%
	4.5	3%

* This table presents the costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051. The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically.
** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 5 percent, 3 percent, and 2.5 percent. For example, for 2015 emissions, these values are $12.4/t, $40.6/t, and $63.2/t, in 2015$, respectively. The fourth set ($118/t in 2015$ for 2015 emissions), which represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the "Regulatory Impact Analysis for the Clean Power Plan Final Rule," published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011), the values would be nearly two-and-a-half times larger.
‡ Total Benefits for both the 3 percent and 7 percent cases are presented using only the average SCC with 3-percent discount rate.

The benefits and costs of the proposed standby mode and off mode standards, for NWGFs and MHGFs sold in 2022−2051, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are: (1) the national economic value of the benefits in reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the value of the benefits of CO_2 and NO_X emission reductions, all annualized.[13]

Estimates of annualized benefits and costs of the proposed standby mode and off mode standards are shown in Table I.9. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that has a value of $40.6/metric ton in 2015), the estimated cost of the NWGFs and MHGFs standards proposed in this rule is $40.7 million per year in increased equipment costs, while the estimated annual benefits are $188 million in reduced equipment operating costs, $28.2 million in CO_2 reductions, and $1.79 million in reduced NO_X emissions. In this case, the net benefit amounts to $178 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that has a value of $40.6/metric ton in 2015, the estimated cost of the proposed NWGFs and MHGFs standby mode and off mode standards is $41.4 million per year in increased equipment costs, while the estimated annual benefits are $276 million in reduced operating costs, $28.2 million in CO_2 reductions, and $2.77 million in reduced NO_X emissions. In this case, the net benefit amounts to $265 million per year.

[13] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (e.g., 2020 or 2030), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates, as shown in Table I.8. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

Table I.9 Annualized Benefits and Costs of Proposed Standby Mode and Off Mode Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces (TSL 3)*

	Discount Rate	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7%	188	169	219
	3%	276	246	329
CO_2 Reduction (using mean SCC at 5% discount rate)**	5%	8.2	7.4	9.2
CO_2 Reduction (using mean SCC at 3% discount rate)**	3%	28.2	25.5	31.8
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5%	41.6	37.6	46.9
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3%	86.0	77.8	96.9
NO_X Reduction†	7%	1.8	1.6	4.5
	3%	2.8	2.5	7.1
Total Benefits‡	7% plus CO_2 range	198 to 276	178 to 249	233 to 321
	7%	218	197	255
	3% plus CO_2 range	287 to 365	256 to 326	345 to 433
	3%	307	274	368
Costs				
Consumer Incremental Product Costs	7%	40.7	37.2	45.4
	3%	41.4	37.5	46.5
Net Benefits				
Total‡	7% plus CO_2 range	157 to 235	141 to 212	187 to 275
	7%	178	159	210
	3% plus CO_2 range	245 to 323	218 to 288	298 to 386
	3%	265	236	321

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022-2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022-2051.The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental product costs reflect a constant price trend for each of the estimates. .Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using 4 different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th

percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NOx emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al., 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al., 2011); these are nearly two-and-a-half times larger than those from the ACS study.
†† Total Benefits for both the 3-percent and 7-percent cases are presented using only the average SCC with 3-percent discount rate. In the rows labeled "7 percent plus CO_2 range" and "3 percent plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

3. Combined Results for AFUE Standards and Standby Mode and Off Mode Standards

DOE also added the annualized benefits and costs from the individual annualized tables to provide a combined benefit and cost estimate of the proposed AFUE and standby mode and off mode standards, as shown in Table I.10.[14] The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that has a value of $40.6/metric ton in 2015), the estimated cost of the NWGF and MHGF standards proposed in this rule is $541 million per year in increased equipment costs, while the estimated annual benefits are $1,326 million in reduced equipment operating costs, $272 million in CO_2 reductions, and $20 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,077 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series that has a value of $40.6/metric ton in 2015, the estimated cost of the proposed NWGF and MHGF standards is $546 million per year in increased equipment costs, while the estimated annual benefits are $2,061 million in reduced operating costs, $272 million in CO_2

[14] To obtain the combined results, DOE added the results for the AFUE standards in Table I.**7** with the results for the standby mode and off mode standards in Table I.9.

reductions, and $32 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,819 million per year.

Table I.10 Annualized Benefits and Costs of Proposed AFUE (TSL 6) and Standby Mode and Off Mode (TSL 3) Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces*

	Discount Rate	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7%	1326	1176	1572
	3%	2061	1794	2486
CO_2 Reduction (using mean SCC at 5% discount rate)**	5%	78	70	90
CO_2 Reduction (using mean SCC at 3% discount rate)**	3%	272	242	315
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5%	401	358	465
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3%	828	739	959
NO_X Reduction†	7%	20	18	52
	3%	32	29	84
Total Benefits‡	7% plus CO_2 range	1424 to 2175	1264 to 1933	1715 to 2584
	7%	1618	1437	1939
	3% plus CO_2 range	2171 to 2921	1892 to 2561	2660 to 3529
	3%	2364	2065	2884
Costs				
Consumer Incremental Product Costs	7%	541	592	497
	3%	546	597	506
Net Benefits				
Total‡	7% plus CO_2 range	884 to 1634	673 to 1342	1217 to 2086
	7%	1077	845	1442
	3% plus CO_2 range	1625 to 2375	1295 to 1964	2154 to 3023
	3%	1819	1468	2378

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051. The results account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards,

some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015 Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental product costs for AFUE standards reflect a medium decline rate in the Primary Estimate, a constant price trend in the Low-Net-Benefits Estimate, and a high decline rate in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using four different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1for more details.

† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.

‡ Total Benefits for both the 3-percent and 7-percent cases are presented using only the average SCC with 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

DOE's analysis of the national impacts of the proposed standards is described in further detail in sections IV.H, IV.K, and IV.L of this document.

D. Conclusion

DOE has tentatively concluded that the proposed AFUE standards and standby mode and off mode standards represent the maximum improvement in energy efficiency that DOE has determined is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE further notes that products achieving these standard levels are already commercially available for all product classes covered by this proposal. Based on the analyses described above, DOE has tentatively concluded that the benefits of the proposed standards to the Nation (energy savings, positive NPV of consumer benefits, consumer LCC savings, and emission reductions) would outweigh the burdens (loss of INPV for manufacturers and LCC increases for some consumers).

DOE also considered more-stringent energy efficiency levels as potential standards, and is still considering them in this rulemaking. However, DOE has tentatively concluded that the potential burdens of the more-stringent energy efficiency levels would outweigh the projected benefits. DOE is also seeking comment on an option that considers an alternate capacity size for the small furnace threshold for the 80 percent AFUE standard (See section V.C.1), which reduces the fuel switching impacts relative to the proposed option (see Table V.3), and has a significantly lower fraction of consumers who would be negatively impacted (see Table V.41). Based on consideration of the public comments DOE receives in response to this SNOPR and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this notice that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

The following section briefly discusses the statutory authority underlying this supplemental proposal, as well as some of the relevant historical background related to the establishment of amended and new standards for residential NWGFs and MHGFs.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94-163 (42 U.S.C. 6291-6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as "covered products"). These products includes the residential furnaces that are the subject of this rulemaking. (42 U.S.C. 6292(a)(5)) EPCA, as amended, prescribed energy conservation standards for these products (42 U.S.C. 6295(f)(1) and (2)), and directed DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(f)(4)) Under 42 U.S.C. 6295(m), the agency must periodically review its already established energy conservation standards for a covered product no later than six years from the issuance of any final rule establishing or amending a standard for a covered product.

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product prior to the adoption of a new or amended energy conservation standard. (42 U.S.C. 6295(o)(3)(A) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for residential furnaces appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix N.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including residential furnaces. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and (3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) for certain products, including residential furnaces, if no test procedure has been established for the product, or (2) if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)-(B)) In deciding whether a proposed standard is economically justified after receiving comments on the proposed standard, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination by, to the greatest extent practicable, considering the following seven statutory factors:

1) The economic impact of the standard on manufacturers and consumers of the products subject to the standard;

2) The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the standard;
3) The total projected amount of energy (or as applicable, water) savings likely to result directly from the standard;
4) Any lessening of the utility or the performance of the covered products likely to result from the standard;
5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;
6) The need for national energy and water conservation; and
7) Other factors the Secretary of Energy (Secretary) considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA, as amended, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii))

EPCA, as amended, also contains what is known as an “anti-backsliding” provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of product that has the same function or intended use, if DOE determines that products within such group: (A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether capacity or another performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. Id. Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

Federal energy conservation requirements generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C.

6297(a)–(c)) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions set forth under 42 U.S.C. 6297(d)).

Pursuant to amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110-140, DOE may consider the establishment of regional energy conservation standards for furnaces (except boilers). (42 U.S.C. 6295(o)(6)(B)) Specifically, in addition to a base national standard for a product, DOE may establish for furnaces a single more-restrictive regional standard. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which may be included in regions with which they are not contiguous), and each State may be placed in only one region (i.e., an entire State cannot simultaneously be placed in two regions, nor can it be divided between two regions). (42 U.S.C. 6295(o)(6)(C)) Further, DOE can establish the additional regional standards only: (1) where doing so would produce significant energy savings in comparison to a single national standard; (2) if the regional standards are economically justified; and (3) after considering the impact of these standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D))

Finally, pursuant to the amendments contained in EISA 2007, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B)) DOE's current test procedures for residential furnaces address standby mode and off mode energy use. In this rulemaking, DOE intends to adopt separate energy conservation standards to address standby mode and off mode energy use.

B. Background

1. Current Standards

EPCA established the energy conservation standards that apply to most residential furnaces currently being manufactured. The original standards established a minimum AFUE of 75-percent for mobile home furnaces. For all other furnaces, the original standards generally established a minimum AFUE of 78-percent. However, Congress recognized the potential need for a separate standard based on the capacity of a furnace and directed DOE to undertake a rulemaking to establish a standard for "small" gas furnaces (those having an input of less than 45,000 Btu per hour). (42 U.S.C. 6295(f)(1)-(2)) DOE initially established a standard for small furnaces at the same level as furnaces generally (i.e., a minimum AFUE of 78-percent). (10 CFR 430.32(e)(1)(i); 54 FR 47916 (Nov. 17, 1989))

EPCA also required DOE to conduct two rounds of rulemaking to consider amended standards for residential furnaces (42 U.S.C. 6295(f)(4)(B)-(C)), a requirement subsequently expanded to encompass a six-year look back review of all covered products

(42 U.S.C. 6295(m)(1)). In a final rule published on November 19, 2007 (November 2007 final rule), DOE prescribed amended energy conservation standards for residential furnaces manufactured on or after November 19, 2015. 72 FR 65136. The November 2007 final rule revised the energy conservation standards to 80-percent AFUE for non-weatherized gas furnaces (NWGF), to 81-percent AFUE for weatherized gas furnaces, to 80-percent AFUE for mobile home gas furnaces (MHGF), and to 82-percent AFUE for non-weatherized oil-fired furnaces. Id. at 65169. Based on market assessment and the standard levels at issue, the October 2006 NOPR proposed and the November 2007 final rule established standards without regard to the certified input capacity of a furnace. 71 FR 59204, 59214 (Oct. 6, 2006); 72 FR 65136, 65169 (Nov. 19, 2007). Subsequently, on October 31, 2011, DOE published a notice of effective date and compliance dates (76 FR 67037) to confirm amended energy conservation standards and compliance dates contained in a June 27, 2011 direct final rule (June 2011 DFR; 76 FR 37408) for residential central air conditioners and residential furnaces. These two rulemakings represented the first and the second, respectively, of the two rulemakings required under 42 U.S.C. 6295(f)(4)(B)-(C) to consider amending the standards for residential furnaces.

The June 2011 DFR and October 2011 notice of effective date and compliance dates amended, in relevant part, the energy conservation standards and compliance dates for three product classes of residential furnaces (i.e., NWGFs, MHGFs, and non-weatherized oil furnaces). The existing standards were left in place for three classes of residential furnaces (i.e., weatherized oil-fired furnaces, mobile home oil-fired furnaces, and electric furnaces). For one class of residential furnaces (weatherized gas furnaces), the existing standard was left in place, but the compliance date was amended. Electrical standby mode and off mode energy consumption standards were established for non-weatherized gas and oil-fired furnaces (including mobile home furnaces) and electric furnaces. Compliance with the energy conservation standards promulgated in the June 2011 DFR was to be required on May 1, 2013 for non-weatherized furnaces and on January 1, 2015 for weatherized furnaces. 76 FR 37408, 37547-48 (June 27, 2011); 76 FR 67037, 67051 (Oct. 31, 2011). The amended energy conservation standards and compliance dates in the June 2011 DFR would have superseded those standards and compliance dates promulgated by the November 2007 final rule for NWGFs, MHGFs, and non-weatherized oil furnaces. Similarly, the amended compliance date for weatherized gas furnaces in the June 2011 DFR superseded the compliance date in the November 2007 final rule.

After publication of the October 2011 notice, the American Public Gas Association (APGA) sued DOE[15] in the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit) to invalidate the rule as it pertained to NWGFs (as discussed further in section II.B.2). Petition for Review, American Public Gas Association, et al. v. Department of Energy, et al., No. 11-1485 (D.C. Cir. filed Dec. 23, 2011). The parties to the litigation engaged in settlement negotiations which ultimately led to filing of an unopposed motion on March 11, 2014, seeking to vacate DOE's rule in part and to remand to the agency for further rulemaking. On April 24, 2014, the Court granted the motion and ordered that the standards established for NWGFs and MHGFs be vacated and remanded to DOE for further rulemaking. As a result, only the standards for

[15] After APGA filed its petition for review on December 23, 2011, various entities subsequently intervened.

non-weatherized oil-fired furnaces and weatherized gas furnaces established in the June 2011 DFR went into effect as stated in that final rule. The standards established by the June 2011 DFR for the NWGFs and MHGFs did not go into effect, and thus, compliance with the standards established in the November 2007 final rule for these products was required beginning on November 19, 2015. As stated previously, the standards for weatherized oil-fired furnaces, mobile home oil-fired furnaces, and electric furnaces were unchanged, and as such, the original standards for those product classes remain in effect. The standards for all residential furnaces, including the two product classes being analyzed in this SNOPR, are set forth in DOE's regulations at 10 CFR 430.32(e)(1)(ii). Table II.1 below shows the current standards for product classes that have been previously amended (either by the November 2007 final rule or June 2011 DFR) and the existing standards for the product classes where the AFUE standard has not been amended.

Table II.1 Federal Energy Conservation Standards for Residential Furnaces

Product Class	Minimum Annual Fuel Utilization Efficiency %	Compliance Date
Non-weatherized Gas*	80	11/19/2015
Mobile Home Gas*	80	11/19/2015
Weatherized Gas	81	1/1/2015
Non-weatherized Oil-Fired	83	5/1/2013
Mobile Home Oil-Fired	75	9/1/1990
Weatherized Oil-Fired	78	1/1/1992
Electric	78	1/1/1992

*Only non-weatherized gas and mobile home gas furnaces are being analyzed for this current rulemaking.

2. History of Standards Rulemaking for Residential Furnaces

Given the somewhat complicated interplay of recent DOE rulemakings and statutory provisions related to residential furnaces, DOE provides the following regulatory history as background leading to the present rulemaking. Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (NAECA; Public Law 100-12) established EPCA's original energy conservation standards for furnaces, consisting of the minimum AFUE levels described above for mobile home furnaces and for all other furnaces except "small" gas furnaces. (42 U.S.C. 6295(f)(1)-(2)) Pursuant to 42 U.S.C. 6295(f)(1)(B), in November 1989, DOE adopted a mandatory minimum AFUE level for "small" furnaces. 54 FR 47916 (Nov. 17, 1989). The standards established by NAECA and the November 1989 final rule for "small" gas furnaces are still in effect for mobile home oil-fired furnaces, weatherized oil-fired furnaces, and electric furnaces.

Pursuant to EPCA, DOE was required to conduct two rounds of rulemaking to consider amended energy conservation standards for furnaces. (42 U.S.C. 6295(f)(4)(B) and (C)) In satisfaction of this first round of amended standards rulemaking under 42 U.S.C. 6295(f)(4)(B), as noted above, DOE published a final rule in the Federal Register on November 19, 2007 (the November 2007 Rule) that revised these standards for most furnaces, but left them in place for two product classes (i.e., mobile home oil-fired furnaces and weatherized oil-fired furnaces). The standards amended in the November 2007 Rule were to apply to furnaces manufactured or imported on and after November 19, 2015. 72 FR 65136. The energy conservation standards in the November 2007 final rule consist of a minimum AFUE level for each of the six classes of furnaces. Id. at

65169. As previously noted, based on the market analysis for the November 2007 final rule and the standards established under that rule, the November 2007 final rule eliminated the distinction between furnaces based on their certified input capacity, (i.e., the standards applicable to "small' furnaces were established at the same level and as part of their appropriate class of furnace generally).

Following DOE's adoption of the November 2007 final rule, several parties jointly sued DOE in the United States Court of Appeals for the Second Circuit (Second Circuit) to invalidate the rule. Petition for Review, State of New York, et al. v. Department of Energy, et al., Nos. 08– 0311–ag(L); 08–0312–ag(con) (2d Cir. filed Jan. 17, 2008). The petitioners asserted that the standards for residential furnaces promulgated in the November 2007 final rule did not reflect the ''maximum improvement in energy efficiency'' that ''is technologically feasible and economically justified'' under 42 U.S.C. 6295(o)(2)(A). On April 16, 2009, DOE filed with the Court a motion for voluntary remand that the petitioners did not oppose. The motion did not state that the November 2007 final rule would be vacated, but indicated that DOE would revisit its initial conclusions outlined in the November 2007 Rule in a subsequent rulemaking action. DOE also agreed that the final rule in that subsequent rulemaking action would address both regional standards for furnaces, as well as the effects of alternate standards on natural gas prices. The Second Circuit granted DOE's motion on April 21, 2009. DOE notes that the Second Circuit's order did not vacate the energy conservation standards set forth in the November 2007 final rule, and during the remand, they went into effect as originally scheduled.

As described previously in section II.B, on June 27, 2011, DOE published a direct final rule (June 2011 DFR) revising the energy conservation standards for residential furnaces pursuant to the voluntary remand in State of New York, et al. v. Department of Energy, et al. 76 FR 37408. In the June 2011 DFR, DOE considered the amendment of the same six product classes considered in the November 2007 final rule analysis plus electric furnaces. As discussed in section II.B.1, the June 2011 DFR amended the existing energy conservation standards for NWGFs, MHGFs, and non-weatherized oil furnaces, and amended the compliance date (but left the existing standards in place) for weatherized gas furnaces. The June 2011 DFR also established electrical standby mode and off mode standards for NWGFs, non-weatherized oil furnaces, and electric furnaces. DOE confirmed the standards and compliance dates promulgated in the June 2011 DFR in a notice of effective date and compliance dates published on October 31, 2011. 76 FR 67037.

As noted earlier, following DOE's adoption of the June 2011 DFR, APGA filed a petition for review with the United States Court of Appeals for the District of Columbia Circuit to invalidate the DOE rule as it pertained to NWGFs. Petition for Review, American Public Gas Association, et al. v. Department of Energy, et al., No. 11-1485 (D.C. Cir. filed Dec. 23, 2011). On April 24, 2014, the Court granted a motion that approved a settlement agreement that was reached between DOE, APGA, and the various intervenors in the case, in which DOE agreed to a partial vacatur and remand of the NWGFs and MHGFs portions of the June 2011 DFR in order to conduct further notice-and-comment rulemaking. Accordingly, the Court's order vacated the June 2011 DFR in part (i.e., those portions relating to NWGFs and MHGFs) and remanded to the agency for further rulemaking.

As part of the settlement, DOE agreed to use best efforts to issue a notice of proposed rulemaking within one year of the remand, and to issue a final rule within the later of two years of the issuance of remand, or one year of the issuance of the proposed rule, including at least a ninety-day public comment period. Due to the extensive and recent rulemaking history for residential furnaces, as well as the associated opportunities for notice and comment described above, DOE forwent the typical earlier rulemaking stages (e.g., Framework Document, preliminary analysis) and instead published a NOPR on March 12, 2015 (March 2015 NOPR). 80 FR 13120. DOE concluded that there was a sufficient recent exchange of information between interested parties and DOE regarding the energy conservation standards for residential furnaces such as to allow for this proceeding to move directly to the NOPR stage. Moreover, DOE notes that under 42 U.S.C. 6295(p) and 5 U.S.C. 553(b) and (c), DOE is only required to publish a notice of proposed rulemaking and accept public comments before amending energy conservation standards in a final rule (i.e., DOE is not required to conduct any earlier rulemaking stages).

In the March 2015 NOPR, DOE proposed adopting a national standard of 92-percent AFUE for all NWGFs and MHGFs. 80 FR 13120, 13198 (March 12, 2015). In response, while some stakeholders supported the national 92-percent AFUE standard, others opposed the proposed standards and encouraged DOE to withdraw the March 2015

NOPR. (See section III.F.1 for comments providing specific reasons for opposing or supporting the proposed standards are summarized in that section.)

Multiple parties suggested that DOE should create a separate product class for furnaces based on input capacity and set lower standards for the "small furnaces" product class in order to mitigate some of the negative impacts of the proposed standards. Among other reasons, commenters suggested that such an approach would reduce the number of low-income consumers switching to electric heat due to higher installation costs, because those consumers typically have smaller homes in which a furnace with a lower input capacity would be installed and, therefore, would not be impacted if a condensing standard were adopted only for higher-input-capacity furnaces. (These comments are discussed further in section IV.I.A.) To explore the potential impacts of such an approach, DOE published a notice of data availability (NODA) in the Federal Register on September 14, 2015 (September 2015 NODA). 80 FR 55038. The September 2015 NODA contained analysis that considered thresholds for defining the small furnace product class from 45 kBtu/h to 65 kBtu/h certified input capacity and maintaining a non-condensing 80-percent AFUE standard for that product class, while increasing the standard to a condensing level (i.e., either 90-percent, 92-percent, 95-percent, or 98-percent AFUE) for large furnaces. Id. at 55042. The results indicated that life-cycle cost savings increased and the share of consumers with net costs decreased as a result of an 80-percent AFUE standard for the small furnace product class. Id. at 55042-44. It also showed that national energy savings increased because fewer consumers switched to more energy-intensive electric heat. Id. at 55044.

DOE has initiated this rulemaking in partial fulfillment of the remand in American Public Gas Association, et al. v. Department of Energy, et al. and pursuant to its authority under 42 U.S.C. 42 U.S.C. 6295(f)(4)(C), which requires DOE to conduct a second round of amended standards rulemaking for residential non-weatherized gas furnaces and mobile home gas furnaces. EPCA, as amended by EISA 2007, also requires that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of the determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) To this end, DOE published a NOPR for the subject furnaces on March 12, 2015, and this SNOPR is a continuation of that rulemaking in light of comments and other information received at earlier stages of the process. Once completed, this rulemaking will satisfy both statutory provisions.

Furthermore, EISA 2007 amended EPCA to require that any new or amended energy conservation standard adopted after July 1, 2010, shall address standby mode and off mode energy consumption pursuant to 42 U.S.C. 6295(o). (42 U.S.C. 6295(gg)(3)) If feasible, the statute directs DOE to incorporate standby mode and off mode energy consumption into a single standard with the product's active mode energy use. If a single standard is not feasible, DOE may consider establishing a separate standard to regulate standby mode and off mode energy consumption. Consequently, DOE is considering standby mode and off mode energy use as part of this rulemaking for residential furnaces. In the March 2015 NOPR, DOE proposed a maximum energy use of 8.5 watts in both standby and off mode for NWGF and MHGF. 80 FR 13120, 13198 (March 12, 2015).

The changes in this SNOPR apply only to the active mode AFUE standards, and therefore, the proposed standby mode and off mode standards set forth in the March 2015 NOPR remain part of this SNOPR.

DOE received a number of written comments from interested parties in response to the March 2015 NOPR and September 2015 NODA. DOE considered these comments, as well as comments from the March 2015 NOPR public meeting, in preparing this SNOPR. The commenters are summarized in Table II.2. Relevant comments, and DOE's responses, are provided in the appropriate sections of this notice.[16]

Table II.2 Interested Parties Providing Written Comment on the NOPR and NODA for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Name	Acronyms	Type
A Ware Productions	A Ware	CR
African American Environmentalist Association	AAEA	CR
American Gas Association and American Public Gas Association	AGA and APGA	U
American Gas Association, American Public Gas Association, and Gas Technology Institute	AGA, APGA, and GTI	U
AGL Resources		U
Air Conditioning Contractors of America	ACCA	TA
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	TA
Alliance to Save Energy	ASE	EA
Allied Air		M
American Association of Blacks in Energy	AABE	CR
American Council for an Energy-Efficient Economy	ACEEE	EA
American Council for an Energy-Efficient Economy, Appliance Standards Awareness Project, and Alliance to Save Energy	Joint Advocates	EA
American Energy Alliance	AEA	EA
American Gas Association	AGA	U
American Public Gas Association	APGA	U
American Public Power Association	APPA	U

[16] To the extent interested parties filed requests under the Freedom of Information Act (FOIA) that related to this rulemaking, such requests were addressed through DOE's FOIA process under 10 CFR Part 1004.

Anonymous		I
Appliance Standards Awareness Project	ASAP	EA
Austell Natural Gas System	Austell	U
Borough of Chambersburg, PA	Chambersburg	G
California Energy Commission	CEC	G
Cato Institute		PP
CenterPoint Energy		U
City of Adairsville, Georgia	Adairsville	G
City of Cairo, Georgia	Cairo	G
City of Camilla, Georgia	Camilla	G
City of Cartersville, Georgia	Cartersville	G
City of Commerce, Georgia	Commerce	G
City of Covington, Georgia	Covington	G
City of Dublin Georgia	Dublin	G
City of Lawrenceville, Georgia	Lawrenceville	G
City of Louisville, Georgia	Louisville	G
City of Monroe, Georgia	Monroe	G
City of Moultrie	Moultrie	G
City of Sugar Hill, Georgia	Sugar Hill	G
City of Sylvania, Georgia	Sylvania	G
City of Thomasville, Georgia	Thomasville	G
City of Tifton, Georgia	Tifton	G
City of Toccoa/Toccoa Natural Gas	Toccoa	G/U
Clearwater Gas System	CGS	U
Members of the U.S. Congress*	Joint Congress Members	G
Gregory W. Meeks (Member of Congress)	Meeks	G
Sanford D. Bishop, Jr. (Member of Congress)	Bishop	G
Donald M. Payne, Jr. (Member of Congress)	Payne	G
Consumer Federation of America, National Consumer Law Center, Massachusetts Union of Public Housing Tenants, and Texas Ratepayers' Organization to Save Energy	Joint Consumer Commenters	CR
Contractor Advisors		C
Arthur Corbin	Corbin	I
Jim Darling	Darling	I
DC Jobs or Else	DC Jobs or Else	CR
Earthjustice		EA
Edison Electric Institute	EEI	U
Energy Association of Pennsylvania		U
Environmental Defense Fund, Institute for Policy Integrity at NYU School of Law, Natural Resources Defense Council, and Union of Concerned Scientists	Joint Advocates	EA
Fitzgerald Utilities	Fitzgerald	U
Catherine Fletcher	Fletcher	I

Florida Natural Gas Association	FNGA	U
Gas Technology Institute	GTI	U
Goodman Global, Inc.	Goodman	M
Heating, Air-Conditioning & Refrigeration Distributors International	HARDI	TA
Jennifer Hombach	Hombach	I
Ingersoll Rand	Ingersoll Rand	M
David Johnson	Johnson	I
Johnson Controls, Inc.	JCI	M
Jointly Owned Natural Gas		U
Aaron Kelly	Kelly	I
The Laclede Group, Inc	Laclede	U
Lennox International Inc.	Lennox	M
Liberty Utilities		U
Manufactured Housing Institute	MHI	TA
Mark Nayes	Nayes	I
Mercatus Center at George Mason University	Abdukadirov et al.	I
Metal-Fab		CS
Metropolitan Utilities District, Omaha, NE	Metropolitan Utilities District	U
Don Meyers	Meyers	I
Cameron Moore	Moore	I
Mortex Products, Inc.	Mortex	M
Municipal Gas Authority of Georgia	Gas Authority	U
National Association of Home Builders	NAHB	TA
National Energy & Utility Affordability Coalition	NEUAC	CR
National Multifamily Housing Council, National Apartment Association, National Leased Housing Association	NMHC, NAA, NLHA	TA
National Propane Gas Association	NPGA	U
Natural Gas Association of Georgia	NGA	U
Natural Resources Defense Council	NRDC	EA
New Jersey Natural Gas	NJNG	U
NiSource Inc.	NiSource	U
Nortek Global HVAC	Nortek	M
Northeast Energy Efficiency Partnerships	NEEP	EA
ONE Gas, Inc.	ONE Gas	U
Pacific Gas and Electric Company	PG&E	U
Pennsylvania Chamber of Business and Industry		G
Pennsylvania Department of Environmental Protection		G
Philadelphia Gas Works	PGW	U
Plumbing-Heating-Cooling Contractors	PHCC	C
Prime Energy Partners, LLC	Prime Energy Partners	
Questar Gas Company	Questar Gas	U

Rheem Manufacturing Company	Rheem	M
David Schroeder	Schroeder	I
Terry Small	Small	I
Southern California Gas Company	SoCalGas	U
Southern Company		U
Southern Gas Association	SGA	U
Southside Heating and Air Conditioning		C
State of Indiana	Indiana	G
Kimberly Swanson	Swanson	I
Town of Rockford Alabama	Rockford	G
Ubuntu Center of Chicago	Ubuntu	CR
United Technologies Building and Industrial Systems - Carrier Corporation	Carrier	M
United States Joint Representatives**	Joint Representatives	G
University of Pennsylvania, Kleinman Center for Energy Policy	Kleinman Center	EI
U.S. Chamber of Commerce, the American Chemistry Council, the American Coke and Coal Chemicals Institute, the American Forest & Paper Association, the American Fuel & Petrochemical Manufacturers, the American Petroleum Institute, the Brick Industry Association, the Council of Industrial Boiler Owners, the National Association of Home Builders, the National Association of Manufacturers, the National Mining Association, the National Oilseed Processors Association, and the Portland Cement Association	Associations	TA
Vectren Corporation	Vectren	U
John von Harz	von Harz	I
Washington Gas Light Company	Washington Gas	U
Walter Wood	Wood	I

C: Mechanical Contractor; CS: Component Supplier; CR: Consumer Representative; EA: Efficiency/Environmental Advocate; EI: Educational Institution; G: Government; I: Individual; M: Manufacturer; PP: Public Policy Research Organization; TA: Trade Association; U: Utility or Utility Trade Association.

* Paul D. Tonka, Raúl M. Grijalva, Michael M. Honda, Scott H. Peters, Alan S. Lowenthal, Jerrold Nadler, Sander M. Levin, Chris Van Hollen, Alan S. Lowenthal, Rep.Ted Lieu, Donald S. Beyer, Jr., Louise M. Slaughter, Rep.Lois Capps, and Donna F. Edwards.

** Mo Brooks, Tom Price, Lou Barletta, Bradley Byrne, Glenn ‘GT’ Thompson, Steve Russell, Joe Heck, Gary Palmer, Kevin Yoder, Jim Bridenstine, Scott Tipton, Robert Pittenger, Chuck Fleischmann , Robert Aderholt, Mimi Walters, Barry Loudermilk, Gregg Harper, Mark Walker, Brian Babin, Candice S. Miller, Chris Stewart, Mike D. Rogers, Jim Renacci, Bob Gibbs, Dave Brat, Jeff Miller, Phil Roe, David Schweikert, Tom Marino, David B. McKinley, Scott DesJarlais, Marc Veasey, Ralph Abraham, Matt Salmon, David Rouzer, Richard Hudson, Cresent Hardy, Buddy Carter, Mike Pompeo, Martha Roby, Glenn Grothman, Tom Emmer, Paul Gosar, Ted S. Yoho, Rick Allen, Dan Benishek, David Young, Randy Weber, Mark Meadows, Kay Granger, Blake Farenthold, Bill Flores, Kevin Cramer, Daniel Webster, Tim Huelskamp, Markwayne Mullin, Chris Collins, Jason Smith, Steve Womack, Diane Black, Keith Rothfus, Sean P. Duffy, Renee Ellmers, Alex X. Mooney, Jim Costa, Brad Wenstrup, Sam Graves, Charles W. Boustany, Jr., Andy Barr, Mike Bost, Doug Collins, Jody Hice, Mike Kelly, Jim Jordan, Lynn Jenkins, Andy Harris, Billy Long, Bill Johnson, Rob Woodall, David W. Jolly, Rodney Davis, Joe Barton, Gus M. Bilirakis, Pete Olson, Randy Forbes, Ed Whitfield, Ken Calvert, John Duncan, Henry Cuellar, Steve King, John Shimkus, Jeb Hensarling, Pete Sessions, Vicky Hartzler, Adrian Smith, Louie Gohmert, Marsha Blackburn, Sam Johnson, Tom McClintock, Walter Jones, Patrick T. McHenry, Steve Chabot, Doug Lamborn, Frank D. Lucas, Sanford D. Bishop, Jr., Lamar Smith, Austin Scott, Mick Mulvaney, Steve Pearce, Brett Guthrie, Trent Franks, Blaine Luetkemeyer, Tom

Graves, Mike Coffman, Robert E. Latta, F. James Sensenbrenner, Jr., Stephen Fincher, Tom Cole, Lynn Westmoreland, John Ratcliffe, and John Moolenaar.

III. General Discussion

DOE issued this supplemental proposal after considering oral and written comments, data, and information from interested parties that represent a variety of interests. DOE considered all comments received in response to both the March 2015 NOPR and the September 2015 NODA when developing this SNOPR, but acknowledges that in light of this modified proposal some comments received to date may no longer apply. The following discussion addresses issues raised by commenters in response to both notices on the listed topics.

A. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or by other performance-related feature that justify a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors such as the utility of the feature to the consumer and other factors DOE deems appropriate. (42 U.S.C. 6295(q))

DOE agreed to the partial vacatur and remand of the June 2011 DFR, specifically as it related to energy conservation standards for NWGFs and MHGFs in the settlement agreement to resolve the litigation in *American Public Gas Ass'n v. U.S. Dept. of Energy*

(No. 11-1485, D.C. Cir. Filed Dec 23, 2011). 80 FR 13120, 13130-32 (March 12, 2015). These two product classes were evaluated in the March 2015 NOPR. In today's SNOPR, DOE is proposing to further divide NWGFs into two product classes based on capacity. For a detailed discussion of this proposal and the comments on product classes received in response to the March 2015 NOPR and September 2015 NODA, please see Section IV.A.1.

B. Test Procedure

DOE's current energy conservation standards for residential furnaces are expressed in terms of AFUE for fossil fuel consumption (see 10 CFR 430.32(e)(1)). AFUE is an annualized fuel efficiency metric that fully accounts for fuel consumption in active, standby, and off modes. The existing DOE test procedure for determining the AFUE of residential furnaces is located at 10 CFR part 430, subpart B, appendix N. The current DOE test procedure for residential furnaces was originally established by a May 12, 1997 final rule, which incorporates by reference the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)/American National Standards Institute (ANSI) Standard 103-1993, Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers (1993). 62 FR 26140, 26157.

On October 20, 2010, DOE updated its test procedures for residential furnaces in a final rule published in the Federal Register (October 2010 test procedure rule). 75 FR 64621. This rule amended DOE's test procedure for residential furnaces and boilers to establish a method for measuring the electrical energy use in standby mode and off mode for gas-fired, oil-fired, and electric furnaces pursuant to requirements established by

EISA 2007. These test procedure amendments were primarily based on and incorporate by reference provisions of the International Electrotechnical Commission (IEC) Standard 62301 (First Edition), ''Household electrical appliances—Measurement of standby power." On December 31, 2012, DOE published a final rule in the Federal Register which updated the incorporation by reference of the standby mode and off mode test procedure provisions to refer to the latest edition of IEC Standard 62301 (Second Edition). 77 FR 76831.

On July 10, 2013, DOE published a final rule in the Federal Register (July 2013 final rule) that modified the existing testing procedures for residential furnaces and boilers. 78 FR 41265. The modification addressed the omission of equations needed to calculate AFUE for two-stage and modulating condensing furnaces and boilers that are tested using an optional procedure provided by section 9.10 of ASHRAE 103-1993 (incorporated by reference into DOE's test procedure), which allows the test engineer to omit the heat-up and cool-down tests if certain conditions are met. Specifically, the DOE test procedure allows condensing boilers and furnaces to omit the heat-up and cool-down tests provided that the units have no measurable airflow through the combustion chamber and heat exchanger during the burner off period and have post-purge period(s) of less than 5 seconds. For two-stage and modulating condensing furnaces and boilers, ASHRAE 103-1993 (and by extension the DOE test procedure) does not contain the necessary equations to calculate the heating seasonal efficiency (which contributes to the ultimate calculation of AFUE) when the option in section 9.10 is selected. The July 2013 final rule adopted two new equations needed to account for the use of section 9.10 for two-stage and modulating condensing furnaces and boilers. Id.

On March 11, 2015, DOE published a notice of proposed rulemaking for its test procedure for residential furnaces and boilers in the Federal Register (March 2015 Test Procedure NOPR). 80 FR 12876. In the March 2015 Test Procedure NOPR, DOE proposed a range of changes to the test procedure including incorporating by reference ANSI/ASHRAE 103-2007 in place of ANSI/ASHRAE 103-1993. After publication of the March 2015 Test Procedure NOPR, DOE granted a request from AHRI to reopen the comment period for an additional 45 days, so as to allow further time to conduct product testing and to review supporting information. 80 FR 31324 (June 2, 2015). In response to the March 2015 Test Procedure NOPR, several commenters raised concerns that some proposed test provisions would affect efficiency ratings. DOE published a final rule for the residential furnaces and boilers test procedure in the Federal Register on January 15, 2016 (January 2016 test procedure final rule). 81 FR 2628. In that final rule, DOE did not adopt those provisions for which commenters expressed concern regarding impacts on efficiency ratings, including a decision to withdraw its proposal to incorporate by reference ANSI/ASHRAE 103-2007. Id. at 2628-30. The final revisions included:

- Clarification of the electrical power term "PE";
- Adoption of a smoke stick test for determining use of minimum default draft factors;
- Allowance for the measurement of condensate under steady-state conditions;
- Reference to manufacturer's installation and operation manual and clarifications for when that manual does not specify test set-up;
- Specification of ductwork requirements for units that are installed without a return duct; and

- Revision of the requirements regarding AFUE reporting precision.

Id. at 2628.

DOE determined that none of the adopted test procedure amendments would alter the projected measured energy efficiency or energy use of residential furnaces. 81 FR 2628-2641 (Jan. 15, 2016). Commenters also raised issues regarding the timing of the test procedure rulemaking vis-à-vis the standards rulemaking. In response to the March 2015 NOPR, AHRI asserted that the timing of the test procedure rulemaking and proposed standards rulemaking was contrary to both EPCA and DOE's own regulation on process. AHRI added that it is unfair to propose a standard that will be enforced by DOE and FTC in terms of labeling requirements, but that will be measured by some undetermined test procedure. AHRI further stated that it is only after DOE has considered and resolved all comments on the test procedure that the required analysis of the impact on the related standard can be actually determined. (AHRI, No. 0159 at pp. 9-10) Several stakeholders stated that the test procedure must be finalized before issuing a NOPR for efficiency standards, which DOE did not do for residential furnaces. (AGA, No. 0118 at p. 6; Vectren, No. 0111 at p. 7; Goodman, No. 0135 at p. 10; Laclede, No. 0141 at p. 35, JCI, No. 0148 at pp. 3-4; ACCA, No. 0158-1 at pp. 4-5; APGA, No. 0106 at pp. 8-9) AGA and HARDI stated that stakeholders cannot properly assess the proposed standards without knowing the impact of the final test procedure on AFUE. (AGA, No. 0118 at pp. 43-44; HARDI, No. 0131 at p. 2)

In response to the March 2015 NOPR and the September 2015 NODA, several stakeholders expressed concern about the potential change in furnace efficiency due to the provisions of the proposed furnace and boiler test procedure and the resulting impact on the standards rulemaking analyses. (Laclede, No. 0141 at p. 35; JCI, No. 0148 at pp. 3-4; Ingersoll Rand, No. 0156 at p. 7; Ingersoll Rand, No. 0182 at p. 2) Ingersoll Rand also suggested that the amended test procedure proposed in the March 2015 Test Procedure NOPR would have an impact on the measured efficiency of furnaces. Ingersoll Rand suggested that on average, two-stage/modulating condensing furnaces would see a drop of 0.7-percent AFUE, and two-stage/modulating non-condensing furnaces would see an increase of 0.4-percent AFUE under the proposed test procedure, and that the efficiency levels analyzed in the engineering analysis should be adjusted based on these changes in ratings. (Ingersoll Rand, No. 0182 at p. 2) AGA urged DOE to issue an SNOPR and re-open the comment period after the test procedure is finalized to implement appropriate adjustments regarding the test procedure. (AGA, No. 0118 at pp. 43-44)

In response, DOE finalized its amendments to the residential furnace and boiler test procedure on January 15, 2016, which means that the test procedure amendments have been completed as of the issuance of the modified proposal contained in this SNOPR. Furthermore, in the January 2016 test procedure final rule, DOE addressed the comments regarding the timing of that test procedure final rule and the standards rulemaking process, stating that appendix A to 10 CFR part 430, subpart C, establishes procedures, interpretations, and policies to guide DOE in the consideration and promulgation of new or revised appliance efficiency standards under EPCA. (See section 1 of 10 CFR part 430, subpart C, appendix A) Those procedures are a general guide to the steps DOE typically follows in promulgating energy conservation standards, but the guidance recognizes that DOE can and will, on occasion, deviate from the typical process. (See 10 CFR part 430, subpart C, appendix A, section 14(a)) Accordingly, DOE concluded that there was no basis to either: (1) delay the final rules adopting standards for residential furnaces and boilers; or (2) suspend the test procedure rulemaking until the standards rulemaking has been completed. 81 FR 2628, 2631 (Jan. 15, 2016). With regards to the effect of test procedure changes on measured efficiency and accounting for such changes in the standards rulemaking analyses, DOE again notes that its final rule did not adopt those specific provisions about which commenters on the test procedure rulemaking expressed concern for these impacts. As DOE concluded in the January 2016 test procedure final rule, the amendments to the test procedure adopted in that final rule will not alter the measured energy efficiency or energy use of the covered products that are subject to the test procedures. Id. at 2642. Therefore, no further action is necessary in this standards rulemaking in order to accommodate the test procedure amendments. This SNOPR is consistent with the guidance provided in the Process Rule, section 7(c) of 10 CFR part 430, subpart C, appendix A, because it was issued subsequent to the finalization of the relevant test procedure.

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i).

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)-(iv). Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this notice discusses the results of the screening analysis for NWGFs and MHGFs, particularly the designs DOE considered, those it screened out, and those that are the basis for the potential standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the SNOPR technical support document (TSD).

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for NWGFs and MHGFs, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C.1.b of this SNOPR and in chapter 5 of the SNOPR TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (TSL), DOE projected energy savings from application of the TSL to NWGFs and MHGFs purchased in the 30-year period that begins in the expected first year of compliance with the proposed standards (2022–2051).[17] The savings are measured over the entire lifetime of NWGFs and MHGFs purchased in the above 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis (NIA) spreadsheet model to estimate national energy savings (NES) from potential amended standards for NWGFs and MHGFs. The NIA spreadsheet model (described in section IV.H of this SNOPR) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national

[17] Each TSL is composed of specific efficiency levels for each product class. The TSLs considered for this SNOPR are described in section 0. DOE conducted a sensitivity analysis that considers impacts for products shipped in a 9-year period.

energy impacts on an annual basis in terms of primary (source) energy, which is the energy that is used to generate and transmit the site electricity. To calculate the primary energy impacts, DOE derives annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) most recent Annual Energy Outlook (AEO).[18] DOE also calculates NES in terms of full-fuel-cycle (FFC) energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (i.e., coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy conservation standards.[19] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this notice. For natural gas, the primary energy savings are considered to be equal to the site energy savings.

2. Significance of Savings

To adopt any new or amended standards for a covered product, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term "significant" is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit, in Natural Resources Defense Council v. Herrington, 768 F.2d 1355, 1373 (D.C. Cir. 1985), opined that Congress intended "significant" energy savings in the context of EPCA to be savings that are not "genuinely trivial." The energy savings for all of the TSLs considered in this rulemaking, including

[18] At the time when the SNOPR was prepared, AEO 2015 was the most recent available AEO. DOE intends to use AEO 2016 for the final rule.
[19] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012).

the proposed standards (presented in section V.B.3.a), are nontrivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

E. Economic Justification

1. Specific Criteria

As noted above, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(I)-(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of a potential amended standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) industry net present value (INPV), which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and payback period (PBP) associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the consumer costs and benefits expected to result from particular standards. DOE also evaluates the impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a standard.

b. Savings in Operating Costs Compared to Increase in Price (LCC and PBP)

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section III.D, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing product classes and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards proposed in this document would not reduce the utility or performance of the products under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this supplemental proposed rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. DOE will publish and respond to the Attorney General's determination in the final rule. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See **ADDRESSES** section for information to send comments to DOJ.

f. Need for National Energy Conservation

DOE also considers the need for national energy conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the proposed standards are likely to provide improvements to the security and reliability of the nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The proposed standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (GHGs) associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K; the emissions impacts are reported in section V.B.6 of this notice. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described above, DOE could potentially consider such information under “other factors.”

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first full year’s energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE’s LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE’s evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.9.d of this document.

F. Other Issues

1. Economic Justification of the March 2015 NOPR Proposed Standards

a. General

The March 2015 NOPR elicited a large number of public comments which represented a range of views regarding DOE's proposed standards for NWGFs and MHGFs and the economic justification and other impacts thereof. Comments on the general reasons for opposing or supporting the proposed standards are summarized and summarily addressed here. Comments related to DOE's NOPR analysis, and how DOE addressed them in its subsequent analyses, are presented in section IV.

Several stakeholders stated that there was no economic justification for a national condensing standard for NWGFs. (AGA, No. 0036 at p. 3; AGL Resources, No. 0039 at p. 1; APGA, No. 0106 at p. 12; AGL Resources, No. 0112 at pp. 1-, 2; Carrier, No. 0116 at pp. 3-4; AGA, No. 0118 at pp. 3-5; Lennox, No. 0125 at p. 15; NPGA, No. 0130 at p. 8; SoCalGas, No. 0132 at p. 5; Goodman, No. 0135 at p. 2; Nortek, No. 0137 at p. 2; Laclede, No. 0141 at p. 58; Rheem, No. 0142 at p. 2; JCI, No. 0148 at p. 9; AHRI, No. 0181 at p. 1; Metal-Fab, No. 0192 at p. 2; Municipal Gas Authority of Georgia, No. 0086 at p. 3; Natural Gas Association of Georgia, No. 0110 at p. 1) Stakeholders also expressed concern that the proposed standard would harm rather than benefit consumers. (AGA, No. 0040 at pp. 2-3; AGA, No. 0118 at pp. 2-3; Joint Representatives, No. 0067 at p. 1; NAHB, No. 0124 at p. 5; Southern Gas Association, No. 0145 at p. 1; Energy Association of Pennsylvania, No. 0146 at p. 1; NiSource, No. 0127 at pp. 8-9) Many stakeholders stated that the proposed standard would result in a net cost for many consumers, particularly those living in the south and low-income consumers (see section

III.F.1.b), and would cause an unacceptable amount of switching from NWGFs to electric heating products (see section III.F.1.c).

Many other stakeholders opposed the proposed 92-percent AFUE national standards for NWGFs and encouraged DOE to withdraw the NOPR. (Moore, No. 0033 at p. 1; Wood, No. 0068 at p. 1; Dublin, No. 0071 at p. 1; CenterPoint Energy, No. 0083 at p. 5; NGA, No. 0110 at p. 1; PGW, No. 0122 at p. 1; NiSource, No. 0127 at p. 10; Nortek, No. 0137 at p. 2; Meeks, No. 0140 at p. 2; Laclede, No. 0141 at p. 7; Rockford, No. 0070 at p. 1; Chambersburg, No. 0084 at p. 1; Dublin, No. 0071 at p. 1; Sylvania, No. 0085 at p. 1; Louisville, No. 0087 at p. 1; Monroe, No. 0088 at p. 1; Cairo, No. 0089 at p. 1; Jointly Owned Natural Gas, No. 0090 at p. 1; Adairsville, No. 0091 at p. 1; Camilla, No. 0092 at p. 1; Sugar Hill, No. 0093 at p. 1; Covington, No. 0096 at p. 1; Austell, No. 0097 at p. 1; Fitzgerald, No. 0100 at p. 1; Cartersville, No. 0101 at p. 1; Commerce, No. 0103 at p. 1; Thomasville, No. 0104 at p. 1; Toccoa, No. 0105 at p. 1; Tifton, No. 0114 at p. 1; Moultrie; No. 0121 at p. 1; SGA, No. 0145 at p. 2; Gas Authority, No. 0086 at pp. 7-8; Laclede, No. 0178 at pp. 3-4; Rheem, No. 0184 at p. 2; Johnson, No. 0190 at p. 1; AABE, No. 0197 at p. 1; Rheem, No. 0199 at p. 2; APGA, No. 0106 at pp. 1, 50; AGA, No. 0118 at p. 45; SoCalGas, No. 0132-1 at p. 2)

On the other hand, the Joint Congress Members, PG&E, CEC, the Joint Consumer Commenters, ACEEE, ASE, NRDC, NEEP, and Fletcher supported the standards proposed in the NOPR. (Joint Consumer Commenters, No. 0123 at p. 1; PG&E, No. 0153 at pp. 1-2; CEC, No. 0120 at p. 4; Joint Congress Members, No. 0161 at pp. 1-3; ACEEE, No. 0113 at p. 1; ASE, No. 0115 at p. 1; NRDC, No. 0134 at p. 2; NEEP, No.

0150 at p. 2; Fletcher, No. 0064 at p. 1) The Joint Consumer Commenters stated that the performance standards in the proposed rule is are well designed in that it addresses clear market imperfections which lead to market failure; is technology neutral, product neutral, and pro-competitive; is technologically feasible; and offers adequate lead time. (Joint Consumer Commenters, No. 0123 at pp. 27-28) The Joint Congress Members stated that because furnaces are one of the longest-lived products in a home, it is important to set an aggressive standard to ensure that consumers will benefit from maximum energy savings over the lifetime of this investment. NEEP and the Joint Congress Members stated that many States have been actively pursuing and advocating for condensing furnace standards but are preempted by Federal standards. (Joint Congress Members, No. 0161 at pp. 1-3; NEEP, No. 0150 at pp. 1-2) The CEC stated that DOE's current standards for furnaces have formed a significant barrier to California being able to achieve its climate goals for new and existing buildings. The CEC stated that any further delay in adopting more stringent Federal furnace standards threatens to set California back in its efforts to double energy efficiency in existing buildings by 2030 and to achieve zero net energy in newly constructed residential buildings by 2020. (CEC, No. 0120 at p. 3)

ACEEE, ASE, NRDC, PG&E, and Kelly suggested that DOE should establish a 95-percent AFUE national standard for NWGFs. (ACEEE, No. 0113 at p. 4; ASE, No.0115 at p. 1; NRDC, No. 0134 at p. 3; PG&E, No. 0153 at pp. 2-3; Kelly, No. 0038 at p. 1) Prime Energy Partners and CGS stated that DOE's analysis presents a clear case for a standard for NWGFs at 98-percent AFUE as the maximum improvement in energy efficiency that is technologically feasible and economically justified. (Prime Energy Partners, No. 0143 at p. 2; CGS, No. 0098 at p. 5)

b. Consumer Impacts from the Proposed Standards

AGA stated that DOE should not find that a standard is economically justified when such a significant share of consumers would be worse off under the proposed rule. (AGA, No. 0036 at p. 3; AGA, No. 0118 at p. 5) AGA, Ingersoll Rand, and Laclede stated that the majority of consumers impacted by the rule would see a net cost under a condensing standard. (AGA, No. 0118 at pp. 16, 26; Ingersoll Rand, No. 0156 at p. 2;) JCI and Laclede expressed concern about the number of consumers that would be negatively impacted by a condensing furnace standard. (JCI, No. 0202 at p. 2; Laclede, No. 0141 at p. 6) AGA, CGS, PCCBI, NGA, and SoCalGas stated that the proposed rule would unnecessarily burden millions of residents. (AGA, No. 0036 at pp. 2-3; CGS, No. 0098 at p. 1; PCCBI, No. 0082 at p. 1; NGA, No. 0110 at p. 1; SoCalGas, No. 0132-2 at p. 1) AHRI stated that if the proposed standards are finalized, virtually all affected consumers would experience a net cost. (AHRI, No. 0159 at pp. 57-58) AHRI added that purchasers who do not currently buy condensing furnaces predominantly have poor economic returns or face difficult installations. (AHRI, No. 0159 at pp. 69-70) Metal-Fab stated that due to the higher initial cost of condensing gas furnaces and low natural gas prices, installing a condensing gas furnace does not make economic sense for the majority of U.S. consumers. (Metal-Fab, No. 0192 at p. 1)

A number of stakeholders stated that according to DOE’s own analysis for the NOPR, 20 percent of households nationwide would see a net life-cycle cost increase. (AGA, No. 0036 at p. 3; Corbin, No. 0066 at p. 1; Lawrenceville, No. 0074 at p. 1; Mercatus Center, No. 0079 at p. 4; Pennsylvania Chamber of Business and Industry, No. 0082 at p. 1; CenterPoint Energy, No. 0083 at p. 32; Indiana, No. 0094 at p. 1; Vectren, No. 0111 at pp. 2, 5; Goodman, No. 0135 at p. 2; Metropolitan Utilities District, No. 0144 at pp. 1-2; Energy Association of Pennsylvania, No. 0146 at p. 1; ONE Gas, No. 0102 at p. 2) NAHB argued that 20 percent of consumers with net cost is unacceptable, but that such figure would be much higher after incorporating the changes in product cost, energy use, and discount rates that NAHB believes to be more appropriate. NAHB stated that regulations that negatively impact a large portion of the population would result in consumers being priced out of the market for a new home and living in older, less-efficient homes with less-efficient equipment, which is contrary to the purpose of the rule. (NAHB, No. 0124 at p. 5) AGA, ONE Gas, and Vectren also stated that according to DOE's analysis, in the replacement market, fully one-quarter of all households would see a net cost increase. (AGA, No. 0118 at p. 5; ONE Gas, No. 0102 at p. 2; Vectren, No. 0111 at pp. 2, 5) The report by GTI submitted by SoCalGas stated that DOE’s analysis shows that more Southern California consumers would suffer a net cost than would experience a net benefit under the proposed standard. (SoCalGas, No. 0132-7 at p. v)

On the other hand, the Joint Consumer Commenters stated that in the case of a NWGF standard at 92-percent AFUE or higher, the winners exceed the losers by a wide margin. (The Joint Consumer Commenters considered those who break even financially and enjoy other indirect benefits of the standard as winners.) The Joint Consumer Commenters stated that the economic analysis also shows that the winners gain more per household, on average, than the losers lose. (Joint Consumer Commenters, No. 0123 at pp. 9-11)

Many stakeholders expressed concern that consumers in the South may be disproportionately impacted by the proposed NWGF standard. (Contractor Advisors, No. 0061 at p. 1; Corbin, No. 0066 at p. 1; U.S. Joint Representatives, No. 0067 at p. 1; Lawrenceville, No. 0074 at p. 1; PGW, No. 0122 at p. 3; Liberty Utilities, No. 0109 at p. 1; NPGA, No. 0130 at p. 5; Anonymous, No. 0060 at p. 1; AEA, No. 0069 at p. 1; Meyers, No. 0072 at p. 1; JCI, No. 0202 at p. 2; Vectren, No. 0111 at pp. 2, 5; CenterPoint Energy, No. 0083 at p. 3; Rheem, No. 0142 at pp. 1-2; MUD, No. 0144 at p. 1) APGA, AGA, and NAHB stated that the proposed NWGF standard is too burdensome on consumers in the South to be economically justified. (APGA, No. 0034 at p. 6; AGA, No. 0036 at p. 3; AGA, No. 0118 at pp. 27-28; NAHB, No. 0124 at p. 5) Several stakeholders stated that according to DOE’s analysis, 31 percent of overall consumers in the South and 39% of low-income consumers in the South would experience a net life-cycle cost increase. (AGA, No. 0036 at p. 3; Corbin, No. 0066 at p. 1; Lawrenceville, No. 0074 at p. 1; Mercatus Center, No. 0079 at p. 4; PCCBI, No. 0082 at p. 1; CenterPoint Energy, No. 0083 at p. 3; Indiana, No. 0094 at p. 1; Vectren, No. 0111 at pp. 2, 5; MHI, No. 0129 at p. 2; Goodman, No. 0135 at p. 2; Nortek, No. 0137 at p. 4; SGA, No. 0145 at p. 1) Many contractors who responded to PHCC and ACCA's survey commented that in some Southern areas, the payback from a condensing furnace is unacceptable to the customer. (PHCC, No. 0136 at p. 12; ACCA, No. 0158-2 at p. 12) Metal-Fab stated that based on current natural gas prices, for consumers in the South, the LCC is higher for a condensing furnace than a non-condensing furnace. (Metal-Fab, No. 0192 at p. 1)

Many stakeholders expressed concern that low-income consumers may be disproportionately impacted by the proposed standards. (Contractor Advisors, No. 0061 at p. 1; Corbin, No. 0066 at p. 1; U.S. Joint Representatives, No. 0067 at p. 1; Lawrenceville, No. 0074 at p. 1; PGW, No. 0122 at p. 3; Liberty Utilities, No. 0109 at p. 1; NPGA, No. 0130 at pp. 3-4; Anonymous, No. 0060 at p. 1; AEA, No. 0069 at p. 1; Meyers, No. 0072 at p. 1; JCI, No. 0202 at p. 24; Vectren, No. 0111 at pp. 2, 5; CenterPoint Energy, No. 0083 at p. 3; Rheem, No. 0142 at pp. 1-2; AGA, No. 0036 at p. 3; Lawrenceville, No. 0074 at p. 1; Mercatus Center, No. 0079 at p. 4; PCCBI, No. 0082 at p. 1; CenterPoint Energy, No. 0083 at p. 3; Indiana, No. 0094 at p. 1; Vectren, No. 0111 at pp. 2, 5; AGL Resources, No. 0112 at p. 8; Goodman, No. 0135 at p. 2; MUD, No. 0144 at p. 2; Nortek, No. 0137 at p. 4; SGA, No. 0145 at p. 1; Energy Association of Pennsylvania, No. 0146 at p. 12; ONE Gas, No. 0102 at p. 2; MUD, No. 0144 at p. 41) Many stakeholders stated that the proposed rule would hurt the very people who can least afford additional costs. (Corbin, No. 0066 at p. 1; Rockford, No. 0070 at p. 1; Chambersburg, No. 0084 at p. 1; Sylvania, No. 0085 at p. 1; Louisville, No. 0087 at p. 1; Monroe, No. 0088 at p. 1; Cairo, No. 0089 at p. 1; Jointly Owned Natural Gas, No. 0090 at p. 1; Adairsville, No. 0091 at p. 1; Camilla, No. 0092 at p. 1; Sugar Hill, No. 0093 at p. 1; Covington, No. 0096 at p. 1; Austell, No. 0097 at p. 1; Fitzgerald, No. 0100 at p. 1; Cartersville, No. 0101 at p. 1; Commerce, No. 0103 at p. 1; Thomasville, No. 0104 at p. 1; Toccoa, No. 0105 at p. 1; Tifton, No. 0114 at p. 1; Moultrie; No. 0121 at p. 1; Carrier, No. 0116 at p. 37) APGA and, AGA, and NAHB stated that the proposed NWGF standard is too burdensome on low-income consumers to be economically justified.

(APGA, No. 0034 at p. 6; AGA, No. 0036 at p. 3; AGA, No. 0118 at pp. 27-28; NAHB, No. 0124 at p. 5)

AGA, the U.S. Joint Representatives, CenterPoint Energy, Energy Association of Pennsylvania, SoCalGas, NiSource, CA, Indiana, and A Ware stated that a condensing standard would place an undue burden on low-income consumers, especially in the South, who will be faced with the difficult choice of having to replace their non-condensing furnace with either a condensing furnace with higher installation costs or an electric space heating appliance with higher monthly energy bills. (AGA, No. 0036 at p. 3; U.S. Joint Representatives, No. 0067 at p. 1; CenterPoint Energy, No. 0083 at p. 3; Energy Association of Pennsylvania, No. 0146 at pp. 1-2; SoCalGas, No. 0132-2 at p. 4; SoCalGas, No. 0132-6 at p. 8; NiSource, No. 0127 at pp. 8-9; Contractor Advisors, No. 0061 at p. 1; Indiana, No. 0094 at p. 1; A Ware, No. 0204 at p. 1) Vectren stated that a large percentage of its customers, who fall within Federal poverty guidelines, would be negatively impacted by the proposed furnace rule. (Vectren, No. 0111 at p. 5)

AGL Resources, SoCalGas, and Nortek stated that the rule would disproportionally affect low- and fixed-income consumers. AGL Resources and SoCalGas stated that because low- and fixed-income homeowners typically live in smaller spaces that require less energy to heat, the reduced fuel costs from a 92-percent AFUE furnace would never be enough to offset the total installed cost of a condensing furnace. AGL Resources stated that the overwhelming majority of low- and fixed-income homeowners would receive neutral or negative paybacks when they install a new condensing furnace. (AGL Resources, No. 0039 at p. 4; AGL Resources, No. 0112 at p.

8; SoCalGas, No. 0132-2 at p. 3; SoCalGas, No. 0132-6 at p. 8; Nortek, No. 0137 at pp. 3-4)

AABE, Payne, Bishop, Meeks, and Nortek stated that many low-income homeowners have less access to capital, and consequently, they do not have the equity or cash savings to afford the significant upfront costs of a condensing NWGF. Payne and Bishop stated that while it is true that low-income consumers would save money in the long run by switching to a condensing furnace, many low-income families do not have the financial flexibility to make decisions based on life-cycle-costs. (AABE, No. 0155 at p. 1; AABE, No. 0197 at p. 1; Payne, No. 0075 at p. 1; Bishop, No. 0076 at p. 12; Meeks, No. 0140 at p. 1; Nortek, No. 0137 at pp. 3-4) MHI stated that low-income homeowners have limited access to credit to finance a new furnace, creating additional hardships. (MHI, No. 0129 at p. 2) AABE stated that because over 50 percent of low-income gas households are owner-occupied, it is important that the rulemaking process acknowledge the social, financial, and economic implications on low-income communities of retrofitting gas furnaces. (AABE, No. 0155 at p. 1; AABE, No. 0197 at p. 1)

On the other hand, the Joint Congress Members, CEC, the Joint Consumer Commenters, PG&E, NEEP, and ASAP stated that furnace efficiency standards are beneficial for low-income consumers because heating bills represent such a large portion of their monthly bills and income. (Joint Congress Members, No. 0161 at p. 23; Joint Consumer Commenters, No. 0123 at p. 13; PG&E, No. 0153 at pp. 11-12; NEEP, No. 0150 at p. CEC, No. 120 at p. 5; ASAP, No. 0154 at p. 6) NEEP stated that roughly 75 percent of low-income consumers would receive net benefits from the proposed standards. (NEEP, No. 0150 at p. 3)

Many stakeholders are concerned that landlords would avoid the high costs of installing a condensing natural gas furnace by installing a system less expensive to install but more expensive to operate, with the operating costs being left in the hands of the tenant. (A Ware, No. 0045 at p. 1; PGW, No. 0003-1 at p. 3; PWG, No. 0003-2 at pp. 4-6; AAEA, No. 0056 at p. 2; Ubuntu, No. 0057 at p. 1; DC Jobs or Else, No. 0059 at p. 1; Corbin, No. 0066 at p. 1; Lawrenceville, No. 0074 at p. 1; Payne, No. 0075 at p. 1; Bishop, No. 0076 at p. 1; Gas Authority, No. 0086 at p. 6; Vectren, No. 0111 at p. 6; NiSource, No. 0127 at p. 5; AGL Resources, No. 0112 at p. 8; AGL Resources, No. 0039 at p. 5; SoCalGas, No. 0132-2 at pp. 3-4; SoCalGas, No. 0132-6 at p. 8; Ubuntu, No. 0191 at p. 1; A Ware, No. 0204 at p. 1) NMHC, NAA, and NLHA stated that for properties that replace gas furnaces with electric furnaces, there would likely be an increase in operating cost for consumers. (NMHC, NAA, and NLHA, No. 0117 at p. 4)

NMHC, NAA, and NLHA stated that unplanned retrofits would likely require property owners to raise their rents. (NMHC, NAA, and NLHA, No. 0117 at p. 1) NEUAC, AGL Resources, SoCalGas, and MUD stated that landlords often pass along infrastructure costs to their tenants in higher rents. (NEUAC, No. 0095 at pp. 1-2; AGL Resources, No. 0039 at pp. 5, 8; SoCalGas, No. 0132-2 at pp. 3-4; SoCalGas, No. 0132-6 at p. 8; MUD, No. 0144 at p. 2) NAHB stated that increases in energy efficiency will not be free to renters, because if landlords cannot get an adequate return on their investment, they will leave the market, thereby decreasing supply and increasing rents. (NAHB, No.

0050 at pp. 24-25) However, PG&E stated that replacement of equipment is part of normal repair and maintenance of a property and is built into the landlord's cost structure, so rents do not necessarily increase because a furnace is replaced. (PG&E, No. 0153 at pp. 11-12)

Several stakeholders pointed to positive impacts of the proposed standards on low-income renters. The Joint Congress Members, Joint Consumer Commenters, PG&E, NEEP, and CEC, and ASAP stated that many low-income consumers are renters who are responsible for monthly energy bills, but do not choose their heating equipment. They stated that a strong national energy efficiency standard would address the split incentive situation, protecting these consumers from having to pay higher bills to heat their homes. (Joint Congress Members, No. 0161 at p. 23; Joint Consumer Commenters, No. 0123 at pp. 26-27; PG&E, No. 0153 at pp. 11-12; NEEP, No. 0150 at p. 3; CEC, No. 0120 at pp. 5-6; ASAP, No. 0154-1 at p. 6) ACEEE stated that the majority of low-income households are renters, so in many cases, the capital costs will be borne by the owners. ACEEE stated that because DOE's analysis implicitly assumes that the full cost of furnace efficiency improvements are passed on in rent increases, the LCC analysis underestimates the LCC savings for such low-income consumers. (ACEEE, No. 0113 at p. 8) PG&E stated that utility subsidies are given to low-income customers, who are predominantly renters, to cover gas and electricity consumption. PG&E stated that a condensing furnace would reduce the gas consumption of low-income consumers, thereby allowing the subsidy to cover a large portion of the heating season gas costs. (PG&E, No. 0153 at p. 12)

c. Product Switching Due to the Proposed Standards

Many stakeholders expressed concern that the proposed standards would cause product switching from gas furnaces to less-efficient heating alternatives, which are less expensive to install but more costly to operate, because consumers would not be able to afford the initial purchase and installation cost of a condensing furnace, the installation of a condensing furnace may be impossible, or consumers would not realize sufficient savings. (Contractor Advisors, No. 0061 at p. 1; Corbin, No. 0066 at p. 1; U.S. Joint Representatives, No. 0067 at p. 1; Lawrenceville, No. 0074 at p. 1; PGW, No. 0122 at p. 3; Liberty Utilities, No. 0109 at p. 1; Goodman, No. 0135 at p. 1; Laclede, No. 0141 at pp. 3, 6; Anonymous, No. 0060 at p. 1; AEA, No. 0069 at p. 1; Meyers, No. 0072 at p. 1; Chambersburg, No. 0084 at p. 1; Gas Authority, No. 0086 at pp. 4-5; NPGA, No. 0130 at pp. 4-5; PCCBI, No. 0082 at p. 1; Carrier, No. 0116 at p. 10; Nortek, No. 0137 at pp. 2-3; NGA, No. 0110 at p. 1; SoCalGas, No. 0132-2 at pp. 2-3; SoCalGas, No. 0132-6 at p. 9; SoCalGas, No. 0132-7 at p. 2; NMHC, NAA, and NLHA, No. 0117 at p. 4; Washington Gas, No. 0133 at p. 2; NiSource, No. 0127 at pp. 4-5; Ingersoll Rand, No. 0203 at p. 2) Specifically, many stakeholders expressed concern that due to physical limitations, building code issues, or prohibitively high costs, the venting and condensate withdrawal requirements of condensing furnaces would be impossible or impractical to accommodate in some buildings, such as rowhouses, older buildings, and multi-family housing, and could force consumers to switch to alternative space heating systems. (PGW, No. 0003-2 at p. 3; Kleinman Center, No. 0053 at p. 1; AAEA, No. 0056 at pp. 1-2; Corbin, No. 0066 at p. 1; Lawrenceville, No. 0074 at p. 1; Pennsylvania Department of Environmental Protection, No. 0099 at p. 1; AGL Resources, No. 0112 at pp. 11-12; NMHC, NAA, and

NLHA, No. 0117 at pp. 2, 3; NiSource, No. 0127 at p. 5; Washington Gas, No. 0133 at p. 2; Rheem, No. 0142 at p. 8; MHI, No. 0129 at p. 1)

APGA stated that the high levels of fuel switching reported in the NOPR render the proposed standard unacceptable. (APGA, No. 0034 at p. 5) The U.S. Joint Representatives, Lawrenceville, Nortek, and AAEA are concerned that product switching caused by the proposed rule would financially burden consumers and ultimately undermine the efficiency goals that underlie the Energy Policy and Conservation Act. (U.S. Joint Representatives, No. 0067 at p. 1; Lawrenceville, No. 0074 at p. 1; Nortek, No. 0137 at pp. 2-3-4; AAEA, No. 0056 at pp. 1-2) ONE Gas, NiSource, Vectren, Dublin, Gas Authority, and Lawrenceville stated that an efficiency standard that encourages consumers to switch from natural gas to electricity would not improve overall efficiency and would be bad economic and environmental policy. (ONE Gas, No. 0102 at p. 2; NiSource, No. 0127 at p. 6; Vectren, No. 0111 at p. 2; Dublin, No. 0071 at p. 1; Gas Authority, No. 0086 at pp. 6-7; Lawrenceville, No. 0074 at p. 1) JCI stated that given the life of furnaces, the lost energy savings, increased emissions, and costs for consumers become a significant number over a 20-year lifetime for each household that switches fuel. (JCI, No. 0148 at p. 7)

Many stakeholders expressed concern that low-income and/or senior-only households would be unable to afford the higher up-front costs for a condensing furnace and would switch to alternative space heating products that are cheaper to install but have higher operating costs. (AGA, No. 0036 at p. 3; U.S. Joint Representatives, No. 0067 at p. 1; CenterPoint Energy, No. 0083 at p. 3; Energy Association of Pennsylvania, No.

0146 at pp. 1-2; SoCalGas, No. 0132-2 at p. 4; SoCalGas, No. 0132-6 at p. 8; A Ware, No. 0045 at p. 1; AAEA, No. 0056 at p. 1; Ubuntu, No. 0057 at p. 1; DC Jobs or Else, No. 0059 at p. 1; Contractor Advisors, No. 0061 at p. 1; Rockford, No. 0070 at p. 1; Dublin, No. 0071 at p. 1; Chambersburg, No. 0084 at p. 1; Sylvania, No. 0085 at p. 1; Louisville, No. 0087 at p. 1; Monroe, No. 0088 at p. 1; Cairo, No. 0089 at p. 1; Jointly Owned Natural Gas, No. 0090 at p. 1; Adairsville, No. 0091 at p. 1; Sugar Hill, No. 0093 at p. 1; Camilla, No. 0092 at p. 1; Covington, No. 0096 at p. 1; Austell, No. 0097 at p. 1; Fitzgerald, No. 0100 at p. 1; Cartersville, No. 0101 at p. 1; Commerce, No. 0103 at p. 1; Thomasville, No. 0104 at p. 1; Toccoa, No. 0105 at p. 1; NGA, No. 0110 at p. 1; Tifton, No. 0114 at p. 1; Moultrie,; No. 0121 at p. 1; A Ware, No. 02054 at p. 1; Payne, No. 0075 at p. 1; Bishop, No. 0076 at p. 1; Meeks, No. 0140 at p. 1; NJNG, No. 0119 AT P. 2; Pennsylvania Department of Environmental Protection, No. 0099 at p. 1; PGW, No. 0003-1 at p. 3; PGW, No. 0003-2 at pp. 2-6; PGW, No. 0122 at p. 2; Gas Authority, No. 0086 at pp. 5-6; NGA, No. 0110 at p. 1; DC Jobs or Else, No. 0059 at p. 1; Pennsylvania Department of Environmental Protection, No. 0099 at p. 1) NPGA stated that consumers in the South and low-income consumers would be more likely to switch fuels based on the high total installed cost of a condensing furnace combined with their less frequent reliance on heating appliances. (NPGA, No. 0171 at pp. 1-2) NPGA also stated that consumers who switch from a propane furnace to another product would have less incentive to maintain a propane storage tank to supply appliances that utilize a smaller amount of fuel, thus encouraging switching to all electric appliances (e.g., water heater or stove). (NPGA, No. 0130 at p. 5; NPGA, No. 0171 at pp. 1-2; NPGA, No. 0200 at pp. 2-3) Gas Authority stated that consumers would likely fuel switch to avoid the high cost of a condensing furnace, especially given the generous incentives for installing heat pumps offered by electric utilities. (Gas Authority, No. 0086 at pp. 6-7)

CenterPoint Energy stated that fuel switching from natural gas to electric space heating would create a net cost for consumers and increase energy use. (CenterPoint Energy, No. 0083 at pp. 2-3) Questar Gas stated that because condensing furnaces are not economically justified in the new single-family home market, especially in areas with limited need for heating, home builders may choose electric space heating options that significantly lower FFC energy efficiency and increase operating costs. (Questar Gas, No. 0151 at p. 1)

Many stakeholders stated that the proposed standards would cause switching to electric or oil-fired space heating equipment that would increase harmful emissions. (AGL Resources, No. 0039 at p. 3; DC Jobs or Else, No. 0059 at p. 1; Dublin, No. 0071 at p. 1; AGA, No. 0036 at p. 3; AGA, No. 0118 at pp. 3, 5-6, 29; Rockford, No. 0070 at p. 1; Chambersburg, No. 0084 at p. 1; Sylvania, No. 0085 at p. 1; Louisville, No. 0087 at p. 1; Monroe, No. 0088 at p. 1; Cairo, No. 0089 at p. 1; Jointly Owned Natural Gas, No. 0090 at p. 1; Adairsville, No. 0091 at p. 1; Sugarhill, No. 0093 at p. 1; Camilla, No. 0092 at p. 1; Covington, No. 0096 at p. 1; Austell, No. 0097 at p. 1; Fitzgerald, No. 0100 at p. 1; Cartersville, No. 0101 at p. 1; Commerce, No. 0103 at p. 1; Thomasville, No. 0104 at p. 1; Toccoa, No. 0105 at p. 1; NGA, No. 0110 at p. 1; Tifton, No. 0114 at p. 1; Moultrie; No. 0121 at p. 1; Vectren, No. 0111 at p. 2; PGW, No. 0003-2 at p. 5; CenterPoint Energy, No. 0083 at pp. 2-3; Lawrenceville, No. 0074 at p. 1; NPGA, No. 0130 at p. 6; AGL Resources, No. 0112 at pp. 5-6; Carrier, No. 0116 at p. 10; NMHC, NAA, and

NLHA, No. 0117 at p. 4; Laclede, No. 0141 at p. 6; Questar Gas, No. 0151 at p. 1; AAEA, No. 0056 at pp. 1-2; Questar Gas, No. 0151 at p. 1; Corbin, No. 0066 at p. 1; A Ware, No. 0204 at p. 1; Liberty Utilities, No. 0109 at p. 1) Laclede stated that emissions benefits are likely not to materialize due to fuel switching to electric space heaters and water heaters. (Laclede, No. 0141 at p. 23) In contrast, EEI stated that due to flaws in the product switching analysis, the emissions impacts of increased use of electricity for home heating are overestimated. (EEI, No. 0179 at p. 4)

The Joint Congress Members stated that while product switching may occur in a small number of situations, such as new construction in the South where air conditioning is a higher priority than heating, it is unrealistic for other parts of the country or for existing residences because the cost of fuel switching would likely be much greater for installation and operation than the incremental costs of installing a condensing furnace. The Joint Congress Members stated that the most likely alternative choice, a heat pump, is not as cost-competitive or as effective as a gas furnace for most housing in regions with sustained cold weather. (Joint Congress Members, No. 0161 at p. 3)

d. Summary Response to Comments on the Economic Justification of the March 2015 NOPR Proposed Standards for Non-weatherized Gas Furnaces

The Department appreciates the stakeholder comments with regard to the proposed standards for NWGFs. As discussed in section II.B.2, a number of parties suggested that DOE should create a separate product class for NWGFs based on certified input capacity and set lower standards for that product class in order to mitigate some of the negative impacts of the proposed standards, and in particular, the impact of fuel switching. The September 2015 NODA evaluated the impacts of adopting separate standards for product classes based on certified input capacity. Subsequent refinement of that analysis, along with comments on the September 2015 NODA, formed the basis for selecting the standards proposed in this document. The results of the SNOPR analysis, and the reasons why DOE has tentatively determined that the currently-proposed standards are economically justified, are presented in section V of this document.

DOE believes that the standards for NWGFs proposed in this SNOPR address many of the concerns raised in the March 2015 NOPR comments described in sections III.F.1.a through III.F.1.c. Because replacement of a non-condensing NWGF with a condensing NWGF would not be necessary in many of the buildings where their installation poses challenges or would entail considerable cost, the currently-proposed standards significantly reduce the number of consumers expected to experience negative impacts or to switch to electric heating, compared with a standard at 92-percent AFUE for all NWGFs.

e. Economic Justification of the March 2015 NOPR Proposed Standards for Mobile Home Gas Furnaces

AHRI and JCI expressed concern that MHGF consumers would be negatively affected or would switch fuels for heating if an amended minimum efficiency standard of 92-percent were adopted. (AHRI, No. 0195 at p. 1; JCI, No. 0202 at pp. 2-4) MHI and Mortex commented that the proposed rule would be particularly burdensome to many of the 22 million Americans residing in mobile homes, which primarily house low- and moderate-income families. (MHI, No. 0129 at p. 2; Mortex, No. 0157 at pp. 2-3) MHI and Nortek commented that mobile home buyers are particularly sensitive to price increases because of their limited incomes and limited access to credit. (MHI, No. 0129 at p. 2; Nortek, No. 0137 at pp. 4-5)

The results presented in section V.B.1 indicate that under the proposed standard of 92-percent AFUE for MHGFs, 63 percent of MHGF consumers would see a net benefit, and only 8 percent would see a net cost. DOE believes that there would be minimal switching away from MHGFs for several reasons. First, for new mobile homes, the type of heating equipment is determined more by the intended location of the home, the expected heating load, and availability of a gas supply. For replacement applications, switching away from gas is not likely because the cost increase for installing a condensing furnace relative to a non-condensing furnace is not a significant factor due to the much simpler venting system compared to installation of a NWGF.

MHI and Nortek stated that the proposed energy conservation standards for manufactured housing developed by DOE's Appliance Standards Rulemaking Advisory Committee (ASRAC) Working Group on Manufactured Housing will likely increase the cost a new single-section mobile home by an average of $1,734. MHI and Nortek stated that adding an additional cost for a condensing furnace and an upgraded furnace fan could mean that more than one million households would be unable to afford an average-priced single-section mobile home. (MHI, No. 0129 at p. 2; Nortek, No. 0137 at pp. 4-5)

In response, DOE notes that the expected average cost of a condensing furnace in a new mobile home is comparable to a non-condensing furnace because the increase in the price of the product is offset by a lower installation cost for a condensing furnace for most installations.[20] New furnaces installed in mobile homes must be approved by the U.S. Department of Housing and Urban Development, which requires special sealed combustion (direct vent) for all non-condensing and condensing installations of manufactured home furnaces. (24 CFR 3280.709(d)(1)) For condensing installations, the PVC piping is usually less expensive than the metal vent system used for non-condensing furnaces. Thus, there is not likely to be any effect on the affordability of single-section mobile homes due to the proposed MHGF standard.

2. Safety Concerns Regarding the Proposed Standards

Several stakeholders raised potential safety concerns related to condensing furnace installations. CenterPoint Energy and NMHC, NAA, and NLHA stated that in the case of replacement with a condensing furnace, changes in the volume of gas being vented due to orphaning the water heater would affect the draw of the venting system, and could result in toxic combustion gases being drawn back into the building.[21] NMHC, NAA, and NLHA stated that it is foreseeable that local building inspectors would have concerns about the adequacies of the draw of a vent when it is carrying a reduced volume of gases. (CenterPoint Energy, No. 0083 at p. 23; NMHC, NAA, and NLHA, No. 0117 at pp. 3-4) MUD stated that many contractors fail to inform consumers that an orphaned

[20] The standard for MHGF furnace fans requires technology (improved PSC motor) that entails a slight price increase ($11) in 2013$ compared to the baseline PSC motor (see furnace fan energy conservation standards final rule; available at: https://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0011-0117). This cost is applicable to less than 50 percent of installations because the rest of the market is already comprised of MHGFs with improved PSC motors or motors with higher efficiencies.

[21] The venting systems for commonly vented non-condensing NWGFs and gas water heaters that are atmospherically vented rely on a certain volume of air to operate properly. When a water heater is orphaned, the volume of air being vented is reduced.

water heater may require resizing existing vent stacks or installing chimney liners, resulting in the vent stacks of consumers who elect not to make those changes eventually being degraded. (MUD, No. 0144 at p. 2)

As discussed in section IV.F.2, DOE's analysis accounts for resizing existing vent stacks or installing chimney liners in the case of an orphaned water heater. DOE has concluded that the National Fuel Gas Code (NFGC) provides adequate guidance for installers regarding vent sizing to ensure that the venting system is safe when a condensing furnace is installed.[22] DOE notes that AHRI has previously stated that from 2000 to 2010, there were about 7.5 million replacement installations of condensing NWGFs, some of which must have resulted in orphaned gas water heaters. (Docket No. EERE-2011-BT-STD-0011, AHRI, No. 0046 at p. 4) However, there is no evidence from the field over that time that consumers incurred a higher safety risk because they chose to not address the water heater's venting system when the new condensing furnace was installed.

The Pennsylvania Department of Environmental Protection, Carrier, PGW, Gas Authority, Nayes, and AGL Resources stated that due to the difficulty and expense of installing a condensing furnace, many homeowners will probably choose to repair rather than replace their failing furnace, or they might turn to an unlicensed contractor, thereby jeopardizing safety by not following the minimum fuel gas code requirements.

[22] National Fire Protection Association and American Gas Association. National Fuel Gas Code. 2015. (Last accessed April 20, 2016.) available at: www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=54.

(Pennsylvania Department of Environmental Protection, No. 0099 at p. 2; Carrier, No. 0116 at pp. 8, 20; PGW, No. 0122 at p. 3; Gas Authority, No. 0086 at pp. 4-5; Nayes, No. 0055 at p. 1; AGL Resources, No. 0112 at p. 7) PGW stated that repairing existing products long after the point when they should be replaced has serious potential safety ramifications related to gas leaks for consumers, neighbors, and utility employees. (PGW, No. 0003-2 at pp. 5-6) AGL Resources, PGW, and MUD stated that trying to extend the life of a worn-out product is dangerous, and can lead to fires or carbon monoxide (CO) poisoning. (AGL Resources, No. 0112 at pp. 6-7; PGW, No. 0122 at p. 3; MUD, No. 0144 at p. 2)

In response, DOE has tentatively concluded that the vast majority of furnace consumers will make efforts to ensure that furnace repairs are done properly, despite certain commenters' speculation to the contrary. DOE notes that establishing a minimum efficiency standard that requires a condensing design does not alter the existing situation regarding the fraction of consumers who do not repair faulty equipment. Regarding extended repair of a furnace, DOE notes that AHRI previously stated that establishing a minimum condensing standard for NWGFs would not alter the situation regarding consumers who do not repair faulty equipment or who perform unsafe home repairs. AHRI also stated that service technicians must alert the consumer when they determine that the appliance is unsafe, and utility service technicians are obligated to turn off the gas to an unsafe appliance. (Docket No. EERE-2011-BT-STD-0011, AHRI, No. 0046 at pp. 4-5) Thus, consumers' own safety incentives and these additional safeguards would be expected to ensure proper furnace operation, maintenance, and repair.

Rheem believes that the conversion of a non-condensing furnace to a condensing furnace has significant safety implications that may not be addressed in a no-heat emergency. (Rheem, No. 0142 at pp. 1-2; Rheem, No. 0184 at pp. 1, 2-3; Rheem, No. 0199 at pp. 1, 2-3) Carrier stated that in some cases, it is impossible to install a condensing furnace due to physical constraints, and forcing homeowners into these situations could lead to dangerous complications arising from life-threatening no-heat situations. (Carrier, No. 0116 at pp. 8, 20)

In response, DOE has tentatively concluded that the provisions of the NFGC and manufacturers provide adequate guidance for installers to ensure that the condensing furnace is installed safely, and the vast majority of contractors understand that they are liable for safety problems. DOE's analysis accounts for situations where extreme difficulties in installing a condensing furnace could lead to significant installation costs or switching to electric furnaces or heat pumps to maintain adequate indoor space heating.

PGW, AGL Resources, NiSource, and Carrier stated that many consumers, particularly low-income consumers, may choose to rely on electric space heaters or other supplemental heating sources, which puts them at increased risk of fire, especially with older electric space heaters. (PGW, No. 0122 at p. 3; AGL Resources, No. 0112 at p. 7; NiSource, No. 0127 at pp. 8-9; Carrier, No. 0116 at pp. 8, 20) Jointly Owned Natural Gas and Adairsville areis concerned that consumers may choose an inferior source of heat that may not be intended or safe for homes. (Jointly Owned Natural Gas, No. 0090 at p. 1; Adairsville, No. 0091 at p. 1)

DOE believes that it is speculative to assume that the currently-proposed standards would lead to greater use of unsafe electric space heaters or other supplemental heating sources. Unsafe use of electric space heaters may occur with or without the proposed standards. There is no evidence to indicate that the proposed standards would lead to switching of this kind.

AGL Resources stated that because DOE is effectively forcing homeowners to install heat tape in a large percentage of U.S. homes, it can be assumed that the number of heat tape-related fires, injuries, and deaths will increase proportionally. AGL Resources stated that according to data published by the National Fire Protection Association in 2013, on average, heat tape causes 350 fires per year, leads to around seven injuries per year, accounts for $9.4 million in property damage per year, and causes about two deaths per year. (AGL Resources, No. 0112 at pp. 6-7)

DOE notes that like other appliances, heat tape requires proper installation, maintenance, and replacement to operate safely. In addition, DOE believes that once condensing furnace become more common, contractors will become better trained and more aware of potential issues, thereby reducing the impacts of heat tape or using other options that protect the condensate pipe from exposure to freezing environments.

3. Standby Mode and Off Mode Standards

DOE received comments on the standby mode and off mode standards proposed for NWGFs and MHGFS in the NOPR. In response to the March 2015 NOPR, APPA and EEI commented on DOE’s proposed standby mode and off mode standards. The commenters stated that DOE should select TSL 1 for the standby mode and off mode standards because of the low PBP, LCC, and percentage of consumers experiencing net cost compared to the other TSLs. (APPA, No. 0149 at p. 1; EEI, No. 0160 at pp. 14-15) In response, DOE notes that only a small percentage of consumers experience a net cost under the proposed standby mode and off mode standards, and the national benefits and emission reductions are significantly greater for TSL 3 than TSL 1. Therefore, DOE continues to propose TSL 3 as the standard level for standby mode and off mode.

For NWGFs (including MHGFs), for which this notice proposes new standby mode and off mode standards (see section V.C.2), DOE is proposing to revise the regulatory text governing certification reports in 10 CFR 429.18. The proposed revisions would specify that on and after the compliance dates for the standby mode and off mode standards, reporting of these values would be required.

In this SNOPR, DOE is also proposing to clarify the regulations governing the certification and reporting requirements for non-weatherized oil furnaces (including mobile home oil furnaces) and electric furnaces. For non-weatherized oil furnaces (including mobile home oil furnaces) and electric furnaces, compliance with standby mode and off mode energy conservation standards was required starting May 1, 2013. (10 CFR 430.32(e)(1)(iii)) Each manufacturer, before distributing in commerce any basic model of a covered product subject to an applicable energy conservation standard set forth in parts 430 must submit a certification report to DOE certifying that each basic model meets the applicable energy conservation standard(s). (10 CFR 429.12(a)) Certification reports for these product classes on or after May 1, 2013 must include standby mode and off mode electrical power consumption in order to certify compliance with those standards. DOE proposes to clarify in its certification regulations at 10 CFR 429.18(b)(2)(i) that certification reports for non-weatherized oil furnaces (including mobile home oil furnaces) and electric furnaces must include representative values for standby mode and off mode electrical power consumption.

Additionally, DOE proposes to specify rounding requirements in 10 CFR 429.18(a)(2)(vii) for the representative value of standby mode and off mode electrical power consumption. Specifically, DOE proposes that these values be rounded up to the next tenth of one watt.

4. Rulemaking Process

CenterPoint Energy, NiSource, Meeks, and Laclede urged DOE to work with all stakeholders to develop a natural gas furnace standard that will address stakeholder concerns and will reduce energy use without incentivizing fuel switching. (CenterPoint Energy, No. 0083 at p. 5; NiSource, No. 0127 at p. 10; Meeks, No. 0140 at p. 2; Laclede, No. 0141 at pp. 7-8) AABE argued that DOE should suspend the current rulemaking and start with a new proposal that includes all stakeholders, including those most harmed by the proposal, such as African-American, minority, and low-income communities, and acknowledges the social, financial, and economic implications on low-income families when retrofitting natural gas furnaces. AABE is concerned about the lack of transparency and engagement of all stakeholders in earlier proceedings. (AABE, No. 0197 at pp. 1-2)

In response, DOE conducts all appliance standards rulemakings through the public notice-and-comment process, in which all members of the public are given the opportunity to comment on the rulemaking. DOE provided a longer than normal comment period on the March 2015 NOPR, and it subsequently extended the comment period on both the March 2015 NOPR and the September 2015 NODA at stakeholder request. As part of this rulemaking, DOE also hosted a number of public meetings, including one focused on its analytical models, in order to increase the transparency of its process. In addition, all documents are publicly available at www.regulations.gov. In sum, all proceedings involved in this rulemaking have been open to all members of the interested public.

APGA objected that DOE declined to respond to the joint request from AGA and APGA submitted on September 15, 2015 (before the initial October 14, 2015 deadline to submit comments) for DOE to extend the September 2015 NODA comment period. (AGA, No. 0194 at p. 2; APGA, No. 0193 at p. 2) AGA inquired why a response to their request for more data in response to the NODA or a notice of extension of the NODA comment period was delayed beyond the initial October 14, 2015 comment period close date. AGA noted that multiple stakeholders in favor of DOE's analytical position did not submit comments by the October 14, 2015 date, and inquired if anyone at DOE communicated to these stakeholders that there would be a comment period extension. (AGA, No. 0205 at pp. 1-2) In its comments, Laclede shares the concerns raised by AGA regarding the extension of the comment period that seems designed to provide a substantial advantage to those who support a separate product class for small furnaces. (Laclede, No. 0198 at p. 3)

In response, DOE carefully considered and ultimately granted the request contained in AGA and APGA's September 15, 2015 letter to re-open and extend the comment period, as well as to answer a number of technical questions. (AGA and APGA, No. 0168 at p. 1) On October 15, 2015, DOE published both a document responding to technical questions and a notice re-opening and extending the comment period. In a subsequent October 22, 2015 letter, APGA asserted that certain parties participating in the rulemaking did not submit comments by the original deadline "because they were aware that DOE would be re-opening the comment period." (APGA, No. 0193 at p. 4) DOE cannot speak to the decision-making of other parties participating in the rulemaking. But, as a matter of general practice and policy, DOE does not disclose its deliberative process, including whether a request to re-open a comment period will be granted, and DOE is not aware of any deviation from that policy with respect to the re-opening and extension of the comment period here. DOE is committed to a fair and open rulemaking process, so any characterization of DOE's actions as intended to "tilt the playing field" is simply not correct.

AHRI encouraged DOE to consider other ways to promote energy conservation and the use of efficient products because there will be regions where condensing furnaces will never be economically attractive or practical. AHRI stated that energy use can be reduced through changing consumer behavior and other factors, which would more likely reduce heating fuel consumption at lower cost and with fewer negative impacts than an efficiency standard. (AHRI, No. 0159 at pp. 69-70) The Mercatus Center and Laclede stated that DOE did not consider the alternatives to regulation. (Mercatus Center, No. 0079 at p. 2; Laclede, No. 0141 at p. 20)

Contrary to these commenters' views, DOE did evaluate non-regulatory alternatives to energy conservation standards, as described in chapter 17 of the NOPR TSD and the SNOPR TSD. However, DOE determined that none of the non-regulatory alternatives would save as much energy as the proposed standards. Furthermore, DOE does not have discretion under the statute to substitute energy conservation standards that are economically justified with other policies.

Laclede stated that because average consumers do not use an LCC analysis, DOE should use simple paybacks instead of LCC savings. Laclede stated that the "rebuttable presumption" of a 3-year simple payback is a much more reasonable criterion to use for the general public. (Laclede, No. 0141 at p. 18) DOE's use of LCC analysis is responsive to the EPCA mandate to consider the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, initial charges for, or maintenance expenses of the covered products which are likely to result from the imposition of a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II))

5. Compliance Date

AGA, Vectren, and APGA stated that section 325(f)(4) of EPCA provides a schedule with 10 years between the compliance dates of the first and second required furnace rulemakings. Compliance with DOE's first furnace standard amendment rulemaking was required in 2015. Those commenters stated that the compliance date for the second rulemaking should therefore be 2025. AGA stated that section 325(f)(4)(C) prescribes that DOE undertake a rulemaking between 1997 and 2006 (which it did not do), and that the period from the publication of the final rule to the compliance date was to be from 5 to 15 years. AGA stated that EPCA does not require that the compliance date be set 5 years from the final rule, and a separate provision of EPCA supports adoption of a 2025 compliance date. Laclede supported AGA and APGA's comments on a compliance date of 2025. (AGA, No. 0118 at pp. 42-43; Vectren, No. 0111 at p. 6; APGA, No. 0106 at pp. 9-11; Laclede, No. 0141 at p. 38)

As noted in the March 2015 NOPR, EPCA typically provides for compliance lead time, i.e., the time between publication of amended energy conservation standards for a covered product and the date by which manufacturers must comply with the amended energy conservation standards for such product. 80 FR 13120, 13136 (March 12, 2015). When EPCA was enacted to include furnaces as a covered product, those dates were specified. (See e.g., 42 U.S.C. 6295(f)(4)(B) and (C)). Specifically, EPCA provided a 1994 compliance date for a final rule due in 1992, a 2002 compliance date for a final rule due in 1994, and a 2012 compliance date for a final rule due between 1997 and 2007. By including these dates in the statute, Congress indicated a 2-year period between the rulemaking publication date and compliance date for the first round of amended residential furnace standards, an 8-year lead time for the second round of rulemaking, and a minimum of 5 years for the last round of amended residential furnace standards. Id. Even in situations where statutory deadlines have passed before a rulemaking could be fully completed, DOE has generally maintained these timeframes as a reflection of a congressional choice. However, Congress has also chosen to require DOE to re-examine existing standards and, if appropriate, to update those standards following specific time frames for both completion and compliance. See 42 U.S.C. 6295(m)(4). DOE also recognizes that there is a difference between compliance lead time (i.e., the time between the publication of a final rule and the date compliance is required during which time manufacturers take steps to come into compliance) and rule spacing (i.e., the time between new standards which imposes no requirement on manufacturers).

In the present case, DOE notes that the first remand agreement for residential furnaces (resulting from the Petition for Review, State of New York, et al. v. Department of Energy, et al., Nos. 08– 0311–ag(L); 08–0312–ag(con) (2d Cir. filed Jan. 17, 2008)) did not vacate the November 2007 Rule for furnaces and boilers. Therefore, DOE has concluded that the November 2007 final rule completed the first round of rulemaking for amended energy conservation standards for furnaces, thereby satisfying the requirements of 42 U.S.C. 6295(f)(4)(B). The June 2011 direct final rule (June 2011 DFR) satisfied the second round of rulemaking for amended energy conservation standards for furnaces; however, the settlement resulting from the APGA lawsuit (Petition for Review, American Public Gas Association, et al. v. Department of Energy, et al., No. 011-1485 (DC Cir. filed Dec. 23, 2011) vacated the standards for NWGFs and MHGFs. As a result, the June 2011 DFR completed the second round of rulemaking for the furnace product classes for which that rule was not vacated, and the current rulemaking constitutes the second round of rulemaking for amended energy conservation standards for NWGFs and MHGFs, as required under 42 U.S.C. 6295(f)(4)(C).

Missed deadlines in the furnaces rulemaking history have resulted in ambiguity in terms of the applicable statutory compliance date. More specifically, the statute does not clearly specify an applicable compliance date for the furnaces rulemaking proceedings because the dates set forth in the statute are based on rulemakings that were to have been conducted earlier. For the reasons that follow, DOE does not agree with the commenters' interpretation of the relevant statutory language regarding setting the compliance date for this rulemaking.

These commenters contend that, in 42 U.S.C. 6295(f)(4)(B) and (C), Congress mandated a 10-year gap between the compliance dates for the latest two rounds of rulemaking for amended residential furnace standards (i.e., applicable to products manufactured on or after January 1, 2002 and January 1, 2012, respectively). (42 U.S.C. 6295(f)(4)(B) and (C)). These dates were established by Congress in the National Appliance Energy Conservation Act of 1987, which also established separate product classes for small and large furnaces.[23] However, the statute did not specify that a 10-year gap is always required. Instead the statute linked specific compliance deadlines (2002 and 2012) to specific statutory deadlines for completion of rulemaking proceedings (1994 and 2007). DOE acknowledges that it missed the statutory deadlines for completion of these amended furnace standards rules (along with those of other products) and thus, also missed the statutory compliance dates. In light of those missed deadlines, Congress passed a requirement in the Energy Policy Act of 2005 that DOE submit a semi-annual report to Congress summarizing the reasons DOE did not comply with deadlines and providing a plan to expeditiously eliminate the rulemaking backlog.[24] Congress subsequently passed the Energy Independence and Security Act of 2007 (EISA 2007) to include the 6-year-lookback provision at 42 U.S.C. 6265(m).[25] In establishing this

[23] Public Law 100-12 (enacted March 17, 1987).
[24] Section 141, Public Law 100-58 (enacted Aug. 8, 2005).
[25] Public Law 110-140 (enacted Dec. 19, 2007),

lookback requirement, Congress eliminated the previously-existing lookback requirement, which provided that "the last final rules required under subsections (b) through (i)" must be issued before 42 U.S.C. 6295(m) could apply." Thus, between 2005 and 2007, Congress recognized the need for DOE to quickly promulgate energy conservation rules that should have been issued years earlier and to review those rules regardless whether DOE had exhausted its product-specific rulemaking authority.

Congress enacted EISA 2007 subsequent to the promulgation of the November 2007 final rule fulfilling DOE's rulemaking obligation under 42 U.S.C. 6295(f)(4)(B) and subsequent to the date DOE was obligated to complete the rulemaking required in 42 U.S.C. 6295(f)(4)(C). As such, with knowledge of the missed deadlines for these required furnace rulemakings, Congress specifically mandated a lead time for furnaces rulemakings under 42 U.S.C. 6295(m)(4)(A)(ii) (i.e., 5 years) and set a spacing requirement between rulemakings (i.e., a minimum of 6 years since compliance with the last standards rule). This later-in-time enactment, with awareness of the missed deadlines in 42 U.S.C. 6295(f)(4)(B) and (C), demonstrates Congress's updated direction regarding the lead time and spacing specifically for furnaces rulemakings going forward. Given the ambiguity in the statutory provisions and Congress's desire to expedite the energy conservation standards rulemaking process, DOE interprets the more-recent-in-time provision, specifying a 5-year lead time for compliance, as the most appropriate indicator of congressional intent. Such interpretation is also consistent with EPCA's policy purposes "to conserve energy supplies through energy conservation programs" and "to provide for improved energy efficiency of … major appliances, and certain other consumer products." (42 U.S.C. 6201(4) and (5))

Consequently, DOE has tentatively decided to proceed with a lead time for compliance of 5 years after publication of the final rule for amended furnaces standards, consistent with the requirements of both 42 U.S.C. 6295(f)(4)(C) and (m)(4)(A)(ii). DOE notes that such lead time is the same lead time accorded to other furnace product classes in the June 27, 2011 DFR, thereby providing a level playing field for manufacturers of similar products. Regarding the spacing between rules, DOE will also ensure that any amended standards are not required with respect to furnaces within 6 years of the last time new standards were required (42 U.S.C. 6295(m)(4)(B)); as explained in the paragraphs which immediately follow, this 6-year limitation will also be met in the current rulemaking. For these reasons, in its analysis of amended energy conservation standards for NWGFs and MHGFs in this SNOPR, DOE is using a 5-year lead time between the expected publication of the final rule and the compliance date for the standard.

AGA, Vectren, Rheem, AHRI, and APGA stated that EPCA provides that new standards cannot be applied to a product if other new standards have been required during the prior 6 years. Amended furnace standards took effect in November 2015, and furnace fan standards take effect in 2019. Thus, these commenters argued that new proposed amendments to the furnace standards should not take effect until 2025, 6 years after the compliance date for the furnace fan rule. (AGA, No. 0118 at pp. 42-43; Vectren, No. 0111 at p. 6; Rheem, No. 0142 at p. 3; AHRI, No. 0159 at p. 3; APGA, No. 0106 at p. 11)

DOE disagrees with these commenters' interpretation of the relevant statutory provisions. The standards on furnace fans were responsive to the statutory directive that

DOE "shall consider and prescribe energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work." (42 U.S.C. 6295(f)(4)(D)) DOE published the final rule for "furnace fans"[26] in the Federal Register on July 3, 2014, with a compliance date of July 3, 2019. 79 FR 38130. DOE did not intend nor does it believe Congress intended that the furnace fan standards are to be understood as a standard on residential furnaces, but instead, DOE has interpreted that statutory provision as authority to set standards for a separate covered product. Consequently, the furnace fans rule is not the operative rule for purposes of determining the appropriate compliance date under the statute for NWGFs and MHGFs standards. As described above, under DOE's 6-year-lookback authority to review prior standards rules, manufacturers shall not be subject to new standards for a covered product for which other new standards have been required in the past 6 years. (42 U.S.C. 6295(m)(4)(B)) Therefore, the relevant date for the aforementioned 6-year window is November 2015, and the compliance date for newly-amended standards must be after November 19, 2021.

Accordingly, the relevant statutory timing requirements are in good alignment. The provision at 42 U.S.C. 6295(m)(4)(A)(ii) require a 5-year lead time for amended furnace standards, and given the publication date of this SNOPR combined with the public comment period, the final rule should be completed such that the compliance date would fall after November 19, 2021 (i.e., a date fulfilling the 6-year gap required by 42 U.S.C. 6295(m)(4)(B)). DOE further notes that this lead time for NWGFs and MHGFs

[26] Although in the furnace fan rulemaking DOE only covered those circulation fans that are used in furnaces and modular blowers, the EPCA language could be interpreted as encompassing electrically-powered devices used in any residential HVAC product to circulate air through duct work. If Congress had wanted to limit the regulation of fans to only furnaces, it could have provided narrowly-tailored language to that end, rather than the broader language it employed.

would be consistent with the 5 years of lead time provided under 42 U.S.C. 6295(f)(4)(C) to the other furnaces product classes for which standards were promulgated in the June 2011 DFR.

EEI stated that to act in a more fuel and market neutral manner, the new standards for NWGFs should take effect before or coincident with any new standards for heat pumps. (EEI, No. 0160 at p. 2) DOE notes that the compliance dates for energy conservation standards are specified by EPCA and tied to promulgation of the final rule. In any case, DOE expects that amended standards for central air conditioners and heat pumps will be issued later in 2016 with a compliance year of 2023 (about a year after the compliance year for residential furnaces).

6. Regional Standards

As discussed in section II.A, EISA 2007 amended EPCA to allow for the establishment of a single more-restrictive regional standard in addition to the base national standard for furnaces. (42 U.S.C. 6295(o)(6)(B)) The regions must include only contiguous States (with the exception of Alaska and Hawaii, which can be included in regions with which they are not contiguous), and each State may be placed in only one region (i.e., a State cannot be divided among or otherwise included in two regions). (42 U.S.C. 6295(o)(6)(C))

Further, EPCA mandates that a regional standard must produce significant energy savings in comparison to a single national standard, and provides that DOE must determine that the additional standards are economically justified and consider the impact of the additional regional standards on consumers, manufacturers, and other market participants, including product distributors, dealers, contractors, and installers. (42 U.S.C. 6295(o)(6)(D)) For this rulemaking, DOE has considered the above-delineated impacts of regional standards in addition to national standards.

Where appropriate, DOE has addressed the potential impacts from considered regional standards in the relevant analyses, including the mark-ups to determine product price, the LCC and payback period analysis, the national impact analysis (NIA), and the manufacturer impact analysis (MIA). DOE's approach for addressing regional standards is included in the methodology section corresponding to each individual analysis (see section IV of this notice), and in the SNOPR TSD, specifically Chapter 8 (LCC and PBP Analysis) and Chapter 10 (National Impact Analysis). For certain phases of the analysis, additional regional analysis is not required. For example, technologies for improving product efficiency generally do not vary by region, and thus, DOE did not perform any additional regional analysis for the technology assessment and screening analysis. Similarly, DOE did not examine the impacts of having two regions in the engineering analysis, since the technologies and manufacturer processes are the same under both a national and regional standard.

To evaluate regional standards for residential furnaces, DOE maintained the same regions analyzed in the March 2015 NOPR, which are shown in Table III.1 and Figure III.1. The allocation of individual States to the regions was largely based on whether a

State's annual heating degree day (HDD)[27] average is above or below 5,000, which offers a rough threshold point at which space heating demands are significant enough to require longer operation of heating systems, thereby providing a basis for utilization of higher-efficiency systems.

Table III.1 National Standard and Regional Standard (By State) for Analysis of Furnace Standards

National Standard*	Northern Region Standard	
Alabama	Alaska	Pennsylvania
Arizona	Colorado	Rhode Island
Arkansas	Connecticut	South Dakota
California	Idaho	Utah
Delaware	Illinois	Vermont
District of Columbia	Indiana	Washington
Florida	Iowa	West Virginia
Georgia	Kansas	Wisconsin
Hawaii	Maine	Wyoming
Kentucky	Massachusetts	
Louisiana	Michigan	
Maryland	Minnesota	
Mississippi	Missouri	
Nevada	Montana	
New Mexico	Nebraska	
North Carolina	New Hampshire	
Oklahoma	New Jersey	
South Carolina	New York	
Tennessee	North Dakota	
Texas	Ohio	
Virginia	Oregon	

* DOE analyzes an approach whereby the agency would set a base National standard, as well as a more-stringent standard in the Northern region. Because compliance with the regional standard would also meet the National standard, Table III.1 categorizes States in terms of the most stringent standard applicable to that State.

[27] DOE used the population weighted state HDD as determined by the National Oceanic and Atmospheric Administration (NOAA) in its 1971-2000 United States Climate Normals report, available at http://hurricane.ncdc.noaa.gov/climatenormals/hcs/HCS_51.pdf (last accessed July 28, 2014).

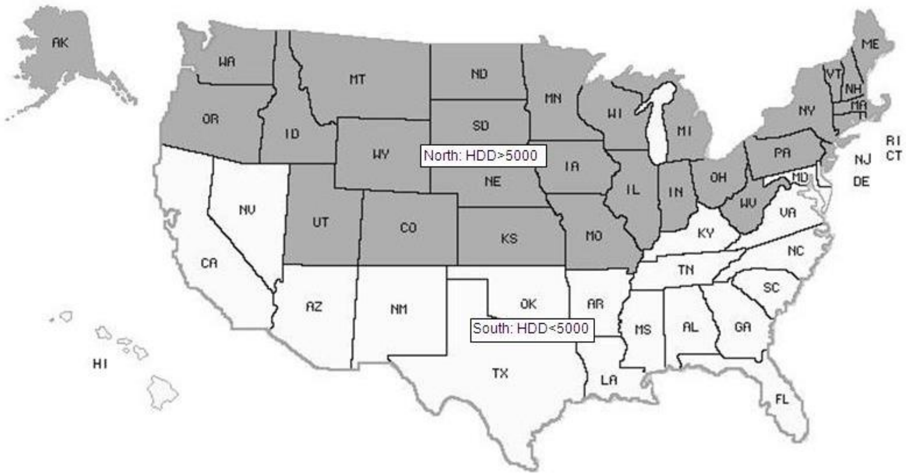

Figure III.1 Map of the Regions for the Analysis of Furnace Standards

ACEEE, NAHB, NRDC, SGA, NMHC, NAA, and NLHA stated that setting regional standards with condensing NWGFs in the North and non-condensing NWGFs in the South would be an alternative to a national 92-percent AFUE standard, separate standards for non-condensing and condensing furnaces, or separate standards for small furnaces. (ACEEE, No. 0113 at pp. 4-5; NAHB, No. 0124 at p. 5; NRDC, No. 0134 at p. 4; SGA, No. 0145 at p. 2; NMHC, NAA, and NLHA, No. 0117 at p. 5) However, ACEEE and NRDC added that enforcing a regional standard is more difficult than enforcing a standard for small-capacity units. (ACEEE, No. 0113 at p. 5; NRDC, No. 0134 at p. 4)

SGA stated that even regional standards would only be a partial solution because there are still numerous situations where condensing furnaces cannot be installed, including multi-family or row houses and other situations where side venting is not possible. SGA stated that many single-family retrofits, especially in small homes, would not be able to economically justify replacing a non-condensing furnace with a condensing furnace. (SGA, No. 0145 at p. 2) NMHC, NAA, and NLHA stated that with a regional standard, it would be necessary to provide a condensing furnace exemption in the North for existing buildings or a waiver process for especially difficult retrofits to provide relief for some or all of the more expensive retrofits. (NMHC, NAA, and NLHA, No. 0117 at p. 5)

DOE evaluated regional standards (North/South) for the SNOPR as TSL 3, and it determined that they would save much less energy than the currently-proposed standards. In addition, as discussed in section IV.F.2.b, DOE's analysis already includes installation costs where venting for condensing furnaces is difficult. Also, in Canada, where the national standards require condensing furnaces and which has many similarities to the stock using NWGFs in the North, neither Natural Resources Canada nor its mortgage agency has found any significant implementation problems with that standard. DOE's proposed separate standards for small and large NWGFs would significantly reduce the number of installations described as difficult. Therefore, DOE is not proposing regional standards for residential furnaces.

7. Regulatory Issues

AGA and Laclede stated that NEPA compliance should be required for this rulemaking because the rule is projected by DOE to cause significant changes in the outdoor concentrations of potentially harmful substances, including significant increases in the emission of mercury, SO_2, and N_2O. AGA and Laclede stated that in addition, DOE projects that the proposed standards would result in net increases of about 3,000 MW of electricity generation capacity, including 600 MW of coal-fired generation capacity, which should be considered a significant change in manufacturing infrastructure. AGA and Laclede also stated that categorical exclusions are not appropriate due to extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal. (AGA, No. 0118 at p. 30; Laclede, No. 0141 at p. 35)

DOE has reviewed the proposed rule pursuant to the National Environmental Policy Act (NEPA) of 1969. Section VI.D of this document describes this review, including the consideration of the factors mentioned in the above comments.

AHRI stated that including environmental benefits in EPCA's cost-benefit analysis is impermissible. AHRI stated that by relying on environmental impacts in the cost-benefit analysis, which Congress did not intend DOE to consider, DOE acted arbitrarily and capriciously. AHRI stated that although DOE might argue that environmental factors can be considered as "other factors the Secretary considers relevant," DOE specifically disclaimed any such argument in the NOPR. (AHRI, No. 0159 at p. 23) Rheem expressed agreement with AHRI's points. (Rheem, No. 0142 at p. 2)

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy and water conservation, which is one of the seven factors that EPCA requires DOE to consider when tentatively determining whether proposed standards are economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) In particular, given the threats posed by global climate change to the economy, public health, ecosystems, and national security,[28] combined with the well-recognized potential of well-designed energy conservation measures to reduce GHG emissions, DOE believes that evaluation of the potential benefits from slowing anthropogenic climate change are properly part of the consideration of the need for national energy conservation.

AHRI also stated that DOE's consideration of environmental factors is imbalanced relative to the other required factors under EPCA, and the environmental impacts, rather than energy savings at point of use, are the fundamental justification of the proposed standards. (AHRI, No. 0159 at p. 23) DOE disagrees. As discussed in section III.E.1, DOE considers seven factors (listed at 42 U.S.C. 6295(o)(2)(B)(i)) when tentatively determining whether the proposed standards are economically justified. DOE considers environmental benefits as part of its evaluation of the need for national energy and water conservation. To date, this accounting for environmental benefits has not had a decisive impact on the outcome of any standards rulemaking—i.e., DOE would have adopted the same standards even if environmental benefits had not been considered at all. The same is true for today's SNOPR. DOE further notes that EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected

[28] National Climate Assessment 2014 (Available at: http://nca2014.globalchange.gov/). The National Security Implications of a Changing Climate (May 2015), The White House (Available at: https://www.whitehouse.gov/the-press-office/2015/05/20/white-house-report-national-security-implications-changing-climate).

energy savings that are expected to result directly from the standard, and not just the energy savings at point of use. (42 U.S.C. 6295(o)(2)(B)(i)(III))

Laclede stated that key elements of the analysis have not been subjected to an unbiased and current peer review as required by an OMB Bulletin. Laclede commented that the peer review cited in the NOPR is approximately eight years old and does not cover a number of key elements in DOE's furnaces analysis. Laclede stated that the peer review process was insufficiently robust and independent. (Laclede, No. 0141 at pp. 37-38)

As discussed in more detail in section VI.L, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used, and prepared a Peer Review Report, consistent with the requirements of OMB's Bulletin, that describes the peer review. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. DOE has determined that the peer-reviewed analytical process continues to reflect current practice, and the Department followed that process for developing energy conservation standards in the case of the present NWGFs and MHGFs rulemaking.

In addition, there has been extensive interaction with stakeholder experts and detailed review by these parties of DOE's analytical models and data in the subject furnace standards rulemaking. As further discussed in section VI.L, DOE incorporated a number of inputs from these reviewers into its analyses in this rulemaking. For the reasons described in section VI.L, DOE believes that the reviews provided by stakeholders in the course of this rulemaking could complement the prior peer review.

Laclede stated that DOE did not respond to Laclede's Freedom of Information Act (FOIA) request. (Laclede, No. 0141 at pp. 38-39). DOE has since responded to this request.

CGS and NJNG stated that under section 305(f) [sic] of EPCA and 42 U.S.C. 6291(f) [sic], for furnaces with an input capacity of 45 kBtu/h or smaller, DOE cannot promulgate efficiency standards that would lead to significant switching from natural gas furnaces to electric resistance heating systems. (CGS, No. 0098 at pp. 4-5; NJNG, No. 0119 at p. 2) (DOE believes the commenters intended to reference 42 U.S.C. 6295(f); 42 U.S.C. 6291(f) does not exist.) In response, DOE notes that because the standard proposed in this SNOPR for furnaces with a certified input capacity of 55 kBtu/h or smaller is easily met by typical equipment in the market, it would not be expected to lead to significant fuel switching for such furnaces.

Carrier stated that the rapid pace of regulatory change on contractors and consumers (due to revised furnace standards in addition to other regulatory revisions and new regulations introduced throughout the last decade) will create ongoing confusion in the marketplace, thereby increasing the risk of poor installation quality and customer dissatisfaction. (Carrier, No. 0116 at p. 33) There have been limited changes in the standards applicable for NWGFs since originally established in EPCA. In addition, condensing NWGFs already have a significant market share, indicating that contractors have experience installing these furnaces. Distributors and manufacturers will have ample time to prepare for the amended standards, given the lead time of 5 years prior to the compliance date.

Nortek stated that DOE must consider the cumulative burden of all rulemakings affecting heating and air conditioning systems. According to Nortek, rulemakings on standby power, furnace fan efficiency, and CAC and heat pumps are on a path to potentially take effect within a year or two of each other. Nortek stated that depending on the level set by the CAC and heat pump rule, this could mean that a consumer that now can simply replace a CAC system with a condensing unit and a coil, may instead have to purchase and install not only a condensing unit and coil, but also a 92-percent AFUE furnace with a high efficiency motor and a new thermostat required by the new CAC system. Nortek believes this could increase the cost by several thousand dollars, pricing a complete system out of the reach of many homeowners and forcing them to seek less expensive alternatives. (Nortek, No. 0137 at p. 5) In response, DOE understands that many consumers replacing a CAC would be more likely to use the existing noncondensing furnace (albeit achieving lower CAC efficiency) rather than purchase and install a new furnace at the same time. It is expected that a consumer's decision to install a new furnace would depend on the age and condition of the existing furnace.

8. Certification of Compliance and Level of Precision

In this SNOPR, DOE is clarifying the standards to reflect the level of precision required under the reporting and compliance requirements. In the January 2016 Test Procedure Final Rule, DOE clarified that a represented AFUE value is to be truncated to the tenth of a percentage point. 81 FR 2628, 2638; 10 CFR 429.18(a)(2)(vii). Compliance for furnaces and boilers is determined at this level of precision. This SNOPR proposes to amend the standards to reflect a consistent level of precision with the compliance and reporting requirements. DOE also proposes a clarification that input capacity for the purpose of certifying compliance means the nameplate maximum fuel input rate. These revisions are for clarification and consistency, and reflect current practice. DOE does not anticipate that these revisions would impact the current compliance of a manufacturer.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to NWGFs and MHGFs. Separate subsections address each component of DOE's analyses. Comments on the methodology and DOE's responses are presented in each section.

DOE used several analytical tools to estimate the impact of the standards proposed in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments forecasts and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=62. Additionally, DOE used output from the latest version of EIA's Annual Energy Outlook (AEO), a widely known energy forecast for the United States, for the emissions and utility impact analyses.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this rulemaking include: (1) a determination of the scope of the rulemaking and product classes; (2) manufacturers and industry structure; (3) existing efficiency programs; (4) historical shipments information; (5) market and industry trends; and (6) technologies or design options that could improve the energy efficiency of NWGFs and MHGFs. The key findings of DOE's market assessment are summarized below. See chapter 3 of the SNOPR TSD for further discussion of the market and technology assessment.

1. Scope of Coverage and Product Classes

a. General Approach

EPCA defines a "furnace" as "a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which:

(1) is designed to be the principal heating source for the living space of a residence;
(2) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;
(3) is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and
(4) has a heat input rate[29] of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces." (42 U.S.C. 6291(23))

DOE has incorporated this definition into its regulations in the Code of Federal Regulations (CFR) at 10 CFR 430.2.

EPCA's definition of a "furnace" covers the following types of products: (1) gas furnaces (non-weatherized and weatherized); (2) oil-fired furnaces (non-weatherized and

[29] DOE uses certified input capacity to mean heat input rate in determining scope of coverage and product class.

weatherized); (3) mobile home furnaces (gas and oil-fired); (4) electric resistance furnaces; (5) hot water boilers (gas and oil-fired); (6) steam boilers (gas and oil-fired); and (7) combination space/water heating appliances (water-heater/fancoil combination units and boiler/tankless coil combination units). As discussed in the March 2015 NOPR, DOE agreed to the partial vacatur and remand of the June 2011 DFR, specifically as it related to energy conservation standards for NWGFs and MHGFs in the settlement agreement to resolve the litigation in *American Public Gas Ass'n v. U.S. Dept. of Energy* (No. 11-1485, D.C. Cir. Filed Dec 23, 2011). 80 FR 13120, 13130-32 (March 12, 2015). Therefore, DOE only considered amending the energy conservation standards for these two product classes of residential furnaces (i.e., NWGFs and MHGFs) in the March 2015 NOPR.

As discussed in section III.A, when evaluating and establishing energy conservation standards, DOE is authorized to divide covered products into product classes by the type of energy used, by capacity, or by other performance-related features that justify a different standard. In making a determination whether capacity or other performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE deems appropriate. (42 U.S.C. 6295(q))

In response to the March 2015 NOPR, a number of interested parties raised concerns pertaining to potential impacts of a national condensing standard on certain consumers as a result of either increased installation costs (due to installing a condensing furnace) or switching to electric heat (resulting in higher monthly bills). Several commenters responding to the March 2015 NOPR recommended that DOE consider establishing a separate product class for furnaces with a lower input capacity, one of the statutory bases for establishing a separate product class, and analyze a less stringent standard to reduce negative impacts on some furnace consumers while maintaining the overall economic and environmental benefits of the standards. 80 FR 55038, 55038-39 (Sept. 14, 2015). The September 2015 NODA, therefore, contained analyses examining the potential impacts of such a product class. In the September 2015 NODA, DOE discussed certain comments that were received in response to the March 2015 NOPR that were relevant to such a product class.

In response to the March 2015 NOPR and September 2015 NODA, several stakeholders recommended that DOE establish separate product classes based on furnace capacity to preserve the availability of non-condensing NWGFs for buildings with lower heating loads and, thereby help alleviate the negative impacts of the proposed standard. (ASAP, No. 0154-1 at p. 8; ASE, No. 0115 at p. 1; ACEEE, No. 0113 at p. 3; NMHC, NAA, and NLHA, No. 0117 at p. 5; Joint Consumer Commenters, No. 0123 at pp. 8, 35; NRDC, No. 0134 at pp. 2, 4-5; NRDC, No. 0186 at p. 1; A Ware, No. 0204 at p. 1; NPGA, No. 0171 at p. 2)[30] Furthermore, ACEEE and AHRI stated that a size threshold would not present the potential enforcement challenges associated with regional standards. (ACEEE, No. 0113 at p. 3; AHRI, No. 0181 at p. 2) Ubuntu expressed the belief that establishing separate furnace classes by capacity is a viable solution for

[30] A notation in this form provides a reference for information that is in Docket No. EERE-2014-BT-STD-0031 (unless otherwise denoted) from the listed stakeholder on the specified page of the specified docket number. For example, the first comment is from ASAP on p. 8 of document number 0154-1 in the docket.

achieving energy efficiency while also protecting low-income and minority communities. (Ubuntu, No. 0191 at p. 1)

NRDC stated that separating furnaces based on capacity is reasonable because larger and smaller furnaces are distinct products that serve different homes. NRDC stated that the consumer utility in both cases is still home heating but smaller furnaces provide sufficient consumer utility only for those homes with lower heating loads, whether due to excellent insulation or geographic location. (NRDC, No. 0134 at pp. 6-7) NRDC also theorized that separating furnaces based on capacity may reduce the negative impacts for manufacturers by limiting conversion costs. (NRDC, No. 0134 at pp. 3-4)

Many stakeholders commented in response to DOE’s September 2015 NODA that they supported creation of product classes by capacity. AHRI, Carrier, JCI, and Ingersoll Rand stated that separating small and large furnaces by product class provides a reasonable solution for most of the installations that cannot accommodate a condensing furnace without extraordinary costs or installation site renovations; address the concern of those areas of the U.S. that have low heating loads where the installation of a condensing furnace is not economically justified; and focus the benefit of a condensing standard on the input capacities where energy savings are maximized. (AHRI, No. 0181 at pp. 1-2; Carrier, No. 0183 at pp. 2-3; JCI, No. 0202 at p. 3; Ingersoll Rand, No. 0203 at p. 1) Carrier and JCI added that it benefits economically-challenged or low-income individuals/families with a gas furnace option that minimizes installation or electrical changes. (Carrier, No. 0183 at p.3; JCI, No. 0202 at p. 3) Carrier commented that the approach may be satisfactory to all stakeholders and satisfy the parameters that guide

DOE's decision-making process. Carrier, Ingersoll Rand, and AHRI stated that this concept warranted further consideration. (Carrier, No. 0183 at p. 2; Ingersoll Rand, No. 0182 at p. 4; AHRI, No. 0181 at p. 1)

Lennox also agreed that the September 2015 NODA justified creating a separate product class for lower-input capacity non-condensing furnaces. Lennox stated that lower capacity furnaces serve smaller residences where the physical complexities and costs of replacing non-condensing furnaces with condensing furnaces is unduly burdensome, and that setting separate standard levels for smaller non-condensing furnaces could increase economic benefits and energy savings. (Lennox, No. 0201 at pp. 3-4)

AGL Resources stated that EPCA gives DOE the authority to establish separate product classes on the basis of product capacity, and DOE has previously opted to create separate product classes on the basis of product capacity for a wide variety of covered products. (AGL Resources, No. 0112 at pp. 15-16)

Johnson also commented that a two-product-class standard could help prevent furnace oversizing, which could increase the seasonal efficiency of the furnace and reduce energy consumption. In addition, Johnson stated that a two-product-class standard could help encourage other energy conservation measures, such as increasing the insulation in the ceiling and walls, improved caulking and weather-stripping doors and windows, to enable consumers to purchase a small furnace. (Johnson, No. 0190 at p. 1) In its comments, the Joint Consumer Commenters requested DOE consider tailoring the rule to the particular circumstances (e.g. mild climates) that result in consumers having net costs based on furnace input capacity in order to reduce the number of losers and increase the overall net benefit. (Joint Consumer Commenters, No. 0123 at pp. 1, 11)

DOE has tentatively concluded that the establishment of a small furnace class has merit. Accordingly, DOE decided to develop a capacity-based approach to set standards for NWGFs. In determining whether a less-stringent standard is justified for small NWGFs pursuant to 42 U.S.C. 6295(q), DOE considered the costs and benefits of such a capacity-based approach in light of the results contained in the September 2015 NODA. In this way, DOE sought to determine the impact that a modified standard in an SNOPR would be expected to have in terms of mitigating fuel switching. The building sample and furnace sizing criteria developed for the LCC analysis (described in section E) show that small furnaces are commonly installed in circumstances that are different from those of large furnaces—namely that the buildings into which small furnaces are installed are more often smaller or are found in the South where heating loads are much lower due to warmer climate. The cost-benefit analysis found that a less-stringent standard for small furnaces would be economically justified because it would reduce the number of consumers experiencing net costs (due to higher installation costs for condensing furnaces or switching to electric heat). Thus, establishing a less stringent standard for small furnaces would reduce fuel switching because they are more likely to be used in instances where there would otherwise be negative impacts due to a higher standard.

b. Condensing and Non-Condensing Furnaces

Other stakeholders urged DOE to set standards based on the use of condensing vs. non-condensing technology, arguing that the type of venting required for furnaces constitutes a "feature." In the March 2015 NOPR, DOE stated that it would not consider separate product classes for condensing and non-condensing furnaces and detailed its reasons for not doing so. 80 FR 13120, 13137-38 (March 12, 2015) However, in response to the March 2015 NOPR, a number of stakeholders still encouraged DOE to establish separate efficiency standards for non-condensing and condensing NWGFs. Those comments are available in the docket for this rulemaking. Those same commenters raised, essentially, the same comments in response to the September 2015 NODA while also responding to the concept of a small capacity product class.

As explained in detail in the March 2015 NOPR, DOE has implemented the "feature" provision of EPCA such that the Department ascertains the utility of the purported feature to the consumer as the basis for setting a separate product class. 80 FR 13120, 13137-38 (March 12, 2015). In the present case, DOE maintains the view that the consumer utility of a furnace is that it provides heat to a dwelling, and that the type of venting used for particular furnace technologies does not impact that utility. As further explained in the March 2015 NOPR, DOE has consistently followed this approach in its various appliance rulemakings, making such determinations on a case-by-case basis to reflect the unique characteristics and circumstances of different products. As explained in the March 2015 NOPR, disparate products may have very different consumer utilities, thereby making direct comparisons difficult and potentially misleading. Id. Furthermore, tying the concept of "feature" to a specific technology, as suggested in the gas utility comments, would effectively lock in the technology existing at the time of such decision as the ceiling for product efficiency. As a result, doing so would eliminate DOE's ability to address technological advances that could yield significant consumer benefits in the form of lower energy costs while providing the same functionality for consumers. Moreover, establishing separate standards based on preserving a type of venting (i.e., establishing separate classes for condensing and non-condensing furnaces) would not place any restriction on the use of non-condensing furnaces and, therefore, would not be a meaningful standard, resulting in little or no change in products offered and their market shares nor energy savings. If such classes were to be established, the baseline efficiency level for non-condensing products would be 80-percent (i.e., the current minimum standard) and baseline for the condensing product class would likely be 90-percent AFUE (based on condensing products currently on the market). There are currently no efficiency levels available for non-condensing furnaces that are above 80-percent. Using such a product class approach, furnace manufacturers could continue making and selling furnaces at the current baseline efficiency (80-percent AFUE), undercutting any possible energy savings that might be achieved by improving the efficiency standard for the condensing product class (i.e., setting a standard higher than 90-percent AFUE for the condensing product class). For these reasons, DOE continues to decline to define a separate product class for furnaces based on venting. (i.e., non-condensing and condensing product classes).

In its comments in response to the September 2015 NODA, Laclede stated that creating a separate product class based on the input capacities analyzed would still result in the unavailability of large non-condensing furnaces and cause millions of customers to either choose a furnace that is not cost effective or switch to other equipment that will increase overall energy usage and degrade the environment. Laclede believed that the September 2015 NODA did not provide evidence or analysis that would support the establishment of a separate product class for small furnaces. (Laclede, No. 0178 at pp. 5-6)

Rheem also commented that the adoption of a two-tier product class system would limit choices for residential furnace consumers. Rheem added that although capacity-based product classes would benefit low and fixed income consumers who live in small energy-efficient homes, the concept would not aid consumers with challenging financial circumstances who live in older homes that are not well insulated or maintained. (Rheem, No. 0184 at p. 2; Rheem, No. 0199 at p. 2)

NPGA stated that DOE's categorization of "small" furnaces by input capacity is not adequately justified and that DOE must produce analysis and technical documents that demonstrate the division of product classes based on input capacity is the most practical and economical means to achieve the energy efficiency objectives. (NPGA, No. 0200 at pp. 1-2)

With regards to concerns that the separate small furnace product class approach would result in the unavailability of a covered product (namely non-condensing large furnaces), DOE notes that, as discussed above, venting is not a "feature" of furnaces under U.S.C. 6295(o)(4).). Therefore, DOE does not agree that a standard that would effectively require the use of condensing technology for large furnaces, as has been proposed in this SNOPR, would result in the unavailability of products with similar performance characteristics and features that are substantially the same as those generally available today. DOE has tentatively concluded that the methods by which a furnace is vented, which is a significant differentiator of condensing and non-condensing furnaces, do not provide any separate performance-related utility, and, therefore, DOE has no statutory basis for defining a separate product class based on venting and drainage characterisitics. NWGF and MHGF venting methods do not provide unique utility to consumers beyond the basic function of providing heat, which all furnaces perform. The possibility that installing a non-condensing furnace may be less costly than a condensing furnace due to the difference in venting methods does not justify separating the two types of NWGFs into different product classes. As previously discussed, DOE is proposing a separate product class based on the input capacity of NWGFs. The establishment of a small furnace product class would reduce the number of consumers that would experience a net cost, as compared to a single, more stringent standard, including consumers in buildings such as rowhomes, townhomes, or multi-family dwellings.

In response to Laclede's and Rheem's concern that some consumers may experience a net cost under the proposed standard, DOE has taken such considerations into account through its LCC analysis (see section IV.E.3) and consumer subgroup analysis (see section IV.I), while national energy savings (NES) are estimated as described in section IV.H and environmental impacts are estimated as described in sections IV.K and IV.L. As described in section IV.A.1.c below, DOE has tentatively determined based on its comprehensive cost-benefit analysis that the benefits of separate standards for small and large NWGFs outweigh the burdens.

EEI stated that DOE cannot justify a separate standard for small and large furnaces by claiming that the small furnace standard produces greater savings due to less fuel switching. (EEI, No. 0179 at p. 10) In response, DOE notes that fuel switching is only one component of the rationale for proposing such an approach, and for the reasons stated it is a valid consideration. Moreover, as described below in IV.A.1.c, DOE was required by statute in a prior rulemaking to consider differential standards for small furnaces based upon input capacity as a means to address fuel switching pursuant to 42 U.S.C. 6295(f)(1)(B).

c. Input Capacity

Because there are potential benefits of establishing a separate small furnaces product class, DOE analyzed these benefits to determine a potential capacity cutoff for small furnaces. Typically, DOE looks to natural capacity breakpoints in a given market to create new product classes based on capacity. However, DOE did not find an obvious breakpoint in the residential gas furnace market based upon input capacity that would delineate a boundary between the small and large non-weatherized gas furnace product classes. Commenters on the September 2015 NODA who supported the concept of separate, capacity-based product classes expressed varying viewpoints as to the most appropriate boundary for those classes, as outlined below.

ACEEE and the Joint Consumer Commenters recommended a capacity limit for small NWGFs of 50 kBtu/h or less. (ACEEE, No. 0113 at p. 3; Joint Consumer Commenters, No. 0123 at pp. 1, 9) ACEEE also stated that by setting a higher standard for large NWGFs, DOE will make up some of the lost energy savings by leaving the standard for small NWGFs unchanged, achieving larger national benefits. (ACEEE, No. 0113 at p. 4)

NRDC stated that the capacity threshold should be set low enough that the benefits of a national condensing standard are largely preserved while allowing consumers in small and moderately-sized, well insulated, and weatherized homes in moderate and warm climates to have a non-condensing option. NRDC stated that a key objective in choosing a capacity threshold is to capture most of the energy and cost savings potential of high efficiency furnaces while simultaneously allowing homes with the lowest heating load to use 80-percent AFUE furnaces where those are significantly more cost-effective. NRDC stated that encouraging utility efficiency programs that improve insulation and weatherization in new and existing homes, and reducing the risk and extent of negative impacts on manufacturers, are valuable secondary objectives. (NRDC, No. 0134 at pp. 2, 4-5) NRDC stated that the NODA analysis suggests that the most appropriate capacity threshold lies between 50 kBtu/h and 65 kBtu/h input capacity. (NRDC, No. 0186 at p. 2) (In response to the March 2015 NOPR, NRDC had initially suggested a threshold of 50 kBtu/h output capacity; NRDC, No. 134 at p. 5). NRDC commented that DOE should evaluate and publish the distribution of consumer, environmental, energy savings, and manufacturer impacts as a function of furnace capacity. This will serve to highlight that larger and smaller furnaces are distinct products that serve different homes. (NRDC, No. 0134, pp. 6134, p. 2-7) NRDC encouraged DOE to perform a broader range of analyses in an SNOPR, e.g., from 40 kBtu/h to 75 kBtu/h, to choose an appropriate threshold. (NRDC, No. 0186 at p. 2) NRDC also recommended that DOE adopt a 95-percent AFUE for large furnaces, regardless of the capacity threshold for small furnaces due to the significant benefits to customers and the environment, and that DOE adopt an 80-percent AFUE standard for furnaces below the specified maximum capacity threshold. (NRDC, No. 0186 at pp. 2-3)

CEC requested that if DOE continues with a two-tier capacity-based approach, it should publish a final rule that at minimum incorporates the following recommendations: 1) defines a small furnace capacity cutoff at 45 kBtu/hour to ensure that smaller furnaces are used only for homes with small heating loads, while also achieving the most energy savings of any of the cutoff points; 2) analyzes alternative standard levels in addition to 80 percent AFUE for small furnaces; 3) set the standard for large furnaces at 98 percent AFUE. (CEC, No. 0172 at p. 2)

The Efficiency Advocates stated that it is important that the cut-off for small furnaces be set low enough to avoid having non-condensing furnaces installed in a large fraction of new homes each year. The Efficiency Advocates expressed support for a capacity limit of no more than 55 kBtu/h because of impacts on state and local building energy code requirements. The Efficiency Advocates also stated that using the 50 to 55 kBtu/h small furnace limit, the energy savings and net consumer benefits are significantly higher for a 95-percent AFUE standard for large furnaces than for a 92-percent AFUE standard. Therefore, the Efficiency Advocates recommended that DOE adopt a 95-percent AFUE for large furnaces, regardless of the capacity threshold for small furnaces due to the significant benefits to customers and the environment. The Efficiency Advocates stated that a 95-percent AFUE standard becomes even more important if DOE sets the size limit higher than they recommend, because the higher the breakpoint between small and large furnaces, the lower the energy savings. (Efficiency Advocates, No. 0196 at pp. 3-5)

ASE suggested an input capacity limit for small NWGFs of no more than 50 kBtu/h to 65 kBtu/h. However, ASE urged DOE to take more fully into account the success with condensing furnace installations in many parts of the US, Canada, and Europe, as well as the recent emergence of innovative venting solutions. (ASE, No. 0115 at p. 1) ASE also recommended that DOE assure that the majority of furnaces be covered by a 95-percent AFUE standard. (ASE, No. 0115 at ppp. 1-2)

AHRI commented that the NODA indicates that at each efficiency level, the average LCC savings across the considered small furnace input capacity definitions are similar, but the estimated percentage of consumers who experience a net cost decreases significantly as the input capacity definition for small furnaces increases. AHRI stated that the average LCC savings for the small furnace capacity limits from 70 kBtu/h to 85 kBtu/h are higher than the LCC savings for the small furnace capacity limits lower than 60 kBtu/h. AHRI stated that at a small furnace capacity limit of 80 kBtu/h or higher, the percent of consumer with a net cost drops to 2 percent, less than one-third the percentage at the 65 kBtu/h limit and less than one-eighth the percentage at the 55 kBtu/h limit. AHRI noted that the combination of 92-percent AFUE for large furnaces and 80 percent for small furnaces provides the highest average LCC savings for every input capacity. (AHRI, No. 0181 at pp. 1, 3)

Of the input capacities reviewed by DOE in the NODA, NPGA stated that ≤ 65 kBtu/h presents the most reasonable benefits. NPGA stated that the information presented by DOE demonstrates that ≤ 65 kBtu/h presents valuable LCC savings that are comparable among consumers in different regions. NPGA also stated that an input capacity of less than 65 kBtu/h presents the lowest percentage of consumers likely to experience a net cost. (NPGA, No. 0171 at p. 4)

Johnson stated that the small furnace size limit should be at least 65 kBtu/h. (Johnson, No. 0190 at p. 1)

Ubuntu stated that based on existing housing data, a furnace size threshold of 75 kBtu/h is needed to effectively target larger furnaces and homes that have the greatest impact on national energy efficiency, while also protecting smaller furnaces in homes where low-income and working class families are likely to reside. Ubuntu also stated that a furnace size threshold of 75 kBtu/h is necessary to prevent low-income homeowners and landlords who rent to low-income families from trying to avoid costly condensing furnace installations by switching to lower-initial cost electric alternatives that lead to higher energy expenses in the long term. (Ubuntu, No. 0191 at p. 1)

Lennox stated that a limit of 55 kBtu/h for small furnaces only provides for the installation of non-condensing options in very small dwellings, especially in colder climates, and is not adequate to provide relief for many consumers. Lennox stated that the 55 kBtu/h limit also negatively impacts Southern consumers where a condensing furnace is not economically feasible and will detract from cooling operational efficiency, which is paramount in the South. Additionally, Lennox stated that the 55 kBtu/h limit disproportionately impacts low-income consumers. Lennox indicated that a limit of 80 kBtu/h improves LCC savings and significantly reduces the percentage of consumers with net cost. Lennox recommended DOE to further analyze the 80 kBtu/h input level for non-condensing products combined with a 92-percent AFUE standard for products above 80 kBtu/h. (Lennox, No. 0201 at p. 2) Lennox stated that with higher input capacity limits for small furnaces, the LCC analysis indicates that a 92-percent AFUE standard optimizes the LCC savings while minimizing the percentage of consumers with negative cost impacts. (Lennox, No. 0201 at p. 5) Lennox also stated that higher capacity limits need to be analyzed to fully evaluate the trend of a decreasing percentage of consumers that would experience a net cost as the definition of small furnace expands to include more furnaces. (Lennox, No. 0201 at p. 4)

JCI recommended DOE consider thresholds of up to 80 kBtu/h to properly consider the various applications, installations and geographic regions. (JCI, No. 0202 at pp. 3-4)

Ingersoll Rand stated that DOE must consider input capacity limits greater than 65 kBtu/h to reflect the furnace market and consumer needs. Ingersoll Rand recommended that DOE consider not only the furnace but also the central air conditioner in defining the input capacity of small furnaces because the air conditioning needs in the South are hard to meet with a furnace that is smaller than 65 kBtu/h while at the same time providing a comfortable supply air temperature in heating mode. For these situations, Ingersoll Rand stated that an appropriate maximum input for the non-condensing class is in the 75-80 kBtu/h range. (Ingersoll Rand, No. 0182 at p. 5; Ingersoll Rand, No. 0203 at p. 2)

NAHB and NMHC, NAA, and NLHA requested that DOE retain the 80-percent AFUE minimum for NWGFs with an input capacity of 80 kBtu/h or less. (NAHB, No. 0124 at p. 5; NMHC, NAA, and NLHA, No. 0117 at p. 5) Carrier recommended DOE keep non-condensing furnaces with an input capacity of up to 90 kBtu/h for replacement applications where a condensing furnace would be cost prohibitive. (Carrier, No. 0116 at p. 9)

NPGA and AHRI urged DOE to broaden the input capacities reviewed and present for public comment separate standards for small NWGFs defined as ≤ 100 kBtu/h. (NPGA, No. 0171 at pp. 3-4; AHRI, No. 0167 at p. 1)

Several commenters suggested establishing a separate product class based on the size of the dwelling in which the furnace would be installed, which would serve as a proxy for capacity. Washington Gas and NJNG recommended that DOE establish a separate product class for NWGFs for consumers living in smaller dwellings. (Washington Gas, No. 0133 at p. 2; NJNG, No. 0119 at pp. 2-3) AABE, A Ware, and AGL Resources stated that establishing a cut-off at 1,500 square feet and below could potentially protect the larger part of low-income and working-class families. (AABE, No. 0197 at pp. 1-2; A Ware, No. 0204 at p. 1; AGL Resources, No. 0112 at pp. 15-16)

DOE relied on the results of the September 2015 NODA and the analyses prepared for this SNOPR and its policy discretion based on congressional intent to set the proposed bounds of the small and large non-weatherized gas furnace products classes, with special attention being paid to the prevention of fuel switching. In its analysis, in response to suggestions to broaden the range of input capacities considered for the small furnace threshold, DOE also considered TSLs for this SNOPR using 70 kBtu/h and 80 kBtu/h for the small furnace threshold.

For the small furnace product class, DOE only analyzed a standard at 80 percent AFUE. DOE did not find furnaces with AFUE ratings between 80 percent and 90 percent on the current market. DOE understands that such units are generally not viable products in the residential furnace market because such efficiencies approach condensing or in some applications may condense, requiring the design of the unit to incorporate features to handle condensation and prevent corrosion. DOE understands that such features are not cost effective for consumers unless the unit is designed to fully condense, and therefore furnaces with AFUE between 80 percent and 90 percent are generally not produced by manufacturers. DOE did, however, consider a 95 percent standard level for the proposed large furnace product class, as was suggested by some stakeholders. DOE did not ultimately propose this level, and DOE's rationale for selecting the proposed standard levels is contained in section V of this document.

In its analysis, DOE prioritized alleviating the most difficult installation problems and impacts on consumers in the South, all while carefully balancing the impacts on NES and NPV. As a result of these deliberations, DOE has tentatively determined that the requirements of 42 U.S.C. 6295(q)(1) would be satisfied by a small furnace product class for non-weatherized gas furnaces with a certified input capacity cut-off of 55 kBtu/h (for which a non-condensing standard (80 percent AFUE) would apply). An input capacity product class distinction at this level would allow for the best balance of alleviating installation and other cost concerns for the consumer while maintaining national energy savings and associated benefits. Under such a scenario with a 92-percent AFUE standard level for large furnaces (i.e., > 55 kBtu/h certified input capacity) and an 80-percent AFUE standard level for small furnaces (i.e., ≤ 55 kBtu/h certified input capacity), the estimated average LCC savings would increase by $75 to $692, as compared to a savings of $617 for the single standard at 92-percent AFUE. The share of consumers experiencing a net cost would be reduced from 17 percent under the single 92-percent to 11 percent under the approach presented in this SNOPR. National energy savings would increase from 2.8 quads for the single 92-percent AFUE standard to 2.9 quads under the approach presented in this SNOPR (by reducing the share of consumers switching to electric heat from 11.5 percent to 6.8 percent). See section V for full analytical results.

Based upon the foregoing considerations, DOE proposes to establish a separate product class for small NWGFs, defined as those furnaces with a certified input capacity of less than or equal to 55 kBtu/h. Pursuant to 42 U.S.C. 6295(q)(1), DOE has tentatively determined that the certified input capacity of these furnaces is a statutorily permissible basis for setting a class and that a less-stringent standard would be justified for this class, as compared to furnaces with a certified input capacity above 55 kBtu/h, due to the potential for less fuel switching. It is noted in addition that these positive impacts would also be accompanied by an overall increase in NES, NPV, and CO_2 reductions, as compared to the 92-percent AFUE standard originally proposed for all of the subject furnaces.

DOE notes that it was required by statute in a prior rulemaking to consider differential standards for small furnaces based upon input capacity as a means to address fuel switching. Specifically, under 42 U.S.C. 6295(f)(1)(B), Congress directed DOE to consider the appropriate standard level to be set for furnaces with an input capacity of less than 45 kBtu/h. In doing so, Congress directed DOE to consider a standard level within a specified range that was not likely to result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacement. Id. at 6295(f)(1)(B)(iii)).

DOE could justify more than one product class capacity cutoff for small furnaces based on the available data. For example, if DOE only prioritized reducing fuel switching for small gas furnaces, a small furnace product class at 60 kBtu/h or less might be more appropriate. DOE notes that at a 60 kBtu/h cut-off, the share of consumers with net costs is further reduced from 11.1-percent to 6.6-percent and the share of consumers switching to electric heat is further reduced from 6.8-percent to 4.1-percent, but the national energy savings is also reduced from 2.9 to 2.3 quads.

DOE seeks further input regarding selection of the most appropriate small furnaces product class. DOE may consider adopting a different certified input capacity threshold for defining the class of small furnaces in the final rule, or may not adopt a small capacity product class, and seeks comment from stakeholders on its weighing of the benefits and burdens of the various certified input capacity thresholds for defining the small furnaces product class. Although DOE has tentatively determined that the 55 kBtu/h division offers the best balance of benefits and burdens, DOE seeks comment on the balancing of benefits and burdens regarding a small furnace product class of 60 kBtu/h or less. This is identified as issue 1 in section VII.E "Issues on Which DOE Seeks Comment."

d. Other Comments

CEC expressed concern about the impact that a two-tier capacity-based approach would have on new construction in the nation, particularly given the preemptive effect of federal appliance standards on state building codes. CEC stated that a two-tier capacity-based approach would create a difficult situation for California: either the state could continue to ensure that furnaces are properly sized, which may mean installing a smaller-size furnace with a lower efficiency standard, or it could require larger furnaces to be installed, but sacrifice proper sizing for a more-efficient product. (CEC, No. 0172 at pp. 1-2) DOE recognizes the preemptive effect energy conservation standards may have on State building code standards. (See 42 U.S.C. 6297(f)(3)) The sizing assumptions used for the cost-benefit analysis are discussed in section IV.E.

Some stakeholders commented on separate small and large product classes for MHGFs. AHRI and JCI requested that DOE analyze separate standard levels for small and large MHGFs. (AHRI, No. 0195 at p. 1; JCI, No. 0202 at p. 4) JCI suggested that 80-percent AFUE MHGFs with an input capacity of up to 80 kBtu/h should be allowed in replacement applications to provide cost-effective replacement units for consumers that are typically known to be an economically-challenged market segment. (JCI, No. 0202 at p. 4) ACEEE did not recommend a size cutoff for MHGFs, but stated that if DOE were to consider such a cutoff, it would need to be much lower than that for NWGFs. (ACEEE, No. 0113 at p. 5)

DOE does not believe that the considerations for small NWGFs apply equally to small MHGFs. In particular, DOE believes the installation and usage of small and large MHGF are not significantly different and that the cost-benefit is similar regardless of capacity. Therefore, DOE is not proposing a separate product class for small MHGFs.

2. Technology Options

In the market analysis and technology assessment for the March 2015 NOPR, DOE identified 12 technology options that would be expected to improve the AFUE of NWGFs and MHGFs, as measured by the DOE test procedure: (1) using a condensing secondary heat exchanger; (2) increasing the heat exchanger surface area; (3) heat exchanger baffles; (4) heat exchanger surface feature improvements; (5) two-stage combustion; (6) step-modulating combustion; (7) pulse combustion; (8) low NO_X premix burners; (9) burner de-rating; (10) insulation improvements; (11) off-cycle dampers; and (12) direct venting. 80 FR 13119, 13138 (Mar. 12, 2015). In addition, DOE identified three technologies that would reduce the standby mode and off mode energy consumption of residential furnaces: (1) low-loss linear transformer (LL-LTX); (2) switching mode power supply (SMPS); and (3) control relay for models with brushless permanent magnet (BPM) motors. Id.

In response to DOE's proposal, NRDC commented that DOE should consider using a control relay to completely disconnect the BPM motor and other controls when these components of a furnace are not in use. In order to address manufacturer concerns with regard to product lifetime, NRDC suggests that DOE assess whether such a technology option can be implemented in a way that minimizes the number of power cycles, such as only disconnecting the motor and controls components when the furnace has been inactive for more than 24 hours. NRDC estimates that this technology option could potentially provide 2.5 billion kWh of annual energy savings. (NRDC, No. 0134 at p. 8)

In response, DOE notes that in most furnace installations, the furnace fan is still used during periods when the furnace itself is not operating in order to provide airflow for cooling and ventilation purposes. As such, DOE believes that the potential energy savings of a technology option which disconnects power from BPM and controls components after long periods of inactivity would be small, due to the frequency for which the fan is in active mode. However, DOE welcomes further feedback as to a technology option that would disconnect the BPM motor and controls components after long periods of inactivity, especially with regard to the potential energy savings and reliability impacts of such a technology option. This is identified as issue 2 in section VII.E, "Issues on Which DOE Seeks Comment."

After identifying potential technology options for improving the efficiency of residential furnaces, DOE performed the screening analysis (see section IV.B of this

SNOPR or chapter 4 of the SNOPR TSD) on these technologies to determine which could be considered further in the analysis and which should be eliminated.

B. Screening Analysis

DOE uses the following four screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

1) Technological feasibility. Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.

2) Practicability to manufacture, install, and service. If it is determined that mass production and reliable installation and servicing of a technology in commercial products could not be achieved on the scale necessary to serve the relevant market at the time of the projected compliance date of the standard, then that technology will not be considered further.

3) Impacts on product utility or product availability. If it is determined that a technology would have significant adverse impact on the utility of the product to significant subgroups of consumers or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the

same as products generally available in the United States at the time, it will not be considered further.

4) Adverse impacts on health or safety. If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.

10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b).

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the above four criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed below.

The subsequent sections include comments from interested parties in response to the March 2015 NOPR and the September 2015 NODA pertinent to the screening criteria, DOE's evaluation of each technology option against the screening analysis criteria, and whether DOE determined that a technology option should be excluded ("screened out") based on the screening criteria.

1. Screened-Out Technologies

DOE screened out four identified technologies: pulse combustion, burner de-rating, low-NOx premix burners, and control relay to depower brushless permanent magnetic motors. The rationale for screening out each these technologies is outlined below.

DOE decided to screen out the use of pulse combustion from further analysis. Pulse combustion furnaces use self-sustaining pressure waves to draw a fresh fuel-air mixture into the combustion chamber, heat it by way of compression, and then ignite it using a spark. Based on manufacturer feedback received during the manufacturer interviews conducted for the analysis for the June 2011 DFR, DOE understands that pulse combustion furnaces have had reliability and safety issues in the past, and therefore, manufacturers do not consider their use a viable option to improve efficiency. In addition, manufacturers can achieve similar or greater efficiencies through the use of other technologies that do not operate with positive pressure in the heat exchanger, such as those relying on induced draft. (In pulse combustion systems, the positive pressure in the heat exchanger could cause hazardous combustion products (e.g., carbon monoxide) to leak into the home if fatigue caused the heat exchanger to breach.) For these reasons, DOE is not including pulse combustion as a technology option.

DOE also decided to screen out burner de-rating. Burner de-rating reduces the burner firing rate while maintaining the same heat exchanger geometry/surface area and fuel-air ratio, which increases the ratio of heat transfer surface area to the energy input, which increases efficiency. However, the lower energy input means that less heat is provided to the user than is provided using conventional burner firing rates, resulting in slower heating and longer operating hours and/or not enough heat available to heat the intended space. As a result of the decreased heat output of furnaces with de-rated burners, DOE has screened out burner de-rating as a technology option, as it could reduce consumer utility.

In addition, DOE is screening out low-NO_X premix burners from further analysis. Premix burners eliminate the need for secondary air in the combustion process by completely mixing heating fuel with primary air prior to ignition. This raises the overall flame temperature, which improves heat transfer and AFUE. In-shot burners that are commonly used in residential furnaces, on the other hand, cannot entrain sufficient primary air to completely premix the air and gas. As a result, premix burner design incorporates a fan to ensure sufficient and complete mixing of the air and fuel prior to combustion and does so by delivering the air to the fuel at positive pressure. To the extent of DOE's knowledge, and based on manufacturer feedback during the manufacturer interviews conducted prior to the March 2015 NOPR, low-NO_X premix burners have not yet been successfully incorporated into a residential furnace design that is widely available on the market. DOE is aware that low-NO_X premix burners have been incorporated into boilers, but boilers have significantly different heat exchangers and burners, allowing for the integration of premix burner technology in those products. Incorporating this technology into furnaces on a large scale will require further research and development due to the technical constraints imposed by current furnace burner and heat exchanger design.

Lennox commented that the screening analysis should have prevented the elimination of non-condensing furnaces from the market because these units cannot be easily replaced by condensing furnaces. Lennox argued that under a condensing furnace standard, consumers using non-condensing furnaces in cold weather could be at a safety risk if the furnace fails, due to the difficulty of replacing a non-condensing furnace with a condensing model. Therefore, Lennox believes that the potential elimination of non-condensing furnaces from the marketplace is a violation of screening criteria number 4: adverse impacts on health or safety. (Lennox, No. 0125 at pp. 6-7)

As stated in 10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b), DOE screens out a technology option from further consideration in the engineering analysis if DOE determines that the technology option itself would have “significant adverse impacts on health or safety.” Although DOE recognizes that replacing a non-condensing furnace with a condensing furnace may take additional time as compared to replacing a non-condensing furnace, DOE does not believe that the amount of time is significant enough to constitute a safety issue for occupants whose furnace has failed. The additional time for replacing a non-condensing furnace with a condensing furnaces was considered in the LCC analysis (section IV.F of this SNOPR and chapter 8 of the SNOPR TSD), and DOE estimated that the maximum additional time needed for such replacement would total approximately 5 hours. DOE considered safety concerns presented by commenters responding to the March 2015 NOPR and September 2015 NODA (see section III.F.2) but determined that they were not sufficient to screen out condensing heat exchanger technology.

Among the standby and off mode technologies, DOE screened out using a control relay to depower BPM motors due to feedback received during the manufacturer interviews conducted for the residential furnaces June 2011 DFR. For this technology option, a switch is spring-loaded to a disconnected position, and can only close to allow a supply of electrical power to the BPM motor upon an inrush of current. Manufacturer interviews indicated that using a control relay to depower BPM motors could reduce the lifetime of the motors (the reason for this reduction in product lifetime is further explained in chapter 4 of the TSD). DOE believes that this reduction in lifetime would lead to a reduction in utility of the product. For this reason, DOE is not including control relays for models with brushless permanent magnet motors as a technology option, as it could reduce consumer utility.

Ingersoll Rand commented that due to a lack of manufacturer experience, implementation of SMPS as a technology option for improving furnace efficiency in standby/off mode may introduce reliability issues. Ingersoll Rand believes that when considering the amount of energy savings offered by SMPS, which Ingersoll Rand considers to be low, the potential reliability issues for consumers are not justified. (Ingersoll Rand, NOPR public meeting transcript, No. 0044 at pp. 99-100) In response, DOE considers SMPS to have reached technological maturity in other consumer products, and is not aware of any specific reasons as to why it would not be able to achieve the same level of long-term reliability in furnaces that it has reached in other products. As such, DOE considers SMPS as a technology option to reduce standby/off mode energy consumption in the analyses for this SNOPR.

Goodman commented that DOE should not consider LL-LTX as a technology option for reducing standby/off mode energy consumption. Due to what Goodman sees as currently limited market penetration, Goodman believes that manufacturers need more time to research the failure modes, repair costs, and design changes that are incurred with implementation of LL-LTX technology, and that the LCC analysis cannot currently address the repair costs associated with LL-LTX. (Goodman, No. 0135 at pp. 4-5) DOE is not aware of any specific barriers to implementation of LL-LTX as a technology option to reduce standby/off mode energy consumption. DOE believes that due to the technological similarities between LL-LTX and LTX technology, the latter of which is already commonplace in many consumer products, LL-LTX would have little difficulty achieving market acceptance in furnaces. Therefore, DOE has considered LL-LTX as a technology option to reduce standby/off mode energy consumption in this SNOPR.

2. Remaining Technologies

Through a review of each technology, DOE tentatively concludes that all of the other identified technologies listed in section IV.A.2 met all four screening criteria as needed to be examined further as design options in DOE's NOPR analysis. In summary, DOE did not screen out the following technology options to improve AFUE: (1) condensing secondary heat exchanger; (2) increased heat exchanger face area; (3) heat exchanger baffles; (4) heat exchanger surface feature improvements; (5) two-stage combustion; (6) step-modulating combustion; (7) insulation improvements; (8) off-cycle dampers; and (9) direct venting. DOE also maintained the following technology options to improve standby mode and off mode energy consumption: (1) low-loss transformer; and (2) switching mode power supply. DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially-available products or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (i.e., practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety). For additional details, see chapter 4 of the SNOPR TSD.

C. Engineering Analysis

In the engineering analysis, DOE establishes the relationship between the manufacturer selling price (MSP) and improved NWGF and MHGF efficiency. This relationship serves as the basis for cost-benefit calculations for individual consumers, manufacturers, and the Nation. DOE typically structures the engineering analysis using one of three approaches: (1) design option; (2) efficiency level; or (3) reverse engineering (or cost assessment). The design-option approach involves adding the estimated cost and associated efficiency of various efficiency-improving design changes to the baseline product to model different levels of efficiency. The efficiency-level approach uses estimates of cost and efficiency of products available on the market at distinct efficiency levels to develop the cost-efficiency relationship. The reverse-engineering approach involves testing products for efficiency and determining cost from a detailed bill of materials (BOM) derived from reverse engineering representative products. For both NWGF and MHGF, the efficiency ranges from that of the least-efficient unit sold today (i.e., the baseline efficiency level) to the maximum technologically feasible efficiency level. At each efficiency level examined, DOE determines the MSP; this relationship is referred to as a cost-efficiency curve.

DOE conducted the AFUE engineering analysis for residential furnaces in this SNOPR using a methodology similar to that which was used for the March 2015 NOPR, but with some updates which are discussed both below and in chapter 5 of the SNOPR TSD. For completeness and convenience of the reader, DOE is reiterating portions of the engineering analysis information already presented in the March 2015 NOPR. The AFUE engineering analysis for this SNOPR used a combination of the efficiency-level and reverse-engineering approaches. More specifically, DOE identified the efficiency levels for analysis and then used the reverse-engineering approach to determine both the technologies used and their associated manufacturing costs at those levels. In the residential furnace market, manufacturers may use slight variations on designs to achieve a given efficiency level. The benefit of using the efficiency-level approach is that it allows DOE to examine products at each efficiency level regardless of the specific design options that manufacturers use to achieve that level, so the analysis can account for variations in design. Using the reverse-engineering approach to estimate production cost at each efficiency level allows DOE to analyze actual models as the basis for developing the MSPs.

For the standby mode and off mode analysis conducted for this SNOPR, DOE also replicated the methodology that was used for this analysis in the March 2015 NOPR. In this analysis, DOE adopted a design option approach, which allowed for the calculation of incremental costs through the addition of specific design options to a baseline model. DOE decided on this approach because it did not have sufficient data to execute an efficiency-level analysis, as manufacturers typically do not rate or publish data on the standby mode and/or off mode energy consumption of their products. As such, DOE was not able to conduct a reverse-engineering approach due to a lack of definitive knowledge of the electrical energy consumption of products on the market.

Also, the design options used to obtain higher efficiencies were composed of purchased parts, so obtaining price quotes on these electrical components was more accurate than attempting to determine their manufacturing costs via a reverse-engineering analysis.

1. Efficiency Levels

As noted above, for analysis of amended AFUE standards in this SNOPR, DOE used an efficiency-level approach in combination with a reverse-engineering approach to identify the technology options needed to reach incrementally higher efficiency levels. DOE physically tore down newly manufactured furnaces for its analysis. Prior to teardown, all of the furnaces were tested to verify their AFUE ratings and determine their standby mode and off mode power consumption (in watts). From the market analysis, DOE was able to identify the most common AFUE ratings of NWGF and MHGF on the market and used this information to select AFUE efficiency levels for analysis. After identifying AFUE efficiency levels for analysis, DOE used the reverse-engineering approach (see section IV.C.2.a) to determine the manufacturer production cost (MPC) at each AFUE efficiency level identified for analysis.

For the analysis of new standby mode and off-mode energy conservation standards, DOE used a design-option approach to identify the efficiency levels that would result from implementing certain design options for reducing power consumption in standby mode and off mode.

a. Baseline Efficiency Level and Product Characteristics

DOE selected baseline units typical of the least-efficient commercially-available residential furnaces. DOE selected baseline units as reference points for both NWGFs and MHGFs, against which it measured changes resulting from potential amended energy conservation standards. The baseline unit in each product class represents the basic characteristics of products in that class. Additional details on the selection of baseline units may be found in chapter 5 of the SNOPR TSD.

DOE uses the baseline unit for comparison in several phases of the analyses, including the engineering analysis, LCC analysis, PBP analysis, and the NIA. To determine energy savings that will result from an amended energy conservation standard, DOE compares energy use at each of the higher energy efficiency levels to the energy consumption of the baseline unit. Similarly, to determine the changes in price to the consumer that will result from an amended energy conservation standard, DOE compares the price of a baseline unit to the price of a unit at each higher efficiency level.

AFUE

In the analysis of amended AFUE standards, when calculating the price of a baseline furnace and comparing it to the price of units at each higher efficiency level, DOE factored in future changes to the indoor blower motor baseline design option resulting from the 2014 furnace fans final rule.[31] 79 FR 38219 (July 3, 2014), 10 CFR §430.32(y). The 2014 furnace fans final rule set new baseline efficiency levels for

[31] For more information on the Furnace Fans Rulemaking, see the DOE Furnace Fans Rulemaking webpage at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/41.

furnace fans requiring compliance on July 3, 2019, which include a level effectively requiring constant torque BPM motors as the minimum standard indoor blower motor technology option for NWGF units, and improved primary split capacitor (PSC) motors as the minimum standard technology option for MHGF units. As such, beginning in July 2019, constant torque BPM motors will be the baseline design feature for NWGF units, and improved PSC motors will be the baseline design feature for MHGF units. DOE has included constant torque BPM motors and improved PSC motors in the MPCs for NWGF and MHGF units, respectively. The current and expected baseline motor types are listed in Table IV.**1**.

Table IV.1 Baseline Blower Motor Types (Current and Expected in 2019)

Product Class	**Current Typical Baseline Blower Motor Type**	**Expected Typical Baseline Blower Motor Type Starting in 2019**
NWGF	PSC	Constant-Torque BPM
MHGF	PSC	Improved PSC

Currently, the baseline indoor blower motor design option for all residential furnace types is a PSC motor. From here, the next step up is an improved PSC motor, which consumes less energy during fan operation than a standard PSC motor. As compared to improved PSC motors, BPM motors offer further efficiency improvements. BPM motors feature a completely redesigned inner drive mechanism, which significantly reduces electricity wasted as heat during fan operation. The basic type of BPM motor is a constant torque BPM motor, which accepts a specified number of torque commands from an outside control source. A second type of BPM motor is a constant airflow BPM motor, which is similar to a constant torque BPM motor, but allows for more precise operational commands. Constant airflow BPM motors accept precise airflow commands from an outside control source, which allow it to adjust the building airflow to a wide range of operational demands.

Table IV.**2** presents the baseline AFUE levels identified for each product class of furnaces. The baseline AFUE levels analyzed are the same as the current federal minimum AFUE standards for furnaces, as established by the November 2007 final rule. 10 CFR 430.32(e)(1)(ii); 72 FR 65136, 65169 (Nov. 19, 2007).

Table IV.2 Baseline Residential Furnace AFUE Efficiency Levels

Product Class	Certified Input Capacity (kBtu/h)	AFUE (percent)
Non-Weatherized Gas Furnaces	≤ 55 kBtu/h	80
	> 55 kBtu/h	80
Mobile Home Gas Furnaces	All	80

Standby/off mode

"Standby mode" and "off mode" power consumption are defined in the DOE test procedure for residential furnaces and boilers. DOE defines "standby mode" for residential furnaces and boilers as "the condition during the heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as blowers or pumps, are activated." (10 CFR part 430, subpart B, appendix N, section 2.8) "Off mode" for residential furnaces and boilers is defined as "the condition during the non-heating season in which the furnace or boiler is connected to the power source, and neither the burner, electric resistance elements, nor any electrical auxiliaries such as the blowers or pumps, are activated." (10 CFR part 430, subpart B, appendix N, section 2.6) A "seasonal off switch" is defined as "the switch on the furnace or boiler that, when activated, results in a measurable change in energy consumption between the standby and off modes." (10 CFR part 430, subpart B, appendix N, section 2.7.)

Through reviewing product literature and discussions with manufacturers, DOE has found that furnaces generally do not have a seasonal off switch that would be used to turn the product off during the off season. Manufacturers stated that if a switch is included with a product, it is left in the on position during the non-heating season because the indoor blower motor in the furnace is needed to move air for the AC side of the home's HVAC system and that the switch is typically used only as a service or repair switch. Rheem commented that it does not believe that energy consumption is the same for standby and off mode, but also stated that it has not rated any furnaces in the off mode. (Rheem, No. 0142 at p. 5). As previously discussed, DOE estimates that for a large majority of furnaces an off switch is not included on the unit. However, DOE notes that if a furnace does include an off switch, then the energy consumption in off mode for that furnace would be reduced below that of standby mode. Accordingly, in the analysis of standby mode and off mode energy conservation standards, DOE treated the standby mode and the off mode power consumption for residential furnaces as equal in order to be conservative. DOE requests further comment on the treatment of standby mode and off mode energy consumption (as defined by DOE) as equal. This is identified as issue 3 in section VII.E, "Issues on Which DOE Seeks Comment."

For the standby mode and off-mode analysis, DOE identified baseline components as those that consume the most electricity during the operation of those modes. Because it would not be practical for DOE to test every furnace on the market to determine the baseline efficiency, and manufacturers do not currently report standby mode and off mode energy consumption, DOE “assembled” the most consumptive baseline components from the models tested to model the electrical system of a furnace with the expected maximum system standby mode and off mode power consumption observed during testing of furnaces.

In response to this approach detailed in the March 2015 NOPR, EEI commented that this method of selecting the baseline efficiency level is very conservative, and as a result, there are many units on the market which will already comply with the max-tech standby/off mode efficiency level proposed in the March 2015 NOPR. (EEI, No. 169 at p. 12) However, EEI also commented that due to potential future additions of furnace functions that consume energy in standby/off mode (i.e. smart-grid applications, gas demand response, carbon mono$_{X}$ide monitoring, self-diagnostics, maintenance warnings, energy usage displays, remote temperature settings, methane leak detection/warnings, etc.), the future max-tech standby/off mode efficiency level may have higher energy consumption in standby/off mode than the max-tech identified by DOE. (EEI, No. 0169 at pp. 12-14)

DOE understands EEI’s concern that the max-tech efficiency level identified in the March 2015 NOPR analysis does not account for additional functions that consume energy in standby/off mode that may be added to units in the future. However, DOE believes that, as EEI also commented, the conservatively-selected baseline efficiency level that DOE selected in the March 2015 NOPR may be substantially lower (i.e. higher power consumption) than the efficiencies of many units currently on the market today. DOE believes that the baseline used for this SNOPR allows for the future addition of furnace functions that operate in the standby/off mode, while still allowing the unit to comply with the proposed standard. Additionally, due to a lack of detailed information as to what additional functions may be added to furnaces in the future, DOE has tentatively maintained the March 2015 NOPR baseline efficiency level in this SNOPR. However, DOE seeks further detailed feedback as to anticipated furnace functions that would operate in the standby/off mode and the energy consumption of such functions in relation to the baseline efficiency in standby/off mode. This is identified as issue 4 in section VII.E, "Issues on Which DOE Seeks Comment." The components of the baseline standby mode and off-mode consumption level used in this SNOPR analysis are presented in Table IV.3.

Table IV.3 Baseline Standby Mode and Off Mode Power Consumption for NWGF and MHGF

Component	Standby Mode and Off-Mode Power Consumption (watts)
Transformer	4
ECM Blower Motor (includes controls)	3
Controls/Other	4
Total (watts)	**11**

b. Other Energy Efficiency Levels

<u>AFUE</u>

Table IV.4 and Table IV.5 show the efficiency levels DOE selected for analysis of amended AFUE standards for NWGF (both small and large) and MHGF, respectively, along with a description of the typical technological change at each level. The efficiency levels analyzed for both small and large NWGF in this SNOPR are the same as those which were analyzed for NWGF in the March 2015 NOPR. For MHGF, the efficiency levels analyzed in this SNOPR are the same as in the NOPR, except at the max-tech efficiency level, which is 96 percent AFUE in this SNOPR, but was 97 percent AFUE in the March 2015 NOPR. 80 FR 13120, 13141 (March 12, 2015). This change occurred because the January 2016 residential furnaces test procedure final rule amended the rounding requirements for AFUE ratings to require rounding to the nearest 0.1 percent AFUE point, rather than rounding to the nearest 1 percent AFUE point, as was required prior to the test procedure amendment. 81 FR 2627, 2638 (Jan. 15, 2016). Because the max-tech MHGF unit in the March 2015 NOPR analysis was 96.5 percent AFUE, this unit could have been rated as 97 percent AFUE under the test procedure requirements at the time of the March 2015 NOPR. (10 CFR 430.23(n) as codified on January 1, 2016) The max-tech MHGF unit at the time of the analysis for this SNOPR was still 96.5 percent AFUE, but due to the changes in rounding procedures for AFUE ratings since the March 2015 NOPR, this unit would not be able to achieve a 97 percent AFUE rating under the current DOE test procedure. As such, DOE revised the MHGF max-tech efficiency level to 96 percent AFUE in the analyses for this SNOPR.

Table IV.4 AFUE Efficiency Levels for Non-Weatherized Gas Furnaces (Small and Large)

Efficiency Level (EL)	**AFUE %**	**Technology Options**
0 – Baseline	80	Baseline
1	90	EL0 + Secondary condensing heat exchanger
2	92	EL1 + Increased heat exchanger area
3	95	EL2 + Increased heat exchanger area

4 – Max-Tech	98	EL3 + Increased heat exchanger area + Step-modulating combustion + Constant-airflow BPM blower motor

Table IV.5 AFUE Efficiency Levels for Mobile Home Gas Furnaces

Efficiency Level	**AFUE %**	**Technology Options**
0 – Baseline	80	Baseline
1	92	EL0 + Secondary condensing heat exchanger
2	95	EL1 + Increased heat exchanger area
3 – Max-Tech	96	EL2 + Increased heat exchanger area

In addition to the technology options listed in Table IV.4 and Table IV.5, DOE considered certain enhanced design features that may be chosen for consumer comfort or to reduce electrical energy consumption during furnace operating periods. These enhancements are listed in Table IV.6.

Table IV.6 Design features not directly included in analysis of AFUE efficiency levels

Design Feature	**Baseline option**	**Enhanced Option**
NWGF Indoor Blower Motor	Constant torque brushless permanent magnet (BPM) motor*	Constant airflow BPM motor
MHGF Indoor Blower Motor	Improved PSC motor*	Constant torque BPM motor
		Constant airflow BPM motor
MHGF combustion system	Single-stage combustion	Two-stage combustion (includes two-stage gas valve, two-speed inducer assembly, upgraded pressure switch, and additional controls and wiring)

*The baseline design options listed for NWGF and MHGF indoor blower motors will not become effective until 2019 when the 2014 furnace fan rulemaking mandates new efficiency standards for furnace fans.

DOE research suggests that furnaces contain either PSC or BPM fan motors; PSC motors are typically available with up to 5 speeds, whereas BPM fan motors are variable-speed and typically offer higher efficiency. Within the BPM product family, fan motors are generally classified as either constant torque or constant airflow. The construction of these motors is similar, but the more sophisticated electronics on constant airflow fan motors allow a wider fan modulation range and can be programmed to maintain a desired airflow across a wide range of static pressures. DOE research suggests that systems with constant airflow BPM motors can better accommodate varying building conditions than constant torque BPM and PSC motors, and may be chosen for enhanced consumer comfort. Constant airflow BPM motors are also the current standard motor type at the max-tech AFUE level for NWGF units.

The combustion system baseline design feature for MHGF is a single-stage combustion system, which includes a single-stage gas valve and a single-speed inducer fan assembly. The hysteresis of the thermostat controlling the furnace may cause this system to over- and undershoot the target temperature, which is uncomfortable for the mobile home occupants and consumes more energy than is necessary. To improve comfort and potentially save energy, a two-stage combustion system can be used in place of a single-stage combustion system. A two-stage combustion system allows a suitable thermostat to vary the heating input in stages, potentially resulting in better actual building versus target temperature performance. As discussed in the 2014 furnace fans final rule, the furnace fans energy conservation standards have a mandatory compliance date of July 3, 2019. Thus, manufacturers will likely incorporate two-stage combustion into the designs of most NWGFs by 2019 in order to comply with the furnace fans standards. 79 FR 38129, 38184, 38201 (July 3, 2014). Therefore, for the purpose of its engineering analysis in the March 2015 NOPR and in this SNOPR, DOE assumed that a majority of furnaces would switch to two-stage combustion in order to comply with the furnace fan standard. As such, DOE included two-stage combustion as a standard design for NWGF in this analysis.

Two-stage combustion technology was also one of the technology options DOE considered in the engineering analysis for improving AFUE. However, depending on the product, this option appears to offer a minor to negligible improvement of AFUE. Based on market analysis, DOE determined that two-stage combustion is a common design feature in residential furnaces. DOE research suggests that two-stage combustion is currently primarily offered to consumers as a comfort feature rather than for its efficiency benefits.

Standby/off mode

Table IV.**7** shows the efficiency levels DOE selected for the analysis of standby mode and off mode standards in this SNOPR, along with a description of the design options used to achieve each efficiency level above baseline. The baseline technology options include a linear power supply and a 40VA linear transformer (LTX). Technology options that may be used to achieve efficiency levels above baseline include a low-loss LTX (LL-LTX) and a switching mode power supply (SMPS).

Table IV.7 Standby Mode and Off Mode Efficiency Levels for Non-Weatherized Gas and Mobile Home Gas furnaces

Efficiency Level EL	Standby Mode and Off Mode Power Consumption (W)	Technology Options
0 – Baseline	11	Linear Power Supply with 40VA LTX
1	9.5	Linear Power Supply with 40VA LL-LTX
2	9.2	SMPS with 20VA LTX
3 – Max-Tech	8.5	SMPS with 20VA LL-LTX

In response to the analysis DOE presented in the March 2015 NOPR for standby/off mode efficiency standards, EEI commented that the Nielsen study referenced by DOE in Chapter 3 (on page 3-38) of the March 2015 NOPR TSD states that standard 2-3 watt transformers have no load losses ranging between 0.5 and 1.5 watts, and therefore EEI wanted clarification on how DOE determined in the March 2015 NOPR that transitioning from a conventional linear transformer to a low-loss linear transformer (LL-LTX) could save 1.5 watts. (EEI, No. 0160 at p. 14) DOE notes that, as discussed in the Nielsen study, these "standard 2-3 watt transformers" feature a much lower capacity than the transformers typically used in residential furnaces. DOE's teardown analysis (see section IV.C.2) and review of product literature indicated that furnaces typically ship with much larger 40VA transformers. DOE estimates that larger 40 VA transformers used in residential furnaces will have standby losses of approximately two watts. The Nielsen study concludes that an LL-LTX standby losses are about 25 percent of the losses of a LTX[32]. As such, an LL-LTX will consume approximately 25 percent of

[32] N. Nielsen. "Loss Optimizing Low Power 50 Hz Transformers Intended for AC/DC Standby Power Supplies." *Applied Power Electronics Conference and Exposition, 2004.* IEEE, pp. 420–25, September 9, 2004.

the two watts consumed in standby mode by a LTX, which for a 40 VA LL-LTX is 0.5 watts, thus reducing LTX transformer losses by 1.5 watts. Therefore, DOE has maintained in the SNOPR standby/off mode analysis that the implementation of an LL-LTX at EL1 will result in a 1.5 watt reduction in standby losses relative to the baseline efficiency level. Similarly, at EL3 a 20 VA LL-LTX will consume approximately 25 percent of the one watt consumed at EL2 by a 20 VA LTX. As such, the 20 VA LL-LTX at EL3 will consume approximately 0.25 watts, reducing 20 VA LTX transformer losses by 0.75 watts at EL2.

EEI also commented that the margin of error for the equipment used to test the standby/off mode energy consumption of furnaces may be larger than the incremental reduction in standby losses between some efficiency levels. As a result, EEI stated that some units would not experience a measurable reduction in standby losses as a result of implementing some of the design options. (EEI, NOPR Public Meeting Transcript, No. 0044 at pp. 94-95) DOE notes that the equipment used to test the standby/off mode energy consumption of the furnaces in this analysis has a published accuracy of within 0.1 percent (see Chapter 5 of the SNOPR TSD for further information). Between the efficiency levels analyzed, the smallest incremental decrease in standby/off mode energy consumption (which occurs between EL1 and EL2) is 0.3 watts. This is significantly larger than both of the 0.1 percent margins of error for EL1 and EL2, which are 0.0095 watts and 0.0092 watts, respectively. Therefore, DOE believes that a reduction in standby losses at each efficiency level would be captured by current test methods, because the incremental reductions in standby losses are outside of the margin of error of testing equipment.

In addition, EEI questioned how implementation of an LL-LTX at EL1 offers 1.5 watts of energy savings and implementation of a SMPS at EL2 offers 1.8 watts of energy savings, but implementation of both of these design options at EL3 only offers 2.5 watts of energy savings, rather than the sum of the savings at EL1 and EL2, which would be 3.3 watts of savings. (EEI, No. 0169 at p. 13) In response, DOE clarifies that the implementation of a SMPS provides the proper voltage reduction needed for the furnace control board, but a smaller AC-AC transformer is still required to provide 24VAC power for thermostats. DOE estimated that a 20VA transformer would be sufficient to power thermostats. As such, the required capacity for a LL-LTX implemented in tandem with a SMPS at EL3 is smaller than that of a LL-LTX implemented with a linear power supply at EL1 (20VA vs. 40VA, respectively, as shown in Table IV.**7**). Because the transformer at EL3 has half the capacity of the transformer at EL1, the potential energy savings of switching to a LL-LTX at EL3 is lower than the savings provided at EL1(see prior discussion).

EEI commented that due to the low wattage differences between each efficiency level, implementing the design options listed (see Table IV.**7**) to achieve efficiency levels above baseline may not always result in a reduction in energy consumption. EEI suggested that, due to the potential range of standby/off mode energy consumption values for units that incorporate any of these given design options, units could potentially have a higher energy usage than units which incorporate a design option corresponding with a lower efficiency level (corresponding efficiency levels also listed in Table IV.**7**).

In response, DOE understands that units which incorporate any of the design options listed in Table IV.**7** will have a range of energy consumption values which may differ from the corresponding energy consumption value listed in the table.

As mentioned previously, DOE developed the baseline efficiency level as a sum of the highest energy consumption measurements it obtained by testing the various components that consume standby power in furnaces. The specific energy consumption values associated with each incremental efficiency levels were then developed by reducing the baseline energy consumption by the reduction in energy consumption provided by the particular design option implemented at that efficiency level. Because of the conservative nature by which the baseline energy consumption value was developed, DOE expects that many units already achieve standby/off mode energy usage levels which are lower than the current baseline. DOE further expects that those units that do not currently meet the proposed efficiency level could do so via implementation of the listed design options corresponding with that level in Table IV.**7**.

Goodman commented that to properly accommodate the LL-LTX design option (which is used at EL1 and EL3), it may be necessary to redesign the furnace platform, because LL-LTX are larger than baseline LTX. (Goodman, No. 0135 at pp. 4-5) In the engineering analyses for this SNOPR, DOE has not accounted for any particular design changes to the furnace platform as a requirement in order to implement an LL-LTX. Every furnace reverse-engineered by DOE appeared to have room for a larger transformer. DOE estimates that the 20VA LL-LTX transformer that could be used (along with other components) to reach EL3 is not significantly larger than the current 40VA LTX typically used in baseline designs. DOE has reverse-engineered a number of control boards in space-constrained appliances where the power supplies made a transition from a linear power supply to SMPS without any changes to the size of the printed circuit board. DOE welcomes further feedback as to any design modifications which may be necessary in order to integrate LL-LTX into furnaces. This is identified as issue 5 in section VII.E, "Issues on Which DOE Seeks Comment."

DOE requests further comment on the efficiency levels analyzed for standby mode and off mode. In particular, DOE welcomes any additional feedback as to the technological feasibility of achieving the proposed max-tech standby/off mode energy consumption value of 8.5 watts. This is identified as issue 6 in section VII.E, "Issues on Which DOE Seeks Comment."

2. Cost-Assessment Methodology

At the start of the engineering analysis, DOE identified the energy efficiency levels associated with residential furnaces on the market using data gathered in the market assessment. DOE also identified the technologies and features that are typically incorporated into products at the baseline level and at the various energy efficiency levels analyzed above the baseline. Next, DOE selected products for physical teardown analysis having characteristics of typical products on the market at the representative input capacity. DOE gathered information by performing a physical teardown analysis (see section IV.C.2.a) to create detailed BOMs, which included all components and processes used to manufacture the products. DOE used the BOMs from the teardowns as inputs to calculate the MPC for products at various efficiency levels spanning the full range of efficiencies from the baseline to the maximum technology achievable ("max-tech") level.

During the development of the engineering analysis for the March 2015 NOPR, DOE held interviews with manufacturers to gain insight into the residential furnace industry, and to request feedback on the engineering analysis. DOE used the information gathered from these interviews, along with the information obtained through the teardown analysis, to refine its MPC estimates for this rulemaking. Next, DOE derived manufacturer markups using publicly-available residential furnace industry financial data in conjunction with manufacturers' feedback. The markups were used to convert the MPCs into MSPs. Further information on the analytical methodology is presented in the subsections below. For additional detail, see chapter 5 of the SNOPR TSD.

a. Teardown Analysis

To assemble BOMs and to calculate the manufacturing costs for the different components in residential furnaces, DOE disassembled multiple units into their base components and estimated the materials, processes, and labor required for the manufacture of each individual component, a process referred to as a "physical teardown." Using the data gathered from the physical teardowns, DOE characterized each component according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it.

DOE also used a supplementary method, called a “virtual teardown,” which examines published manufacturer catalogs and supplementary component data to estimate the major physical differences between a product that was physically disassembled and a similar product that was not. For supplementary virtual teardowns, DOE gathered product data such as dimensions, weight, and design features from publicly-available information, such as manufacturer catalogs. For this SNOPR, data from a total of 77 physical and virtual teardowns of residential furnaces were used to calculate industry MPCs in the engineering analysis.

The teardown analysis allowed DOE to identify the technologies that manufacturers typically incorporate into their products, along with the efficiency levels associated with each technology or combination of technologies. The end result of each teardown is a structured BOM, which DOE developed for each of the physical and virtual teardowns. The BOMs incorporate all materials, components, and fasteners (classified as either raw materials or purchased parts and assemblies), and characterize the materials and components by weight, manufacturing processes used, dimensions, material, and quantity. The BOMs from the teardown analysis were then used as inputs to calculate the MPC for each product that was torn down. The MPCs resulting from the teardowns were then used to develop an industry average MPC for each efficiency level of each product class analyzed. For more detailed information on DOE’s teardown analysis, see Chapter chapter 5 of the SNOPR TSD.

In response to the NOPR, DOE received multiple comments suggesting that the engineering analysis be based on furnace pricing currently seen in the market, rather than teardowns, due to the fact that the inputs to the teardown analysis are not made publicly available. APGA expressed concern with the level of transparency given that DOE does not disclose the product specific details obtained through the teardown analysis. APGA stated that without disclosure of the product specific details from the teardown analysis, it is not possible to verify that its outputs are accurate. Further, APGA stated that DOE should not use inputs to its analysis that it cannot make public, and should examine the real world prices of furnaces as a way of determining consumer prices. (APGA, No. 0106 at pp. 32-34) Laclede commented that its employees solicited price bids for installation of condensing furnaces in their homes, and found that the incremental installed costs were higher than those determined by DOE's analysis. Laclede stated that using this type of methodology to determine costs is better founded than the teardown methodology used by DOE. (Laclede, No. 0141 at pp. 24-27) Ingersoll Rand inquired as to whether DOE compares the manufacturing costs generated by the teardown analysis with the prices that DOE pays to purchase the furnaces which it tears down. (Ingersoll Rand, NOPR Public Meeting Transcript, No. 0044 at p. 5960)

DOE notes that the sales prices of furnaces currently seen in the market place, which include both an MPC and various markups applied through the distribution chain, are not necessarily indicative of what the sales prices of those furnaces would be following the implementation of a more stringent energy conservation standard. At a given efficiency level, the furnace MPC depends in part on the production volume. At any given efficiency level above the current baseline, the industry-aggregated MPC for furnaces at that level may be high relative to what it would be under a more stringent standard, due to the increase in production volume (and thus, improved economies of scale and purchasing power for furnace components) which would occur at that level if a federal standard made it the new baseline efficiency. Under a more stringent standard, the markups incorporated into the sales price may change relative to current markups. This could occur due to the changes in market forces caused by an increase in demand for furnaces at that higher efficiency, as well as changes in the production and installation costs of furnaces at that level resulting from higher production volumes, greater experience with condensing furnace installations, and a multitude of other factors. As higher efficiency furnaces become a commodity rather than a premium product, high efficiency furnaces may not command the same markups that can be applied to such products presently. Therefore, basing the engineering analysis on prices of furnaces as currently seen in the market place would be a less accurate method of estimating future furnace prices following an amended standard. It is for these reasons that DOE conducts - interviews with manufacturers under non-disclosure agreements (NDAs) to determine if the MPCs developed by the analysis reflect the industry average cost rather than current sales prices. Because the cost estimation methodology uses data supplied by manufacturers under the NDAs (such as raw material and purchased part prices), the resulting individual model cost estimates themselves cannot be published.

Stakeholders also suggested that DOE take action to improve the transparency of the engineering analysis by releasing certain information currently not available within the public domain. AGA requested that all information used as inputs to the development of manufacturing costs be made publicly available so that its validity can be assessed, emphasizing its view that MPC calculations are foundational to the entire analytical process. (AGA, NOPR Public Meeting Transcript, No. 0044 at pp. 73-74) Similarly, Laclede commented that it would like access to the BOM spreadsheets used in the engineering analysis in order to determine how accurate the manufacturer cost calculations are. (Laclede, NOPR Public Meeting Transcript, No. 0044, at pp. 71-72) However, Rheem objected to DOE publishing any information on the manufacturing costs of Rheem's units. Further, Rheem commented that manufacturers in general will object to having a BOM from a complete teardown analysis of their product(s) available to the public. (Rheem, NOPR Public Meeting Transcript, No. 0044, at pp. 74-75).

DOE acknowledges both AGA and Laclede's concern about the public availability of the information that is derived from the teardown analysis. However, DOE also understands Rheem's comment that furnace manufacturers would object to having any sensitive information related to the design of their products being released into the public domain. Additionally, DOE notes that all manufacturers that participated in manufacturer interviews had access to DOE's MPC estimates for models they manufacture that were torn down, as well as the raw material and purchased part price data underlying the MPC estimates for those models. These discussions were covered by NDAs to allow manufacturers to submit confidential data and to comment freely on the inputs into the DOE analysis as well as the results. The MPCs presented herein take into account this feedback from manufacturers.

DOE's treatment of confidential business information is governed by the Freedom of Information Act (FOIA) and 10 CFR 1004.11. (5 U.S.C. 552(b)(4)) While DOE is responsible for making the final determination whether to disclose such information contained in requested documents, DOE will consider the submitter's views in making its determination. (10 CFR 1004.11(a),(c)) Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest. (10 CFR 429.7(c)(2)) For additional discussion of confidential business information, see the Confidential Business Information Discussion below.

In the present case, as is generally the case in appliance standards rulemakings, manufacturer and product specific data is presented in aggregate. Given the potential for competitive harm, data is not released outside the aggregated form to DOE or its National Labs. The BOMs used to estimate the industry-aggregate MPCs are developed by a DOE contractor and are not provided to DOE; DOE only receives the industry-aggregate MPCs from its contractor for use in its analyses. This approach allows manufacturers to provide feedback under NDA, improving the quality of the analysis.

More information regarding details on the teardown analysis can be found in chapter 5 of the SNOPR TSD.

b. Cost Estimation Method

The costs of individual models are estimated using the content of the BOMs (i.e. materials, fabrication, labor, and all other aspects that make up a production facility) to generate MPCs. These MPCs hence include overhead and depreciation, for example. DOE collected information on labor rates, tooling costs, raw material prices, and other factors as inputs into the cost estimates. For purchased parts, DOE estimates the purchase price based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers. For fabricated parts, the prices of raw metal materials`[33] (e.g., tube, sheet metal) are estimated on the basis of 5-year averages (from 2010 to 2015). The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing.[34]

c. Manufacturing Production Costs

In estimating the MPC, DOE took into account the various furnace design enhancements offered for consumer comfort or to reduce electrical energy consumption during furnace operating periods (see Table IV.6 in section IV.C.1.b of this document). In order to accommodate these additional design features into the MPC estimates, DOE

[33] American Metals Market, available at http://www.amm.com/.
[34] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices, available at http://www.bls.gov/ppi/.

calculated MPC estimates both with and without these added design features. DOE estimated the MPC at each efficiency level considered for each product class, from the baseline through the max-tech and then calculated the percentages attributable to each cost category (i.e., materials, labor, depreciation, and overhead). These percentages are used to validate the assumptions by comparing them to manufacturers' actual financial data published in annual reports, along with feedback obtained from manufacturers during interviews. DOE uses these production cost percentages in the manufacturer impact analysis (MIA) (see section IV.J).

All of the furnaces torn down during the teardown analysis used PSC indoor blower motors, except for at the max-tech efficiency level, where constant airflow BPM motors were used. Constant torque BPM indoor blower motors were considered the baseline design for NWGF units, because the July 2014 furnace fans final rule set a level[35] at which manufacturers are likely to incorporate constant torque BPM indoor blower motors into NWGFs before the compliance date of amended furnace standards resulting from today's rulemaking (2022), the 2014 furnace fan final rule compliance date of July 3, 2019. (10 CFR 430.32(y)). Similarly, improved PSC indoor blower motors were considered as the baseline design feature for MHGF units as a result of the requirements set in the 2014 furnace fans rulemaking[35]. 79 FR 38129, 38151 (July 3, 2014). DOE used the results of the furnace fans rulemaking to calculate the increase in

[35] The Furnace Fans rule set a mandatory fan energy rating (FER) of .044*Qmax + 182 for NWGF units, .071*Qmax + 222 for non-condensing MHGF units, and .071*Qmax + 240 for condensing MHGF units, where Qmax equals the airflow through the furnace at the maximum airflow-control setting operating point. For more information, see the furnace fans rulemaking webpage at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/41.

furnace MPC needed to accommodate constant torque BPM and improved PSC indoor blower motors into NWGF and MHGF units, respectively, in place of the PSC motors present in the tear down units. In addition, DOE considered the increase in MPC resulting from the implementation of a constant airflow BPM indoor blower motor. Motor type was assigned in the LCC analysis based on the market penetration of each type of motor at different efficiency levels. At the max-tech efficiency level for NWGF, DOE determined that constant airflow BPM motors are a required technology option. As such, the incremental MPC changes of using a constant airflow BPM indoor blower motor in place of a PSC motor were included in the MPC for NWGF at the max-tech AFUE level.

PG&E commented that it found the language regarding the costs of BPM motor technology in chapter 5 of the NOPR TSD to be confusing, and that its interpretation of DOE's analyses is that no incremental PSC to BPM motor costs were applied in the residential furnace NOPR analyses. (PG&E, No. 0153 at pp. 8-9) ASAP expressed the same confusion as PG&E with regard to the incremental costs of a BPM versus PSC motor, and pointed to PG&E's comment in its own comment filings. (ASAP No. 0154 at p. 3) DOE clarifies that the additional costs of implementing constant torque BPM motor technology in place of PSC motor technology were included and based on the results of the engineering analysis performed in the July 2014 furnace fans rulemaking. See chapter 5 of the SNOPR TSD for further information.

For the purpose of its engineering analysis in this SNOPR (and in the March 2015 NOPR) DOE expects that, in light of the July 2014 furnace fan final rule, manufacturers will incorporate two-stage combustion technology into NWGF design in order to comply with the furnace fan standard. DOE therefore developed a single cost adder for two-stage combustion that applies to the MPCs for all furnace input capacities and efficiency levels. The cost to change from a single-stage to a two-stage combustion system includes the cost of a two-stage gas valve, a two-speed inducer assembly, upgraded pressure switch/tubing assembly, and additional controls and wiring; these costs are estimated to be constant across input capacities and efficiency levels.

In response to the March 2015 NOPR, Carrier commented that it believes the costs of a two-stage gas valve, two-stage inducer, additional pressure switch, deluxe control board, wiring harness, and pressure switch tubing were not included in the cost adder for two-stage combustion. Carrier also commented that it believes the value of the two-stage combustion adder was not mentioned anywhere by DOE. (Carrier, No. 0116, at pp. 6-7) DOE included the components that Carrier identified in its comments in the two-stage combustion adder, as discussed in section 5.8.2 of the March 2015 NOPR TSD.

Goodman commented that the efficiency requirements promulgated by the furnace fans rule can be achieved by using single-stage combustion, and do not necessitate the use of two-stage combustion, as is currently implemented in the analysis. (Goodman, No. 0135, at p. 7) Based on the engineering analysis performed for the furnace fans rule, DOE estimates that a minority of NWGF designs would be able to achieve the new furnace fan efficiency standards by using a constant-torque BPM motor while still using single-stage combustion technology. However, DOE had limited quantitative data to use in the March 2015 NOPR and this SNOPR that detailed what portion of furnace designs would be capable of achieving the new standards without transitioning from single-stage to two-stage combustion. As such, in this SNOPR DOE has continued to apply a two-stage combustion adder to the MPCs for all units at the 80 AFUE though 95 AFUE efficiency levels for NWGFs. DOE requests comment as to what percentage of NWGFs may be capable of achieving the efficiency levels promulgated by the furnace fans rule via implementation of a constant-torque BPM motor with single-stage combustion technology, rather than two-stage combustion technology. This is identified as issue 7 in section VII.E, "Issues on Which DOE Seeks Comment."

Multiple stakeholders commented on the accuracy of the incremental differences between the baseline MPC (for a non-condensing furnace) and the MPCs for higher efficiency levels (condensing furnaces), as presented in the March 2015 NOPR. APGA commented that it found it counter-intuitive for the MPC of a baseline furnace to increase substantially between the June 2011 DFR and March 2015 NOPR, while the MPCs for condensing furnaces increased by what they regard as a 'very minor' amount. (APGA, No. 0106, at pp. 33-34) Both AHRI and Lennox commented that a survey of AHRI member manufacturers demonstrate that the incremental MPCs for higher efficiency levels (relative to baseline) estimated by DOE in the March 2015 NOPR are between 35 percent and 45 percent lower than the actual incremental MPCs relative to baseline that the industry sees, and that the actual costs themselves (not the incremental costs) are approximately 10 percent lower than the actual costs faced by industry. AHRI supplemented these comments with aggregated MPCs for each efficiency level, which were developed based on feedback from furnace manufacturers that are AHRI members. (AHRI, No. 0159 at pp. 48-49;, Lennox, No. 0125 at p. 13) Similarly, Ingersoll Rand commented in response to the September 2015 NODA that the MPC for 92 percent AFUE furnaces is likely underestimated. (Ingersoll Rand, No. 0182 at p. 3) NiSource stated that according to information compiled by AGA, the initial purchase price of a condensing furnace is $300 to $700 more than a non-condensing one. (NiSource, No. 0127 at p. 3) Metropolitan Utilities District stated that DOE's product prices derived from a teardown analysis do not agree with actual market pricing as noted in the GTI report[36]. (Metropolitan Utilities District, No. 0144 at p. 1)

In the March 2015 NOPR analysis, DOE calculated the incremental difference between the baseline efficiency level (80 percent AFUE) and EL1 (90 percent AFUE) for NWGFs to be $83 (in 2013$). 80 FR 13120, 13144 (March 12, 2015). In the analysis conducted for this SNOPR, DOE conducted additional teardowns and updated its database of component and material prices for furnaces to account for market changes through December 2015 and provided results in 2015$. This data update from 2013 data to 2015 data, in addition to other refinements of the cost estimation methodology (described in chapter 5 of the SNOPR TSD), resulted in the incremental MPC between baseline and EL1 increasing to $105 (in 2015$). After accounting for inflation, this difference represents a 25-percent increase in the incremental manufacturing cost of a condensing furnace, relative to a non-condensing unit. This change in the incremental

[36] MUD is referring to the report titled "Gas Technology Institute- Fuel Switching Study", located at https://www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0031-0011.

MPC aligns with the stakeholder feedback. However, this 25-percent increase in the incremental MPC (from 80 to 90-percent AFUE) between the March 2015 NOPR and this SNOPR analysis is still lower than the 35-percent to 40-percent deviation AHRI reported between the March 2015 NOPR incremental MPCs and the true incremental MPCs in industry. This variation between the results of DOE's analysis and AHRI's estimates is likely due to the AHRI-estimated industry MPCs being based on current production costs, whereas DOE estimated MPCs for a hypothetical case where the standard is at the analyzed level (e.g., a condensing level such as 90 percent AFUE). Thus, the standards case production volumes would be higher than current production volumes for a given efficiency level and could explain the discrepancy between the incremental MPCs estimated by AHRI and the incremental MPCs estimated by DOE in the engineering analysis for this SNOPR. DOE welcomes additional feedback on the MPCs and incremental MPCs presented in this SNOPR. This is identified as issue 8 in section VII.E, "Issues on Which DOE Seeks Comment."

Table IV.**8** and Table IV.**9** present DOE's estimates of the MPCs by AFUE efficiency level at the representative input capacity (80 kBtu/h) for both the NWGF and MHGF furnaces in this rulemaking. The MPCs presented incorporate the appropriate design characteristics of NWGFs and MHGFs at each efficiency level. These design characteristics include a single-stage gas valve (and corresponding single-stage components) for all MHGF efficiency levels, a two-stage gas valve (and corresponding components) for all NWGF levels (except for the max-tech level, which incorporates a fully modulating (or "step modulating") design), a constant-torque BPM blower motor for NWGF (except for the max-tech level, where the blower motor is a constant-airflow BPM motor), and an improved PSC blower motor for all MHGF efficiency levels. Further discussion of the MPCs that incorporate other design options (e.g., constant-airflow BPM motors) is included in chapter 5 of the TSD.

Table IV.8 Manufacturer Production Cost for Non-Weatherized Gas Furnaces

Efficiency Level	**Efficiency Level (AFUE) %**	**MPC* 2015$**	**Incremental Cost Above Baseline 2015$**
Baseline	80	321	-
EL1	90	426	105
EL2	92	449	127
EL3	95	497	176
EL4	98	601	280

*The MPCs for the NWGF efficiency levels from Baseline through EL3 include two-stage combustion and incorporation of a constant-torque BPM indoor blower motor. DOE has determined that NWGFs at EL4 incorporate modulating operation and a constant-airflow BPM blower motor.

Table IV.9 Manufacturer Production Cost for Mobile Home Gas Furnaces

Efficiency Level	**Efficiency Level (AFUE) %**	**MPC* 2015$**	**Incremental Cost Above Baseline 2015$**
Baseline	80	285	-
EL1	92	379	94
EL2	95	428	143
EL3	96	454	169

*The MPCs for all MHGF efficiency levels include single-stage combustion and incorporation of an improved PSC indoor blower motor.

Table IV.**10** presents DOE's estimates of the incremental MPCs of each standby/off mode efficiency level for this rulemaking, relative to the baseline efficiency level.

Table IV.10 Incremental Manufacturer Production Cost for Non-Weatherized Gas and Mobile Home Gas Furnaces Standby Mode and Off Mode

Efficiency Level	Standby Mode and Off Mode Power Consumption (W)	Incremental MPC 2015$
Baseline	11	0
EL1	9.5	1.02
EL2	9.2	9.19
EL3	8.5	9.85

Chapter 5 of the SNOPR TSD presents more information regarding the development of DOE's estimates of the MPCs for this rulemaking.

d. Cost-Efficiency Relationship

DOE created cost-efficiency curves representing the cost-efficiency relationships for the product classes that it examined (i.e., small and large NWGFs, and MHGFs). To develop the cost-efficiency relationships for NWGFs at the representative capacity (80 kBtu/h), DOE calculated a market-share weighted average MPC for each efficiency level analyzed, based on the units torn down at that efficiency level. As discussed in section IV.C.2.a, DOE also performed virtual teardowns of units at input capacities other than the representative input capacity. These virtual teardowns allowed DOE to develop cost-efficiency curves for NWGF at different input capacities. These cost-efficiency curves were then used in the downstream analyses. The cost-efficiency curves developed for input capacities other than the representative input capacity are presented in chapter 5 of the SNOPR TSD. For MHGFs, DOE compared both MHGF and NWGF teardowns produced by a common manufacturer, in order to determine the typical design differences between the two product classes. Using this information, DOE then developed cost adders which it applied to the NWGF MPCs, in order to estimate the MPCs of MHGFs at each of the MHGF efficiency levels. Additional details on how DOE developed the cost-efficiency relationships and related results are available in chapter 5 of the SNOPR TSD.

The results indicate that cost-efficiency relationships are nonlinear. The cost increase between the non-condensing (80 percent AFUE) and condensing (90 percent AFUE) efficiency levels is due to the addition a secondary heat exchanger, and so there is a large step in both AFUE and MPC. For NWGFs, a significant cost increase also occurs between the 95 percent and 98 percent AFUE levels due to the addition of modulating combustion components paired with a constant airflow BPM indoor blower motor at 98 percent AFUE. However, the ratio of the incremental increase in MPC to incremental increase in AFUE (i.e. the slope of the cost-efficiency curve) always increases with AFUE.

e. Manufacturer Markup

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer markup) to the MPC. The resulting MSP is the price that DOE research suggests the manufacturer can sell a given unit into marketplace under a standards scenario. To meet new or amended energy conservation standards, manufacturers typically redesign their baseline products. These design changes typically increase MPCs relative to those of previous baseline MPCs. Depending on the competitive environment for these particular products, some or all of the increased production costs may be passed from manufacturers to retailers and eventually to consumers in the form of higher purchase prices. As production costs increase, manufacturers may also incur additional overhead (e.g., warranty costs). The MSP is typically high enough so that the manufacturer can recover the full cost of the product (i.e. full production and non-production costs) and yield a profit.

The manufacturer markup has an important bearing on profitability. A high markup under a standards scenario suggests manufacturers can readily pass along the increased variable costs and some of the capital and product conversion costs (the one-time expenditures) to consumers. A low markup suggests that manufacturers will have greater difficulty recovering their investments, product conversion costs, and/or incremental MPCs.

To calculate the manufacturer markups, DOE used 10-K reports[37] submitted to the U.S. Securities and Exchange Commission (SEC) by six publicly-owned residential furnace manufacturing companies. The financial figures necessary for calculating the manufacturer markup are net sales, costs of sales, and gross profit. For furnaces, DOE averaged the financial figures spanning the years 2009 to 2013 in order to calculate the manufacturer markups. DOE used this approach because amended standards may reduce product differentiation opportunities for manufacturers and may hence reduce markup opportunities as well. DOE acknowledges that numerous residential furnace manufacturers are privately-held companies and do not file SEC 10-K reports. In addition, while the publicly-owned companies file SEC 10-K reports, the financial

[37] U.S. Securities and Exchange Commission, Annual 10-K Reports (various years between 2009 and 2013), available at http://sec.gov.

information summarized may not be exclusively for the residential furnace portion of their business and can also include financial information from other product sectors, whose margins could be quite different from the residential furnace industries. DOE discussed the manufacturer markup with manufacturers during interviews, and used product specific feedback on market share, markups and cost structure from manufacturers to adjust the markup initially calculated through review of SEC 10-K reports. See chapter 12 of the SNOPR TSD for more details about the manufacturer markup calculation.

f. Manufacturer Interviews

Throughout the rulemaking process, DOE has sought and continues to seek feedback and insight from interested parties that would improve the information used in its analyses. DOE interviewed NWGF and MHGF manufacturers as a part of the NOPR manufacturer impact analysis (see section IV.J). During the interviews, DOE sought feedback on all aspects of its analyses for residential furnaces. DOE discussed the analytical assumptions and estimates, cost estimation method, and cost-efficiency curves with residential furnace manufacturers. DOE considered all the information manufacturers provided while refining its cost estimates (and underlying data) and analytical assumptions. In order to avoid disclosing sensitive information about individual manufacturers' products or manufacturing processes, DOE incorporated equipment and manufacturing process figures into the analysis as averages. Additional information on manufacturer interviews can be found in chapter 12 of the TSD.

3. Electric Furnaces

In addition to NWGFs and MHGFs, DOE also performed an engineering analysis to estimate the MPCs of electric furnaces. This analysis was performed to develop accurate electric furnace cost data as an input to the product switching analysis (see section IV.F.9 for additional information). To estimate the MPCs of electric furnaces, DOE used information obtained from the teardowns of three modular blower units, as well as a teardown of an electric heat kit assembly, which were all originally used as inputs to the engineering analysis performed for the 2014 furnace fans rulemaking.[38]

The MPCs of electric furnaces were developed by calculating a market share-weighted MPC of the three modular blower units that were torn down, and then adding the MPC of the electric heat kit to the market share-weighted modular blower MPC. The MPC of the electric heat kit was scaled appropriately in order to approximate the MPCs of different input capacity electric furnaces. Similar to the engineering analysis performed for NWGFs, DOE estimated the MPCs of electric furnaces at input capacities of 60, 80, 100, and 120 kBtu/h. These MPCs are presented below in Table IV.**11**.

Table IV.11 Electric Furnace MPCs

Input Capacity (kBtu/h)	**MPC $**
60	$239
80	$261
100	$270
120	$293

[38] Modular blower units with electric heat kits are also referred to as electric furnaces.

Further details regarding the methodology used to estimate electric furnace MPCs are provided in chapter 5 of the SNOPR TSD. DOE seeks comment on its methodology and estimates for electric furnace MPCs and this is identified as issue 9 in section VII.E "Issues on Which DOE Seeks Comment."

D. Markups Analysis

The markups analysis develops appropriate markups (e.g., for wholesalers, mechanical contractors, general contractors, mobile home manufacturers, and mobile home dealers) in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis and in the MIA. The markups are multipliers that represent increases above the MSP for NWGFs and MHGFs. DOE develops baseline and incremental markups for each step in the distribution chain. The baseline markups are applied to the price of products with baseline efficiency to determine the consumer purchase cost. Likewise, the incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase) to determine the change in the consumer price for higher-efficiency products compared to baseline products. Before developing markups, DOE defines key market participants and identifies distribution channels.

Commenting on the March 2015 NOPR, AHRI stated that DOE's continued reliance on the incremental markup concept is unsupported. AHRI stated that: (1) The minimal empirical data cited in support of DOE's assumption either is irrelevant or tends to support the presence of consistent gross margins; (2) AHRI has supplied interview data with distributors and wholesalers, interview data with contractors, and survey data of contractors, all of which directly contradict DOE's assumption; and (3) DOE has not supplied any references to any empirical data that shows a difference in markups on pre- and post-standard products. (AHRI, No. 0159 at pp. 39) Rheem and HARDI agreed with AHRI. (Rheem, No. 0142 at pp. 3-4; HARDI, No. 0131 at p. 2) Goodman stated that the argument for incremental markups depends on the proposition that firms in aggregate are constrained in some manner so that they cannot earn profits above their normal cost of capital. (Goodman, No. 0135 at pp. 3-4)

DOE's incremental markup approach is based on the widely-accepted economic view that prices closely reflect marginal costs in perfectly competitive markets or in markets with a limited degree of concentration. According to microeconomic theory of firm behavior, an incremental cost may have a markup that is different from the markup on the baseline product. DOE is not aware of any representative empirical observations of markups over time in the air conditioning or heating equipment industries, except at an aggregate level. DOE evaluated time series margins and price data from three industries that experienced rapidly changing input prices—the LCD television retail market, the U.S. oil and gasoline market, and the U.S. housing market. The results indicate that dollar margins vary across different markets to reflect changes in input price, but the percent margins do not remain fixed over time in any of these industries. Appendix 6B in the SNOPR TSD describes DOE's findings. Regarding the interview data with distributors and contractors, and the survey of contractors, DOE has reservations about the applicability of these data, as discussed below.

PHCC, ACCA, and AHRI stated that based on their survey of contractors on markup practices, contractors do not use different markups before and after standards. PHCC, ACCA, and AHRI stated that if anything, contractors report that markups increased. (PHCC, No. 0136 at p. 9; ACCA, No. 0158-2 at p. 9; AHRI, No. 0159 at pp. 38) DOE acknowledges that the survey provides additional insight into contractor markup practices, but DOE found some deficiencies in the way the questions were phrased and presented to contractors. Particularly, the two markup-related questions appear to emphasize the short-term impact of a new standard on pricing strategy, and the limited choices provided under each question do not address the dynamics between short-term and long-term profitability in a fairly competitive market like the HVAC construction industry. In contrast to the survey responses, an in-depth interview with an HVAC consultant conducted by DOE indicates that while HVAC contractors aim to maintain fixed-percentage markups, eventually they will likely either have to lower their markup based on market pressures, or choose to lower their markup after the company's finances have been reviewed. (DOE's questions and consultant responses are provided in appendix 6B of the SNOPR TSD.)

In summary, DOE acknowledges that its approach to estimating distributor and contractor markup practices after amended standards take effect and change product costs is necessarily an approximation of real-world practices that are both complex and varying with business conditions. At this time, however, given the remarks from the consultant about the difficulty of maintaining fixed-percentage markups, and the lack of persuasive evidence that standards facilitate a sustainable increase in profitability for distributors and contractors (as would be implied by keeping a fixed markup when product price increases), DOE continues to maintain that its use of incremental markups is reasonable. DOE intends to further examine this issue and welcomes information that could support improvement in its methodology.

PG&E commented that the incremental markups DOE used in the March 2015 NOPR were too high because once the furnace efficiency standard takes effect, manufacturer, wholesaler, and contractor costs for furnaces meeting the new requirements are likely to drop due to economies of scale for manufacturers (and thereby wholesalers), product familiarity for contractors, and change of high-efficiency furnaces from premium to commodity-priced products. (PG&E, No. 0153 at p. 4) ASAP expressed agreement with PG&E. (ASAP, No. 0154-1 at p. 3)

DOE acknowledges that the costs of manufacturing, distributing and installing condensing furnaces could decline in the future if all or more of the market moves to condensing furnaces. Indeed, decline in the manufacturer selling price is reflected in the price trend discussed in section IV.F.1. However, a decline in costs associated with manufacturing and distributing condensing furnaces does not suggest that DOE's incremental markups are too high for wholesalers and contractors. DOE's incremental markup approach in the March 2015 NOPR was based on the premise that less expensive products (i.e., non-condensing furnaces) would be replaced by more expensive products (i.e., condensing furnaces) under the proposed standards. Applying incremental markups on the incremental cost increase of higher-efficiency products should be addressed separately from potential declines in the costs of distributing and installing condensing furnaces due to the proliferation of higher-efficiency furnaces in the market. However, the increased product price of condensing furnaces DOE analyzed in both the March 2015 NOPR and today's SNOPR are distinguishable from potential declines in the cost of distributing and installing condensing furnaces.

At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin. For the March 2015 NOPR and September 2015 NODA, DOE characterized three distribution channels to describe how NWGF products pass from the manufacturer to residential and commercial consumers:[39] (1) replacement market; (2) new construction, and (3) national accounts.[40] The NWGFs and MHGFs replacement market distribution channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → Consumer

The NWGF new construction distribution channel is characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → General contractor → Consumer

The MHGF new construction distribution channel is characterized as follows:

[39] DOE estimates that three percent of NWGFs are installed in commercial buildings. See section 0 for further discussion.

[40] The national accounts channel is an exception to the usual distribution channel that is only applicable to those NWGFs installed in the small to mid-size commercial buildings where the on-site contractor staff purchase equipment directly from the wholesalers at lower prices due to the large volume of equipment purchased, and perform the installation themselves. DOE's analysis assumes that about 17.5 percent of the NWGFs installed in the commercial sector use national accounts.

Manufacturer → Mobile Home Manufacturer → Mobile Home Dealer → Consumer

In the third distribution channel, the manufacturer sells the product to a wholesaler and then to the NWGF commercial consumer through a national account:

Manufacturer → Wholesaler → Consumer (National Account)

To estimate average baseline and incremental markups, DOE relied on several sources, including: (1) the HARDI 2013 Profit Report[41] (for wholesalers); (1) U.S. Census Bureau 2012 Economic Census data[42] on the residential and commercial building construction industry (for general contractors, mechanical contractors, and mobile home manufacturers). In addition, DOE used the 2005 Air Conditioning Contractors of America's (ACCA) Financial Analysis on the Heating, Ventilation, Air-Conditioning, and Refrigeration (HVACR) contracting industry[43] to disaggregate the mechanical contractor markups into replacement and new construction markets. DOE also used various sources for the derivation of the mobile home dealer markup (see chapter 6 of the SNOPR TSD).

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[41] Heating, Air Conditioning & Refrigeration Distributors International (HARDI). 2013 HARDI Profit Report, available at http://hardinet.org/ (last accessed April 19, 2016).

[42] U.S. Census Bureau, 2012 Economic Census Data, available at: www.census.gov/econ/ (last accessed Dec. 3, 2015).

[43] Air Conditioning Contractors of America (ACCA), Financial Analysis for the HVACR Contracting Industry (2005), available at www.acca.org/store/ (last accessed Apr. 19, 2016)

In addition to the markups, DOE obtained state and local taxes from data provided by the Sales Tax Clearinghouse.[44] These data represent weighted average taxes that include county and city rates. DOE derived shipment-weighted average tax values for each region considered in the analysis.

Chapter 6 of the SNOPR TSD provides details on DOE's development of markups for NWGFs and MHGFs.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of NWGFs and MHGFs at different efficiencies in representative U.S. single-family homes, multi-family residences, and commercial buildings, and to assess the energy savings potential of increased furnace efficiency. The energy use analysis estimates the range of energy use of NWGFs and MHGFs in the field (i.e., as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

DOE estimated the annual energy consumption of NWGFs and MHGFs at specified energy efficiency levels across a range of climate zones, building

[44] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates (2016), available at http://thestc.com/STrates.stm (last accessed April 18, 2016).

characteristics, and heating applications. The annual energy consumption includes the natural gas, liquid petroleum gas (LPG), and electricity used by the furnace.

To determine the field energy use of residential furnaces used in homes, DOE established a sample of households using NWGFs and MHGFs from the Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS 2009).[45] DOE assumed that furnaces in residential buildings smaller than 10,000 sq. ft. are residential furnaces. The RECS data provide information on the vintage of the home, as well as heating energy use in each household. DOE used the household samples not only to determine furnace annual energy consumption, but also as the basis for conducting the LCC and PBP analysis. DOE projected household weights and household characteristics in 2022, the first year of compliance with any amended or new energy conservation standards for NWGFs and MHGFs. To characterize future new homes, DOE used a subset of homes in RECS 2009 that were built after 1990.

To determine the field energy use of NWGFs used in commercial buildings, DOE established a sample of buildings using NWGFs from EIA's 2003 Commercial Building Energy Consumption Survey (CBECS 2003),[46] which is the most recent such survey that

[45] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey: 2009 RECS Survey Data (2013), available at: http://www.eia.gov/consumption/residential/data/2009/ (last accessed July 29, 2014).
[46] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2003), available at http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=microdata) (last accessed July 29, 2014).

is currently available.[47] DOE assumed that 80 percent of furnaces in commercial buildings smaller than 10,000 sq. ft. are residential NWGFs.[48] DOE assumed that each commercial building has one or more NWGFs.

1. Active Mode

To estimate the annual energy consumption in active mode of furnaces meeting the considered efficiency levels, DOE first calculated the house heating load using the RECS 2009 estimates of household furnace annual energy consumption,[49] the existing furnace's estimated capacity and efficiency (AFUE), and the heat generated from the electrical components. The analysis assumes that some homes have two furnaces, with the heating load split evenly between them. The estimation of furnace capacity is discussed further below. The AFUE of the existing furnaces was determined using the furnace vintage (the year of installation of the product) provided by RECS and historical data on the market share of furnaces by AFUE by region (see section IV.E). DOE then used the house heating load to calculate the burner operating hours at each considered efficiency level, which allowed calculation of the fuel consumption and electricity consumption based on the DOE residential furnace test procedure. DOE assumed in this analysis that furnaces will be installed using instructions in the manufacturer's installation manual in order to ensure proper operation. DOE is not aware of any data reporting on deficiencies that will undermine the rated performance.

[47] DOE recognizes that summary energy consumption estimates have been released for 2012 CBECS. For consideration of a final rule, DOE will rely on the most recent, complete version of CBECS.
[48] The remaining 20 percent are assumed to be weatherized gas furnaces.
[49] EIA estimated the equipment's annual energy consumption from the household's utility bills using conditional demand analysis.

a. Furnace Capacity

In the March 2015 NOPR, DOE assigned a input capacity for the existing furnace of each housing unit based on an algorithm that correlates the heating square footage provide by RECS 2009 and the outdoor design temperature for heating (i.e., the temperature that is exceeded by the 30-year minimum average temperature one percent of the time), based on the estimated location of the RECS 2009 household, with the distribution of input capacities of furnaces based on a reduced set of models from the 2013 AHRI residential furnace certification directory.[50] DOE assumed that for the new furnace installation, the input capacity would remain the same as the input capacity for the existing furnace. Id. However, in the September 2015 NODA, DOE distributed the input capacity based on shipments data by input capacity bins for the year 2000 provided by AHRI.[51] 80 FR 55038, 55041 (Sept. 14, 2015). The AHRI data was further disaggregated into 5-kBtu/h bins using the reduced models dataset from the September 2015 NODA analysis.

In response to the September 2015 NODA, AGA and APGA stated that GTI's report found that RECS lacks the data needed to perform furnace capacity assignments, and additional market information is needed to appropriately perform this analysis. (AGA, No. 0175-2 at p. 2; AGA, No. 0175-2 at p. 3; AGA, No. 0175-3 at p. 8; APGA, No. 0180 at p. 6; APGA, No. 0180 (attachment) at p. 8)

[50] AHRI. Directory of Certified Product Performance: Residential Furnaces. Available at: https://www.ahridirectory.org/ahridirectory/pages/rfr/defaultSearch.aspx (last visited May 30, 2016).
[51] AHRI (formerly GAMA). Furnace and Boiler Shipments data provided to DOE for Furnace and Boiler ANOPR. (January 23, 2002).

DOE acknowledges that RECS does not directly report the input capacity of the furnace, but, as described above, it provides data that allows for a reasonable estimation of the capacity when combined with shipments data disaggregated by capacity. In addition, DOE reviewed average shipments data by capacity provided by AHRI over 1995-2014, as well as 2014 HARDI shipments data by capacity and AFUE bins for three regions.[52,53] These two data sources are not consistent and DOE needs further information to be able to utilize this data. For this SNOPR, DOE kept the approach used in the September 2015 NODA and used the AHRI 2000 shipments data. See chapter 7 and appendix 7B of the SNOPR TSD for more detail.

In addition, the GTI report submitted by AGA and APGA in response to the September 2015 NODA stated that correct furnace fan sizing would be important for DOE to ensure that a furnace/air conditioner system will provide adequate cooling, especially in warmer climates dominated by cooling demand. The GTI report stated that furnace capacity in these cases will not be based on the peak heating load, but rather on the furnace fan capacity linked to the air conditioner system capacity. The GTI report stated that, as a result, the furnace will often be oversized for heating. The GTI report stated that the best fit line for heating load vs. furnace size is consistent with the idea that furnaces are generally oversized for the heating load. (AGA, No. 0175-3 at p. 4; APGA, No. 0180 at p. 6; APGA, No. 0180 (attachment) at p. 4)

[52] D+R International, 2014 Natural Gas Furnace Market Report (2014), available at www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0031-0118 (Last accessed May 5, 2016).
[53] The AFUE bins were: <80-percent AFUE, 80 to 85 percent AFUE, 85 to 90 percent AFUE, 90 to 92 percent AFUE, 92 to 94 percent AFUE, 96 to 98 percent AFUE, and 98 percent AFUE and above.

DOE acknowledges that it is common practice is to install a sufficiently large furnace to provide the furnace fan that is required to meet the cooling requirements. However, the furnace fan standards that will take effect in July 2019 require fan motor designs that can modulate the amount of air depending on both heating and cooling requirements. Thus, the size of the furnace fan (and the furnace capacity) will be able to better match the heating requirements of the house. DOE notes that this will primarily affect furnaces located in warmer areas of the country (with higher cooling loads), which potentially lead to higher amount of oversizing than is assumed in the analysis for these households. DOE performed a sensitivity analysis to assess the impact of furnace fan cooling requirements and the pending changes in furnace fan design as part of its furnace sizing methodology by using primarily 2014 HARDI regional shipments data by capacity. See chapter 7 of the SNOPR TSD for further detail.

In response to the March 2015 NOPR, Allied Air stated that the furnace sizing analysis should be based on output capacity, not input capacity. (Allied Air, No. 0044 at p. 216) Although sizing based on output capacity more accurately matches the heating load, sizing the furnace by input capacity slightly increases electricity use, which is offset by slight decrease in fuel use and decrease in total installed cost differential. Therefore, for this SNOPR, DOE did not change the analysis approach.

Under a separate standard for small furnaces that does not require a condensing furnace, DOE expects that some consumers who would otherwise install a typically-oversized furnace[54] would choose to downsize in order to be able to purchase a non-condensing furnace. For the September 2015 NODA analysis, DOE identified a sample of households that would choose to downsize to a non-condensing furnace at each of the considered small furnace capacities. In identifying these households, DOE first determined whether a household would install a non-condensing furnace with an input capacity greater than the small furnace size limit in the no-new-standards case, based on the assigned input capacity and efficiency, determined as described above. In each standards case, DOE applied a smaller-than-typical oversizing factor (1.35 vs 1.7) to estimate the number of consumers who would downsize to the input capacity limit for small furnaces.

Several stakeholders commented on the downsizing methodology used in the September 2015 NODA. AHRI and Rheem stated that the percentage of households assumed to install a small furnace is generally too high for each input rate definition, and significantly overestimated at 60 and 65 kBtu/h. AHRI and Rheem stated that data over the last 20 years indicates that only 10 percent of consumers install furnaces with an input rate under 60 kBtu/h, while DOE assumed 15 percent install such units. AHRI noted what it believed to be similar inconsistencies at 70 kBtu/h and 80 kBtu/h. (AHRI, No. 0181 at pp. 2-3, 5; Rheem, No. 0184 at p. 3; Rheem, No. 0199 at p. 3) Lennox stated that DOE's downsizing assumptions shift significantly from established historical trends. (Lennox, No. 0201 at p. 5) Ingersoll Rand commented that it would be unusual for a newly installed furnace to have a significantly lower input than the one it has replaced, as

[54] By typical oversizing, DOE refers to a value of 1.7 as specified in the DOE residential furnace and boiler test procedure.

would happen with DOE's downsizing methodology. (Ingersoll Rand, No. 0203 at p. 2) In contrast, the Efficiency Advocates stated that although oversizing has been standard practice in the past, under the small furnace scenario, significant up-front cost can be avoided by installing a smaller non-condensing furnace. The Efficiency Advocates stated that downsizing is particularly likely in warm climates where furnaces are commonly oversized to have a large blower for the cooling season. (Efficiency Advocates, No. 0196 at p. 2)

In response, the comments by AHRI, Rheem and Ingersoll Rand reflect market conditions in recent years, where oversizing of furnaces has been a common installation practice. DOE agrees with the Efficiency Advocates that in the case of a standard that allows small furnaces to use non-condensing technology, many consumers would have a financial incentive to downsize their furnace. In such a case, changes from the past practice could be expected.

Ingersoll Rand and the GTI report submitted by AGA and APGA stated that the "small fraction" used to determine the use of a small, non-condensing NWGF was not provided. Ingersoll Rand requested that the "small fraction" used in the analysis be provided along with the reasoning for selecting that level. (Ingersoll Rand, No. 00203 at p. 2; AGA, No. 0175-3 at p. 3; APGA, No. 0180 (attachment) at p. 3) The Efficiency Advocates recommended that DOE prepare several downsizing scenarios in addition to the September 2015 NODA assumption of 35 percent. (Efficiency Advocates, No. 0196 at p. 2)

DOE did not assume that a specific fraction of consumers would downsize. For the September 2015 NODA, for households assigned a non-condensing furnace in the no-new-standards case, DOE determined a downsized input capacity using a reduced oversize factor of 35 percent (instead of the typical 70 percent).[55] If the downsized input capacity was below a given small furnace threshold, DOE assumed that the household would downsize to that capacity. The fractions of consumers purchasing a small furnace under the considered definitions are shown in Table IV.12. Further details about the downsizing methodology, including a sensitivity analysis, are presented in appendix 8J of the SNOPR TSD.

Table IV.12 Share of Sample Households Meeting Small Furnace Definition (percent)

Small Furnace Definition	Without amended standards	With separate small furnace standard and downsizing
≤ 40 kBtu/h	1%	6%
≤ 45 kBtu/h	3%	8%
≤ 50 kBtu/h	8%	14%
≤ 55 kBtu/h	10%	15%
≤ 60 kBtu/h	19%	31%
≤ 65 kBtu/h	19%	38%
≤ 70 kBtu/h	30%	43%
≤ 75 kBtu/h	42%	53%
≤ 80 kBtu/h	56%	65%
≤ 85 kBtu/h	56%	65%
≤ 90 kBtu/h	65%	71%
≤ 95 kBtu/h	67%	73%
≤ 100 kBtu/h	79%	84%

55 ACCA recommends oversizing by maximum of 40 percent. ACCA. Manual S - Residential Equipment Selection (2nd Edition). Available at: https://www.acca.org/.

b. Adjustments to Energy Use Estimated for 2009

DOE adjusted the energy use estimated for 2009 to "normal" weather by using long-term heating degree-day (HDD) data for each geographical region.[56] For the SNOPR, DOE accounted for changes in the geographic distribution of homes based on AEO2015 projections of HDD.[57]

DOE accounted for change in building shell characteristics and building size (square footage) between 2009 and the compliance year by applying the building shell indexes in the National Energy Modeling System (NEMS) associated with the Annual Energy Outlook. The indexes consider projected improvements in building thermal efficiency due to improvement in home insulation and other thermal efficiency practices, as well as projected increases in square footage. In the March 2015 NOPR, application of the index resulted in nine-percent lower building heating load from 2009 to 2021. 80 FR 13120, 13147 (March 12, 2015). EIA provides separate indexes for new buildings and existing buildings.

In developing the building shell index for new construction, building shell efficiency is determined by the relative costs and energy bill savings for several levels of heating and cooling equipment, in conjunction with the building shell attributes. In this SNOPR, DOE used building shell indexes based on AEO2015, which did not incorporate the 2015 IECC. However, the 2015 IECC has to be adopted by state or local jurisdictions

[56] National Oceanic and Atmospheric Administration (NOAA), NNDC Climate Data Online (2009), available at http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp (last accessed July 29, 2014).
[57] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2015, available at www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf (last accessed July 29, 2015).

before it takes effect. As of April 2016, more than half of the country was still under the 2009 IECC or older codes instead of the 2012 IECC or 2015 IECC.[58] Given that the extent of adoption of the 2015 IECC across the United States is uncertain, DOE believes that use of building shell indexes based on AEO2015 is reasonable. For the final rule, DOE plans to use AEO2016, which will include updated building shell efficiency factors that reflect the most current building codes.

c. Furnace Electricity Use

In the March 2015 NOPR, DOE calculated furnace fan electricity consumption using field data on static pressures of duct systems, as well as airflow curves for furnace blowers from manufacturer literature. 80 FR 13120, 13150 (March 12, 2015). As noted in section IV.C, the furnace designs used in DOE's analysis incorporate furnace fans that meet the standards that will take effect in 2019.[59] Condensing furnaces tend to have a more restricted airflow path than non-condensing furnaces because of the presence of a secondary heat exchanger, so the furnace fan generally requires more energy to produce the equivalent airflow output for a condensing furnace compared to a similar non-condensing furnace.

In response to the March 2015 NOPR, Ingersoll Rand asked why DOE's analysis assumed condensing furnaces used 5 percent more electricity compared to non-condensing furnaces in, while the July 2014 furnace fan final rule used a difference of 7

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[58] DOE Building Energy Codes Program. Status of State Energy Code Adoption. (Available at: https://www.energycodes.gov/status-state-energy-code-adoption).
[59] See Table 1 at: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/42.

or 8 percent. (Ingersoll Rand, No. 0044 at p. 205) In response, the March 2015 NOPR analysis applied on average a 10-percent power consumption increase for condensing furnaces based on the 2014 furnace fan efficiency standards final rule (5 percent was reported incorrectly in appendix 7B of the NOPR TSD).

DOE accounted for furnace fan use during heating mode and the difference in electricity use between the baseline efficiency level (80-percent AFUE) and the higher efficiency levels for furnace fan use during cooling mode, not the total furnace fan use during cooling mode. DOE accounted for a 10 percent increase in electricity use for the furnace fan in condensing furnaces during the cooling season due to the increase in static pressure from the secondary heat exchanger. To calculate electricity consumption for the inducer fan, ignition device, gas valve and controls, DOE used the calculation described in DOE's test procedure[60] as well as 2013 AHRI Directory of Certified Furnace Equipment and manufacturer product literature.[61] Electricity consumption of condensing furnaces reflects use of a condensate pumps and heat tape.

Goodman stated that given that auxiliary components such as condensate pumps and heat tape are unique to condensing furnaces, it is impossible for the annual electricity consumption of auxiliary components to be lower for condensing furnaces than for non-condensing furnaces. (Goodman, No. 0135 at p. 7) DOE agrees that a condensate pump and heat tape add to the electricity use of a condensing furnace, but because DOE

[60] Found in 10 CFR part 430, subpart B, appendix N.
[61] AHRI Directory of Certified Furnace Equipment, February 2013 (Available at: www.ahridirectory.org/ahridirectory/pages/home.aspx).

assumed that the input capacity of a condensing furnace is the same as the non-condensing furnace it is replacing, the condensing furnace would operate less than would a non-condensing furnace due to its higher efficiency. Thus, the electricity use of auxiliary components may be lower than for a non-condensing furnace despite the additional electricity use of the condensate pump and heat tape.

As stated above, a condensing furnace uses more electricity than an equivalent non-condensing furnace. DOE accounted for the additional heat released by the furnace fan motor that needs to be compensated by the central air conditioner during the cooling season based on the 2014 furnace fan final rule. DOE also accounted for additional electricity use by the furnace fan during continuous fan operation throughout the year.

d. Rebound Effect

Higher-efficiency furnaces reduce the operating costs for a consumer, which can lead to greater use of the furnace. A direct rebound effect occurs when a product that is made more efficient is used more intensively, such that the expected energy savings from the efficiency improvement may not fully materialize. In the March 2015 NOPR analysis, DOE examined a 2009 review of empirical estimates of the rebound effect for various energy-using products.[62] 80 FR 13120, 13148. This review concluded that the econometric and quasi-experimental studies suggest a mean value for the direct rebound effect for household heating of around 20 percent. DOE also examined a 2012 ACEEE

[62] Steven Sorrell, et. al, Empirical Estimates of the Direct Rebound Effect: A Review, 37 Energy Pol'y 1356–71 (2009).

paper[63] and a 2013 paper by Thomas and Azevedo.[64] Both of these publications examined the same studies that were reviewed by Sorrell, as well as Greening et al,[65] and identified methodological problems with some of the studies. The studies, believed to be most reliable by Thomas and Azevedo, show a direct rebound effect for heating products in the 1-percent to 15-percent range, while Nadel concludes that a more likely range is 1 to 12 percent, with rebound effects sometimes higher than this range for low-income households who could not afford to adequately heat their homes prior to weatherization. Based on DOE's review of these recent assessments (see chapter 10 of the SNOPR TSD), DOE used a 15 percent rebound effect for NWGFs and MHGFs in the March 2015 NOPR and September 2015 NODA.

ASAP stated that the 15 percent rebound value would be too high. (ASAP, No. 0050 at p. 101) Although a lower value might be warranted, DOE prefers to be conservative and not risk understating the rebound effect; therefore, DOE continued to use a 15 percent rebound effect for this SNOPR when accounting for national energy savings.

2. Standby Mode and Off Mode

DOE calculated furnace standby mode electricity consumption for each technology option identified in the engineering analysis by multiplying the power

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[63] Steven Nadel, "The Rebound Effect: Large or Small?" ACEEE White Paper (August 2012) (Available at: www.aceee.org/white-paper/rebound-effect-large-or-small).

[64] Brinda Thomas &Ines Azevedo, Estimating Direct and Indirect Rebound Effects for U.S. Households with Input–Output Analysis, Part 1: Theoretical Framework, 86 Ecological Econ. 199–201 (2013), available at www.sciencedirect.com/science/article/pii/S0921800912004764.

[65] Lorna A. Greening, et. al., Energy Efficiency and Consumption—The Rebound Effect—A Survey, 28 Energy Policy 389–401 (2002).

consumption at each efficiency level by the number of standby mode hours. DOE assumed that furnaces are not usually equipped with an off mode, so only the standby electricity consumption was considered. To calculate the annual number of standby mode hours for each sample household, DOE subtracted the estimated total furnace fan operating hours from the total hours in a year (8,760). The total furnace fan operating hours are the sum of the furnace fan operating hours during heating, cooling and continuous fan modes.

Goodman stated that DOE should take into account that manufacturers will almost completely transition to brushless permanent magnet (BPM) motors in 2019 due to the furnace fan rule, which will increase the standby mode electricity consumption of the furnace. (Goodman, No. 0135 at p. 5) DOE accounted for the additional electricity use of BPM motors in standby mode. Chapter 7 of the SNOPR TSD describes the methodology in more detail.

3. Comments on Energy Use Results

In its comments on the March 2015 NOPR, AHRI stated that the analysis unrealistically estimates zero or negative fuel use for some households with 90-percent AFUE furnaces. (AHRI, No. 0159 at p. 56) The households with zero use are households that switch from an 80-percent AFUE NWGF to either an electric furnace or heat pump. DOE accounts for the fuel switching from a gas water heater to an electrical water as a differential in energy use. Therefore for cases with water heater fuel switching, a negative fuel can occur when: 1) the heating energy use in standards cases is less than the gas water heater energy use; 2) when the household also switches to either an electric furnace or heat pump.

ASAP stated that a 2015 evaluation of furnace incentive programs in Massachusetts[66] suggests that DOE underestimated per-unit energy savings for a 95-percent AFUE furnace compared to an 80-percent AFUE furnace in the North by 31 percent. ASAP stated that Massachusetts is generally representative of average climate conditions in the North. (ASAP, No. 0154-1 at pp. 3, 5) The report cited by ASAP presents the results of a limited case study. DOE agrees that some households may experience greater energy savings from installing a condensing NWGF than others, as is reflected in the distribution of energy savings results. However, the energy savings depend not only on climate conditions, but other factors as well, such as physical building characteristics and household energy consumption behaviors, which may be different in other parts of the North.

F. Life-Cycle Cost and Payback Period Analysis

In determining whether an energy efficiency standard is economically justified, DOE considers the economic impact of potential standards on consumers. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

[66] The Cadmus Group, 2015. High Efficiency Heating Equipment Impact Evaluation. Available at http://www.neep.org/sites/default/files/resources/High-Efficiency-Heating-Equipment-Impact-Evaluation-Final-Report.pdf.

- The LCC (life-cycle cost) is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.

- The PBP (payback period) is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of NWGFs and MHGFs in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of housing units and, for NWGFs, commercial buildings. As stated previously, DOE developed household samples from the 2009 RECS and 2003 CBECS. For each sample household or building, DOE determined the energy consumption for the furnace and the appropriate electricity price. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of NWGFs and MHGFs.

Inputs to the LCC calculation include the installed cost to the consumer, operating expenses, the lifetime of the product, and a discount rate. Inputs to the calculation of total installed cost include the cost of the product—which includes MPCs, manufacturer markups, wholesaler and contractor markups, and sales taxes (where appropriate)—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. Inputs to the payback period calculation include the installed cost to the consumer and first year operating expenses. DOE created distributions of values for aspects of installation cost, repair and maintenance, product lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP, which incorporates Crystal Ball™ (a commercially-available software program), relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample several input values from the probability distributions and NGWF and MHGF user samples. The model calculated the LCC and PBP for products at each efficiency level for 10,000 consumers per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. (42 U.S.C. 6295(o)(B)(ii)) For each considered efficiency level, DOE determines the value of the first year's energy savings by calculating the quantity of those savings in accordance with the applicable DOE test procedure, and multiplying that amount by the average energy price forecast for the year in which compliance with the amended standards would be required.

DOE calculated the LCC and PBP for all consumers of NWGFs and MHGFs as if the consumers were to purchase a new product in the expected year of required compliance with amended or new standards. Any amended or new standards would apply to NWGFs and MHGFs manufactured 5 years after the date on which any amended or new standard is published. (42 U.S.C. 6295(f)(4)(C)) At this time, DOE estimates publication of a final rule in early 2017. Therefore, for purposes of this SNOPR analysis, DOE used 2022 as the first year of compliance with any amended or new standards for NWGFs and MHGFs.

SoCalGas stated that considering that furnace replacement may not be done at move-in, but at a point later during homeownership, in most cases, a condensing furnace will rarely pay for itself from the homeowner's perspective. (SoCalGas, No. 0132-2 at p. 4; SoCalGas, No. 0132-6 at p. 8) AHRI stated that if the purchaser moves before the end of the furnace lifetime, then the consumer does not receive the projected benefits. AHRI stated that analyses by NAHB show that the typical homeowner stays in a home for approximately 13 years, well below the average lifetime assumed by DOE of 22 years. (AHRI, No. 0159 at pp. 15, 52-53)

DOE notes that it modeled the expected product lifetime, and not the expected period of homeownership. DOE recognizes that the lifetime of a gas furnace and the residence time of the purchaser may not always overlap. However, EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) In the context of this requirement, DOE believes that the expected product lifetime, not the expected period of homeownership is the appropriate modeling period for the LCC, as energy cost savings will continue to accrue to the new owner/occupant of a home after its sale. If some of the price premium for a more-efficient furnace is passed on in the price of the home, there would be a reasonable matching of costs and benefits between the original purchaser and the home buyer. To the extent this does not occur, the home buyer would gain at the expense of the original purchaser.

As discussed in section IV.F.9, in its LCC analysis DOE considered the possibility that some consumers may switch to alternative heating systems in the case of a standard that requires condensing technology. The LCC analysis showed that some consumers who switch end up with a reduction in the LCC relative to their projected purchase in the no-new-standards case.

AGA commented that that DOE's rationale considering avoiding a cost imposed by the proposed standard to be a benefit to the consumer does not make sense. (AGA, No. 0050 at p. 121) Ingersoll Rand stated that consumers who are forced to switch from gas to electric heating should be considered to be experiencing a net cost. (Ingersoll Rand, No. 0182 at p. 3) In response, DOE clarifies that no consumers would be forced to switch under any standards case. DOE estimated that some consumers would switch to electric heating if the economics are very favorable compared to installing a condensing furnace. In some cases, the alternative product has a lower LCC than the furnace purchased in the no-new-standards case, which means that the consumer benefits. Although this outcome might suggest that the consumer would switch in the no-new-standards case, reluctance to change and various transaction costs would tend to limit such behavior.

Referring to the situation with households who rent, AHRI expressed concern that analyzing the cost to the purchaser of the product who receives no benefit and the benefit to tenants who do not purchase the product distorts the meaning of the LCC analysis. (AHRI, No. 0050 at p. 27) Because landlords generally seek to recoup their expenses in the rent, DOE's LCC analysis implicitly assumes that the cost of a product incurred by a landlord is passed on to the tenant who pays the utility bills. DOE acknowledges that this assumption is a simplification of the actual division of costs and benefits. DOE welcomes information that would provide more insight on actual landlord practices associated with furnace replacement.

Table IV.13 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the SNOPR TSD and its appendices.

Table IV.13 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Product Cost	Derived by multiplying MPCs by manufacturer, wholesaler, and contractor markups and sales tax, as appropriate. Used historical data to derive a price scaling index to forecast product costs.
Installation Costs	Baseline installation cost determined with data from 2015 RS Means. Assumed no change with efficiency level.
Annual Energy Use	The total annual energy use multiplied by the hours per year. Average number of hours based on field data. Variability: Based on the RECS 2009 and CBECS 2003.
Energy Prices	Natural Gas: Based on EIA's Natural Gas Navigator data for 2014. Propane: Based on EIA's SEDS for 2014. Electricity: Based on EIA's Form 861 data for 2014. Variability: Regional energy prices determined for 30 regions. Marginal prices used for both natural gas and propane
Energy Price Trends	Based on AEO2015 price forecasts.
Repair and Maintenance Costs	Based on 2015 RS Means data and other sources. Assumed variation in cost by efficiency.
Product Lifetime	Based on shipments data, multi-year RECS and American Housing Survey data. Mean lifetime of 21.5 years.
Discount Rates	Residential: approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. Commercial: Calculated as the weighted average cost of capital for businesses purchasing NWGFs. Primary data source was Damodaran Online.
Compliance Date	2022.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the SNOPR TSD.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis with the manufacturer, wholesaler, and contractor markups and sales taxes, as appropriate. DOE used baseline markups for baseline consumer products and it applies an incremental markup to the increase in MSP associated with higher-efficiency products.

Based on the updated engineering analysis and markups, for the SNOPR, the product price was estimated to be $208 to $522 more for a condensing NWGF than a non-condensing one.

For the default price trend for residential furnaces, DOE derived an experience rate based on an analysis of long-term historical data. In the March 2015 NOPR, as a proxy for manufacturer price, DOE used Producer Price Index (PPI) data for warm-air furnace equipment from the Bureau of Labor Statistics from 1990 through 2013.[67] In this SNOPR, DOE used PPI data from the BLS from 1990 through 2015.[68] An inflation-adjusted PPI was calculated using the implicit price deflators for GDP for the same years. To calculate an experience rate, DOE performed a least-squares power-law fit on the inflation-adjusted PPI versus cumulative shipments of residential furnaces, based on a corresponding series for total shipments of residential furnaces (see section IV.G of this notice for discussion of shipments data). DOE then derived a price factor index, with the price in 2015 equal to 1, to forecast prices in 2022 for the LCC and PBP analysis, and, for the NIA, for each subsequent year through 2051. The index value in each year is a function of the experience rate and the cumulative production through that year. To derive the latter, DOE combined the historical shipments data with projected shipments from the no-new-case projection made for the NIA (see section IV.H of this notice). Application of the index results in prices that decline 5 percent from 2015 to 2022.

DOE emphasizes that its learning curve methodology was developed by examining the literature on both economic theory and empirical studies of energy technology learning rates. DOE believes that its current learning curve methodology is

[67] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices Series ID PCU333415333415C, available at www.bls.gov/ppi/ (last accessed April 18, 2016).
[68] Id.

consistent with economic theory, and utilizes the most extensive time series data available specific to this product.

In response to the March 2015 NOPR, some stakeholders suggested that non-condensing and condensing furnaces may have different learning curves. SoCalGas stated that non-condensing furnaces are mature so their learning rate should be near zero; the rate should be different for condensing furnaces. (SoCalGas, No. 0132-2 at p. 6) ASAP stated that it would be expected for the prices of technologies used in high-efficiency products to decline much faster than the total price of the product. ASAP stated that the use of historic price trends of heating products to estimate learning rates for furnaces implicitly assumes that the prices of non-condensing and condensing furnaces will change at the same rate, and will likely significantly underestimate future declines in the cost of condensing furnaces. ASAP recommended that DOE use the high decreasing price trend scenario for its main analysis because the trend captures the market during the period when condensing products grew to significant market share, and is more representative of the expected trends under a condensing standard. (ASAP, No. 0154-1 at pp. 3-5) Fletcher, CEC, and the Joint Consumer Commenters stated that the product price of condensing furnaces will decrease with an increase in production and innovation due to the proposed standards. (Fletcher, No. 0064 at p. 1; CEC, No. 0120 at p. 5; Joint Consumer Commenters, No. 0123 at pp. 18-21) In contrast, AHRI stated that as condensing furnaces have been produced since at least 1984, most of the learning for these products has already been captured in current designs. AHRI stated that it is not likely that there are major future reductions in production cost from learning. (AHRI, No. 0159 at p. 49)

DOE acknowledges that the prices of non-condensing and condensing furnaces may not change at the same rate, and using a trend for all NWGFs to represent the price trend of condensing furnaces may underestimate the future decline in the cost of condensing furnaces. It also acknowledges that an increase in production and innovation due to a condensing standard could result in decline in the cost of condensing furnaces. However, DOE could not find data that would allow a projection of how the price trend for condensing furnaces may differ from the trend for all NWGFs. Thus, for the SNOPR, it used the same price trend projection for condensing and non-condensing furnaces. Although information about price trends related to different furnace technologies is not available, DOE is exploring ways to estimate learning rates for different technologies.[69] DOE welcomes comments on ways to derive learning rates for different types of technologies. This is identified as issue 14 in section VII.E, "Issues on Which DOE Seeks Comment."

A detailed discussion of DOE's derivation of the experience rate is provided in appendix 8C of the SNOPR TSD.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. As part of its analysis, DOE used information in the 2009 RECS to estimate the location of the furnace in each of the sample homes. For the

[69] Taylor, M. and K. S. Fujita, Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique, Lawrence Berkeley National Laboratory, Report No. LBNL-6195E (2013) (Available at: http://efficiency.lbl.gov/sites/all/files/accounting_for_technological_change_in_regulatory_impact_analyses_the_learning_curve_technique_lbnl-6195e.pdf).

March 2015 NOPR and September 2015 NODA, the installation cost estimates, including labor costs, were based on 2013 RS Means data.[70]

In its comments on the March 2015 NOPR, Ingersoll Rand stated that a small survey of dealers around the country showed that homeowners are actually charged an average rate of $100/hour for labor, compared to DOE's estimates of $52/hour to $71/hour from RS Means. (Ingersoll Rand, No. 0156 at p. 8)

In this SNOPR, DOE updated its data to 2015 RS Means.[71] In addition, DOE contacted RS Means to verify what labor costs and associated markups are more appropriate for installation of NWGFs and MHGFs in residential market. Based on RS Means input, DOE has revised its labor costs from residential labor costs to repair/remodeling labor costs, which are about 40 percent higher than previously applied in the NOPR. In addition, based on interactions with RS Means and from the Ingersoll Rand input, DOE modified its labor costs to better reflect actual installation costs applied in the field. See chapter 8 of the SNOPR TSD for additional details about the determination of installation costs.

DOE conducted a detailed analysis of installation costs for all potential installation cases. When a non-condensing is replaced with a non-condensing gas furnaces, the additional costs could include updating flue vent connectors, vent resizing, and chimney relining. When a non-condensing gas furnace is replaced with a condensing

[70] RS Means Company Inc., RS Means Residential Cost Data. Kingston, MA (2013).
[71] RS Means Company Inc., RS Means Residential Repair & Remodeling Cost Data. Kingston, MA (2015).

gas furnace, particular attention paid to venting issues in replacement applications, including adding a new flue venting (PVC), combustion air venting (PVC), concealing vent pipes, addressing an orphaned water heater (by updating flue vent connectors, vent resizing, or chimney relining), as well as condensate removal. DOE also included installation adders for new construction installations. For non-condensing furnaces, the only adder is a new flue vent (metal, including a fraction with stainless steel venting). For condensing gas furnaces, the adders include a new flue vent, combustion air venting for direct vent installations, accounting for a commonly vented water heater, and condensate removal. DOE gave separate consideration to the cost of installing a non-condensing gas furnace and condensing gas furnace in new homes and in mobile homes.

a. Basic Installation Cost

DOE's analysis in the March 2015 NOPR and September 2015 NODA, as well as this SNOPR, estimated basic installation costs that are applicable to both replacement and new home applications. These costs, which apply to both condensing and non-condensing gas furnaces, include furnace setup and transportation, gas piping, ductwork, electrical hookup, permit and removal/disposal fees, and where applicable, additional labor hours for an attic installation.

SoCalGas stated that DOE's analysis in the March 2015 NOPR did not consider the cost of asbestos removal in retrofitted homes. SoCalGas stated that asbestos abatement services in Southern California typically cost from $250 to $3,000 depending on site conditions. (SoCalGas, No. 0132-2 at p. 4) DOE agrees that asbestos presents a safety hazard that should be removed for all retrofit installations where it is present.

However, DOE understands that the cost would be the same regardless of the furnace efficiency level, so it is not necessary to include this cost for the analysis of NWGF standards.

b. Additional Installation Costs for Non-Weatherized Gas Furnaces

For replacement applications, DOE included a number of additional costs ("adders") for a fraction of the sample households. For non-condensing gas furnaces, these additional costs included updating flue vent connectors, vent resizing, and chimney relining. For condensing gas furnaces, DOE included new adders for flue venting (PVC), combustion air venting (PVC), concealing vent pipes, addressing an orphaned water heater (by updating flue vent connectors, vent resizing, or chimney relining), and condensate removal. DOE also updated its analysis in this SNOPR in response to some comments it received as a result of the March 2015 NOPR and the September 2015 NODA, which are outlined below.

AHRI commented that because most furnace installations in existing buildings are emergency replacements during the heating season, there is a high premium on the ability to install a furnace quickly to prevent a house from freezing, so there is rarely time for a major reconstruction to accommodate a condensing furnace. (AHRI, No. 0159 at p. 59) While DOE understands that most homeowners can make accommodations to allow for proper installation of a condensing furnace in unusual cases where major reconstruction might be required, DOE agrees that some emergency situations will generate a higher installation cost. However, DOE understands that emergency situations may arise for both non-condensing and condensing installations, so it did not include the related costs in its analysis.

AGL Resources commented that DOE did not include certain materials and installation charges, like costs associated with ductwork modification and material cost for electrical work, in the non-condensing to condensing NWGF installation scenario. (AGL Resources, No. 0039 at p. 3; AGL Resources, No. 0112 at p. 3) In the March 2015 NOPR and the September 2015 NODA, DOE included the cost of electrical work required to add a condensate pump or heat tape outlet near the NWGF location, but did not include additional ductwork costs. These ductwork costs would impact all efficiency levels equally and DOE therefore did not add them for this analysis. DOE tentatively determined that this approach adequately reflects the electrical work and ductwork cost differential between the efficiency levels, so it did not make any additional changes for this SNOPR.

Venting Requirements of Condensing Non-Weatherized Gas Furnaces

In response to DOE's approach in the March 2015 NOPR and the September 2015 NODA, many stakeholders commented specifically on the venting requirements of condensing NWGFs compared to those of non-condensing NWGFs, which are outlined below.

Ingersoll Rand commented that DOE should use the NFGC venting guide, which has been thoroughly developed and is widely used, to determine vent sizing. (Ingersoll Rand, No. 0044 at p. 159) In response, DOE used the NFGC guidelines in the March

2015 NOPR and this SNOPR to determine vent resizing and chimney relining requirements as described further in appendix 8D.

SoCalGas stated that DOE appears to assume in its analysis that condensing furnaces can be vented horizontally. SoCalGas stated that in its experience in California, flues are typically built vertically, regardless of the type of furnace or installed location. (SoCalGas, No. 0132-2 at p. 7; SoCalGas, No. 0132-6 at pp. 10-11) In the March 2015 NOPR and this SNOPR, DOE determined whether a condensing furnace is horizontally or vertically vented based on the shortest vent length. DOE's analysis assumes that 70 percent of condensing furnaces will be installed with a horizontal vent.

Metal-Fab commented that DOE did not consider the additional cost to properly vent condensing NWGFs, which can cost several hundred to a few thousand dollars in an existing home. (Metal-Fab, No. 0192 at p. 1) In the March 2015 NOPR and this SNOPR, DOE included the venting installation costs to replace a non-condensing NWGF with a condensing NWGF, including possible chimney relining, vent resizing, and orphaned water heater costs. In this SNOPR, DOE updated the vent costs using the latest RS Means 2015 data to predict for a retrofit installation range from $66 to $6,075 (with an average of $584).

NPGA commented that relevant gas codes, in particular the NFGC and International Fuel Gas Code, prohibit condensing furnaces from being directly vented into chimneys because the condensate can freeze and expand, damaging the chimney or chimney liner. (NPGA, No. 0130 at p. 2) PGW stated that venting through a chimney would require major modification of the flue in the chimney, particularly when the water heater currently shares a flue with the furnace. (PGW, No. 0122 at pp. 1-2) In response, DOE maintains its assumption in the March 2015 NOPR and the September 2015 NODA that condensing furnaces are not vented through an existing chimney but rather would require a new plastic vent. This plastic vent is assumed to go through the vent chimney only if it meets all applicable code requirements and is not being vented together with another appliance (such as a non-condensing water heater).

NiSource and Vectren commented that replacing a non-condensing furnace with a condensing one will require a new venting system or substantial modifications to the existing system may be necessary. NiSource and PGW stated that meeting the venting specifications of condensing furnaces may require structural changes to the building to accommodate a new venting system and relocation of the furnace to meet the code and installation requirements of the new condensing furnace system. (NiSource, No. 0127 at p. 3; Vectren, No. 0111 at p. 7; PGW, No. 0122 at pp. 1-2) PGW stated that common walls, which are characteristic of row housing, make side venting of a condensing furnace difficult and expensive. (PGW, No. 0122 at pp. 1-2) AGL Resources stated that longer-than-average vent runs, gas line extensions, ductwork modifications, and "snorkel" vent terminations to accommodate minimum clearances from these design factors will increase the average price of a condensing furnace installation. (AGL Resources, No. 0112 at pp. 3-4) Nortek, AHRI, AGL Resources, Carrier, and NMHC, NAA, and NLHA stated that manufacturers' requirements, local ordinances, and industry codes determine the minimum clearances to sidewalks, average snow accumulation level, overhangs, and air intake sources, including operable doors and windows, building corners, and gas meter vents. (Nortek, No. 0137 at p. 2; AHRI, No. 0159 at pp. 59, 61; AGL Resources, No. 0039 at p. 3; AGL Resources, No. 0112 at pp. 3-4; Carrier, No. 0116 at p. 16; NMHC, NAA, and NLHA, No. 0117 at p. 3) Nortek and AHRI stated that in most cases, access to an outside wall with sufficient clearance from operable windows and doors will be a practical necessity to vent a condensing furnace. (Nortek, No. 0137 at p. 2; AHRI, No. 0159 at pp. 59, 61-62)

In the March 2015 NOPR and the September 2015 NODA, DOE assumed that condensing furnaces do not utilize the existing venting system but instead require new dedicated plastic venting that meets all applicable building codes and manufacturer instructions. DOE understood that vent length varies depending on where a suitable wall is located relative to the furnace. In addition, when applicable, a snorkel termination is accounted for to meet minimum clearances to sidewalks, average snow accumulation level, overhangs, and air intake sources, including operable doors and windows, building corners, and gas meter vents. DOE assumed that the replacement furnace would remain in the same location as the existing furnace and accounted for the new vent length and structural changes such as wall knockouts, to install new venting. In some installations, it could be easier and cheaper to change the furnace location, but this would require gas line extensions and ductwork modifications. DOE accounted for additional vent length for housing units with shared walls. DOE also accounted for the cost of vent resizing in the case of an orphaned water heater.

Nortek and AHRI stated that to properly vent a condensing furnace, there needs to be the ability to run a vent pipe to the outside within the pressure drop limitations of the combustion fan. (Nortek, No. 0137 at p. 2; AHRI, No. 0159 at pp. 59, 61) The vent pipe length limitations depend on a number of factors including number of elbows, vent diameter, horizontal vs. vertical length, as well as combustion fan size. A review of several manufacturer installation manuals shows that the maximum vent lengths range from 30 to 130 feet depending primarily on the vent diameter. DOE used this information for the March 2015 NOPR and this SNOPR. See Chapter 8 in the SNOPR TSD for more details.

Some condensing NWGF installations require an additional cost to conceal the PVC vent pipes that pass through the living space. NMHC, NAA, and NLHA stated that building construction will determine whether the vent pipe can be recessed or must be included in a soffit. (NMHC, NAA, and NLHA, No. 0117 at p. 3) For the March 2015 NOPR and this SNOPR, DOE assumed that a fraction of condensing furnace installations in replacement and new owner applications will require concealing vent pipes. Appendix 8D in the SNOPR TSD describes the methodology used to determine the households that would require concealing vents and the associated costs.

NAHB stated that the additional installation cost for concealing vent pipes in replacement applications reported in the NOPR appears to be very low. NAHB stated that this presumably includes drywall work as well as painting, which would require at least one separate visit from a contractor for each step. NAHB stated that the RS Means labor and materials costs would not account for the multiple set-up, breakdown, and trip charges. (NAHB, No. 0124 at p. 2) For the March 2015 NOPR, DOE accounted for the work required to penetrate walls and conceal vent pipes when required for installation of a new condensing furnace. DOE has tentatively determined that the range of costs applied in this SNOPR analysis sufficiently accounts for the costs required to conceal vent pipes.

Common Venting

Common venting provides a single exhaust flue for multiple gas appliances. In some cases, a non-condensing NWGF is commonly vented with a gas-fired water heater. When the non-condensing NWGF is replaced with a condensing NWGF, the new condensing furnace and the existing water heater can no longer be commonly vented due to different venting requirements,[72] and the water heater becomes "orphaned." The existing vent may need to be modified to safely vent the orphaned water heater. DOE accounted for a fraction of installations that would require chimney relining or vent resizing for the orphaned water heater, including updating flue vent connectors, resizing vents, or relining chimneys when applicable based upon the age of the furnace and the home.

Commenting on the March 2015 NOPR, MHI stated that 92 percent AFUE furnaces require a dedicated venting system to meet positive vent pressures, which is particularly problematic for the replacement market because it alters the performance characteristics of existing common venting. MHI stated that the proposed standard would require consumers to take additional steps to comply with proper venting

[72] The NFGC venting requirements refer to Category I, II, III, and IV gas appliances. Category I gas appliances, such as natural draft gas water heaters, exhaust high-temperature flue gases and are vented using negative static pressure vents designed to avoid excessive condensate production in the vent. Category IV gas appliances, such as condensing furnaces, exhaust low temperature flue gases and are vented using positive static pressure corrosion-resistant vents. Due to the different venting requirements, the NFGC does not allow common venting of condensing and non-condensing appliances.

requirements in existing homes, which in many cases would be impractical, if not impossible. (MHI, No. 0129 at p. 1) NPGA expressed concern that a 92 percent AFUE standard could cause various venting issues during furnace replacement, which could add cost to reconfigure the venting system and raise potential safety concerns in venting an orphaned water heater if the water heater vent is not properly sized. (NPGA, No. 0044 at pp. 18-19). NMHC, NAA, and NLHA stated that replacing both the commonly-vented gas furnace and gas water heater while maintaining the vertical vent is so costly as to be impractical in most situations. (NMHC, NAA, and NLHA, No. 0117 at p. 4) MUD stated that orphaned water heaters would not properly vent or satisfy the installation requirements of NFPA 54 if Category I furnaces are removed from the common stacks. (MUD, No. 0144 at p. 2) CenterPoint Energy, Vectren, and Carrier stated that replacing a non-condensing furnace with a condensing one may require significant and expensive modifications to the existing vent system, such as installing a chimney liner to maintain safe venting of the orphaned natural gas water heater, or replacement of the existing water heater with a new power-vented water heater. (CenterPoint Energy, No. 0083 at p. 2; Vectren, No. 0111 at p. 7; Carrier, No. 0116 at p. 19) AHRI stated that in many new homes, it would be possible to install a condensing gas furnace and a power-vented gas water heater and avoid the cost of installing a chimney. (AHRI, No. 0159 at p. 59)

DOE has tentatively determined that the assumptions it made and costs it included for the March 2015 NOPR and September 2015 NODA adequately address the concerns raised in the above comments. DOE's analysis reflects the likelihood that in some cases, replacing a non-condensing furnace with a condensing one may require significant modifications to the existing vent system for the commonly-vented gas water heater. It accounted for costs for updating the vent connector, relining the chimney, and resizing the vent, which would satisfy the installation requirements of NFPA 54. In the March 2015 NOPR and September 2015 NODA, DOE acknowledged that a potential option is to install either a storage or tankless power-vented water heater to avoid the cost of a chimney or metal flue vent just for the gas water heater or avoid switching to an electric storage water heater. For the SNOPR (similar to the March 2015 NOPR and September 2015 NODA), DOE did not consider the power-vented water heater option but instead added additional installation costs associated with venting of the Category I water heater, so that the orphaned water heater could be vented through the chimney or considered an electric storage water heater as an alternative.

PG&E stated that to accommodate higher-efficiency water heaters, newly constructed homes and many existing homes will need to upgrade their water heater vents, thereby greatly reducing the number of commonly-vented NWGFs and gas water heaters. PG&E expects that the frequency of vent resizing will decrease due to the increase in use of high-efficiency water heaters expected to occur before 2021. (PG&E, No. 0153 at pp. 4-5) ASAP agreed with PG&E that DOE's estimate of commonly-vented appliances is outdated and does not account for water heater market trends. (ASAP, No. 0154-1 at p. 2) PG&E also stated that DOE should eliminate added costs for new owner installations that are assumed to be common-vented with non-condensing water heaters, as homes in this category did not previously have a furnace and, therefore, do not have an existing common vent. (PG&E, No. 0153 at pp. 5-6)

DOE acknowledges that the frequency of chimney relining and vent resizing may decrease somewhat due to increase in use of high-efficiency water heaters. However, DOE did not find any information to predict the market share of high-efficiency water heaters in 2022 or the decrease in the fraction of installations with common vents. For new owner and new construction installations, DOE applied a venting cost differential if the owner/builder was planning to install a commonly-vented non-condensing furnace and water heater. For the SNOPR, DOE prefers to be conservative and not understate the impact of common venting, and consequently, DOE did not change the approach in this SNOPR that it used for the March 2015 NOPR and September 2015 NODA.

NMHC, NAA, and NLHA stated that in many multi-family properties, furnaces and gas water heaters from several units may share a chimney vent, or a furnace and a water heater within one apartment may be commonly vented. NMHC, NAA, and NLHA stated that eliminating a non-condensing furnace from a venting stack may initiate a cascade of equipment replacements due to venting requirements. (NMHC, NAA, and NLHA, No. 0117 at pp. 3-4) Carrier stated that each time a Category I furnace is replaced with a Category IV furnace in a multi-family building, the Category I common-vent system will require resizing. Carrier stated that labor costs for reconfiguration of existing Category I vents for installation of new Category IV vents could be higher than average due to space constraints. (Carrier, No. 0116 at p. 19)

DOE acknowledges that multi-family buildings may require additional measures to replace non-condensing furnaces with condensing furnaces. However, DOE did not find data that would allow a reliable estimation of the associated costs. DOE welcomes data on the costs associated with modifying the existing vent systems for non-condensing gas furnaces in multi-family buildings. This is identified as issue 11 in section VII.E, "Issues on Which DOE Seeks Comment."

CEC expects that retrofit installation costs will decrease as the industry provides innovative solutions to address the orphaned water heater issue for some retrofits. (CEC, No. 0120 at p. 5) Although DOE agrees that installation costs may decrease over time, DOE does not have enough data at this time to project such cost trends in its analysis. See discussion under New Venting Technologies.

<u>Difficult Installations</u>

The March 2015 NOPR analysis accounted for additional vent length to reach a suitable location on an outside wall where the vent termination could be located, as well as for wall penetrations and concealing flue vents in conditioned spaces.

In response to the March 2015 NOPR, several stakeholders commented that there are situations where venting a condensing furnace through an outside wall is impractical or impossible and would require moving walls, ceilings or other construction, especially in multi-family buildings, older homes, homes with shared walls, and homes with completely finished basements. (Nortek, No. 0137 at pp. 2-34; MUD, No. 0144 at p. 1; Questar Gas, No. 0151 at p. 1; AHRI, No. 0159 at p. 59; PGW, No. 0003-1 at pp. 1-3; PHCC, No. 0136 at p. 121; ACCA, No. 0158-2 at p. 121; Southside Heating and Air Conditioning, No. 0044 at pp. 306-307; NMHC, NAA, and NLHA, No. 0117 at pp. 2-3;

Nayes, No. 0055 at p. 1; Meeks, No. 0140 at p. 1) AHRI and Nortek stated that in approximately 15-20 percent of buildings that currently have NWGFs, installing a condensing NWGF is impractical or impossible due to physical constraints of the existing buildings. (AHRI, No. 0159 at pp. 58-59; Nortek, No. 0137 at pp. 2-34)

In contrast, ACEEE stated that the number of installations that would entail high costs to retrofit condensing furnaces are small in number. The commenter stated that in Canada, national standards require condensing furnaces, and neither Natural Resources Canada nor its mortgage agency has found any significant implementation problems with that standard. ACEEE also checked with the U.S. furnace OEM who might have the largest market share in Canada, and that company reported essentially no pushback. ACEEE also contacted a major weatherization program about the costs to retrofit condensing furnaces in Philadelphia row houses. ACEEE stated that according to that source, the program has 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. (ACEEE, No. 0113 at p. 7) The Efficiency Advocates stated that if small furnaces are allowed to remain non-condensing, the already small number of difficult-to-retrofit homes will decrease. (Efficiency Advocates, No. 0196 at p. 3)

Because the stock of buildings using NWGFs in Canada has many similarities to the stock using NWGFs in northern parts of the U.S., DOE investigated ACEEE's reference to the lack of issues related to the implementation of the Canadian standards. Before the 2012 Canadian condensing furnace standard, the Heating, Refrigeration and

Air Conditioning Institute of Canada (HRAI) and other stakeholders raised similar concerns to those presented in the current rulemaking. HRAI afterwards put together a Q&A for installers highlighting the issues and possible solutions related to the standard.[73] Based on consultant research, the number of consumers and other stakeholders that have contacted NRCan about issues related to the condensing furnace standard has been extremely small.[74] The consultant information suggested that the potential problems that were identified with the requirement to retrofit condensing furnaces were either overstated, or that the installing contractors found ways to resolve the issues. In regards to row house installations, DOE believes that its current analysis includes costs comparable to the methods that were identified in the Philadelphia weatherization program to address venting difficulties in condensing NWGF installations. In addition, as suggested by the Efficiency Advocates, DOE's proposed separate standards for small and large NWGFs would significantly reduce the number of installations described as difficult.

NMHC, NAA, and NLHA stated that the location of the furnace determines how extensive the new horizontal venting must be to reach an exterior wall. NMHC, NAA, and NLHA stated that building code requirements present additional challenges for multi-family properties that have few open areas on the exterior of the building to accommodate furnace vents. (NMHC, NAA, and NLHA, No. 0117 at p. 3) Carrier stated that 92-percent AFUE Category IV furnaces require dedicated vent systems and

[73] Heating, Refrigeration and Air Conditioning Institute of Canada, Q&A for Installers: Venting Solutions for Upcoming Changes to Furnace Standard (Available at: www.hrai.ca/PDFs/factsheets/PlasticVentingSystemAlternatives.pdf).
[74] Edwards, P., Impact of Condensing Standard on Consumers (2016).

terminations for multi-family installations. Carrier stated that for these installations, as the number of terminations increases, it becomes increasingly difficult or impossible to safely and reliably locate vent terminations on the outside of the structure. (Carrier, No. 0116 at p. 16) Carrier stated that if 80-percent AFUE Category I furnaces in a multi-unit common vent system must be replaced with condensing Category IV furnaces, each new furnace will require its own plastic venting system next to the metal vent for the remaining Category I furnaces. Carrier stated that the dedicated piping for each condensing furnace may lead to an impossible situation as more common-vented non-condensing furnaces are replaced with individually-vented condensing furnaces and room for venting is exhausted. PHCC stated that mechanical codes prohibit mixing return air from sleeping quarters from different units in a multi-family building, so a common non-condensing furnace used for multiple apartments would have to be replaced with separate condensing furnaces and separate venting systems. (PHCC, No. 0044 at p. 197) Southside Heating and Air Conditioning agreed with PHCC. (Southside Heating and Air Conditioning, No. 0044 at p. 201)

MUD commented that a majority of apartment buildings in its service territory utilize interior common vent stacks. MUD and Carrier stated that space constraints would prohibit the installation of new PVC venting in the existing chases. Carrier and MUD commented that sidewall venting may not be an option due to firewalls, sidewalks adjacent to building, or other local codes. Carrier stated that the situation may be exacerbated if it is desired to provide two-pipe or direct venting for the condensing furnace to provide cleaner outdoor combustion air for better reliability. MUD stated that building owners will face not only the high costs to replace furnaces, but will also need to modify vent stacks to comply with current codes. (MUD, No. 0144 at p. 2; Carrier, No. 0116 at pp. 13-14)

DOE recognizes the unique requirements for installing condensing furnaces in multi-family buildings. The analysis for the March 2015 NOPR and this SNOPR accounts for the cost of measures to address the constraints mentioned by the comments. Such measures include the vent length, existing common vents, and horizontal venting. Moreover, because many multi-family NWGF installations would utilize a relatively small furnace, DOE's proposed standard for NWGFs with a certified input capacity of 55 kBtu/h would greatly reduce the number of multi-family installations where a condensing furnace would be necessary. DOE's analysis estimates that more than 60 percent of replacement multi-family NWGF installations would not be impacted by the proposed standard.

Condensate Withdrawal

DOE accounted for the cost of condensate removal for condensing NWGF installations, including, when applicable, a condensate drain, condensate pump, freeze protection (heat tape), drain pan, condensate neutralizer, and additional electric outlet for the condensate pump.

Carrier stated that code requirements may prevent condensate drainage to wastewater management utilities. (Carrier, No. 0116 at p. 34) AGL Resources stated that the fraction of furnaces requiring condensate neutralizers estimated by DOE is extremely low and does not take into account codes that require condensate neutralization and the high likelihood of encountering cast iron drain lines in older homes that require condensing furnace retrofits. AGL Resources also commented that the International Plumbing Code, the most widely adopted plumbing code in the U.S., requires neutralizers. (AGL Resources, No. 0112 at p. 4) Rheem stated that safe operation of the furnace prohibits a common condensate drain with an air conditioner condensate drain. (Rheem, No. 0142 at p. 8)

In response, DOE notes that although neutralization is included in the International Plumbing Code, it is not mandatory in most U.S. municipalities. To address situations where condensate must be treated before disposal, DOE assumed that a fraction of installations require condensate neutralizer for condensate withdrawal. As discussed in appendix 8D of the SNOPR TSD, DOE determined that the fraction of installations that require condensate neutralizer used in the NOPR analysis (12.5 percent) is representative of the current use. DOE notes that while Rheem does not allow a common condensate drain with an air conditioner condensate drain, other manufacturers allow a common drain.[75,76,77]

Questar Gas argued that with multi-family units, the condensate disposal requirements would be cost prohibitive and, in some cases, impossible. (Questar Gas, No. 0151 at p. 1) Rheem stated that multi-family homes pose the most serious challenges

[75] Carrier, Single-Stage 4-Way Multipoise Condensing Gas Furnace Series A and B: Installation, Start-up, Operating and Service and Maintenance Instructions (IM-PG95SAS-07) (2015).
[76] Goodman Manufacturing Company, L.P., GMH95/GCH95/GME95/GCH9 Gas-Fired Warm Air Furnace Installation Instructions, Houston, TX.
[77] Rheem Manufacturing Company, Installation Instructions For Upflow, Downflow/Horizontal High Efficiency Condensing two-Stage Gas Furnaces RGRM, RGTM Series.

to providing proper condensate management without extensive structural modification to the home. (Rheem, No. 0142 at pp. 8-9) DOE acknowledges that condensate management can be costly for some multi-family units and very difficult in rare cases. DOE notes the proposed standard in this SNOPR would reduce the number of cases where condensate disposal costs would be extremely high.

Darling stated that mobile homes have no provision for disposing of condensate produced by a condensing furnace, leading to either costly plumbing additions to legally accommodate the condensate or the condensate drain dumping onto the ground under the home. (Darling, No. 0065 at p. 1) DOE understands that most mobile homes have air conditioning that has provisions for withdrawing condensate. In the March 2015 NOPR and this SNOPR, DOE included condensate piping for all MHGFs and condensate pump, heat tape, and electrical outlet for condensate pump and heat tape for a fraction of MHGF installations without air conditioning.

Goodman commented that condensate freeze protection is an added installation concern that must be addressed when installing condensing furnaces. (Goodman, No. 0135 at p. 3) Carrier and many contractors who responded to PHCC's and ACCA's survey stated that in some regions, condensate located in an unheated space (e.g., attics, ventilated crawlspaces) could freeze in the condensate line. (Carrier, No. 0116 at p. 34; PHCC, No. 0136 at p. 11; ACCA, No. 0158-2 at p. 11) Darling and AGL Resources stated that replacing a non-condensing furnace located in an attic or crawlspace, which are typically unconditioned, with a condensing furnace may require heat tape to prevent freezing. (Darling, No. 0065 at p. 1; AGL Resources, No. 0112 at p. 4) AHRI stated that a significant number of contractors believe that heat tape is not sufficiently reliable to prevent condensate from freezing. (AHRI, No. 0159 at p. 62) In response, DOE notes that the use of heat tape to prevent condensate pipes from freezing is standard installation practice. DOE assumed that condensing furnaces installed in non-conditioned spaces would require heat tape to prevent condensate from freezing. DOE also accounted for the additional installation cost and energy use of the heat tape. In addition, DOE believes that as condensing furnaces become more common, contractors will become better trained and more aware of potential issues, thus increasing the reliability of heat tape or using other options that do not expose the condensate pipe to freezing environment.

New Venting Technologies

To address certain difficult installation situations, a new venting technology was recently developed to vent a condensing residential furnace and atmospheric combustion water heater through the same vent by reusing of the existing metal vent or masonry chimney with a new vent cap and appropriate liner(s). In the March 2015 NOPR, DOE conducted a sensitivity analysis to estimate the impact of such a technology on the installation cost of a condensing NWGF, but did not include the technology in the primary analysis.

ASAP stated that DOE's main analysis does not account for the latest venting technologies that can significantly reduce installation costs, such as that developed by M&G DuraVent. (ASAP, No. 0154-1 at p. 2) NRDC stated that the analysis shows that the DuraVent technology would deliver large average consumer savings for row homes and condominiums. (NRDC, No. 0134 at p. 6) ACEEE and ASE stated that DOE should consider DuraVent more fully in its main analysis as a venting alternative for orphaned water heaters. ACEEE understands that other manufacturers have developed their own products and are getting UL certification, and that many products will be widely available long before a new furnace standard takes effect. (ACEEE, No. 0113 at pp. 1-2; ASE, No. 0115 at p. 21) The Joint Congress Members and PG&E stated that new venting technologies are reducing the cost of venting condensing furnaces in even the most difficult circumstances, such as row houses. The Joint Congress Members stated that it is reasonable to expect that costs would be lower than estimated. (Joint Congress Members, No. 0161 at p. 3; PG&E, No. 0153 at p. 6) On the other hand, AGL Resources argued that DOE overestimated the capabilities of the DuraVent technology, and noted that per the manufacturer's guidelines, the Category IV liner portion of the product must always maintain at least a 45-degree angle. AGL Resources stated that DuraVent can only be used in very limited applications where the existing common vent has no horizontal sections, and where the furnace and water heater are side by side. AGL Resources stated that because of these limitations, DuraVent cannot be used in masonry chimneys. It added that DuraVent also requires annual maintenance. (AGL Resources, No. 0039 at pp. 8-9; AGL Resources, No. 0112 at pp. 13-15)

According to the available information, DuraVent is UL-approved for use with metal vents,[78] but data on the performance in the field are lacking. In addition, DOE recognizes that there are currently limitations of the DuraVent technology related to

[78] M&G DuraVent's FNS 80/90 Combination Cat I and Cat IV gas vent system is UL listed to applicable portions of ULC S636/UL1738, UL1777, and UL441. (See www.duravent.com/Product.aspx?hProduct=49.)

venting in masonry chimneys. Because of the uncertainty regarding applicability of DuraVent technology, DOE maintained its approach of conducting sensitivity analyses for this SNOPR. For these analyses, DOE only applied the DuraVent option to installations that could meet the DuraVent installation requirements, as it did in the March 2015 NOPR. DOE notes that while venting technology could lower installation costs, DOE must base its approach on currently available data and cannot speculate as to future developments in advanced venting technologies, but welcomes any available data.

Learning in Installation Costs

NRDC and ASAP commented that DOE should apply a learning curve to installation costs that are likely to decline, particularly for homes with challenging installation conditions for which there has been relatively little market experience. NRDC stated that keeping installation costs constant over time implicitly assumes that manufacturers and installers would not deliver any new venting technologies that can significantly reduce installation costs. (NRDC, No. 0134 at pp. 2, 6; ASAP, No. 0154-1 at p. 2) CEC expects that retrofit installation costs would decrease as the industry provides innovative solutions to address venting in all retrofits. (CEC, No. 0120 at p. 5) NRDC suggested including “learning curve” measures, and in particular, lower-cost installation measures that will likely emerge for homes with relatively challenging installation conditions for condensing furnaces. (NRDC, No. 0134 at p. 2; NRDC, No. 0186 at p. 2)

DOE acknowledges the potential for the cost of installing a condensing furnace to decline with experience, but it did not have information that would be required to quantify a learning curve for installation costs.

c. Comments on Installation Cost Results for Non-Weatherized Gas Furnaces

Goodman urged DOE to update its installation cost estimates based on the results presented in the AHRI-ACCA-PHCC contractor survey report to ensure that the installation costs are representative of real world issues faced by contractors and consumers in the field. (Goodman, No. 0135 at p. 2) AHRI also stated that installation costs for NWGFs are significantly underestimated. (AHRI, No. 0181 at p. 3) AHRI stated that according to its survey results, the average installation costs for all furnaces in all regions are over $1,000 more than what DOE estimated, and the distribution of installation costs is higher than DOE's distribution in both the North and the South. (AHRI, No. 0159 at pp. 44-46)

Goodman, PHCC, and ACCA stated that average installation costs from the AHRI-ACCA-PHCC survey range from $1,908 for new installations in the South to $2,730 for replacement installations in the North. (Goodman, No. 0135 at p. 2; PHCC, No. 0136 at p. 6; ACCA, No. 0158-2 at p. 6) Rheem and AHRI stated that survey data of actual contractors show replacement installation costs of two or more times DOE's estimates, depending on the type of furnace. (Rheem, No. 0142 at p. 4; AHRI, No. 0159 at p. 68) AHRI stated that the difference between DOE's installation cost estimates and survey results is unlikely to be due to the RS Means data that DOE used. Rather, AHRI stated that there is no evidence that DOE calibrated its installation cost estimates with market data. (AHRI, No. 0159 at p. 46) Southside Heating and Air Conditioning stated that its installation cost in Minnesota ranges from two to six times as much as DOE's estimate for non-condensing NWGFs. Southside Heating and Air Conditioning stated that its installation cost in Minnesota is triple DOE's installation cost for condensing NWGFs. (Southside Heating and Air Conditioning, No. 0044 at p. 139)

In response, the differences between total installation cost from available survey data and the costs provided in the March 2015 NOPR and September 2015 NODA could be due to various issues affecting both non-condensing and condensing NWGFs, such as: the cost of ductwork upgrades; baseline electrical installation costs; additional labor required in the baseline; underestimation of relining, resizing, or other adjustments of metal venting in the baseline; premium for emergency replacements; and premium installations that include other comfort-related features (e.g., advanced thermostats, zoning, hypoallergenic filters, humidity controls). Also, the installation price varies widely by different contractors and areas of the country/region. For the SNOPR, DOE compared its estimates to the AHRI-ACCA-PHCC contractor survey report and other sources such as Home Advisor,[79] ImproveNet,[80] Angie's List,[81] HomeWyse,[82] Cost Helper,[83] Fixr,[84] CostOwl,[85] and Gas Furnace Guide,[86] and also consulted with RS Means

[79] Home Advisor, How Much Does a New Gas Furnace Cost? (Available at: http://www.homeadvisor.com/cost/heating-and-cooling/gas-furnace-prices/) (Last accessed April 26, 2016).
[80] Improvenet, Furnace Installation Cost Guide (Available at: http://www.improvenet.com/r/costs-and-prices/furnace-installation-cost-estimator) (Last accessed April 26, 2016).
[81] Angie's List, How Much Does it Cost to Install a New Furnace (Available at: https://www.angieslist.com/articles/how-much-does-it-cost-install-new-furnace.htm) (Last accessed April 26, 2016).
[82] HomeWyse, Cost to Install a Furnace (Available at: http://www.homewyse.com/services/cost_to_install_furnace.html) (Last accessed April 26, 2016).
[83] Cost Helper, How Much Does a Furnace Cost? (Available at: http://home.costhelper.com/furnace.html) (Last accessed April 26, 2016).

staff to make its baseline installation cost estimates more comparable. It appears that much of the additional cost not included in the March 2015 NOPR is the same for a non-condensing and condensing furnace (such as ductwork, emergency replacement, etc.). The LCC impacts are driven by the differential between the non-condensing and condensing designs, so for the SNOPR did not add these additional costs.

Many stakeholders commented on the installation cost when replacing a non-condensing NWGF with a condensing NWGF. NiSource, Meeks, AAEA, Ubuntu, DC Jobs or Else, CA, Payne, Bishop, Indiana, Nayes, and A Ware stated that the installation cost of a condensing furnace is $1,500 to $2,500, which is higher than DOE's estimate. (NiSource, No. 0127 at p. 3; Meeks, No. 0140 at p. 1; AAEA, No. 0056 at p. 1; Ubuntu, No. 0057 at p. 1; Ubuntu, No. 0191 at p. 1; DC Jobs or Else, No. 0059 at p. 1; CA, No. 0061 at p. 1; Payne, No. 0075 at p. 1; Bishop, No. 0076 at p. 1; Indiana, No. 0094 at p. 1; Nayes, No. 0055 at p. 1; A Ware, No. 0204 at p. 1)

Laclede stated that DOE significantly understated the incremental costs to install a condensing furnace compared to a non-condensing furnace. (Laclede, No. 0141 at p. 5) Washington Gas stated that according to contractors in its service territory, a replacement condensing furnace could be as much as 50 percent higher than the installation cost of a replacement non-condensing furnace. (Washington Gas, No. 0133 at p. 2) SoCalGas

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[84] FIXr, Gas Central Heating Installation Cost (Available at: http://www.fixr.com/costs/gas-central-heating-installation) (Last accessed April 26, 2016).
[85] CostOwl.com, How much Does a New Furnace Cost? (Available at: http://www.costowl.com/home-improvement/hvac-furnace-replacement-cost.html) (Last accessed April 26, 2016).
[86] Gas Furnace Guide, Gas Furnace Prices and Installation Cost Comparison (Available at: http://gasfurnaceguide.com/compare/) (Last accessed April 26, 2016).

stated that data for production housing in California demonstrates that the installed cost for a 92-percent furnace is higher than that of an 82-percent furnace by $385, $495, and $551 for 40, 60, and 80 kBtu/h, respectively. (SoCalGas, No. 0132-2 at p. 7; SoCalGas, No. 0132-6 at pp. 10-11) Goodman, PHCC, and ACCA stated that the installation costs for condensing furnaces from their survey is between $500 and $600 more than for non-condensing furnaces. (Goodman, No. 0135 at p. 2; PHCC, No. 0136 at p. 6; ACCA, No. 0158-2 at p. 6) PHCC and ACCA stated that because contractors almost always install condensing furnaces where the economic returns are acceptable to consumers, the results of their survey represent a lower bound on the costs that might be incurred under a national condensing NWGF standard. (PHCC, No. 0136 at p. 11; ACCA, No. 0158-2 at p. 11) AHRI stated that the survey responses do not include costs for replacement installations that are expensive, difficult, and require added system or site work. (AHRI, No. 0159 at p. 68)

As noted previously, installation cost varies widely for different contractors and areas of the country. For both the March 2015 NOPR and September 2015 NODA, the average incremental installation cost for a condensing NWGF was $564 (in 2014$) for a retrofit installation, which matches the contractor survey and data provided by SoCalGas. For the SNOPR, revised its estimates using RS Means 2015 data such that the average cost incremental is $528 in 2015$ for a retrofit installation.

Table IV.15 shows the fraction of installations impacted and the average cost for each of the installation cost adders in replacement applications. The estimates of the fraction of installations impacted were based on the furnace location (primarily derived from information in the 2009 RECS) and a number of other sources that are described in chapter 8 of the SNOPR TSD.

Table IV.14 Additional Installation Costs for Non-Weatherized Gas Furnaces in Replacement Applications

Installation Cost Adder	Replacement Installations Impacted	Average Cost (2015$)
Non-Condensing Furnaces		
Updating Flue Vent*	2%	$612
Condensing Furnaces		
New Flue Venting (PVC)	100%	$263
Combustion Air Venting (PVC)	59%	$263
Concealing Vent Pipes	9%	$379
Orphaned Water Heater	19%	$702
Condensate Removal	100%	$47

* For a fraction of installations, this cost includes the commonly-vented water heater vent connector, chimney relining, and vent resizing.

Table IV.15 shows the estimated fraction of new home installations impacted and the average cost for each of the adders.

Table IV.15 Additional Installation Costs for Non-Weatherized Gas Furnaces in New Home Applications

Installation Cost Adder	New Construction Installations Impacted	Average Cost (2015$)
Non-Condensing Furnaces		
New Flue Vent (Metal)*	100%	$1,364
Condensing Furnaces		
New Flue Venting (PVC)	100%	$178
Combustion Air Venting (PVC)	60%	$176
Concealing Vent Pipes	3%	$113
Orphaned Water Heater	45%	$1,061
Condensate Removal	100%	$35

* For a fraction of installations, this cost includes the commonly-vented water heater vent connector.

d. Installation Cost for Mobile Home Gas Furnaces

For the March 2015 NOPR, DOE included basic installation costs for MHGFs described above for NWGFs. DOE also included costs for venting and condensate removal. Freeze protection, a condensate pipe, condensate neutralizer, and an additional electricity connection are accounted for in the cost of condensate removal when where applicable.

JCI stated that for replacement installations in mobile homes, significant rebuilding of closets and/or alcoves may be required to accommodate a standard residential furnace design. JCI also stated that the design of venting systems, return air connections, and supply air ductwork are all different for standard residential furnace designs, which increase the complexity and cost for a retrofit application. JCI stated that these additional costs are not included in DOE's analysis to their full extent. (JCI, No. 0148 at p. 6)

In response, DOE notes that MHGFs are usually installed in tight spaces and often require space modifications if the replacement furnace dimensions are different from those of the existing furnace. Manufacturer literature shows that some condensing furnaces are wider and shorter than existing non-condensing furnaces. DOE notes that most of models at the proposed standard at 92 percent AFUE are similar in size to the existing non-condensing furnaces. DOE performed a sensitivity analysis to assess the impact of adding the costs of dealing with space constraints that could be encountered when a standard condensing MHGF replaces an older mobile home-specific furnace.

MHI stated that the dedicated vent system required for 92percent AFUE MHGFs, which alters the performance characteristics of common venting, is especially problematic because these furnaces are only produced for the mobile home market. (MHI, No. 0129 at p. 1) DOE disagrees that a dedicated vent system would be problematic because furnaces installed in mobile homes must be approved by the U.S. Department of Housing and Urban Development, which requires special sealed combustion venting that cannot be commonly vented.

For further details on the installation cost methodology, see chapter 8 of the SNOPR TSD.

3. Annual Energy Consumption

For each sampled household or building, DOE determined the energy consumption for a NWGF or MHGF at different efficiency levels using the approach described in section IV.E of this notice.

For the LCC analysis, DOE does not include the increase in energy use associated with the rebound effect discussed in section IV.E.1.d because the increased furnace usage associated with the rebound effect provides consumers with increased value (e.g., a more comfortable indoor temperature). DOE believes that, if it were able to monetize the increased value to consumers of the rebound effect, this value would be similar in monetary value to the foregone energy savings. Therefore, the economic impacts on consumers, with or without including the rebound effect in the analysis, are the same.

Several stakeholders believe that the cost of increased energy use due to the rebound effect should be accounted for in the LCC analysis. AGA stated that exclusion of direct rebound effect energy costs from the LCC analysis is inconsistent with DOE's definition of LCC analysis as a cost metric. AGA stated that the definition of life-cycle cost demonstrates that LCC is a cost metric that does not encompass non-financial consumer benefits. (AGA, No. 0118 at p. 32) Ingersoll Rand and Laclede commented that DOE underestimated the economic impacts of standards by not accounting for the reduction in energy savings due to the rebound effect. Laclede stated that the rebound effect is a cost with no associated monetary offsets. (Ingersoll Rand, No. 0156 at pp. 6, 9; Laclede, No. 0141 at pp. 36-37) NPGA, Ingersoll Rand, and Laclede stated that DOE should consider the direct rebound effect in total operating costs. (NPGA, No. 0130 at p. 3; Ingersoll Rand, No. 0156 at p. 26; Laclede, No. 0141 at p. 37) AHRI stated that DOE provides no reasoned basis for not applying the rebound effect in the LCC analysis as it does in the NIA. AHRI stated that although comfort is real, it has no real monetary value. AHRI stated that the cost of the new higher-efficiency furnace must be compared against the actual monthly energy bill paid to operate the furnace. (AHRI, No. 0159 at pp. 21, 68) Ingersoll Rand stated that including fuel switching but not the rebound effect in the LCC analysis arbitrarily lowers the LCC of the space heating options in the standards case. (Ingersoll Rand, No. 0156 at p. 9)

The approach suggested by the comments would place no value on the increased comfort associated with the rebound effect, yet clearly consumers are paying for that service in their energy bill. DOE could reduce the energy cost savings to account for the rebound effect, but then it would have to add the value of increased comfort in order to conduct a proper economic analysis. The approach that DOE uses–not reducing the energy cost savings to account for the rebound effect and not adding the value of increased comfort–assumes that the value of increased comfort is equal to the monetary value of the higher energy use. Although DOE cannot measure the actual value of increased comfort to the consumers, the monetary value of the higher energy use represents a lower bound for this quantity. For these reasons, DOE is retaining its current approach to rebound effect.

4. Energy Prices

For the September 2015 NODA, DOE derived average annual residential and commercial electricity, natural gas, and LPG prices for States and various regions using data from the Energy Information Administration (EIA).[87,88,89] DOE calculated an average annual regional residential energy prices by: (1) estimating an average residential price for each utility in the region (by dividing the residential revenues by residential sales); and (2) weighting each utility by the number of residential consumers it served in that region. DOE used the same methodology for average annual regional commercial energy prices. Further details may be found in chapter 8 of the SNOPR TSD.

SoCalGas stated that DOE used questionable values for marginal electricity prices in California in its LCC analysis. 3 (SoCalGas, No. 0132-2 at p. 5) MUD stated that its

[87] U.S. Department of Energy-Energy Information Administration, Form EIA-826 Database Monthly Electric Utility Sales and Revenue Data (2014) available at: www.eia.doe.gov/cneaf/electricity/page/eia826.html

[88] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2014), available at: http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm).

[89] U.S. Department of Energy-Energy Information Administration, 2014 State Energy Consumption, Price, and Expenditure Estimates (SEDS) (2014), available at: www.eia.doe.gov/emeu/states/_seds.html.

average residential natural gas rate has averaged $5.41/MMBtu during the past 48 months, whereas the forecasted prices in AEO2014 for Census Division 4 are $10/MMBtu in 2015. MUD stated that AEO2015 provides a lower estimate. (MUD, No. 0144 at pp. 2-3) In response, DOE calculated average annual energy prices based on historical data from EIA. DOE only used AEO forecasts to project future energy price trends. For this SNOPR analysis, DOE included the most recent EIA energy price data.

Average electricity and natural gas prices from the EIA data were adjusted using seasonal marginal price factors to derive monthly marginal electricity and natural gas prices.

Several stakeholders criticized DOE's methodology to determine marginal energy prices. AGA stated that a comparison of AGA's tariff-based marginal gas price factors, which are based on a dataset of about 200 tariffs, and DOE's EIA-based marginal gas price factors shows that DOE's factors significantly overestimate marginal prices. AGA stated that the AGA tariff-based marginal price methodology uses a conservative approach to calculate marginal prices because merely subtracting fixed customer charges from the customer bill does not account for all fixed charges found in some utility rate structures that could decrease marginal rates further. AGA further stated that DOE should revise its economic analysis to incorporate marginal gas price factors calculated with tariff data provided by AGA. (AGA, No. 0118 at pp. 21-23) Vectren stated that AGA calculated marginal gas prices based on actual tariff data, and found that DOE's estimated national averages are between 6 and 11 percent too high, depending on the season. (Vectren, No. 0111 at pp. 3-4) The GTI report submitted by SoCalGas stated that DOE's marginal gas prices differ from gas company tariff data. (SoCalGas, No. 0132-7 at p. v)

To evaluate AGA’s tariff-based marginal gas price factors, DOE developed seasonal marginal price factors for 23 gas tariffs provided by the Gas Technology Institute for the 2016 residential boilers energy conservation standards rulemaking,[90] and compared them to marginal price factors developed by DOE from the EIA data. The winter price factors used by DOE are generally comparable to those computed from the tariff data, indicating that DOE’s marginal price estimates are reasonable at average usage levels. The summer price factors are also generally comparable. Of the 23 tariffs analyzed, eight have multiple tiers, and of these eight, six have ascending rates and two have descending rates. The tariff-based marginal factors use an average of the two tiers as the commodity price. A full tariff-based analysis would require information about the household's total baseline gas usage (to establish which tier the consumer is in), and a weight factor for each tariff that determines how many customers are served by that utility on that tariff. These data are generally not available in the public domain. DOE's use of EIA State-level data effectively averages overall consumer sales in each State, and so incorporates information about all utilities. DOE's approach is, therefore, more representative of a large group of consumers with diverse baseline gas usage levels than an approach that uses only tariffs. For more details on the comparative analysis, refer to appendix 8D of the SNOPR TSD.

[90] GTI provided a reference located in the docket of DOE’s rulemaking to develop energy conservation standards for residential furnaces. (Docket No. EERE-2014-BT-STD-0031-0118) (Available at www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0031-0118). DOE is also including this information in the docket for the present rulemaking at www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0047-0068.

Laclede stated that DOE's marginal monthly natural gas prices are much higher than actual marginal prices because they are an average across multiple blocks. Laclede stated that true marginal pricing uses the tail block tariff rate. (Laclede, No. 0141 at pp. 18-19) Laclede compared actual marginal tail block tariff rates in five States and found DOE's prices to be two to three times higher. (Laclede, No. 0141 at pp. 29-30) In response, DOE finds that the use of tail blocks with low rates for some utilities, as the commenter recommends, does not provide sufficient information to determine the marginal prices that consumers pay. The information required is: what tariff structures are used most commonly by utilities; how many consumers are on each tariff, and for those consumers, what block is relevant to their monthly consumption level. The EIA data that DOE used to estimate marginal gas prices implicitly incorporate this information. Accordingly, DOE is maintaining its existing methodology, because it is equivalent to a consumption-weighted average marginal price across all households in the State.

To estimate energy prices in future years for the March 2015 NOPR, DOE multiplied the average regional energy prices by the forecast of annual change in national-average residential energy price in the Reference case from AEO2014, which has an end year of 2040. 80 FR 13120, 13150 (March 12, 2015).

AGA stated that DOE should use AEO 2015 energy price forecasts instead of those from AEO 2014 because of the significant impacts of the updated energy price data on the LCC results. (AGA, No. 0118 at pp. 5, 23) DOE updated the energy price forecasts to AEO 2015 for the September 2015 NODA and the SNOPR. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2020 to 2040.

Laclede stated that gas prices have remained relatively low over the past 3 years, and there is nothing that has occurred to indicated that they will be materially higher in the future. (Laclede, No. 0141 at p. 12) Laclede commented that the AEO has overstated gas prices for the past 10 years and understated electricity prices for the past 16 years. (Laclede, No. 0141 at p. 20) Laclede stated that DOE overestimated the incremental benefits from condensing furnaces by failing to use accurate estimates of how natural gas commodity, transportation, and delivery costs are likely to change, and how such cost changes are passed to consumers under existing utility rate design and ratemaking procedures. (Laclede, No. 0141 at p. 5)

DOE acknowledges that the Reference case projection of natural gas prices in AEO 2015 may seem high in the light of recent natural gas market conditions. However, it is important to bear in mind that the AEO is focused on long-term projections. The LCC analysis requires a projection for a period of approximately 20 years beginning in 2022, and market conditions in that period may be quite different from the present situation. DOE acknowledges that the EIA generally overestimated natural gas prices in AEO 2006 through AEO 2012, but before that there was a tendency to underestimate.[91] There also has been a tendency to underestimate electricity prices, but beginning with

[91] Each year, EIA produces an AEO Retrospective Review document, which presents a comparison between realized energy outcomes and the Reference case projections included in previous editions of the AEO. (Available at: https://www.eia.gov/forecasts/aeo/retrospective/).

AEO 2008, the underestimates have been slight. Given the difficulty of projecting the two key drivers—the world oil price and the macroeconomic growth baseline—that are determined exogenously to the model used to prepare the AEO, DOE maintains that the patterns of difference between AEO projections and actual energy prices do not reflect a systematic bias in the model used to prepare the AEO or the assumptions. DOE expects to use energy price projections from AEO 2016, which will incorporate the latest available information, for the final rule.

The Joint Consumer Commenters surmised that reduced demand for natural gas due to increased furnace efficiency would lower the price of the fuel. The Joint Consumer Commenters stated that given the size of the residential gas heating market and the magnitude of the reduction in demand, the reduction in price for natural gas could raise the consumer benefits significantly. (Joint Consumer Commenters, No. 0123 at pp. 21-23)

DOE acknowledges that reduced demand for natural gas due to increased furnace efficiency could put downward pressure on the price of natural gas, which could provide additional consumer benefits. However, the growing use of revenue decoupling, which decouples a utility's revenues from its volume of sales,[92] makes it difficult to predict the magnitude of an effect on retail natural gas prices. In addition, DOE has previously noted that when gas prices drop in response to lower demand, which in turn results in lower output of existing natural gas production capacity, consumers benefit but producers

[92] See discussion of revenue decoupling in section IV.M.

suffer. In economic terms, the situation represents a benefits transfer to consumers (whose expenditures fall) from producers (whose revenue falls equally).[93] If the revenues and costs of producers both fall, the change in natural gas prices represents a net gain to society. Determining what takes place in the gas production sector when gas prices decline is complex, and at this time, DOE is not able to reasonably determine the extent of transfers associated with a decrease in gas prices that may result from appliance standards.

5. Maintenance and Repair Costs

Maintenance costs are associated with maintaining the operation of the product. Repair costs are associated with repairing or replacing product components that fail in an appliance.

For the March 2015 NOPR and September 2015 NODA, DOE estimated maintenance costs for residential furnaces at each considered efficiency level using a variety of sources, including 2013 RS Means,[94] manufacturer literature, and information from expert consultants. DOE estimated the frequency of annual maintenance using data from RECS 2009 and a 2008 consumer survey[95] to derive the frequency with which furnace owners perform maintenance. DOE assumed that condensing furnaces require more maintenance than non-condensing furnaces. DOE also accounted for checking the condensate withdrawal system and regular replacement of the condensate neutralizer, if

[93] See discussion in the June 2011 DFR. 76 FR 37408, 37487-88 (June 27, 2011).
[94] RS Means Company Inc., RS Means Facilities Maintenance & Repair Cost Data. Kingston, MA (2015).
[95] Decision Analysts, 2008 American Home Comfort Study: Online Database Tool 2009) (Available at: www.decisionanalyst.com/Syndicated/HomeComfort.dai).

present. For the standby mode and off mode standard, DOE assumed that no additional maintenance is required.

Laclede stated that DOE significantly understated the incremental costs to maintain a condensing furnace compared to a non-condensing furnace. (Laclede, No. 0141 at p. 5) Johnson stated that DOE failed to take into account the higher service costs of condensing furnaces. (Johnson, No. 0190 at p. 1) Carrier stated that condensing and non-condensing furnaces have different service and maintenance requirements that are not accounted for in the LCC analysis. Carrier stated that according to contractors, condensing furnaces take 60 minutes to maintain, while non-condensing furnaces only require 30 minutes. Carrier stated that condensing furnaces are more complex than non-condensing furnaces because of additional components like the condensate management system and secondary heat exchanger, which need to be maintained. Carrier stated that utilizing the most common contractor hourly rates of $70/hour, $90/hour, or $110/hour, homeowners will pay between $35 and $55 more annually to properly maintain a condensing furnace compared to a non-condensing furnace. (Carrier, No. 0116 at pp. 31-32)

For the March 2015 NOPR and September 2015 NODA, DOE estimated on average the labor hours for a non-condensing furnace maintenance to be 1.65 hours (which includes a 0.5 hour trip charge). For condensing furnaces, DOE added 0.155 hours to check the secondary heat exchanger and condensate system (including the condensate neutralizer). Based on RS Means 2013, the national average labor cost used for maintenance and repair was $78/hour in 2013$. For the SNOPR, DOE reexamined the issue of maintenance costs but found little evidence that currently contractors are charging more for maintenance of condensing compared to non-condensing furnaces. Nevertheless, DOE also updated its labor costs to 2015 RS Means (with a national average of $82 in 2015$) and the overall cost estimates fall within typical $70-200 maintenance charges from different online sources listed in appendix 8F of the SNOPR TSD.

Southside Heating and Air Conditioning stated that a new condensate neutralizer with a 1-year lifetime costs $50. (Southside Heating and Air Conditioning, No. 0044 at p. 244) For the March 2015 NOPR and September 2015 NODA, DOE applied a $56 cost of the neutralizer (which is also included in the installation cost) with an average 3 year lifetime. For the SNOPR, revised the neutralizer cost to $58, but kept the 3-year average lifetime based on several sources listed in appendix 8F of the SNOPR TSD.

For the March 2015 NOPR and September 2015 NODA, DOE estimated repair costs for residential furnaces at each considered efficiency level using a variety of sources, including 2013 RS Means,[96] manufacturer literature, and information from expert consultants. For repair costs, DOE accounted for repair of the ignition, gas valve, controls, and inducer fan, as well as the furnace fan blower. To determine components'

[96] RS Means Company Inc., RS Means Facilities Maintenance & Repair Cost Data. Kingston, MA (2013).

service lifetime, DOE used a Gas Research Institute (GRI) study.[97] For standby mode and off mode standard, DOE assumed that no additional repair is required.

Darling stated that inadequate ductwork is likely to be present in most households and may restrict the airflow, thereby causing the main blower motor to fail after only a few years of operation. Darling commented that the cost of these high-efficiency motors is much greater than the difference in cost between a non-condensing furnace and a condensing furnace. (Darling, No. 0065 at p. 1) In response, DOE accounted for the repair of the furnace fan based on the technologies that are required to meet the 2019 furnace fan standard. The lifetime distribution accounts for a fraction of furnace fans that fail after only a few years. DOE notes that the 2019 furnace fan standards require constant-torque BPM motors (commonly referred to as X13) for both non-condensing and condensing NWGFs, which maintain a predetermined torque in each airflow-control setting as operating conditions change. Thus, the motors are not impacted by the quality of the ductwork. For MHGFs, the 2019 furnace fan standard is an improved PSC design, which is the most common design for both non-condensing and condensing furnaces. DOE notes that the ductwork issues such as airflow restrictions are much less common for mobile homes.

Goodman commented that because the technologies associated with the max-tech level for standby mode and off mode are new to the market, data on the failure modes and

[97] Jakob, F.E., J.J. Crisafulli, J.R. Menkedick, R.D. Fischer, D.B. Philips, R.L. Osbone, J.C. Cross, G.R. Whitacre, J.G. Murray, W.J. Sheppard, D.W. DeWirth, and W.H. Thrasher, Assessment of Technology for Improving the Efficiency of Residential Gas Furnaces and Boilers, Volume I and II—Appendices (September 1994) Gas Research Institute, Report No. GRI–94/0175 (Available at www.gastechnology.org/reports_software/ Pages/default.aspx).

repair costs are limited. (Goodman, No. 0135 at pp. 4-5) Goodman stated that DOE failed to account for the new technology associated with standby mode and off mode that entails an additional learning curve for contractors, which may increase maintenance and repair costs. (Goodman, No. 0135 at p. 4) In response, DOE notes that the LL-LTX technology, which is intended to address standby mode and off mode energy use, is not very different from LTX technology that is found in most furnaces today. The primary difference is that LL-LTX technology is slightly larger and heavier than LTX. Furthermore, there are many furnace models on the market with standby consumption less than the proposed standard levels for standby mode and off mode. Therefore, DOE does not believe that the standby mode and off mode max-tech technology would require additional maintenance or repair.

For this SNOPR, DOE updated the RS Means data to 2015.[98] For more details on DOE's methodology for calculating repair costs, see appendix 8F of the SNOPR TSD.

6. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE conducted an analysis of furnace lifetimes using a combination of data on shipments and the furnace stock (see section IV.G) and RECS data on the age of furnaces in the sampled homes. The data allowed DOE to develop a survival function, which provides a range from minimum to maximum lifetime, as well as an average lifetime. The average lifetime estimated for the NOPR and NODA was 21.5 years for NWGFs and MHGFs.

[98] RS Means Company Inc., RS Means Facilities Maintenance & Repair Cost Data. Kingston, MA (2015) (available at http://www.rsmeans.com/)

Several stakeholders expressed concern that DOE’s estimated average lifetime is too high. AGA, AGL Resources, Vectren, and SoCalGas stated that DOE overestimated the average lifetime of NWGFs compared to industry estimates. AGA stated that industry estimates of residential gas furnace lifetime are 15 or 16 years. (AGA, No. 0036 at p. 3; AGA, No. 0040-2 at p. 3; AGL Resources, No. 0039 at p. 2; AGL Resources, No. 0112 at p. 3; Vectren, No. 0111 at pp. 4-5; SoCalGas, No. 0132-2 at p. 5; SoCalGas, No. 0132-6 at p. 9) AGA stated that DOE overestimated the average lifetime of residential gas furnaces compared to the lifetimes included in DOE’s literature review. (AGA, No. 0118 at pp. 5, 23-24) AGL Resources stated that DOE's lifetime estimate for residential gas furnaces is significantly higher than previous DOE values and other furnace lifetime estimates from Appliance Magazine and NAHB of 15-17.5 years. (AGL Resources, No. 0039 at p. 2; AGL Resources, No. 0112 at p. 3) NAHB stated that its lifetime estimates for furnaces are closer to 16 or 18 years. (NAHB, No. 0044 at p. 318) Vectren stated that the bulk of furnace lifetime estimates from DOE's literature review are between 15 and 18 years. (Vectren, No. 0111 at p. 5) SoCalGas stated that Canada used a product lifetime of 15 years in its furnace efficiency standard analysis in January 2014. (SoCalGas, No. 0132-2 at p. 5; SoCalGas, No. 0132-6 at p. 9)

In response, DOE was unable to obtain data to substantiate the cited industry estimates. The furnace lifetime estimates from DOE's literature review, which includes Appliance Magazine, range between 15 and 20 years,[99] which is below the average lifetime estimated for the NOPR and NODA, but the basis for these estimates is often not

[99] See appendix 8G of the SNOPR TSD for a listing of the sources.

clear. DOE found that the Canadian analysis used an average lifetime of 20 years.[100] DOE believes that its method described in a journal article,[101] which uses a combination of actual shipment and survey data, is more reliable, and also better suited to provide a distribution of lifetimes that is appropriate for U.S. conditions. In response to AGL Resources' statement that DOE's lifetime estimate for residential gas furnaces is significantly higher than previous DOE values, the mean lifetime estimated in the March 2015 NOPR and September 2015 NODA (21.5 years) is lower than the mean lifetime of 23.6 years for non-weatherized gas furnaces used in the 2011 DFR, which is based on more recent data.

AGL Resources criticized DOE for using a proprietary method to determine the lifetime and relying on what it argued were questionable assumptions and on incomplete AHRI unitary shipment data to arrive at its estimate. (AGL Resources, No. 0039 at p. 2; AGL Resources, No. 0112 at p. 3)

For the March 2015 NOPR and September 2015 NODA, DOE determined the lifetime based on the methodology described in a recent journal paper[102] and using publicly-available sources from AHRI,[103] the U.S. Census's American Housing Survey

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[100] Rosalyn Cochrane, Team Leader Standards Development HVAC-R, Energy Sector, Natural Resources Canada/Government of Canada. Personal communication, May 18, 2016.

[101] Lutz, J., A. Hopkins, V. Letschert, V. Franco, and A. Sturges, Using national survey data to estimate lifetimes of residential appliances. *HVAC&R Research*, 2011. 17(5): pp. 28 (Available at: www.tandfonline.com/doi/abs/10.1080/10789669.2011.558166) (Last Accessed: April 26, 2016)

[102] Lutz, J., A. Hopkins, V. Letschert, V. Franco, and A. Sturges, Using national survey data to estimate lifetimes of residential appliances, HVAC&R Research (2011) 17(5): pp. 28 (Available at: www.tandfonline.com/doi/abs/10.1080/10789669.2011.558166).

[103] Air-Conditioning Heating and Refrigeration Institute. Historical Shipments Data (Available at: http://www.ahrinet.org/site/497/Resources/Statistics/Historical-Data/Furnaces-Historical-Data).

(AHS) from 1974-2011,[104] and RECS from 1990 to 2009.[105] The historical shipments (using AHRI data prior to 1996) are also provided in DOE's analytical tools for the NOPR and NODA. DOE also conducted a sensitivity analysis using different furnace lifetime scenarios (see appendix 8G in the SNOPR TSD). In addition for the SNOPR, to better account for differences in lifetime due to furnace utilization, DOE determined separate lifetimes for the North and South for the shipments analysis. The average lifetime used in the SNOPR is 20.1 years in the North and 23.4 years in the South for both NWGFs and MHGFs, compared to 21.5 years nationally in the NOPR and NODA.

AGL Resources also stated that DOE used very high present-day fuel switching trends to determine furnace lifespan. AGL Resources stated that higher rates of fuel switching lead to an overestimation of product lifetime in the DOE model as retired furnaces are replaced by heat pumps and never counted as a "failure" in the DOE model. (AGL Resources, No. 0112 at p. 3) The lifetime methodology takes into account indirectly the impact of product switching that has occurred in the past by accounting for the actual number of furnace installations over time from AHS and RECS (which includes early replacements, non-replacements, product switching, demolitions, etc.).

[104] U.S. Census Bureau: Housing and Household Economic Statistics Division, *American Housing Survey*, Multiple Years (1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, and 2011) (Last accessed March, 2014) (Available at: www.census.gov/programs-surveys/ahs/).
[105] U.S. Department of Energy: Energy Information Administration, Residential Energy Consumption Survey (RECS), Multiple Years (1990, 1993, 1997, 2001, 2005, and 2009) (Last accessed January 7, 2015) (Available at: www.eia.gov/consumption/residential/).

Rheem and AGL Resources stated that the lifetime is dependent on furnace usage. (Rheem, No. 0142 at p. 9; AGL Resources, No. 0112 at p. 3) The distribution of furnace lifetimes used in the LCC analysis accounts for a wide range of furnace utilization.

AGL Resources stated that historical lifetime data primarily track non-condensing furnaces that had little electronic control, a simple heat exchanger design, and atmospheric venting. AGL Resources stated that condensing furnaces have more components that can fail, so data for non-condensing models cannot be used to estimate condensing furnace life expectancy. (AGL Resources, No. 0112 at p. 3) Laclede suggested that condensing furnaces have shorter lifetimes by stating that moving to an all-condensing furnace market would decrease furnace life. (Laclede, No. 0141 at p. 32)

DOE acknowledges that the data it used to derive furnace lifetimes primarily refer to non-condensing furnaces. However, the one source it found on lifetime of condensing furnaces[106] shows the same lifetime (18 years) as other sources provide for non-condensing furnaces. . In addition, DOE reviewed warranty information primarily related to heat exchangers and did not find any significant differences between condensing and non-condensing furnaces. If manufacturers expect condensing furnaces to have a shorter lifetime than non-condensing furnaces, it seems likely that the warranty periods would be different. Based on the information reviewed, DOE maintained the same lifetime for condensing and non-condensing furnaces in the SNOPR.

[106] http://www.neep.org/sites/default/files/resources/A5_Mid_Atlantic_TRM_V2_FINAL_0.pdf

Chapter 8 of the SNOPR TSD provides further details on the methodology and sources DOE used to develop furnace lifetimes.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating costs. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective. DOE estimated a distribution of residential discount rates for NWGFs and MHGFs based on the opportunity cost of funds related to appliance energy cost savings and maintenance costs.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings and maintenance costs. For the NOPR, DOE estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[107] (SCF) for 1995, 1998, 2001, 2004, 2007, and 2010. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended or new standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. For the March 2015 NOPR, DOE tentatively determined that the average residential discount rate across all types of

[107] The Federal Reserve Board, Survey of Consumer Finances (1995, 1998, 2001, 2004, 2007 and 2010) (Available at: www.federalreserve.gov/pubs/oss/oss2/scfindex.html) (Last accessed March 15, 2016).

household debt and equity and income groups, weighted by the shares of each class, is 4.5 percent. 80 FR 13120, 13151 (March 12, 2015).

AHRI stated that DOE inappropriately uses average, not marginal, sources of funds to calculate discount rates. AHRI commented that there is no evidence that consumers draw from or add to their collection of debt and asset holdings approximately in proportion to their current holdings, as DOE claims; rather, consumers have very limited options to raise funds, particularly in the magnitude of $3,000-$54,000 for a new furnace. AHRI argued that only a minority of consumers will be able to use cash or other savings to pay for a furnace replacement. AHRI stated that except for minor purchases, most households access additional funds from credit card debt. AHRI stated that refinancing a mortgage is impractical to purchase a new appliance, and other equity types are not liquid, so other forms of consumer debt are the only marginal source of funds available. AHRI stated that surveys demonstrate that consumers have little savings to finance a furnace purchase, and that 55 percent of consumers use some sort of financing to purchase HVAC equipment. AHRI stated that the true marginal discount rates for consumers are much more likely to cluster around 8-9 percent than around 3-5 percent, as DOE assumed in the NOPR. (AHRI, No. 0159 at pp. 38-43) Rheem stated that the LCC analysis uses unrealistically low consumer discount rates when consumers are known to be unable to meet emergencies from cash or savings, and the actual marginal source of funds is high interest debt. (Rheem, No. 0142 at p. 4)

In response, DOE maintains that the interest rate associated with the specific source of funds used to purchase a furnace (i.e., the marginal rate) is not the appropriate metric to measure the discount rate as defined for the LCC analysis. The marginal interest rate alone would only be the relevant discount rate if the consumer were restricted from re-balancing their debt and asset holdings (by redistributing debt and assets based on the relative interest rates available) over the entire time period modeled in the LCC analysis. The LCC is not analyzing a marginal decision; rather, it estimates net present value over the lifetime of the product, so the discount rate needs to reflect the opportunity cost of both the money flowing in (through operating cost savings) and out (through upfront cost expenditures) of the net present value calculation. In the context of the LCC analysis, the consumer is not only discounting based on their opportunity cost of money spent today, but instead, they are also discounting the stream of future benefits. On the one hand, a consumer could pay for an appliance with cash, thereby forgoing putting that same amount of money into one of the interest earning assets to which they might have access. On the other hand, a consumer could pay for the initial purchase by going into debt. If they do this, they will face the cost of capital at the interest relevant for that purchase; however, they will receive a stream of future benefits in terms of energy savings that they could either put towards paying off that or other debts, or towards assets, depending on the restrictions they face in their debt payment requirements and the relative size of the interest rates on their debts and assets. All those interest rates are relevant, as they all reflect direct costs of borrowing, or opportunity costs of money either now or in the future. DOE maintains that the best proxy for this re-optimization of debt and asset holdings over the lifetime of the LCC analysis is to assume that the distribution of debts and assets in the future will be proportional to the distribution of debts and assets historically. Given the long time horizon modeling in the LCC, the application of a marginal rate alone would be inaccurate. DOE's methodology for deriving residential discount rates is in line with the weighted-average cost of capital used to estimate commercial discount rates. For these reasons, DOE is maintaining its existing approach to discount rates, but it included data from the 2013 SCF and updated several other data sources. The average rate in the SNOPR analysis across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.3 percent for NWGFs and 4.7 percent for MHGFs.

NAHB stated that a mortgage rate does not capture a market participant's time value of money, as mortgage rates are determined by institutional factors. NAHB also commented that rates on liquid assets or assets that trade frequently and easily in well-established secondary markets are equally inappropriate for housing. NAHB argued that once installed, it is difficult and costly to disconnect and sell a furnace like one could sell a mutual fund or withdraw funds from a money market account. NAHB stated that for owner-occupied housing, a reasonable choice for a nominal rate would be the rate households pay on credit card debt. (NAHB, No. 0124 at p. 3)

The time value of money (particularly for the LCC) is the opportunity cost of that money: the value it would have had, had it been applied to another investment or used to pay off another debt. DOE agrees that a mortgage rate by itself does not capture a market participant's time value of money, but a consumer's choice of composition of their debt and asset portfolio provides insight into a consumer's time value of money. Also, while a furnace itself is not a readily tradable commodity, the money used to purchase it and the energy cost savings accruing to it over time flow from and to a household's pool of debt and assets, including mortgages, mutual funds, money market accounts, etc. Thus, the weighted-average interest rate on debts and assets provides a reasonable proxy for a household's opportunity cost (and discount rate) relevant to future energy savings.

Laclede stated that DOE's discount rates are very low. Laclede cited Ruderman et al.[108] for what it argues are a range of more realistic discount rates for different residential appliances from 1972 to 1980. Laclede stated that DOE should use discount rates ranging from 25 percent to 100 percent in increments of 25 percent. (Laclede, No. 0141 at pp. 16-18)

In response, DOE notes that Ruderman et al. and its citations (e.g., Hausman)[109] address implicit discount rates, which are not appropriate in the framework of the LCC analysis. The implicit discount rate is inferred from consumer purchase data and generally incorporates many influences on consumer decision-making (e.g., rates of return, uncertainty, and transaction costs). The implicit discount rate such as those estimated in the cited literature is appropriate for use when modeling a consumer's purchase decision (as in the shipments model). However, in the context of the LCC analysis, many contributing components of the implicit discount rate are not relevant. Factors such as transaction costs are likely to influence a consumer's decision about whether or not to purchase an appliance, but in the LCC, these factors are sunk costs

[108] Ruderman, Henry, Mark D. Levine and James E. McMahon (1987), "The Behavior of the Market for Energy Efficiency in Residential Appliances Including Heating and Cooling Equipment," *The Energy Journal*, 8(1): 101-124 (Available at: www.jstor.org/stable/pdf/41322248.pdf?_=1461360117831).

[109] Hausman, J. A. (1979), Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables, *The Bell Journal of Economics*, 10(1), 33–54 (Available at: www.jstor.org/stable/3003318?seq=1#page_scan_tab_contents
).

(meaning they are costs that have already been incurred and can no longer be changed within the context of the analysis), which are rationally excluded from calculations valuing future costs and benefits associated with the appliance.[110]

To establish commercial discount rates for the small fraction where businesses are using residential furnaces, DOE estimated the weighted-average cost of capital using data from Damodaran Online.[111] The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing. DOE estimated the cost of equity using the capital asset pricing model, which assumes that the cost of equity for a particular company is proportional to the systematic risk faced by that company.

See chapter 8 of the SNOPR TSD for further details on the development of consumer discount rates.

8. Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (i.e., market shares) of product efficiencies

[110] For example, since the LCC analysis starts from the moment of installation, transaction costs related to researching furnace models have no bearing on the future stream of energy cost savings, and ought not to be incorporated into the discount rate.
[111] Damodaran Online, Data Page: Costs of Capital by Industry Sector (2016) (Available at: http://pages.stern.nyu.edu/~adamodar/) (Last accessed April, 2016).

under the no-new-standards case (i.e., the case without amended or new energy conservation standards).

For the March 2015 NOPR and September 2015 NODA, to estimate the efficiency distribution of NWGFs and MHGFs in 2021, DOE considered incentives and other market forces that have increased the sales of high-efficiency furnaces to estimate base-case efficiency distributions for the considered products. DOE started with data provided by AHRI on historical shipments for each product class. DOE reviewed AHRI data from 1992 to 2009 (which includes both NWGF and MHGF shipments data), detailing the market shares of non-condensing (80-percent AFUE) and condensing (90-percent AFUE and greater) furnaces by region.[112] DOE also compiled data on the national market shares of non-condensing and condensing gas furnaces from 2010 to 2012 from the ENERGY STAR program.[113] With these data, DOE derived historic trends for 30 RECS regions and 9 CBECS Census Divisions, by using the 1992-2003 non-condensing and condensing shipments by State provided by AHRI. For the September 2015 NODA, DOE extended its historical data to be include shipments data for non-condensing and condensing shipments data provide by AHRI for 2010−2014.[114]

[112] The market share of furnaces with AFUE between 80 and 90 percent is well below 1 percent due to the very high installed cost of 81-percent AFUE furnaces, compared with condensing designs, and concerns about safety of operation. The data prior to 1992 were not disaggregated by region.
[113] ENERGY STAR Unit Shipment Data (2012) (Available at: https://www.energystar.gov/index.cfm?c=partners.unit_shipment_data).
[114] For the March 2015 NOPR, the AHRI shipments data were not available, and DOE instead relied on shipments data from the ENERGY STAR program to derive its estimates. Based on the AHRI shipments data, DOE's estimate of the condensing furnace market share in 2021 increased from 47 percent in the March 2015 NOPR to 53 percent in the September 2015 NODA.

To project trends from 2011 to 2021 for the March 2015 NOPR, DOE only used the trends from 1993 to 2004 because from 2005 to 2011, there was a sharp increase in the share of condensing furnaces primarily due to Federal tax credits, which was followed by a sharp decrease in 2012. DOE determined that excluding these years provides a more reasonable projection. For the September 2015 NODA, DOE used the data from 2012 to 2014 to project the trends from 2014 to 2021, which excludes the Federal tax incentive years. The maximum share of condensing shipments for each region is assumed to be 95 percent. In other words, at least five percent of NWGF and MHGF furnace shipments will be non-condensing. The condensing market share for MHGFs was estimated to be half the fraction estimated for NWGFs.

DOE used data on the distribution of models in AHRI's Directory of Certified Product Performance[115] to disaggregate the condensing-level shipments among condensing efficiency levels. Based on stakeholder input, DOE assumed that for furnace replacements, the fraction of 95-percent AFUE and above shipments in the replacement market would be double the fraction in the new construction market. DOE also assumed that the fraction of 95-percent AFUE and above shipments would be higher in the North compared to the South, because the ENERGY STAR level in the North is 95-percent AFUE compared to 90-percent AFUE in the South. The resulting distributions by 30 RECS regions and 9 CBECS Census Divisions divided by replacement and new construction in 2021 was then used to assign the AFUE of each sampled household or building in the no-new-standards case.

[115] Air Conditioning, Heating, and Refrigeration Institute, Directory of Certified Performance: Furnaces (2013), (Available at: www.ahridirectory.org/).

Commenting on the NOPR, a number of parties stated that based on new AHRI shipments data, the projected shipments of condensing furnaces in the absence of any revised standard is significantly underestimated. (AHRI, No. 0159 at pp. 67-68; AGA, No. 0118 at p. 20; AGL Resources, No. 0112 at p. 5; Vectren, No. 0111 at p. 4; Ingersoll Rand, No. 0156 at p. 67; Laclede, No. 0141 at p. 32)

The September 2015 NODA analysis incorporated the new AHRI shipments data.[116] The update resulted in an increase in the fraction of consumers already purchasing a condensing furnaces in the no-new-standards case.

Several stakeholders commented on the methodology DOE used to assign efficiencies to sample households in the no-new-standards case.

AHRI stated that the use of a randomized Monte Carlo analysis that does not account for consumer preferences based on climate, income levels, and physical constraints of existing buildings, does not analyze the real-world market for these products. (AHRI, No. 0159 at p. 13) AHRI suggested that DOE should assign furnace efficiency by ranking households based on the benefit from purchasing a condensing furnace as shown by the LCC savings calculation. (AHRI, No. 0159 at pp. 30-31) AHRI stated that relying on the current LCC model is inappropriate because it uses a random

[116] For the March 2015 NOPR, the AHRI shipments data were not available, and DOE instead relied on shipments data from the ENERGY STAR program to derive its estimates. Based on the AHRI shipments data, DOE's estimate of the condensing furnace market share in 2021 increased from 47 percent in the March 2015 NOPR to 53 percent in the September 2015 NODA.

assignment of furnace choice to model a non-random environment. (AHRI, No. 0159 at p. 35)

AGA, Vectren, SoCalGas, Rheem, and the GTI report submitted by SoCalGas similarly criticized DOE's LCC model for randomly assigning furnace efficiency in the absence of standards without any regard to consumer costs and benefits. (AGA, No. 0118 at p. 4; Vectren, No. 0111 at p. 3; SoCalGas, No. 0132-2 at p. 5; SoCalGas, No. 0132-7 at p. v, 10; Rheem, No. 0142 at p. 4; SoCalGas, No. 0132-7 at p. 10; SoCalGas, No. 0177-1 at p. 2) AGA, Vectren, and the GTI report submitted by SoCalGas stated that the random assignment methodology misallocates the fraction of consumers who use economic criteria for their decisions, resulting in higher LCC savings compared to use of rational economic decision making criteria. (AGA, No. 0036 at pp. 3-4; AGA, No. 0040-2 at p. 3; Vectren, No. 0111 at pp. 3-4; SoCalGas, No. 0132-7 at p. 10) Lennox and the GTI report submitted by AGA and APGA stated that the September 2015 NODA LCC model did not address the random no-new-standards case furnace efficiency assignment methodology used in the March 2015 NOPR. (AGA, No. 0175-3 at p. 11; APGA, No. 0180 (attachment) at p. 11; Lennox, No. 0201 at p. 2)

ACEEE and the Efficiency Advocates stated that site-specific economics should enter into the determination of the base-case furnace efficiency, but economics is only one of the factors influencing the choice of furnace. ACEEE stated that only using economics to assign efficiency in the no-new-standards case ignores consumers who upgrade for environmental reasons despite poor economics or because of utility incentives. ACEEE recommended including site-specific economics as well as non-economic decision making criteria in the Monte Carlo simulation. (ACEEE, No. 0113 at pp. 5-6; Efficiency Advocates, No. 0196 at p. 3)

NRDC stated that the GTI Report on the March 2015 NOPR appears to suggest that DOE should have assumed a greater level of optimal economic decision making by customers. However, NRDC stated that the real world data and literature on which DOE based the NOPR shows that many purchasers do not make the most economic decision because of market barriers like split incentives and bounded rationality. NRDC stated that GTI provided no basis on which to assume that future consumers will be different. (NRDC, No. 0134 at p. 1)

The Joint Consumer Commenters stated that a well-designed performance standard that raises the efficiency of gas furnaces can address important market imperfections that are difficult to correct with other policies. (Joint Consumer Commenters, No. 0123 at pp. 25-26)

In response, DOE notes that the assignment of furnace efficiency in the no-new-standards case is not entirely random. Assignment of furnace efficiency is done in two steps, first at the regional level, then the building specific level. Furnace efficiencies are first assigned for the 30 RECS and 9 CBECS regions. The market share of each efficiency level at the regional level is based on historical shipments data and an estimation of trends between 2014 and the compliance year. The historic market shares are influenced by factors that affect the cost-effectiveness of condensing furnaces, including climate, the characteristics of the housing stock, natural gas prices, and the presence of incentives to purchase a condensing furnace.

Furnace efficiency is then allocated to specific RECS households or CBECS buildings located within each of the 30 RECS or 9 CBECS regions. The building-specific assignment is not entirely random either. If a household's existing furnace is estimated to be a condensing gas furnace, the replacement furnace is assumed to be condensing as well. (The assignment of condensing furnace efficiency—92-, 95-, or 98-percentAFUE—was random, adding up to the market share of these types of furnaces for that region.)

DOE acknowledges that furnace efficiency choice is affected by economic factors. However, it is DOE's position that the method of assignment, which is in part random, may simulate actual behavior as well as assigning furnace efficiency based solely on imputed cost-effectiveness. This is because there are a variety of aspects of consumer preference, as well as documented and relevant market failures, which complicate the relevant process of consumer choice.

First, consumers are motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more energy-efficient products because they are environmentally conscious.[117] Additionally, there are systematic market

[117] Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011): "Factors influencing willingness-to pay for the ENERGY STAR® label," Energy Policy, *39*(3), 1450-1458.

failures that are likely to contribute further complexity to the way products are chosen by consumers, as explained in the following paragraphs.

The first of these market failures—the split incentive, or principal-agent, problem—is likely to affect furnaces even more than many other types of appliances. The principal-agent problem is a market failure that results when the consumer that purchases the equipment does not internalize all of the costs associated with operating the equipment. Instead, the user of the product, who has no control over the purchase decision, pays the operating costs. There is a high likelihood of split incentive problems in the case of rental properties where the landlord makes the choice of furnace to install, but the renter is responsible for paying energy bills. In addition, given that the type of furnace that can be installed in a home is often dependent on structural and design decisions made when the building was constructed, builders end up influencing the type of furnace used in many homes. Finally, contractors install a large share of furnaces in replacement situations, and they can exert a high degree of influence over the type of furnace purchased.

In addition to the split-incentive problem, there are other market failures that are likely to affect the choice of furnace energy efficiency level made by consumers. Davis and Metcalf[118] conducted an experiment demonstrating that the nature of the information available to consumers from the EnergyGuide labels posted on air conditioning equipment results in an inefficient allocation of energy efficiency across households with

[118] Davis, L. W., and G. E. Metcalf (2014): "Does better information lead to better choices? Evidence from energy-efficiency labels," National Bureau of Economic Research Working Paper No. 20720.

different usage levels. Their findings indicate that households are likely to make decisions about the efficiency of the climate control equipment of their homes that do not result in the highest net present value for their specific usage pattern (i.e., their decision is based on imperfect information, and therefore is not necessarily optimal).

In part because of the way information is presented, and in part because of the way people process information, there is also a market failure consisting of a systematic bias in the perception of equipment energy usage, which can affect consumer choices. Attari, Krantz, and Weber[119] show that consumers tend to underestimate the energy use of large energy-intensive appliances, but overestimate the energy use of small appliances. This means that it is likely consumers systematically underestimate the energy use associated with furnaces, resulting in less cost-effective furnace purchases.

These market failures affect a sizeable share of the consumer population. A study by Houde[120] indicates that there is a significant subset of consumers that appear to purchase appliances without taking into account their energy efficiency and operating costs at all.

DOE recognizes that its approach to allocating the efficiency level of a new gas furnace across RECS households within States may not fully reflect actual consumer behavior. However, it is far from clear that allocating the efficiency of furnaces based

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[119] Attari, S. Z., M.L. DeKay, C.I. Davidson, and W. Bruine de Bruin (2010): "Public perceptions of energy consumption and savings." Proceedings of the National Academy of Sciences 107(37), 16054-16059.
[120] Houde, S. (2014): "How Consumers Respond to Environmental Certification and the Value of Energy Information," National Bureau of Economic Research Working Paper No. 20019.

solely on estimated cost-effectiveness is likely to be any more accurate than the method currently used by DOE. An attempt to more explicitly model consumer choices across furnace efficiency would have to take into account the non-monetary preferences and market failures outlined above, in addition to the economic tradeoffs. At the present time, DOE does not have a method to include site-specific economics as well as non-economic decision making criteria in the Monte Carlo simulation, as suggested by ACEEE. However, this is an issue that DOE intends to investigate, and it welcomes suggestions as to how it might incorporate economic and other relevant factors in its assignment of furnace efficiency in its analyses.

The estimated market shares for the no-new-standards case for NWGFs and MHGFs in 2022 are shown in Table IV.16 and Table IV.17. See chapter 8 of the SNOPR TSD for further information on the derivation of the efficiency distributions.

Table IV.16 AFUE Distribution in the No-New-Standards Case for Non-Weatherized Gas Furnaces

Efficiency, AFUE	2022 Market Share in Percent				
	National	North, Repl	North, New	South, Repl	South, New
80%	46.5%	25.6%	30.2%	70.0%	64.5%
90%	5.9%	5.6%	10.0%	4.6%	6.5%
92%	21.2%	18.4%	33.5%	18.4%	24.4%
95%	25.4%	48.7%	25.7%	6.6%	4.4%
98%	0.9%	1.7%	0.7%	0.4%	0.2%

"Repl" means "replacement."

Table IV.17 AFUE Distribution in the No-New-Standards Case for Mobile Home Gas Furnaces

Efficiency, AFUE	2022 Market Share in Percent				
	National	North, Repl	North, New	South, Repl	South, New

80%	71.4%	62.8%	60.9%	85.9%	87.4%
92%	13.4%	6.6%	23.3%	10.5%	11.3%
95%	15.0%	30.2%	15.6%	3.6%	1.3%
97%	0.2%	0.4%	0.2%	0.0%	0.0%

"Repl" means "replacement."

DOE also estimated no-new-standards case efficiency distributions for furnace standby mode and off mode power. As shown in Table IV.18, DOE estimated that 61 percent of the affected market would be at the baseline level in 2022, according to data from 18 furnace models from a field study conducted in Wisconsin[121] and data from DOE laboratory tests (see appendix 8I of the SNOPR TSD). In addition, for MHGFs, DOE assigned all PSC furnace fan motor models to the max-tech efficiency level. DOE received no comments about these fractions or assumptions and, therefore, for the SNOPR, kept the same values as used in the March 2015 NOPR and the September 2015 NODA.

Table IV.18 Standby Mode and Off Mode Base-Case Efficiency Distribution in 2022 for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Efficiency Level	Standby/Off Mode Watts	NWGF Market Share in Percent	MHGF Market Share in Percent
Baseline	11.0	61	5
1	9.5	0	0
2	9.2	17	1
3	8.5	22	94

[121] Scott Pigg, Electricity Use by New Furnaces: A Wisconsin Field Study, Energy Center of Wisconsin (2003) (Available at: www.ecw.org/publications/electricity-use-new-furnaces-wisconsin-field-study).

9. Accounting for Product Switching Under Potential Standards

DOE considered the potential for a standard level to impact the choice between types of heating products, both for new construction and the replacement of existing products. Because home builders are sensitive to the cost of heating equipment, a standard level that significantly increases purchase price may induce some builders to switch to a different heating product than they would have otherwise installed (i.e., in the no-new-standards case). Such an amended standard level may also induce some home owners to replace their existing furnace at the end of its useful life with a different type of heating product.

Some stakeholders questioned the appropriateness of incorporating a product switching model in the LCC analysis. Ingersoll Rand, Prime Energy Partners, APPA, and EEI stated that the LCC calculation in the March 2015 NOPR goes beyond that performed by the Department in previous rulemakings by including the first cost and operating costs of products purchased in lieu of the covered classes. Ingersoll Rand, Prime Energy Partners, and CGS believe that the LCC calculation in the March 2015 NOPR is inconsistent with the requirement in section 325(o)(2)(B)(i)(II) of EPCA that DOE should consider "the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard." Prime Energy Partners stated that DOE's approach would bias the average LCCs and PBPs favorably toward the analyzed standard level by replacing the costs of covered products with lower-cost alternatives. Prime Energy Partners stated that DOE should remove the cost of electric heating products from the LCC and PBP analysis. (Ingersoll Rand, No. 0156 at pp. 8-9; Ingersoll Rand, No. 0182 at p. 2; Prime Energy Partners, No. 0143 at pp. 2-3; APPA, No. 0149 at pp. 2-3; EEI, No. 0160 at p. 103; CGS, No. 0098 at pp. 3-4)

According to DOE's reading, the language in section 325(o)(2)(B)(i)(II) does not specify what the savings in operating costs and increase in price of a standards-compliant product should be measured against. DOE reasons that the most compelling reference point is the product that a consumer would purchase in the absence of amended standards. In most cases, this product would be of the same type as a standards-compliant product, though possibly with different efficiency. In the case of NWGFs, however, switching to alternative heating products is a realistic possibility. Accounting for potential switching provides a more realistic characterization of the no-new-standards case and is not inconsistent with the requirement in section 325(o)(2)(B)(i)(II) of EPCA.

a. Consumer Choice Model

For the March 2015 NOPR, DOE developed a consumer choice model to estimate the response of builders and home owners to potential amended AFUE standards for NWGFs. The model considers three options available to each sample household, which are to purchase and install: (1) a NWGF that meets a particular standard level, (2) a heat pump, or (3) an electric furnace. In addition, for situations in which installation of a condensing furnace would leave an "orphaned" gas water heater requiring costly re-venting, the model allows for the option to purchase an electric water heater as an alternative. For option 2, purchase a heat pump, DOE took into consideration the age of the existing central air conditioner, if one exists, because if the air conditioner is not very old, it is unlikely that the consumer would opt to install a heat pump, which also provides cooling. 80 FR 13120, 13152 (March 12, 2015).

The consumer choice model uses the installed cost of each option, as estimated for each sample household, and the operating costs, taking into account the space heating load and the water heating load for each household and the energy prices it will pay over the lifetime of the available product options.[122] DOE accounted for any additional costs to accommodate a new product. DOE also accounted for the cooling load of each relevant household that might switch from a NWGF and CAC to a heat pump.The GTI report submitted by SoCalGas, PGW, and Laclede stated that fuel switching from gas to electricity is expected to occur in water heating systems if a gas-fired water heater is orphaned. (SoCalGas, No. 0132-7 at p. 2; PGW, No. 0003-2 at p. 3; Laclede, No. 0141 at p. 23) As noted previously, DOE accounted for potential switching from gas-fired water heaters to electric water heaters if the existing water heater is orphaned.

Other stakeholders pointed out limitations to the opportunity for fuel switching due to local codes and regulations. For example, PG&E commented that fuel switching is unlikely in California, given the requirements of the State's building energy efficiency standards. (PG&E, No. 0153 at p. 3) Von Harz stated that Iowa's HVAC System Adjusted and Verified Efficiency program, despite requiring high-efficiency furnaces, did not experience significant levels of fuel switching. (von Harz, No. 0080 at p. 1)

[122] Electric furnaces are estimated to have the same lifetime as NWGFs (21.5 years), but heat pumps have an estimated average lifetime of 19 years, which is 2.5 years less than the estimated average lifetime of NWGFs. To ensure comparable accounting, DOE annualized the installed cost of a second heat pump and multiplied the annualized cost by the difference in lifetime between the heat pump and a NWGF in a particular switching situation.

Southern Company stated that the estimated level of switching to electric furnaces is unreasonably high, even in the South. Southern Company stated that contrary to DOE's results, it would expect much less switching to electric furnaces over heat pumps in the South and minimal switching to electric furnaces over heat pumps in the North. (Southern Company, No. 0044 at pp. 290-291) In response, DOE recognizes that in some areas switching to electric heating, and electric furnaces in particular, may be minimal. The SNOPR analysis projects only a small amount of switching to electric furnaces (1.1 percent of all NWGF consumers) for the standards proposed in this SNOPR.

As noted previously, the consumer choice model considered the total installed costs associated with the different product options. For the March 2015 NOPR and September 2015 NODA, DOE used efficiencies and consumer prices for heat pumps and CACs that meet the energy conservation standards that took effect on January 1, 2015 (10 CFR 430.32(c)(3)). For electric furnaces, DOE used an efficiency of 98-percent and a consumer price based on 2013 RS Means. For water heaters, it used efficiency and consumer prices for models that meet the standards that took effect on April 16, 2015. (10 CFR 430.32(d)) For situations where a household with a NWGF might switch to an electric space heating appliance, DOE determined the total installed cost of the electric heating options, including a separate circuit up to 100 amps that would need to be installed to power the electric resistance heater within an electric furnace or heat pump, as well as a cost for upgrading the electrical service panel for a fraction of households. For all installations, DOE used regional labor rates from RS Means 2015 data.[123]

Some stakeholders commented on the product prices used in the March 2015 NOPR for alternative space heating products. ASAP stated that it is unclear whether DOE accounted for the impact of new efficiency standards that took effect in 2015 on heat pump prices. ASAP further argued that heat pump prices will be affected by the next revision to the DOE heat pump standard, which could take effect as soon as 2021, and also by refrigerant phase outs mandated by EPA. (ASAP, No. 0154-1 at p. 4) APPA and EEI stated that the analysis should account for increases in heat pump efficiency standards in 2006 and 2015. (APPA, No. 0149 at pp. 2-3; EEI, No. 0179 at pp. 4-5) EEI stated that it is very likely that new energy efficiency standards for residential heat pumps will be effective in 2021 at the latest. (EEI, No. 0160, pp. 10-11; EEI, No. 0179 at p. 5) EEI stated that the analysis does not take into account the new water heater standards that took effect in 2015 and the associated cost increases of heat pump and condensing water heaters above 55 gallons. (EEI, No. 0160, pp. 11-12)

For the SNOPR, DOE used updated CAC and heat pump prices from the current rulemaking for CACs and heat pumps.[124] These prices account for refrigerant phase outs mandated by EPA. DOE estimated the price of electric furnaces in the engineering

[123] RS Means Company, Inc., RS Means Residential Cost Data 2015 (2014).
[124] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy, Residential Central Air Conditioners and Heat Pumps (Available at: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive) (Last accessed May 2, 2016).

analysis. DOE used the same data for water heaters as for the March 2015 NOPR and the September 2015 NODA, which accounted for the standards that took effect in 2015.

b. Product Switching Decision Criteria

The decision criteria in the model were based on proprietary data from Decision Analysts, [125] which identified for a representative sample of consumers their willingness to purchase more-efficient space-conditioning systems (non-proprietary data of a similar nature were not available). Each of the four surveys that DOE used, which span the period 2006 to 2013, involved approximately 30,000 homeowners. The surveys asked respondents the maximum price they would be willing to pay for a product that was 25 percent more efficient than their existing product, which DOE assumed is equivalent to a 25-percent decrease in annual energy costs. DOE also used Decision Analyst data for consumer choice model in the June 27, 2011 direct final rule for residential central air conditioners and residential furnaces. 76 FR 37408. From these data and RECS billing data, DOE deduced that consumers on average would require a payback period of 3.5 years or less for a more-expensive but more-efficient product.

The consumer choice model calculates the PBP between the higher-efficiency NWGF in each standards case compared to the electric heating options using the total installed cost and first -year operating cost as estimated for each sample household or building. For switching to occur, the total installed cost of the electric option must be less than the NWGF standards case option. The model assumes that a consumer will

[125] Decision Analysts, 2006, 2008, 2010, and 2013 American Home Comfort Studies (Available at www.decisionanalyst.com/Syndicated/HomeComfort.dai).

switch to an electric heating option if the PBP of the condensing NWGF relative to the electric heating option is greater than 3.5 years or the PBP is negative. In the case of switching to an electric heating option, the model selects the most economically beneficial case.

Several stakeholders commented on the criteria used to determine whether a household would switch space heating products. AGA stated that the product switching methodology assumes switching will not take place in cases where the payback period is less than 3.5 years; however, in the LCC model, if the payback for the specified efficiency level is less than 3.5 years, switching does take place if switching options with paybacks over 3.5 years are present. (AGA, No. 0040-2 at p. 4) To clarify, DOE notes that if the PBP of a specific condensing NWGF efficiency level relative to a specific electric heating option is less than 3.5 years, switching does not take place.

AGA and NPGA stated that it is unrealistic to use the same criteria for every consumer to determine fuel switching. (AGA, No. 0118 at p. 13; NPGA, No. 0130 at p. 4) NPGA stated that the factors considered by consumers are multiple and varying according to the consumer’s rationale, personal finances, home construction, region, etc. (NPGA, No. 0130 at p. 4) DOE acknowledges that different consumers are likely to use different criteria when considering fuel switching, but the survey used by DOE does not provide sufficient information to derive a distribution of required payback periods that is transferable to DOE’s methodology. Commenters did not provide any additional data on this point, nor did they suggest a more suitable source. As DOE is not aware of any better data source, it maintained its existing approach for this SNOPR.

EEI, ACEEE, ASAP, and the Efficiency Advocates stated that DOE overestimated the amount of fuel switching likely to occur as a result of increased furnace efficiency standards. ACEEE stated that many decision makers will not make an investment at the 3.5-year payback threshold. Furthermore, ACEEE, ASAP, and Rheem would expect consumers, particularly in the North, to be reluctant to switch to electricity, which has a reputation for high bills, less reliability, less comfort, and, in some areas, greater risk of outages. (EEI, No. 0160 at p. 3; EEI, No. 0050 at pp. 56-59; ACEEE, No. 0113 at pp. 2-3; ASAP, No. 0154-1 at pp. 3-4; Rheem, No. 0142 at p. 12; EEI, No. 0179 at p. 4; Efficiency Advocates, No. 0196 at p. 3) ASAP stated that the changes required to switch to an electric space heating appliance are complex, and consumers may face considerable cost and uncertainty about the impacts of changing gas and electric utility services. ASAP stated that the consumer survey data used to determine the switching criterion do not directly address the consumer choice to switch heating fuels, as the decision to buy a more expensive but more efficient product is very different than the decision to switch from one heating fuel to another. (ASAP, No. 0154-1 at pp. 3-4)

DOE acknowledges that the consumer survey data it used to determine the switching criterion do not directly address the consumer choice to switch heating fuels, but in the absence of any data directly associated with fuel switching, DOE believes that the payback criterion is broadly reflective of the potential consumer response. In addition to the primary estimate, DOE conducted sensitivity analyses using higher and lower levels of switching. Whereas the primary estimate uses a consumer decision metric involving expectation of a payback period of 3.5 years or less for a more-expensive but more-efficient product, the sensitivity analyses use payback periods that are one year higher or lower than 3.5 years (i.e., 2.5 years and 4.5 years).

ASAP stated that no fuel switching is a more realistic assumption, but at a minimum, DOE should use the low-switching scenario described in the switching appendix, which is based on what ASAP stated is a slightly more realistic payback threshold. (ASAP, No. 0154-1 at pp. 3-4) ACEEE also recommended using the low-switching scenario. (ACEEE, No. 0113 at pp. 2-3) Given the concerns about switching raised by many stakeholders, DOE is reluctant to rely on the low-switching scenario for its primary estimate.

See appendix 8J of the SNOPR for more details on the decision criteria used in the product switching model.

c. Summary of Product Switching Model

The key parameters of the product switching model includes product switching options, payback criteria, installation cost, and operating costs. DOE analyzed product switching scenarios that represent the most common combinations of space conditioning and water heating products that could be used in the case of a condensing NWGF energy efficiency standard. The consumer choice model calculates the PBP between the higher-efficiency NWGF in each standards case compared to the electric heating options using the total installed cost and first-year operating cost as estimated for each sample household or building. For switching to occur, the total installed cost of the electric option must be less than the NWGF standards case option.

The product switching model is based on the payback of a higher efficiency furnace in comparison to the heat pump and electric furnace alternatives. Based on data from consumer surveys, DOE applied payback criteria of 3.5 years for all consumers. In order to characterize the uncertainty associated with the payback criteria value, DOE conducted sensitivity analyses using higher and lower payback criteria. Whereas the primary estimate uses a consumer decision metric involving expectation of a payback period of 3.5 years or less for a more-expensive but more-efficient product, the sensitivity analyses use payback periods that are one year higher or lower than 3.5 years (i.e., 2.5 years and 4.5 years). The results of the sensitivity analyses on the estimated extent of product switching and on the LCC and PBP results are given in section V.B.1.a, and the results on the national energy savings and NPV are given in section V.B.3.

d. Switching Resulting from Standards for Mobile Home Gas Furnaces

For the March 2015 NOPR, DOE concluded that fuel switching would be unlikely for MHGFs. 80 FR 13120, 13164 (March 12, 2015). Nortek and Mortex responded that the higher total installed cost of a condensing MHGF would likely force consumers to switch to a less-efficient electric furnace, resulting in higher monthly utility bills. (Nortek, No. 0137 at p. 4; Mortex, No. 0157 at p. 3) AHRI also stated that DOE should consider product switching from MHGFs to other space heating products. (AHRI, No. 0050 at pp. 67-68) JCI commented that the mobile home market is particularly price sensitive, so the higher initial cost of a condensing furnace will drive many builders from natural gas to electric heating products. (JCI, No. 0148 at pp. 6-7)

For replacement MHGFs, DOE has tentatively concluded that the installation costs of switching to electric heating (which include increasing the electrical requirements) and high electricity prices in some regions would tend to discourage owners of MHGFs from switching. For MHGFs in the new construction market, the estimated average incremental cost of a 92-percent AFUE condensing furnace is $150. According to the recently issued Notice of Proposed Rulemaking[126] for manufactured housing, DOE estimates that a baseline single section manufactured home costs $45,000 and a baseline double section manufactured home costs $82,000. Based on this, DOE has tentatively concluded that a cost of this magnitude would be unlikely to cause producers of manufactured homes to make furnace-related design changes.

10. Payback Period

The payback period is the amount of time it takes the consumer to recover the additional installed cost of more-efficient products, compared to baseline products, through energy cost savings. Payback periods are expressed in years. Payback periods that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

[126] See: http://energy.gov/sites/prod/files/2016/05/f31/Manufactured%20Housing%20NOPR_1.pdf

As noted above in section III.E.2, EPCA, as amended, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price forecast for the year in which compliance with the amended or new standards would be required.

G. Shipments Analysis

1. Shipments Model and Inputs

DOE uses forecasts of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[127] The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

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[127] DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general one would expect a close correspondence between shipments and sales.

DOE developed shipment projections based on historical data and an analysis of key market drivers for each product. DOE estimated gas furnace shipments by projecting shipments in three market segments: (1) replacements; (2) new housing; and (3) new owners in buildings that did not previously have a NWGF. DOE also considered whether standards that require more-efficient furnaces would have an impact on furnace shipments.

For the March 2015 NOPR, DOE assembled historic shipments data for NWGFs and MHGFs from Appliance Magazine,[128] AHRI,[129] and Census Mobile Home.[130] For the September 2015 NODA, DOE added the 2014 shipments from AHRI.[131]

The GTI report submitted by SoCalGas stated that DOE's condensing furnace shipment forecasts are based on assumed current market conditions that differ from AHRI condensing furnace shipment data. (SoCalGas, No. 0132-7 at p. v) DOE disagrees with this comment, because DOE did use the latest-available shipments data from AHRI in its analysis. For the September 2015 NODA and this SNOPR, DOE used the 2010-2014 shipments data provided by AHRI, with disaggregated non-condensing

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[128] Appliance Historical Statistical Review: 1954-2012, Appliance Magazine (2014).
[129] Air-Conditioning, Heating, & Refrigeration Institute, Furnace Historical Shipments Data. (1994-2013) (Available at: http://www.ahrinet.org/site/497/Resources/Statistics/Historical-Data/Furnaces-Historical-Data) (Last accessed October 15, 2014).
[130] US Census. Manufactured Homes Survey: Historical Data. (Available at: http://www.census.gov/construction/mhs/mhsindex.html) (Last accessed April 26, 2016.).
[131] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Regional Gas Furnace Shipments for 2010-2014 (2015), Air-Conditioning, Heating, and Refrigeration Institute: Arlington, VA. (Available at: www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0031-0052) (Last accessed January 6, 2016.).

and condensing shipments.[132] For the SNOPR, DOE used updated total 2015 shipments data from AHRI,[133] but disaggregated data by non-condensing and condensing shipments for 2015 was not available for the SNOPR analysis.

For the March 2015 NOPR and September 2015 NODA, DOE disaggregated MHGF shipments from the gas furnace total by using a combination of data from the U.S. Census[134] and American Housing Survey (AHS).[135] Disaggregated condensing and non-condensing gas furnace shipments by region from 1992 to 2009 were used to estimate shipments by region before 1992 and after 2009. For the SNOPR, DOE updated to the latest U.S. Census[136] and AHS data.[137]

Mortex stated that the number of MHGFs manufactured in 2014 was estimated to be about 54,000, and about two-thirds were sold to the replacement market. Mortex stated that MHGF sales have not been growing. (Mortex, No. 0157 at p. 3) For the SNOPR, DOE revised its data for current MHGF shipments to align with the estimate from Mortex.

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[132] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Regional Gas Furnace Shipments for 2010-2014 (2015), Air-Conditioning, Heating, and Refrigeration Institute: Arlington, VA. (Available at: www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0031-0052) (Last accessed January 6, 2016).
[133] Air-Conditioning, Heating, & Refrigeration Institute, Furnace Historical Shipments Data. (1996-2015) (Available at: http://www.ahrinet.org/site/497/Resources/Statistics/Historical-Data/Furnaces-Historical-Data) (Last accessed April 26, 2016).
[134] U.S. Census Bureau, Manufactured Homes Survey (June 1, 2013) (Available at: https://www.census.gov/construction/mhs/mhsindex.html) (Last accessed July 9, 2015).
[135] U.S. Census Bureau–Housing and Household Economic Statistics Division, 2011 American Housing Survey (2011) (Available: www.census.gov/programs-surveys/ahs/data.2011.html) (Last accessed June 30, 2015).
[136] U.S. Census Bureau, Manufactured Homes Survey (Available at: https://www.census.gov/construction/mhs/mhsindex.html) (Last accessed August 26 2015).
[137] U.S. Census Bureau–Housing and Household Economic Statistics Division, 2013 American Housing Survey (2013) (Available at: www.census.gov/programs-surveys/ahs/data.2013.html) (Last accessed June 30, 2015).

To project furnace replacement shipments, DOE developed retirement functions from the furnace lifetime estimates and applied them to the existing products in the housing stock, which are tracked by vintage.

To project shipments to the new housing market, DOE utilized a forecast of new housing construction and historic saturation rates of furnace product types in new housing. DOE used AEO 2014 for forecasts of new housing for the March 2015 NOPR.[138] DOE estimated future furnace saturation rates in new housing based on a weighted-average of U.S. Census Bureau's Characteristics of New Housing[139] values from 1990 through 2013. For the September 2015 NODA and this SNOPR, DOE used AEO 2015 for forecasts of new housing from the NOPR[140] and added the U.S. Census Bureau's Characteristics of New Housing[141] values from 2014 to 2015.

For the March 2015 NOPR and the September 2015 NODA, to project shipments to new owners of NWGFs, DOE used the shipments model together with data in the

[138] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2014, Table 20 (Available at: www.eia.gov/forecasts/aeo/data.cfm?filter=macroeconomic#macroeconomic) (Last accessed July 29, 2014).

[139] U.S. Census Bureau, Characteristics of New Housing (Available at: www.census.gov/const/www/charindex.html) (Last accessed Aug. 19, 2014).

[140] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2015, Table 20 (Available at: www.eia.gov/forecasts/aeo/data.cfm?filter=macroeconomic#macroeconomic) (Last accessed July 29, 2015).

[141] U.S. Census Bureau, Characteristics of New Housing (Available at: www.census.gov/const/www/charindex.html) (Last accessed April 26, 2016).

American Home Comfort Survey[142] to estimate that the annual total amounts to ten percent of NWGF replacement shipments in 2021.

AHRI stated that the population of new owners is by definition an ever decreasing base and should not have constant shipments. (AHRI, No. 0050 at pp. 54-55) In response, DOE notes that new houses are continually being built, some without NWGFs. Some of these homeowners could potentially install a NWGF at a later point, so the new owner market may not necessarily decrease.

For shipments of NWGFs to commercial applications, DOE developed no-new-standards case shipments forecasts for each of the four Census regions that, in turn, were aggregated to produce regional and national forecasts. DOE estimated that the fraction of residential NWGFs shipped to the commercial sector is approximately three percent.[143]

Mortex questioned if DOE's forecast of declining MHGF shipments means that consumers are not replacing their MHGFs, given that there are a lot of older MHGFs, and DOE assumes that there is no switching to other products. (Mortex, No. 0157 at p. 3) As mentioned before, DOE revised its data for current MHGF shipments to align with the estimate from Mortex. These revised shipments show a slight increase. DOE's analysis assumes that some MHGFs are not replaced because the lifetime of a mobile home is often similar to that of a MHGF.

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[142] Decision Analysts, 2008 American Home Comfort Study: Online Database Tool (Available at: www.decisionanalyst.com/Syndicated/HomeComfort.dai) (Last accessed April 26, 2016).

[143] The results derived from RECS 2009 and CBECS 2003 show there are 45.6 and 1.2 million residential furnaces in residential and commercial buildings, respectively. DOE assumed that the share of shipments is similar to the share in the stock.

2. Impact of Potential Standards on Shipments

For the March 2015 NOPR, to estimate the impact on NWGF shipments of product switching that may be incentivized by potential standards, DOE applied the consumer choice model described in section IV.F.9. The options available to each sample household or building are to purchase and install: (1) the NWGF that meets a particular standard level, (2) a heat pump, or (3) an electric furnace.[144]

As applied in the LCC and PBP analysis, the model considers product prices in the compliance year and energy prices over the lifetime of products installed in that year. The shipments model considers the switching that might occur in each year of the analysis period (2022-2051). To do so, DOE estimated the switching in the final year of the analysis period (2051) and derived trends from 2022 to 2051. First, DOE applied the NWGF product price trend described above to project prices in 2051. DOE used the appropriate energy prices over the lifetime of products installed in each year. Although the inputs vary, the decision criteria, as described in section IV.F.9, were the same in each year. For each considered standard level, the number of NWGFs shipped in each year is equal to the base shipments in the no-new-standards case minus the number of NWGF buyers who switch to either a heat pump or an electric furnace. The shipments model also tracks the number of additional heat pumps and electric furnaces shipped in each year.

[144] DOE also accounted for situations when installing a condensing furnace could leave an “orphaned” gas water heater that would require expensive re-sizing of the vent system. Rather than incurring this cost, the consumer could choose to purchase an electric water heater along with a new furnace.

AHRI stated that in the shipments analysis, DOE concluded that higher prices for condensing furnaces would not significantly affect shipments, but at the same time, DOE concluded that higher NWGF prices would lead consumers to switch products to avoid the LCC and PBP cost impacts from a higher-efficiency furnace. (AHRI, No. 0159 at p. 22) DOE clarifies that the estimated degree of switching away from NWGFs under each TSL is reflected in a decrease in shipments.

AHRI stated that increasing the installed cost would impact the projected shipments due to price elasticity. (AHRI, No. 0159 at p. 48) Goodman expects that a standard would decrease shipments. (Goodman, No. 0135 at p. 8) For NWGFs, DOE maintains that the response to an increase in installed cost would primarily be in the form of product switching. Therefore, rather than applying a price elasticity parameter to relate increase in installed cost to the demand for furnaces, DOE accounted for the impact of such increase by incorporating product switching in the shipments model. This approach captures not only the decrease in NWGF shipments, but also the increase in shipments (and use) of heat pumps and electric furnaces resulting from switching. For MHGFs, DOE has tentatively concluded that either the impact of price elasticity or product switching in response to amended standards would be minimal, since the installation cost differential is small between non-condensing and condensing MHGFs.

Many stakeholders stated that due to the high cost of condensing furnaces, consumers (particularly low- and moderate-income consumers) may choose to repair existing non-condensing furnaces instead of replacing them with a condensing furnace. (Carrier, No. 0116 at pp. 9, 11; PGW, No. 0003-2 at pp. 5-6; PGW, No. 0122 at p. 3;

AGL Resources, No. 0112 at p. 7; Gas Authority, No. 0086 at pp. 4-5; Laclede, No. 0141 at p. 37; Questar Gas, No. 0151 at p. 1; Allied Air, No. 0044 at p. 267; Nayes, No. 0055 at p. 1; AHRI, No. 0159 at pp. 15, 23) DOE notes that replacement of a furnace in the shipments model is generally associated with failure of major components such as the heat exchanger. Because such repair is a large expense, DOE believes that relatively few consumers would choose to undertake such a repair, given concerns that other major repairs may soon follow. In addition, under the currently-proposed standards, many low-income consumers or owners of multi-family homes could use a small furnace and, thus, could install a new non-condensing furnace.

Because measures to limit standby mode and off mode power consumption have a very small impact on the total installed cost and do not impact consumer utility, and thus have a minimal effect on consumer purchase decisions, DOE assumed that NWGF shipments in the no-new-standards case would be unaffected by new standby mode and off mode standards.

For details on DOE's shipments analysis of product and fuel switching, see chapter 9 of the SNOPR TSD.

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the national net present value (NPV) from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[145] ("Consumer" in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses.[146] For the present NIA analysis, DOE forecasted the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of NWGFs and MHGFs sold from 2022 through 2051.

DOE evaluates the impacts of amended or new standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (i.e., the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

[145] The NIA accounts for impacts in the 50 states and U.S. territories.
[146] For the NIA, DOE adjusts the installed cost data from the LCC analysis to exclude sales tax, which is a transfer.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV.19 summarizes the inputs and methods DOE used for the NIA analysis for the SNOPR. Discussion of these inputs and methods follows the table. See chapter 10 of the SNOPR TSD for further details.

Table IV.19 Summary of Inputs and Methods for the National Impact Analysis for the SNOPR

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2022.
Efficiency Trends	No-new-standards case: Based on historical data. Standards cases: Roll-up in the compliance year and then DOE estimated growth in shipment-weighted efficiency in all the standards cases, except max-tech.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Prices	AEO2015 forecasts (to 2040) and extrapolation through 2051.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on AEO2015.
Discount Rate	Three and seven percent.
Present Year	2016.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this notice describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for the considered product classes in the year of anticipated compliance with an amended or new standard (2022). To project the trend in efficiency absent amended standards for NWGFs and MHGFs over the entire 30-year shipments projection period, DOE extrapolated the historical trends in efficiency that were described in section IV.F.8. DOE estimated that the national market share of condensing products would grow from 53 percent in 2022 to 65 percent by 2051 for NWGFs, and from 26 percent to 32 percent for MHGFs. The market shares of the different condensing efficiency levels (i.e., 90-, 92-, 95-, and 98-percent AFUE for NWGF and 92-, 95-, and 97-percent AFUE for MHGF) are maintained in the same proportional relationship as in 2022.

Due to the lack of historical efficiency data for standby mode and off mode power consumption, DOE estimated that the efficiency distribution would remain the same throughout the forecast period.

For the standards cases, DOE used a "roll-up" scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2022). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would "roll up" to meet the new standard level, and the market share of products above the standard would remain unchanged. For the March 2015 NOPR, in the standards case with a 90-percent AFUE national standard, DOE estimated that many consumers will purchase a 92-percent AFUE furnace rather than a 90-percent AFUE furnace because the extra installed cost is minimal, and the market has already moved significantly toward the 92-percent level.

ACEEE and ASAP commented that a "roll up" scenario is overly conservative and stated that DOE should use a "shift" scenario for all TSLs. (A “shift” scenario assumes increases in the market share of products at efficiencies above the standard level following an increase in the standard level.) DOE acknowledges that there could be some increase in the market share of products at efficiencies above the standard level in the compliance year, but DOE has found the roll-up approach to provide a conservative estimate of the potential energy savings in the standards case. As described below, DOE did project increase in the market share of products at efficiencies above the standard level after the compliance year.

ACEEE and ASAP stated that there are many market forces and public policies that will foster market share growth for condensing furnaces exceeding any new standard. (ACEEE, No. 0113 at p. 2; ASAP, No. 0154-1 at pp. 3, 5-6) To develop standards case efficiency trends after 2022, DOE estimated growth in shipment-weighted efficiency in the standards cases, except in the max-tech standards case. The estimated growth accounts for potential changes in ENERGY STAR criteria and the response of manufacturers to minimum standards in the condensing range

DOE did not have a basis on which to predict a change in efficiency trend for standby mode and off mode power consumption, so DOE assumed that the efficiency distribution would not change after the first year of compliance.

The efficiency trends are further described in chapter 10 of the SNOPR TSD.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each potential standards case (TSL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new standards case and for each higher-efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted any electricity consumption or savings to primary energy (i.e., the energy consumed by power plants to generate site electricity) using annual conversion factors derived from the AEO. For natural gas and LPG, DOE assumed that site energy consumption is the same as primary energy consumption.

The per-unit annual energy use is adjusted with the building shell improvement index, which results in a decline of 8 percent in the heating load from 2022 to 2051, and the climate index, which results in a decline of 7 percent in the heating load. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Commenting on the energy consumption for each efficiency level in the NIA, AHRI stated that the average energy demand in buildings with condensing NWGFs in the absence of standards is almost certainly higher than the average energy use of the buildings with non-condensing NWGFs absent standards.[147] AHRI stated that using average energy consumption of all buildings for each efficiency level in the NIA substantially overestimates the energy savings. (AHRI, No. 0159 at pp. 64-65) In response, DOE's approach for the modeling of unit energy consumption (UEC) in the no-new-standards case reflects a matching between the UEC for each efficiency level and the subset of homes that are estimated to install furnaces at each AFUE level. See chapter 10 of the SNOPR TSD for details.

In the standards cases, there are fewer shipments of NWGFs or MHGFs compared to the no-new-standards case because of product switching, but there are additional shipments of heat pumps, electric furnaces, and electric water heaters. DOE incorporated the per-unit annual energy use of the heat pumps and electric furnaces that was calculated in the LCC and PBP analysis (based on the specific sample households that switch to these products) into the NIA model.

AHRI stated that the increased cost of a furnace as a result of this rulemaking would mean that the replacement of furnaces with PSC motors by furnaces with higher-efficiency motors would be lower than projected in the furnace fan rulemaking. AHRI argued that DOE must recalculate the projected savings from the furnace fan standards and account for those reduced savings in this rulemaking. (AHRI, No. 0159 at p. 65) DOE does not agree with AHRI's reasoning or its recommendation. DOE acknowledges

[147] DOE's understanding of AHRI's reasoning is that homes purchasing a condensing furnace in the no-new-standards case would tend to have a higher heating load because a condensing furnace would tend to be more cost-effective in such cases.

that the standards proposed for NWGFs in this document may result in slightly lower replacement of furnaces with PSC motors by furnaces with higher efficiency motors than projected in the furnace fan rulemaking. However, the purpose of DOE's analysis is to accurately estimate the impacts of the proposed standards, and not to incorporate any adjustments associated with past rulemakings for a different product (i.e., furnace fans).[148]

DOE incorporated a rebound effect for NWGFs and MHGFs by reducing the site energy savings in each year by 15 percent.

DOE used a multiplicative factor to convert site electricity consumption (at the home or commercial building) into primary energy consumption (the energy required to convert and deliver the site electricity). These conversion factors account for the energy used at power plants to generate electricity and energy losses during transmission and distribution. The factors vary over time due to changes in generation sources (i.e., the power plant types projected to provide electricity to the country) projected in AEO 2015.[149] The factors that DOE developed are marginal values, which represent the response of the electricity sector to an incremental decrease in consumption associated with potential appliance standards. Because AEO projections end in 2040, DOE maintained the 2040 value for years after 2040.

[148] DOE's analysis of potential standards for NWGFs and MHGFs fully accounts for the standards for furnace fans that take effect in 2019.
[149] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2015 (Available at: www.eia.gov/forecasts/aeo/data.cfm) (Last accessed July 29, 2015).

NRDC stated that the source energy factor for electricity from AEO 2014 does not accurately account for marginal, rather than average, generation source energy. NRDC argued that a marginal factor is much more appropriate measure because fuel switching happens at the margin of electricity generation. (NRDC, No. 0134 at pp. 2, 7-8) For the SNOPR, DOE uses marginal factors to convert site electricity consumption into primary energy consumption.

EEI pointed out that the conversion factor increases slightly from 2035 to 2040 without explanation but shows no improvement from 2040 on. EEI stated that this post-2035 increase does not comport with the expected fuel mix that will be generating electricity after 2030. (EEI, No. 0179 at p. 10) In response, the site-to-primary energy factors that DOE derived based on AEO 2015 show a relatively flat trend between 2030 and 2040, so it is reasonable to use the 2040 value for years after 2040. DOE interprets EEI's comment as suggesting that expected growth in renewable energy would result in a fuel mix to generate electricity that would affect the site-to-primary energy factors. However, the growing penetration of renewable electricity generation has little effect on the trend in site-to-primary energy factors because EIA uses an average fossil fuel heat to characterize the primary energy associated with renewable generation. DOE has recently issued a Request for Information (RFI)[150] regarding site-to-primary energy factors and may revisit these factors in the future based on responses to the RFI.

[150] See: https://www.regulations.gov/#!docketDetail;D=EERE-2016-OT-0010.

AGA, Vectren, and NPGA stated that after correcting for DOE's analytical errors, fuel switching to electricity will increase primary energy consumption because increased electricity demand outweighs the reduced natural gas use. (AGA, No. 0118 at pp. 3, 5-6; Vectren, No. 0111 at p. 2; NPGA, No. 0171 at pp. 2-3) Indiana and Carrier stated that the proposed standard may increase energy usage due to fuel switching by consumers who choose lower-cost, less-efficient space heating products. (Indiana, No. 0094 at p. 1; Carrier, No. 0116 at p. 10) On this point, DOE would first note that switching to electric heating products was significantly higher under the standards proposed in the March 2015 NOPR than it is under the standards proposed in this SNOPR.[151] Even so, these comments lost sight of the overall landscape of energy savings associated with amended standards by focusing solely on the differences in primary energy use between gas and electric home heating products for that small portion of consumers who would engage in fuel switching. Although switching to electric heating products does increase primary energy consumption relative to use of NWGFs, the savings in primary natural gas resulting from the currently-proposed standards far outweigh the increase in energy use due to switching.

In 2011, in response to the recommendations of a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" appointed by the National Academy of Sciences, DOE announced its intention to use full-fuel-cycle (FFC) measures of energy use and greenhouse gas and other emissions in the

[151] The main reason why the estimated switching is lower under the standards proposed in this SNOPR is because of the creation of a product class for small furnaces for which a non-condensing furnace would meet the standard. In this case, there is less incentive for switching.

national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the Federal Register in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial-equilibrium model of the U.S. energy sector[152] that EIA uses to prepare its Annual Energy Outlook. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the SNOPR TSD.[153]

NPGA commented that there is no indication that DOE applied FFC analysis to the electric alternatives that are likely to increase as consumers switch fuels due to the retrofit and redesign costs of propane-powered furnaces. (NPGA, No. 0130 at p. 5) In response, DOE did determine the FFC energy use associated with the projected increase in electricity use resulting from fuel switching.

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[152] For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (98) (Feb.1998) (Available at: www.eia.gov/oiaf/aeo/overview/).

[153] DOE generally does not include possible indirect impacts of standards on energy use outside of the full-fuel-cycle. Such indirect impacts could include changes in the energy used to manufacture and transport covered products, or in the energy used to process material inputs to covered products. DOE maintains that such indirect impacts fall outside of the EPCA mandate for DOE to to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III))

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are: (1) total annual installed cost; (2) total annual operating costs (energy costs and repair and maintenance costs); and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each product shipped during the forecast period.

As discussed in section IV.F.1, DOE used an experience curve method to project future product price trends. Application of the price index results in a decline of 17 percent in furnace prices from 2022 to 2051. In addition to the default trend described in section IV.F.1, which shows a modest rate of decline, DOE performed price trend sensitivity calculations in the NIA to examine the dependence of the analytical results on different analytical assumptions. The price trend sensitivity analysis considered a trend with a greater rate of decline than the default trend and a trend with constant prices. The derivation of these trends is described in appendix 10C of the SNOPR TSD.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the forecast of annual national-average residential energy price changes in the Reference case from AEO 2015, which has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2020 to

2040. As part of the NIA, DOE also analyzed scenarios that used inputs from the AEO 2015 Low Economic Growth and High Economic Growth cases. Those cases have higher and lower energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the SNOPR TSD.

As mentioned previously, in the standards cases, there are fewer shipments of NWGFs or MHGFs than in the base case because of product switching, but there are additional shipments of heat pumps and electric furnaces. For these products, the appropriate annual operating costs and installed costs that were calculated in the LCC and PBP analysis were incorporated into the NIA model.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. DOE estimates the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate.

AHRI stated that the 3-percent and 7-percent discount rates used in the NIA are too low because the 3-percent rate is lower than the consumer rate actually used in the LCC and the 7-percent rate is lower than the rate that DOE should use in the LCC. (AHRI, No. 0159 at p. 64) Regarding this point, DOE notes that the discount rates used in the NIA reflect a national perspective, which is distinct from the consumer perspective used in the LCC analysis. DOE uses 3-percent and 7-percent discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to

Federal agencies on the development of regulatory analysis.[154] The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

As noted above, in determining national energy savings, DOE is accounting for the rebound effect associated with more-efficient furnaces.[155] Because consumers have foregone a monetary savings in energy expenses, it is reasonable to conclude that the value of the increased utility is equivalent to the monetary value of the energy savings that would have occurred without the rebound effect. Therefore, the economic impacts on consumers with or without the rebound effect, as measured in the NPV, are the same.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. DOE analyzed the impacts of the considered standard levels on two subgroups: (1) low-income households and (2) senior-only households. The analysis

[154] United States Office of Management and Budget. Circular A-4: Regulatory Analysis (Sept. 17, 2003), section E. (Available at www.whitehouse.gov/omb/memoranda/m03-21.html).
[155] As previously discussed in section 0, the rebound effect provides consumers with increased utility (e.g., a more comfortable indoor environment).

used subsets of the RECS 2009 sample comprised of households that meet the criteria for the two subgroups for both NWGFs and MHGFs. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups.

Some stakeholders questioned the discount rates that DOE used for low-income households and senior-only households.

AHRI stated that DOE did not address the higher cost of capital for the subgroups relative to the average residential discount rate. (AHRI, No. 0159 at pp. 13-14) As described in section IV.F.7, DOE developed a distribution of discount rates by income group. The low-income households and senior-only households in the subgroup samples are identified by income, and they are assigned a discount rate from the appropriate income category. The average rate is higher for the low-income subgroup compared to the overall average.

AGA stated that DOE's discount rate underweights low-income consumer reliance on credit cards and other high-interest forms of financing. (AGA, No. 0118 at p. 28) AGL Resources stated that in order to purchase and install furnaces that comply with the standards proposed in the NOPR, many low-income and fixed-income homeowners would borrow money at high interest rates due to sub-par credit, further diminishing any benefits derived from lower utility bills. (AGL Resources, No. 0112 at p. 8) DOE uses a weighted-average cost of capital that is distinct from the financing that may be used to directly purchase a furnace. As discussed in the response to comments in section IV.F.7, DOE maintains that the interest rate associated with the specific source of funds used to purchase a furnace (i.e., the marginal rate) is not the appropriate metric to measure the discount rate as defined for the LCC analysis. See section IV.F.7 for elaboration of DOE's reasoning.

NRDC stated that if a significant fraction of low-income households are renters rather than owners, the NOPR may overestimate consumer costs, as renters have limited and indirect exposure to installed costs, although they are often responsible for paying utility bills. (NRDC, No. 0134 at pp. 2, 8) DOE acknowledges that it assumed that the cost of a product incurred by a landlord is passed on to the tenant who pays the utility bills may overestimate the costs actually incurred by renters. Although economic theory would suggest that landlords do pass on their costs through increased rent, the extent and timing of such pass-through is not well understood, given that rental markets can be either rent controlled or very competitive in terms of rental rates. To the extent that such transfer does not occur, low-income renters would benefit more than is shown by DOE's analysis.

Chapter 11 in the SNOPR TSD describes the consumer subgroup analysis and its results.

J. Manufacturer Impact Analysis

1. Overview

DOE performed a manufacturer impact analysis (MIA) to determine the financial impact of amended energy conservation standards on manufacturers of NWGFs and

MHGFs and to estimate the potential impacts of such standards on domestic employment, manufacturing capacity, and cumulative regulatory burden for those manufacturers. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA includes analyses of forecasted industry cash flows to calculate the INPV, additional investments in research and development (R&D) and manufacturing capital necessary to comply with amended standards, and the potential impact on domestic manufacturing employment. Additionally, the MIA seeks to qualitatively determine how amended energy conservation standards might affect manufacturers' capacity and competition, as well as how standards contribute to manufacturers' overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are INPV, which is the sum of industry annual cash flows throughout the analysis period discounted using the industry-weighted average cost of capital, and the impact on domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of amended energy conservation standards on the NWGF and MHGF manufacturing industry by comparing changes in INPV and domestic production employment between the no-new-standards case and each of the standard levels. To capture the uncertainty relating to manufacturer pricing strategy following amended standards, the GRIM estimates a range of possible impacts under different manufacturer markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as manufacturing capacity, competition within the industry, the cumulative regulatory burden of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the SNOPR TSD.

DOE conducted the MIA for this rulemaking in three phases. In the first phase of the MIA, DOE prepared a profile of the NWGF and MHGF manufacturer industry based on the market and technology assessment and publicly available information. This included a top-down cost analysis of NWGF and MHGF manufacturers in order to derive preliminary financial inputs for the GRIM (e.g., selling, general, and administration (SG&A) expenses; research and development (R&D) expenses; and tax rates). DOE used public sources of information, including company SEC 10-K filings,[156] corporate annual reports, the U.S. Census Bureau's Economic Census,[157] and Hoover's reports[158] to conduct this analysis.

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[156] U.S. Securities and Exchange Commission, Annual 10-K Reports (Various Years), available at: http://www.sec.gov/edgar/searchedgar/companysearch.htm (last accessed August 1, 2014)l.
[157] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2014), available at: http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t
[158] Hoovers Inc. Company Profiles, Various Companies, available at: http://www.hoovers.com.

In the second phase of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of new energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standards and extending over a 30-year period following the compliance date of the standards. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) create a need for increased investment; (2) raise production costs per unit; and (3) alter revenue due to higher per-unit prices and changes in sales volumes.

In addition, during the second phase, DOE developed an interview guide to distribute to NWGF and MHGF manufacturers in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the potential impacts of amended energy conservation standards on revenue, direct employment, capital assets, industry competitiveness, and manufacturer subgroup impacts.

In the third phase of the MIA, DOE conducted structured, detailed interviews with NWGF and MHGF manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM. DOE also solicited information about manufacturers' views of the industry as a whole and their key concerns regarding this rulemaking.

Additionally, in the third phase, DOE evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash-flow analysis. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected by amended energy conservation standards. The small business subgroup is discussed in section VI.B, "Review under the Regulatory Flexibility Act" and in chapter 12 of the SNOPR TSD.

To identify small businesses for this analysis, DOE applied the small business size standards published by the Small Business Administration (SBA) to determine whether a company is considered a small business. The size standards are codified at 13 CFR part 121. To be categorized as a small business under North American Industry Classification System (NAICS) code 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing," a NWGF and or MHGF manufacturer and its affiliates may employ a maximum of 1,250 employees. The 1,250 employee threshold includes all employees in a business' parent company and any subsidiaries. Based on this classification, DOE identified three NWGF and or MHGF companies that qualify as domestic small businesses. The NWGF and MHGF small manufacturer subgroup is discussed in section VI.B of this document and in chapter 12 of the SNOPR TSD.

2. Government Regulatory Impact Model Analysis and Key Inputs

DOE uses the GRIM to quantify the changes in cash flows over time due to amended energy conservation standards. These changes in cash flows result in either a higher or lower INPV for the standards cases compared to the no-new-standards case. The GRIM analysis uses a standard annual cash flow analysis that incorporates manufacturer costs, manufacturer markups, shipments, and industry financial information as inputs. It then models changes in costs, investments, and manufacturer margins that result from new energy conservation standards. The GRIM uses these inputs to calculate a series of annual cash flows beginning with the reference year of the analysis, 2016, and continuing to the terminal year of the analysis, 2051. DOE calculates INPV by summing the stream of annual discounted cash flows throughout the analysis period.

DOE used a real discount rate of 6.4 percent for NWGF and MHGF manufacturers. The discount rate estimate was derived from industry corporate annual reports to the Securities and Exchange Commission (SEC 10-Ks) and then modified according to feedback received during manufacturer interviews. More information on the derivation of the manufacturers' discount rate can be found in chapter 12 of the TSD.

DOE seeks comment on its use of 6.4 percent as a discount rate for NWGF and MHGF manufacturers (see section VII.E).

Many GRIM inputs came from the engineering analysis, the NIA, manufacturer interviews, and other research conducted during the MIA. The major GRIM inputs are described in detail in the following sections.

For consideration of standby mode and off mode regulations, DOE modeled the impacts of the technology options for reducing electricity usage discussed in the engineering analysis (chapter 5 of the TSD). The GRIM analysis incorporates the increases in MPCs and changes in markups into the results from the standby mode and off mode requirements. Due to the small cost of standby mode and off mode components relative to the overall cost of a NWGF or MHGF, DOE assumed that standby mode and off mode standards alone would not significantly impact product shipment numbers. DOE determined that the impacts of the standby and off mode standard are substantially smaller than the impacts of the AFUE standard. Therefore, DOE's analysis focused primarily on impacts of the AFUE standard.

The GRIM results for both the AFUE standards and the standby mode and off mode standards are discussed in section V.B.2. Additional details about the GRIM, discount rate, and other financial parameters can be found in chapter 12 of the SNOPR TSD.

a. Capital and Product Conversion Costs

Amended energy conservation standards could cause manufacturers to incur one-time conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be required to comply with each analyzed efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) capital conversion costs; and (2) product conversion costs. Capital conversion costs are one-time investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant product designs can be fabricated and assembled. Product conversion costs are one-time investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with amended energy conservation standards.

To evaluate the level of capital conversion expenditures manufacturers could incur to comply with amended AFUE energy conservation standards, DOE used manufacturer interviews to gather data on the anticipated level of capital investment that would be required at each efficiency level. Based on this manufacturer feedback, DOE developed a market-share weighted average capital expenditure per manufacturer. DOE then scaled the number to estimate total industry capital conversion costs. DOE validated manufacturer comments with estimates of capital expenditure requirements derived from the product teardown analysis and engineering analysis described in chapter 5 of the SNOPR TSD.

DOE assessed the product conversion costs at each considered AFUE efficiency level by integrating data from quantitative and qualitative sources. DOE considered market-share weighted feedback regarding the potential costs at each efficiency level from multiple manufacturers to estimate product conversion costs. Manufacturer data was aggregated to better reflect the industry as a whole and to protect confidential information.

DOE calculated the conversion costs for the standby mode and off mode standards separately from the AFUE conversion costs. DOE anticipated that manufacturers would incur minimal capital conversion costs to comply with standby and off mode standards, as the engineering analysis indicates that all the design options that improve standby and off mode performance are component swaps which would not require new investments in production lines. However, the standby and off mode standards may require product conversion costs related to testing new components and component configurations as well as one-time updates to marketing materials. DOE estimated these product conversion costs based on the engineering analysis and feedback collected during manufacturer interviews. In general, DOE assumed that all conversion-related investments occur between the year of publication of the final rule and the compliance year. The conversion cost estimates used in the GRIM can be found in section V.B.2.

DOE seeks comment on its methodology used to calculate capital and product conversion costs (see section VII.E).

For additional information on how DOE estimated product and capital conversion costs, see chapter 12 of the SNOPR TSD.

b. Manufacturer Production Costs

Manufacturing a higher-efficiency product is typically more expensive than manufacturing a baseline product due to the use of more complex components, which are typically more expensive than baseline components. The higher MPCs of more efficient products can affect revenue and gross margin, which will then affect the total volume of future shipments, and cash flows of NWGF and MHGF manufacturers. To calculate the MPCs for NWGFs and MHGFs at and above the baseline, DOE performed teardowns for representative units. The data generated from these analyses were then used to estimate the incremental materials, labor, depreciation, and overhead costs for products at each efficiency level. These cost breakdowns and product markups were validated and revised with input from manufacturers during manufacturer interviews and with input from NOPR and NODA written comments. For a complete description of the MPCs, see chapter 5 of the SNOPR TSD.

c. Shipment Scenarios

DOE used the GRIM to estimate industry revenues based on total unit shipment forecasts and the distribution of these values by efficiency level. Changes in sales volumes and efficiency distribution can significantly affect manufacturer finances over the course of the analysis period. For this analysis, DOE used the NIA's annual shipment forecasts derived from the shipments analysis from 2016 (the reference year) to 2051 (the terminal year of the analysis period). In the shipments analysis, DOE estimates the distribution of efficiencies in the no-new-standards case and standards cases for all product classes. To account for a regional standard at TSL 3, shipment values in the GRIM are broken down by region, "north" and "rest of country," for the NWGF product classes.

The NIA assumes that product efficiencies in the no-new-standards case that do not meet the energy conservation standard in the standards case either "roll up" to meet the amended standard or switch to another product such as a heat pump or electric furnace. In other words, the market share of products that are below the energy conservation standard is added to the market share of products at the minimum energy efficiency level allowed under each standard case. The market share of products above the energy conservation standard is assumed to be unaffected by the standard in the compliance year. For a complete description of the shipments analysis see section IV.G.

d. Manufacturer Markup Scenarios

As discussed in section IV.J.2.b, MSPs include direct manufacturing production costs (i.e., labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (i.e., SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. For the MIA, DOE modeled three standards-case markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) a preservation of gross margin markup scenario; (2) a preservation of per-unit operating profit markup scenario; and (3) a tiered markup. These scenarios lead to different markup values that, when applied to the MPCs, result in varying revenue and cash-flow impacts. The industry cash flow analysis results in section V.B.2.a present the impacts of the upper and lower bound markup scenarios on INPV. For the AFUE standards, the preservation of gross margin markup scenario represents the upper bound markup scenario and the tiered markup scenario represents the lower bound markup scenario. For the standby and off mode standards, preservation of gross margin markup scenario represents the upper bound markup scenario and the per-unit preservation of operating profit markup scenario represents the lower bound.

Under the preservation of gross margin percentage markup scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels, which assumes that following amended standards, manufacturers would be able to maintain the same amount of profit as a percentage of revenue at all efficiency levels within a product class. As production costs increase with efficiency, this scenario implies that the absolute dollar markup will increase as well. Based on publicly-available financial information for NWGF and MHGF manufacturers, as well as comments from manufacturer interviews, DOE assumed the average non-production cost markup—which includes SG&A expenses, R&D expenses, interest, and profit—to be 1.34 for NWGFs and 1.27 for MHGFs. DOE assumes that this markup scenario represents the upper bound of the NWGF and MHGF industry's profitability in the standards case because manufacturers are able to fully pass on additional costs due to standards to consumers.

In the per-unit preservation-of-operating-profit markup scenario, as the cost of production increases in the standards case, manufacturers reduce their markups to a level that maintains no-new-standards case operating profit. In this scenario, the industry maintains its operating profit in absolute dollars after the standard but not on a percentage basis, as seen in the preservation of gross margin markup scenario. Manufacturer markups are set so that operating profit in the standards case is the same as in the no-new-standards case one year after the compliance date of the amended energy conservation standards. As a result, manufacturers are not able to earn additional operating profit from the increased production costs and the investments that are required to comply with amended standards. However, manufacturers are able to maintain the same operating profit in the standards case that was earned in the no-new-standards case. Therefore, in percentage terms, the operating margin is reduced between the no-new-standards case and the standards cases.

DOE also modeled a tiered markup scenario, which reflects the industry's "good, better, best" pricing structure. DOE implemented the tiered markup scenario because multiple manufacturers stated in interviews that they offer multiple tiers of product lines that are differentiated, in part, by efficiency level. Higher efficiency is one differentiator of premium products over the baseline product. As a result, higher efficiency products generally command a higher markup than lower efficiency products. Several manufacturers suggested that amended standards would lead to a reduction in premium markups and reduce the profitability of higher efficiency products. During interviews, manufacturers provided information on the range of typical efficiency levels in the "good, better, best" tiers. DOE used this information to estimate markups for NWGFs and MHGFs under a tiered pricing strategy in the no-new-standards case. In the standards cases, DOE modeled the situation in which amended standards result in a reduction of product differentiation, compression of the markup tiers, and an overall reduction in profitability.

3. Discussion of Comments

During the NOPR public meeting, interested parties commented on the assumptions and results of the NOPR analysis. Interested parties also submitted written comments addressing several topics including markup scenarios, alternative heating products, direct employment impacts, lessening of competition, cumulative regulatory burden, compliance date of amended standards, regulatory flexibility analysis, and the impacts of the 2014 furnace fan final rule on the GRIM.

a. Direct Employment Impacts

Lennox and Metal-Fab commented that DOE should factor the lower bound of employment impacts into the economic justification of the standard (Lennox, No. 0125 at p. 11; Metal-Fab, No. 0192 at pp. 1-2). DOE considered the entire range of potential employment impacts, including the lower bound, for this SNOPR. The Department analyzed direct employment impacts in section V.B.2.b of both the 2015 March NOPR and this SNOPR.

b. Cumulative Regulatory Burden

Lennox, Goodman, and Rheem provided a list of rulemakings that they requested be incorporated into DOE's cumulative regulatory burden analysis. (Lennox, No. 125 at p. 5, 13-14) (Goodman, No. 0135 at pp. 8-9) (Rheem, No. 142 at p.13).

Of the rulemakings these manufacturers requested DOE include in the cumulative regulatory burden analysis, the energy conservation standards for commercial warm-air furnaces, furnace fans, commercial air conditioners and heat pumps, and single package vertical air conditioners and heat pumps were already included in the March 2015 NOPR. 80 FR 13172. Other energy conservation standards requested by manufacturers were intentionally excluded from the cumulative regulatory burden analysis. As outlined in appendix A to 10 CFR part 430, subpart C, DOE considers "other significant product-specific regulations that will take effect within three years of the effective date of the standard under consideration and will affect significantly the same manufacturers." (Section 10(g)(2), 10 CFR part 430, subpart C, appendix A.)

At the time of the residential furnaces NOPR publication, the compliance years of energy conservation standards for package terminal air conditioners and heat pumps (2017), commercial refrigeration equipment (2017), electric motors (2016), and walk-in coolers and freezers (2017) fell outside of the 2018 to 2024 cumulative regulatory burden window, based on the proposed rule's 2021 compliance year. For the SNOPR, the cumulative regulatory burden window has changed, now ranging from 2019 to 2025 based on this SNOPR's proposed 2022 compliance year. As a result, compliance with regulations for residential air conditioners and heat pumps has been added to the cumulative regulatory burden list for this SNOPR. The compliance dates for package terminal air conditioners and heat pumps, commercial refrigeration equipment, electric motors, and walk-in coolers and freezers still fall outside of the 2019 to 2025 cumulative regulatory burden window and are not included in this cumulative regulatory burden analysis. Similarly, the regional standards enforcement rulemaking has a 2016 compliance year and falls outside of the scope of this rule's cumulative regulatory burden time frame.

Additionally, the rulemakings for commercial and industrial fans and blowers and regional standards enforcement were in preliminary stages at the time of the residential furnaces NOPR publication. There was insufficient information to determine the effective dates and potential cumulative regulatory impact of these rules. For this SNOPR, DOE has included the commercial and industrial fans and blowers rulemaking in the list of regulations that could present cumulative regulatory burden in section V.B.2.e.

DOE recognizes that changes to test procedures can result in increases in certification costs above typical annual spending due to the need to re-certify large numbers of basic models within a limited period of time. When appropriate, these testing costs are accounted for as one-time expenses or as conversion costs in the analysis of the energy conservation standard. Thus, the costs of test procedure rulemakings were captured in this SNOPR.

Manufacturers also expressed concern that DOE did not quantify the cumulative negative INPV impacts of rulemakings considered in the cumulative regulatory burden analysis in the March 2015 NOPR. (Goodman, No. 0135 at p. 9; Ingersoll Rand, No. 0156 at pp. 9-10). Goodman provided a specific list – citing the Small, Large, and Very Large Commercial Package Air Conditioners and Heating Equipment,[159] Furnace Fans,[160]

[159] 81 FR 2420 (Jan. 15, 2016).
[160] 79 FR 38129 (July 3, 2014).

Packaged Terminal Air Conditioners and Heat Pumps,[161] and Commercial Warm Air Furnaces[162] energy conservation standards as examples of rulemakings that have significant projected changes in INPV. For this SNOPR, DOE estimates that the potential net INPV impacts of these rules range from a decrease of $530.2 million to an increase of $38.6 million, or a decrease of 24.7 percent to an increase of 1.8 percent. DOE notes that these manufacturer impacts are balanced by net consumer benefit projections of $25 billion using a 7-percent discount rate and $78 billion using a 3-percent discount rate as well as net projected carbon dioxide emission reductions of 1,075.6 million metric tons.

c. Impacts of the July 2014 Furnace Fan Final Rule on GRIM

In its comments, AHRI asserted that DOE underestimated in the March 2015 NOPR the adverse impact on manufacturers in its modeling of the GRIM. AHRI suggested DOE was not fully recognizing the impacts of the overlap between the furnace fan and NWGF and MHGF rules. In particular, AHRI expressed concern about the decline in free cash flow due to the successive redesigns associated with the 2014 furnace fan final rule and NWGF and MHGF rule. (AHRI, No. 0159 at pp. 66-67)

For this SNOPR, DOE considered the July 2014 furnace fan final rule in its NWGF and MHGF analysis. It was explicitly noted in the conclusion section of V.C of

[161] 80 FR 43162 (July 21, 2015).
[162] 81 FR 2420 (Jan. 15, 2016).

the March 2015 NOPR that DOE factored the cumulative impacts of the furnace fan final rule in its selection of a proposed standard level. 80 FR 13119, 13176 (March 12, 2015).

In the March 2015 NOPR, the modeling of the GRIM incorporated changes in variable costs for the furnace fan. Changes to the variable costs from the furnace fan standard are reflected as changes to manufacturer production cost in the NWGF and MHGF GRIM. Manufacturer production costs in the GRIM increase in 2019 to reflect the implementation of the 2014 furnace fan final rule. Changes to the fixed costs from the 2014 furnace fan final rule were found in the CRB review, in section V.B.2 of the NOPR. In this SNOPR, DOE integrated both the variable cost impacts and fixed cost impacts of the 2014 furnace fan final rule into the GRIM. The SNOPR GRIM incorporates an adjustment to the MPCs (variable cost impacts) in the standard year of the 2014 furnace fan final rule, 2019, to reflect the changes in furnace fan selection. The SNOPR GRIM also includes the conversion costs from the non-weatherized, non-condensing gas furnace fans; non-weatherized, condensing gas furnace fans; manufactured home non-weatherized, non-condensing gas furnace fans; and manufactured home non-weatherized, condensing gas furnace product classes from the 2014 furnace fan final rule. Those conversion costs (fixed cost impacts) total $24.4 million between the years 2016 and 2019. Those furnace fan conversion costs are in addition the today's proposed rule's conversion costs, which total $54.7 million between the years 2018 and 2022. By incorporating the variable and fixed cost impacts of the 2014 furnace fan final rule, the SNOPR GRIM models the impact of amended MWGF and MHGF standards while taking into account the cash flow impacts of the 2014 furnace fan final rule on the NWGF and MHGF industry.

d. Regulatory Flexibility Analysis

In its comments on the March 2015 NOPR, Mortex stated that DOE did not prepare a regulatory flexibility analysis (Mortex, No. 0157 at p. 4). AHRI and HARDI both were critical of the discussion of the regulatory flexibility analysis provided in the March 2015 NOPR (AHRI, No. 0159 at p. 8; HARDI, No. 0131 at p. 2). HARDI's comments were generic in nature and characterized the NOPR Regulatory Flexibility Analysis as "very brief" but offered no additional data for analysis. AHRI cited select requirements of the Regulatory Flexibility Act, including the requirements for DOE to describe the small entities to which the proposed rule will apply; describe the projected reporting, recordkeeping and other compliance requirements of the proposed rule; and provide an analysis of alternatives that would reduce the burden of regulation on small entities.

In this SNOPR, DOE also presents a revised IRFA to reflect the standards proposed in this SNOPR with additional discussion of significant alternatives and includes discussion of possible exclusion criteria for certain small businesses. The complete IRFA discussion is provided in section VI.B of this notice.

AHRI also noted an inconsistency in the number of small businesses identified by DOE in the March 2015 NOPR. 80 FR 13119, 13172 (March 12, 2015). AHRI went on to comment that small businesses may account for more than 30-percent of the market if the number of small businesses identified is actually five instead of four (AHRI, No. 0159 at p. 7). DOE acknowledges the inconsistency in the NOPR notice and has corrected the inconsistency in this SNOPR. DOE confirms that it has identified five small NWGF and or MHGF manufacturers, three of which are domestic manufacturers.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH_4 and N_2O, as well as the reductions to emissions of all species due to "upstream" activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion. The associated emissions are referred to as upstream emissions.

For this SNOPR, the analysis of power sector emissions uses marginal emissions factors that were derived from data in AEO 2015. The methodology is described in chapter 13 and chapter 15 of the SNOPR TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA: GHG Emissions Factors Hub.[163] The FFC upstream

[163] Available at www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.

emissions are estimated based on the methodology described in chapter 13 of the SNOPR TSD. The upstream emissions include both emissions from fuel combustion during extraction, processing, and transportation of fuel, and "fugitive" emissions (direct leakage to the atmosphere) of CH_4 and CO_2.

AGL Resources stated that DOE overestimated the upstream benefits of the proposed rule by using much higher fugitive methane emissions values than are typically used in Federal estimates. AGL Resources stated that EPA's 2013 U.S. Greenhouse Gas Inventory and recent research by NOAA and the University of Colorado Boulder report methane leakage rates of around 1 percent. (AGL Resources, No. 0039 at p. 3; AGL Resources, No. 0112 at p. 6) In response, DOE uses an estimate of upstream emissions of methane based on Burnham et al. (2012)[164] which, if it were translated to a leakage rate, would be equivalent to 1.3 percent, close to the value cited by AGL Resources. Actual leakage rates of methane at various stages of the production process are highly variable and the subject of ongoing research. DOE reviews and updates the FFC factors annually, and as part of this review, data such as methane leakage rates are updated according to the current scientific consensus.

APPA and EEI stated that DOE only considered the upstream emissions due to electricity generation, ignoring the upstream emissions due to the production of natural gas, propane, or fuel oil. (APPA, No. 0149 at p. 4; EEI, No. 0160 at pp. 8-9; EEI, No.

[164] Burnham, A., J. Han, C. E. Clark, M. Wang, J. B. Dunn, and I. Palou-Rivera. 2012. "Life-Cycle Greenhouse Gas Emissions of Shale Gas, Natural Gas, Coal, and Petroleum." Environmental Science & Technology 46 (2): 619–27.

0179 at pp. 2-3) Contrary to what these commenters contend, DOE did calculate the upstream emissions for natural gas, LPG, and fuel oil, which includes the upstream emissions from fuel production. The methodology is further explained in chapter 13 of the SNOPR TSD.

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. Total emissions reductions (or increases) are estimated using the energy savings (or the increase in electricity use) calculated in the national impact analysis. Because product switching is accounted for in the NIA, the emissions analysis accounts for the impacts of product switching on emissions.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of gas by the gas's global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[165] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

Because the on-site operation of NWGFs and MHGFs requires combustion of fossil fuels and results in emissions of CO_2, NO_X, and SO_2 at the sites where these appliances are used, DOE also accounted for the reduction in these site emissions and the

[165] IPCC (2013), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Chapter 8.

associated upstream emissions due to potential standards. Site emissions of these gases were estimated using emissions intensity factors from an EPA publication.[166]

Rheem commented that low-NO_X furnace designs have been available for more than 25 years. As a result, Rheem argued that DOE should include the sales of low-NO_X furnaces in the emissions analysis, and emission savings should be reduced proportionally. (Rheem, No. 0142 at p. 13) For the SNOPR, DOE accounted for low-NO_X furnaces. For the fraction of the market projected to install residential furnaces with low-NO_X burners, DOE used a lower, technology specific emission factor.[167]

The AEO incorporates the projected impacts of existing air quality regulations on emissions. AEO 2015 generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of October 31, 2014. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 et seq.) SO_2 emissions from 28 eastern

166 U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources (Chapter 1) (Available at www.epa.gov/ttn/chief/ap42/index.html).

167 Environmental Protection Agency, Emission Factor Details (Available at: https://cfpub.epa.gov/webfire/index.cfm?action=fire.showfactor&factorid=25416) (Last accessed April 10, 2016).

States and D.C. were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). CAIR created an allowance-based trading program that operates along with the Title IV program. In 2008, CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.[168] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR,[169] and the court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[170] On July 28, 2015, the D.C. Circuit issued its opinion regarding CSAPR on remand from the Supreme Court. The court largely upheld CSAPR, but remanded to EPA without vacatur certain States' emission budgets for reconsideration.[171] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[172] Pursuant to this action, CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.

EIA was not able to incorporate CSAPR into AEO 2015, so it assumes implementation of CAIR. Although DOE's analysis used emissions factors that assume that CAIR, not CSAPR, is the regulation in force, the difference between CAIR and

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[168] See North Carolina v. EPA, 550 F.3d 1176 (D.C. Cir. 2008); North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008).
[169] See EME Homer City Generation, LP v. EPA, 696 F.3d 7, 38 (D.C. Cir. 2012), cert. granted, 81 U.S.L.W. 3567, 81 U.S.L.W. 3696, 81 U.S.L.W. 3702 (U.S. June 24, 2013) (No. 12-1182).
[170] See EPA v. EME Homer City Generation, 134 S. Ct. 1584, 1610 (U.S. 2014). The Supreme Court held in part that EPA's methodology for quantifying emissions that must be eliminated in certain States due to their impacts in other downwind States was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR.
[171] EME Homer City Generation, LP v. EPA, 795 F.3d 118 (D.C. Cir. 2015).
[172] See EME Homer City Generation, LP v. EPA, Order (D.C. Cir. filed October 23, 2014) (No. 11-1302).

CSAPR is not significant for the purpose of DOE's analysis of emissions impacts from energy conservation standards and does not affect the outcome of the cost-benefit analysis. The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2016, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants.[173] 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to

[173] DOE notes that on June 29, 2015, the U.S. Supreme Court ruled that the EPA erred when the agency concluded that cost did not need to be considered in the finding that regulation of hazardous air pollutants from coal- and oil-fired electric utility steam generating units (EGUs) is appropriate and necessary under section 112 of the Clean Air Act (CAA). Michigan v. EPA, 135 S. Ct. 2699 (2015). The Supreme Court did not vacate the MATS rule, and DOE has tentatively determined that the Court's decision on the MATS rule does not change the assumptions regarding the impact of energy conservation standards on SO2 emissions. Further, the Court's decision does not change the impact of the energy conservation standards on mercury emissions. The EPA, in response to the U.S. Supreme Court's direction, has now considered cost in evaluating whether it is appropriate and necessary to regulate coal- and oil-fired EGUs under the CAA. EPA concluded that a consideration of cost does not alter the EPA's previous determination that regulation of hazardous air pollutants, including mercury, from coal- and oil-fired EGUs is appropriate and necessary. 79 FR 24420 (April 25, 2016).

comply with the MATS requirements for acid gas. AEO 2015 assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions in 2016 and beyond.

CAIR established a cap on NO_X emissions in 28 eastern States and the District of Columbia.[174] Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CAIR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other facilities. However, standards would be expected to impact NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions impacts from the standards considered in this SNOPR for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps, and as such, DOE's energy conservation standards would likely impact

[174] CSAPR also applies to NO_X and it supersedes the regulation of NO_X under CAIR. As stated previously, the current analysis assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR with regard to DOE's analysis of NO_X emissions is slight.

Hg emissions. DOE estimated mercury emissions impacts using emissions factors based on AEO 2015, which incorporates the MATS.

EEI stated that because the AEO only addresses final environmental standards, it often makes predictions about the future composition of the electric generating fleet and the related emissions that are unlikely to be borne out by actual experience. EEI commented that the EPA MATS rule and the Clean Power Plan are estimated to significantly reduce coal-based electricity generation, thus reducing emissions from the power sector after 2020. (EEI, No. 0160, pp. 4-5, 8; EEI, No. 0179 at pp. 2-3) EEI stated that because of the Clean Power Plan, there will be no physical reduction of greenhouse gas emissions from electric generation as a result of energy conservation standards, as DOE has stated with other emissions that have upstream mass-based caps or cap-and-trade systems. (EEI, No. 0189-1 at p. 1) Because AEO 2015 does not account for the Clean Power Plan, EEI requested that DOE consider information found in a recent EPRI/NRDC report that provides updated modeling information reflecting the current and future electric grid, which incorporates the rapid decreases in CO_2, SO_2, and NO_X emissions occurring as a result of various Federal and State policies.[175] (EEI, No. 0179 at pp. 2-3)

[175] EPRI/NRDC, Environmental Assessment of a Full Electric Transportation Portfolio, Volume 1: Background, Methodology, and Best Practices (Sept. 17, 2015) (EPRI/NRDC Vol. 1) (Available at: www.epri.com/abstracts/Pages/ProductAbstract.aspx?productId=000000003002006875); see also, EPRI/NRDC, Environmental Assessment of a Full Electric Transportation Portfolio, Volume 2: Greenhouse Gas Emissions (Sept. 17, 2015) (EPRI/NRDC Vol. 2) (Available at: www.epri.com/abstracts/Pages/ProductAbstract.aspx?productId=000000003002006876); see also, EPRI/NRDC, Environmental Assessment of a Full Electric Transportation Portfolio, Volume 3: Air Quality

In response, DOE notes that AEO 2015 incorporates the MATS rule, but not the Clean Power Plan, which was issued well after AEO 2015 was finalized. At the time the SNOPR analysis was conducted, AEO 2015 was the only source that provides a comprehensive projection of emissions that allows derivation of marginal emissions factors. DOE acknowledges that if the Clean Power Plan is fully implemented following the court challenges, projected emissions of CO_2 would be below those projected in AEO 2015. In the context of the current rulemaking, however, accounting for the Clean Power Plan is of only slight relevance because DOE is not projecting any reduction in electricity generation to result from the proposed standards. DOE intends to use AEO 2016, which is expected to incorporate the Clean Power Plan, for the final rule.

EEI questioned DOE's conclusion that some emissions will increase due to higher electricity use. EEI stated that based on current trends in power plant retirements, additions of new zero-emission electricity generation, and reductions in the use of electricity in nearly all end-use applications, emissions from electric generation will decrease, not increase. (EEI, No. 0160 at pp. 8-9; EEI, No. 0179 at pp. 2-3) In response, it may be true that on a national level, emissions from electricity generation will decrease. The AEO 2015 projections include changes in the composition and emissions intensity of power plants across the Nation. The analysis for this rulemaking considers only the

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Impacts (Sept. 17, 2015) (EPRI/NRDC Vol. 3) (Available at: www.epri.com/abstracts/Pages/ProductAbstract.aspx?productId=000000003002006880).

change in emissions due to amended or new furnace energy conservation standards, as compared to the AEO 2015 projections.[176]

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this supplemental proposed rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. To make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for CO_2 and NO_X emissions and presents the values considered in this SNOPR.

For this SNOPR, DOE is relying on a set of values for the social cost of carbon (SCC) that was developed by an interagency process. A summary of the basis for those values is provided in the following subsection, and a more detailed description of the methodologies used is provided in appendices 14A and 14B of the SNOPR TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) climate-change-related changes in net agricultural productivity, human health,

[176] Under the Clean Power Plan, emissions of CO_2 electricity generation would be significantly reduced. If the Clean Power Plan is accounted for, DOE expects that the increase in emissions from electricity generation that is projected to result from the proposed standards (due to fuel switching) would be less than projected for this SNOPR. DOE intends to use AEO 2016, which is expected to incorporate the Clean Power Plan, for the final rule.

property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in CO_2 emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b)(6) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), agencies must, to the extent permitted by law, assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed these SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of CO_2 emissions, the analyst faces a number of challenges. A report from the National Research Council points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) future emissions of GHGs; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages.[177] As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. Although any numerical estimate of the benefits of reducing carbon dioxide emissions is subject to some uncertainty, that does not relieve DOE of its obligation to attempt to factor those benefits into its cost-benefit analysis. Moreover, the interagency group's SCC estimates are well supported by the existing scientific and economic literature. As a result, DOE has relied on the interagency group's SCC estimates in quantifying the social benefits of reducing CO_2 emissions. Specifically, DOE estimated the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The NPV of the benefits can then

[177] National Research Council, Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use, National Academies Press: Washington, DC (2009).

be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the current SCC values reflect the interagency group's best assessment, based on current data, of the societal effect of CO_2 emissions. The interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across Federal agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC estimate for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules issued by DOE and other agencies.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specially, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models, while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, was included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[178] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.20 presents the values in the 2010 interagency group report,[179] which is reproduced in appendix 14A of the SNOPR TSD.

Table IV.20 Annual SCC Values from 2010 Interagency Report, 2010–2050 (2007$ per Metric Ton CO_2)

Year	Discount Rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

The SCC values used for this SNOPR were generated using the most recent versions of the three integrated assessment models that have been published in the peer-

[178] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time.
[179] Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Interagency Working Group on Social Cost of Carbon, United States Government (February 2010) (Available at: www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf).

reviewed literature, as described in the 2013 update from the interagency working group (revised July 2015).[180] Table IV.21 shows the updated sets of SCC estimates from the latest interagency update (*i.e.*, the 2013 update, as revised in July 2015) in 5-year increments from 2010 to 2050. The full set of annual SCC values between 2010 and 2050 is reported in the 2013 interagency update (as revised in July 2015), which is reproduced in appendix 14B of the SNOPR TSD. The central value that emerges is the average SCC across models at the 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

Table IV.21 Annual SCC Values from 2013 Interagency Update (Revised July 2015), 2010–2050 (2007$ per Metric Ton CO_2)

Year	Discount Rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The interagency group

[180] Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Interagency Working Group on Social Cost of Carbon, United States Government (May 2013; revised July 2015) (Available at: www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf).

also recognizes that the existing models are imperfect and incomplete. The National Research Council report mentioned previously points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.[181]

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report (revised July 2015), adjusted to 2015$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. For each of the four sets of SCC cases specified, the values for emissions in 2015 were $12.4, $40.6, $63.2, and $118 per metric ton avoided (values expressed in 2015$). DOE derived values after 2050 based on the trend in 2010-2050 in each of the four cases in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of

[181] Although uncertainties remain, the revised estimates used for this SNOPR are based on the best available scientific information on the impacts of climate change. The current estimates of the SCC have been developed over many years, and with input from the public. In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586 (Nov. 26, 2013).

monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

DOE received several comments on the development of and the use of the SCC values in the March 2015 NOPR and the September 2015 NODA analyses. A group of trade associations led by the U.S. Chamber of Commerce objected to DOE's continued use of the SCC in the cost-benefit analysis and stated that the SCC calculation should not be used in any rulemaking until it undergoes a more rigorous notice, review, and comment process. (U.S. Chamber of Commerce, No. 0078 at p. 41) AHRI stated that the interagency process was not transparent and that the estimates were not subjected to peer review. (AHRI, No. 0159 at p. 24) AHRI and the Cato Institute criticized DOE's use of SCC estimates on the basis that they are subject to considerable uncertainty. AHRI also stated that the interagency SCC analysis relied on arbitrary damages functions. The Cato Institute criticized several aspects of the determination of the SCC values by the IWG as being discordant with the best climate science, highly sensitive to input parameters and scope of the models, and not reflective of climate change impacts. The Cato Institute stated that until the integrated assessment models (IAMs) are made consistent with mainstream climate science, the SCC should be barred from use in this and all other Federal rulemakings. (AHRI, No. 0159 at p. 24; Cato Institute, No. 0081 at pp. 1-4, 15-16) HARDI questioned the use of the SCC as part of the economic analysis, stating that the science and rationale behind this metric have been questioned at length in this and previous rulemakings. (HARDI, No. 0131 at p. 2)

In contrast, the Joint Advocates stated that only a partial accounting of the costs of climate change (those most easily monetized) can be provided, which inevitably involves incorporating elements of uncertainty. The Joint Advocates commented that accounting for the economic harms caused by climate change is a critical component of sound benefit-cost analyses of regulations that directly or indirectly limit greenhouse gases. The Joint Advocates stated that several Executive Orders direct Federal agencies to consider non-economic costs and benefits, such as environmental and public health impacts. (Joint Advocates, No. 0126 at pp. 2-3) Furthermore, the Joint Advocates argued that without an SCC estimate, regulators would by default be using a value of zero for the benefits of reducing carbon pollution, thereby implying that carbon pollution has no costs. The Joint Advocates stated that it would be arbitrary for a Federal agency to weigh the societal benefits and costs of a rule with significant carbon pollution effects but to assign no value at all to the considerable benefits of reducing carbon pollution. (Joint Advocates, No. 0126 at p. 3)

The Joint Advocates stated that assessment and use of the IAMs in developing the SCC values has been transparent. The Joint Advocates further noted that the Government Accountability Office (GAO) found that the IWG's processes and methods used consensus-based decision making, relied on existing academic literature and models, and took steps to disclose limitations and incorporate new information. The Joint Advocates stated that repeated opportunities for public comment demonstrate that the IWG's SCC estimates were developed and are being used transparently. (Joint Advocates, No. 0126 at p. 4) The Joint Advocates stated that (1) the IAMs used reflect the best available, peer-reviewed science to quantify the benefits of carbon emission reductions; (2) uncertainty is not a valid reason for rejecting the SCC analysis, and (3) the IWG was rigorous in addressing uncertainty inherent in estimating the economic cost of pollution. (Joint Advocates, No. 0126 at pp. 5, 17-18, 18-19) The Joint Advocates added that the increase in the SCC estimate in the 2013 update reflects the growing scientific and economic research on the risks and costs of climate change, but is still very likely an underestimate of the SCC. (Joint Advocates, No. 0126 at p. 4) The Joint Advocates stated that recent research suggests that CO_2 fertilization is overestimated and may be cancelled out by negative impacts on agriculture. (Joint Advocates, No. 0126 at p. 16)

In response to the comments on the SCC, in conducting the interagency process that developed the SCC values, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. Key uncertainties and model differences transparently and consistently inform the range of SCC estimates. These uncertainties and model differences are discussed in the IWG's reports, which are reproduced in appendices 14A and 14B of the SNOPR TSD, as are the major assumptions. Specifically, uncertainties in the assumptions regarding climate sensitivity, as well as other model inputs such as economic growth and emissions trajectories, are discussed and the reasons for the specific input assumptions chosen are explained. However, the three integrated assessment models used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used in 2013 to estimate revised SCC values were published in the peer-reviewed literature (see appendix 14B of the SNOPR TSD for discussion). Although uncertainties remain, the revised estimates that were issued in November 2013 are based on the best available scientific information on the impacts of climate change. The current estimates of the SCC have been developed over many years, using the best science available, and with input from the public. DOE notes that not using SCC estimates because of uncertainty would be tantamount to assuming that the benefits of reduced carbon emissions are zero, which is inappropriate. Furthermore, the commenters have not offered alternative estimates of the SCC that they believe are more accurate.

As noted previously, in November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586 (Nov. 26, 2013). In July 2015, OMB published a detailed summary and formal response to the many comments that were received. DOE stands ready to work with OMB and the other members of the IWG on further review and revision of the SCC estimates as appropriate.[182]

AGA stated that DOE overstated the benefit of CO_2 reductions by reporting estimates from a global, not national, perspective. AGA and Laclede argued that national benefits from reducing CO_2 would be a fraction of the global SCC value. In addition, AGA and AHRI stated that while global benefits may be informative, they should be excluded from DOE's calculation of net benefits. (AGA, No. 0118 at pp. 31-32; AHRI, No. 0159 at p. 176; Laclede, No. 0141 at p. 22) NPGA commented that the value of CO_2

[182] See https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions. OMB also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

emission reductions is based on a global value, whereas estimated operating savings of the proposed standards are calculated in terms of U.S. domestic consumer savings. NPGA expressed concern that this unequal comparison overestimates the economic value of potential CO_2 emission reductions. (NPGA, No. 0130 at p. 6) On the other hand, the Joint Advocates stated that a global SCC value must be used to design the economically efficient policies necessary to address climate change. The Joint Advocates stated that because greenhouse gases do not stay within geographic borders, CO_2 emitted by the United States not only creates domestic harms, but also imposes additional and large externalities on the rest of the world, including disproportionate harms to some of the least-developed nations. The Joint Advocates stated that if all countries set their greenhouse gas emission levels based on only their domestic costs and benefits, ignoring the large global externalities, the collective result would be substantially sub-optimal climate protections and significantly increased risks of severe harms to all nations, including to the United States. (Joint Advocates, No. 0126 at pp. 6-7)

In response, DOE's analysis estimates both global and domestic benefits of CO_2 emissions reductions. Following the recommendation of the IWG, DOE places more focus on a global measure of SCC. As discussed in appendix 14A of the SNOPR TSD, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. The other factors DOE considers (such as operating savings) do not have such a global externality, and thus it is not necessary or appropriate to consider those factors globally. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable. DOE's approach is not in contradiction of the requirement to weigh the need for national energy conservation, as one of the main reasons for national energy conservation is to contribute to efforts to mitigate the effects of global climate change. DOE notes that the use of domestic rather than global SCC estimates would not affect DOE's selection of proposed standards for NWGFs and MHGFs.

AHRI criticized DOE's inclusion of CO_2 emissions impacts over a time period that it asserts greatly exceeds that used to measure the economic costs of the proposed standards. (AHRI, No. 0159 at pp. 16-18) DOE disagrees. For the analysis of all national costs and benefits of standards, DOE considers the lifetime impacts of products shipped in the period 2022-2051. With respect to energy cost savings, impacts continue until all of the equipment shipped in the analysis period is retired, which could occur well after 2051. With respect to the benefits of CO_2 emissions reductions, DOE likewise evaluates the impacts for products shipped during the analysis period and used until they are retired. Because CO_2 emissions in a given year (e.g., 2050) have a long residence time in the atmosphere, they contribute to radiative forcing, which affects global climate, for a long time. Accordingly, emissions reductions occurring in a given year in which products are operated (e.g., 2050), will have environmental benefits not only in that year, but also in many years to come. The SCC estimates developed by the IWG are meant to capture these benefits extending over many years by representing the full discounted value (using an appropriate range of discount rates) of emissions reductions occurring in a given year. Thus, in the case of both consumer economic costs and benefits and the value of CO_2 emissions reductions, DOE is accounting for the lifetime impacts of products shipped in the same analysis period.

Laclede stated that market prices best reflect the cost of CO_2 reduction benefits to U.S. residents, which are around or lower than DOE's lowest SCC value. (Laclede, No. 0141 at p. 22) In response, DOE notes that market prices are simply a reflection of the conditions in specific emissions markets in which emissions caps have been set. Neither the caps nor the resulting prices of traded emissions are intended to reflect the full range of domestic and global impacts from anthropogenic climate change over the appropriate time scales. Consequently, DOE is maintaining its current approach.

2. Social Cost of Other Air Pollutants

As noted previously, DOE has estimated how the considered energy conservation standards would reduce site NO_X emissions nationwide and decrease power sector NO_X emissions in those 22 States not affected by the CAIR.

DOE estimated the monetized value of NO_X emissions reductions from electricity generation using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards.[183] The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 using discount rates of 3 percent and 7 percent; these values are presented in appendix 14C of the SNOPR TSD. DOE primarily relied on the low estimates to be conservative.[184] The national average low values for 2020 (in 2015$) are $3,187/ton at a 3-percent discount rate and $2,869/ton at a 7-percent discount rate. DOE developed values specific to the end-use category for NWGFs and MHGFs using a method described in appendix 14C of the SNOPR TSD. For this analysis DOE used linear interpolation to define values for the years between 2020 and 2025 and between 2025 and 2030; for years beyond 2030 the value is held constant.

DOE estimated the monetized value of NO_X emissions reductions from gas furnaces using benefit-per-ton estimates from the EPA's "Technical Support Document Estimating the Benefit per Ton of Reducing PM-2.5 Precursors from 17 Sectors."[185] Although none of the sectors refers specifically to residential and commercial buildings, DOE believes that the sector called "Area sources" would be a reasonable proxy for residential and commercial buildings. "Area sources" represents all emission sources for

[183] Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis. See Tables 4A-3, 4A-4, and 4A-5 in the report.

[184] For the monetized NO_X benefits associated with PM2.5, the related benefits are primarily based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009), which is the lower of the two EPA central tendencies. Using the lower value is more conservative when making the policy decision concerning whether a particular standard level is economically justified. If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2012), the values would be nearly two-and-a-half times larger. (See chapter 14 of the SNOPR TSD for citations for the studies mentioned above.)

[185] www.epa.gov/sites/production/files/2014-10/documents/sourceapportionmentbpttsd.pdf

which States do not have exact (point) locations in their emissions inventories. Since exact locations would tend to be associated with larger sources, "area sources" would be fairly representative of small dispersed sources like homes and businesses. The EPA Technical Support Document provides high and low estimates for 2016, 2020, 2025, and 2030 at 3-percent and 7-percent discount rates. As with the benefit-per-ton estimates for NO_X emissions reductions from electricity generation, DOE primarily relied on the low estimates to be conservative.

DOE multiplied the emissions reduction (metric tons) in each year by the associated $/metric ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate. DOE will continue to evaluate the monetization of avoided NO_X emissions and will make any appropriate updates for the final rule.

AGA and AGL Resources stated that DOE failed to monetize the impacts of increased Hg, SO_2, and N_2O emissions as it did for the reductions in CO_2 and NO_X emissions. (AGA, No. 0118 at p. 30; AGL Resources, No. 0112 at p. 6) DOE is still evaluating the appropriate monetization of SO_2, N_2O, and Hg emissions in energy conservation standards rulemakings. DOE notes that it has also not monetized the impacts of the projected decrease in methane emissions, but this benefit would far outweigh the costs of increased SO_2, N_2O, and Hg emissions.[186]

[186] The total estimated reduction in methane emissions from the proposed AFUE standards is 2.8 billion tons, while the total estimated increase is 77 thousand tons for SO_2 emissions, 1.07 thousand tons for N_2O emissions, and 0.3 tons for Hg emissions (see Table V.30).

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power generation industry that would result from the adoption of new or amended energy conservation standards. The utility impact analysis estimates the changes in installed electrical capacity and generation that would result for each TSL. The analysis is based on published output from the NEMS associated with AEO 2015. NEMS, which is a public domain, multi-sectored, partial equilibrium model of the U.S. energy sector, produces the AEO Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. DOE uses published side cases to estimate the marginal impacts of reduced energy demand on the utility sector. These marginal factors are estimated based on the changes to electricity sector generation, installed capacity, fuel consumption, and emissions in the AEO Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the SNOPR TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity, and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of new or amended energy conservation standards.

EEI stated that DOE should consider the impacts of the Clean Power Plan when assessing impacts on the utility sector. (EEI, No. 0160 at pp. 4-5) As discussed above, AEO 2015 does not incorporate the Clean Power Plan, and at the time the SNOPR analysis was conducted, AEO 2015 was the only source that provides data that allows derivation of coefficients that DOE uses in the utility impact analysis. DOE intends to use AEO 2016, which will incorporate the Clean Power Plan, for the final rule.

Several gas utilities and gas utility associations stated that DOE should analyze the impact of the proposed rule on natural gas utilities, especially because of the potential for switching away from natural gas to other energy sources. (AGL Resources, No. 0112 at pp. 7-8; AGA, No. 0118 at pp. 6, 42; APGA, No. 0106 at p. 12; CGS, No. 0098 at p. 1; Vectren, No. 0111 at p. 1, 6; Laclede, No. 0141 at p. 36) AGA stated that the Process Rule requires DOE to analyze the impact of standards on gas utilities. (AGA, No. 0118 at pp. 41-42) AGA, APGA, CGS, and Vectren stated that DOE should also consider the impact on natural gas local distribution companies and retail natural gas customers, who may see increased natural gas prices due to fuel switching. (AGA, No. 0118 at pp. 6, 42; APGA, No. 0106 at p. 16; CGS, No. 0098 at p. 1; Vectren, No. 0111 at p. 1, 6)

In response to the comments, DOE conducted a preliminary evaluation of the potential impact of the currently-proposed standards on gas utilities. DOE found that such evaluation is complicated by the upward trend in the use of natural gas revenue decoupling.[187] With revenue decoupling regulation, the revenues of regulated natural gas utilities are essentially fixed by the public utility commission. If a utility's actual revenues are above the fixed level due to a larger volume of sales than expected,

[187] Natural Gas Revenue Decoupling Regulation: Impacts on Industry (July 2010) (Available at: http://www1.eere.energy.gov/manufacturing/states/pdfs/nat-gas-revenue-decoupling-final.pdf).

customers receive a credit from the utility for the difference; if actual revenues are below the fixed level due to a smaller volume of sales than expected, the utility issues a customer surcharge for the difference. To this end, a utility's revenues are decoupled from its volume of sales because its revenues are fixed as sales fluctuate. With revenue decoupling, a decrease in gas sales due to energy conservation standards would not necessarily have a negative impact on gas utilities. DOE welcomes comments on how energy conservation standards may affect gas utilities in the context of growing use of revenue decoupling.

With respect to retail natural gas prices, DOE finds it implausible that a decrease in gas consumption (from use of more-efficient furnaces and switching away from gas furnaces) would increase gas prices. As discussed in section IV.F.4 of this SNOPR, the more likely effect would be a decrease in prices. DOE recognizes that switching away from gas on a very large scale would mean that fixed costs would be distributed among a smaller customer base, thereby putting upward pressure on prices, but with the modest degree of switching projected to result from the currently-proposed standards, such an outcome is highly unlikely.

NPGA stated that mass switching away from propane would severely impact many retail propane marketers, over 95 percent of whom are small businesses. (NPGA, No. 0130 at p. 5) In response, the extent of switching from LPG-fired furnaces projected to result from the currently-proposed standards is significantly less than was the case with the standards proposed in the March 2015 NOPR. Although DOE expects that the impact on retail propane marketers would be small, DOE does not have sufficient information to reliably estimate the potential impact. If stakeholders are able to provide relevant data, including annual propane sales (in gallons and dollars) for a representative sample of retail propane marketers, DOE will undertake an evaluation as it prepares the final rule.

AGL Resources and Camilla stated that by disproportionally raising the minimum efficiency of NWGFs relative to electric heat pumps and electric furnaces, and by causing a significant amount of fuel switching, DOE has put natural gas utilities in a position of competitive disadvantage. (AGL Resources, No. 0039 at pp. 1, 3-4 ; AGL Resources, No. 0112 at pp. 7-8; Camilla, No. 0092 at p. 1) In response, DOE disagrees that the proposed standards would be disproportionally raised for NWGFs. On the contrary, the efficiency standards for CACs and heat pumps have been raised several times over the past two decades, while standards for NWGFs did not change during the same period. Furthermore, DOE is currently undertaking a rulemaking to consider amended energy conservation standards for residential central air conditioners and heat pumps. See, 80 FR 81785 (December 31, 2015).

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by consumers on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased consumer spending on the products to which the new standards apply and other goods and services; and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS).[188] BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[189] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (i.e., the utility sector) to more labor-intensive sectors (e.g., the retail and service sectors). Thus, the

[188] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202-691-5618) or by sending a request by e-mail to dipsweb@bls.gov.
[189] See Bureau of Economic Analysis, Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II), U.S. Department of Commerce (1992).

BLS data suggest that net national employment may increase due to shifts in economic activity resulting from amended energy conservation standards for NWGFs and MHGFs.

DOE estimated indirect national employment impacts for the amended NWGFs and MHGFs standard levels considered in this NOPR using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (ImSET).[190] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" (I–O) model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, for the SNOPR, DOE used ImSET only to generated results for a near-term timeframe (2022-2027), where these uncertainties are reduced.

The Joint Consumer Commenters stated that DOE did not account for the macroeconomic benefit of stimulating the economy by reducing the cost of energy and

[190] Livingston, OV, SR Bender, MJ Scott, and RW Schultz (2015). ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide. Pacific Northwest National Laboratory. PNNL-24563.

diverting spending to other things that tend to have higher economic multipliers, thus accelerating economic growth. The Joint Consumer Commenters stated that greater economic activity from the increase in consumer disposable income raises employment levels in other sectors. (Joint Consumer Commenters, No. 0123 at pp. 23-24) In response, increasing consumer disposable income does not necessarily result in greater economic activity. To the extent that the economy approaches full employment, additional stimulus from a shift in spending toward more labor-intensive sectors is not likely to significantly add to economic growth. In the context of the total economy, the long-run potential stimulus from an energy conservation standard would be extremely difficult to measure.

AHRI stated that DOE provides no reason for its selection of a short-run model to evaluate the indirect employment impact analysis. AHRI stated that qualitatively discussing the long-run impacts means that the cost are not adequately considered in the quantitative analysis and are consequently underestimated. (AHRI, No. 0159 at p. 18)

In response, DOE has tentatively concluded that the primary options available to estimate employment impacts of energy efficiency policies are sectoral multipliers, input-output models, and macroeconomic (i.e., general equilibrium) simulation models. Macroeconomic simulation models allow for the most flexibility of the three options, particularly in portraying differential impacts over time, but this temporal detail comes at the cost of sectoral detail. The developers of ImSET evaluated several macroeconomic simulation models used by other Federal agencies and found none well-suited to the kinds of sectoral relationships and impacts following the adoption of an energy efficiency standard. Although it is a static model, ImSET captures the complexities of intersectoral buying-selling relationships. Additionally, by streamlining the temporal aspects of the model, it is possible to track the differential impacts of changes in energy cost as compared to changes in capital or maintenance cost, each of which can impact sectoral multipliers in different ways. DOE is reluctant to use ImSET to quantify long-run impacts, because ImSET relies on fixed sectoral capital-labor coefficients, while in practice these coefficients may shift in the long run in response to price effects following energy efficiency standards. Since input/output models are fundamentally short-run disequilibrium models, DOE provides quantitative results only for the first and fifth year of the standards.

AGL Resources stated that DOE's model did not account for fuel switching in the employment impact analysis. (AGL Resources, No. 0112 at p. 7) In response, DOE notes that because the employment impact analysis uses the results of the NIA, it accounts for product switching that is captured in the NIA.

For more details on the employment impact analysis, see chapter 16 of the SNOPR TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for NWGFs and MHGFs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for NWGFs and MHGFs, and the standards levels that DOE is proposing to adopt in this SNOPR. Additional details regarding DOE's analyses are contained in the SNOPR TSD supporting this notice.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of nine AFUE TSLs and three separate standby mode and off mode TSLs for NWGFs and MHGFs. These TSLs were developed by combining specific efficiency levels for each of the product classes analyzed by DOE. TSLs are numbered in order of ascending national energy savings. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the SNOPR TSD.

Table V.1 presents the AFUE TSLs and the corresponding efficiency levels for NWGFs and MHGFs that DOE has identified for potential amended energy conservation standards for these products. TSL 9 represents the maximum technologically feasible ("max-tech") energy efficiency for both product classes and therefore maximum potential national energy savings. TSL 8 consists of an efficiency level at 80-percent AFUE for small NWGFs at or below an input capacity of 55 kBtu/h and an efficiency level at 95-percent AFUE for large NWGFs. For all MHGFs, TSL 8 consists of the efficiency level that represents 95-percent AFUE. TSL 7 consists of intermediate efficiency levels at 95-percent AFUE for both product classes. For NWGFs, TSL 6 consists of an efficiency level at 80-percent AFUE for small NWGFs at or below an input capacity of 55 kBtu/h and an efficiency level at 92-percent AFUE for large NWGFs. For all MHGFs, TSL 6 is 92-percent AFUE. TSL 5 consists of intermediate efficiency levels at 92-percent AFUE for both product classes. For NWGFs, TSL 4 consists of the efficiency level that represents 80-percent AFUE for small NWGFs at or below an input capacity of 60 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGFs. For all MHGFs, TSL 4 consists of the efficiency level that represents 92-percent AFUE. TSL 3 consists of the efficiency levels that represent 95-percent AFUE for the Northern region for both product classes, and the baseline efficiency level (80-percent AFUE) for the Rest of Country. For NWGFs, TSL 2 consists of the efficiency level that represents 80-percent AFUE for small NWGFs at or below an input capacity of 70 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGF. For all MHGFs, TSL 2 consists of the efficiency level that represents 92-percent AFUE. For NWGFs, TSL 1 consists of the efficiency level that represents 80-percent AFUE for small NWGFs at or below an input capacity of 80 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGFs. For all MHGFs, TSL 1 consists of the efficiency level that represents 92-percent AFUE standard.

Table V.1 Trial Standard Levels for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace AFUE Standards

TSL	AFUE	
	Non-Weatherized Gas Furnace	**Mobile Home Gas Furnace**
1	92% (>80 kBtu/h) 80% (≤80 kBtu/h)	92%
2	92% (>70 kBtu/h) 80% (≤ 70 kBtu/h)	92%
3	95% (North) 80% (Rest of Country)	95% (North) 80% (Rest of Country)
4	92% (>60 kBtu/h) 80% (≤ 60 kBtu/h)	92%
5	92%	92%
6	92% (> 55kBtu/h) 80% (≤ 55 kBtu/h)	92%
7	95%	95%

8	95% (>55 kBtu/h) 80% (≤ 55 kBtu/h)	95%
9	98%	96%

Table V.2 presents the standby mode and off mode TSLs and the corresponding efficiency levels (values expressed in watts) that DOE considered for NWGFs and MHGFs. DOE considered three efficiency levels. TSL 3 represents the maximum technologically feasible ("max-tech") energy efficiency for both product classes, TSL 2 represents efficiency level 2 for both product classes, and TSL 1 represents efficiency level 1 for both product classes.

Table V.2 Trial Standard Levels for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standby Mode and Off Mode Standards

TSL	Standby and Off Mode Electrical Power Consumption (Watts)	
	Non-Weatherized Gas Furnace	**Mobile Home Gas Furnace**
1	9.5	9.5
2	9.2	9.2
3	8.5	8.5

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on NWGF and MHGF consumers by looking at the effects potential standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed below.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases, and (2) annual operating costs decrease. In addition, some consumers may choose to switch to an alternative heating system rather than purchase and install a NWGF if they judge the economics to be favorable. DOE estimated the extent of switching at each TSL using the consumer choice model discussed in section IV.F.9.

Inputs used for calculating the LCC and PBP include total installed costs (i.e., product price plus installation costs), and operating costs (i.e., annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. In cases where consumers are predicted to switch, the inputs include the total installed costs, operating costs, and product lifetime for the chosen heating system. Chapter 8 of the SNOPR TSD provides detailed information on the LCC and PBP analyses.

Key outputs of the LCC analysis are the average LCC savings (or cost) relative to the no-new-standards case efficiency distribution for each product class of residential NWGFs and MHGFs, and the percentage of consumers for whom the LCC under an amended standard would increase (net cost).

DOE also performed a PBP analysis as part of the consumer impact analysis. The PBP is the number of years it would take for the consumer to recover the increased costs of a higher-efficiency product as a result of energy savings. The PBP is an economic benefit-cost measure that uses benefits and costs without discounting.

The simple payback is measured relative to the baseline product. In contrast, the LCC savings are measured relative to the no-new-standards case efficiency distribution in the compliance year. No impacts occur when the no-new-standards -case efficiency for a specific consumer equals or exceeds the efficiency at a given TSL; a standard would have no effect because the product installed would be at or above that standard level without amended standards.

For NWGFs, the LCC and PBP results at each efficiency level include consumers that would purchase and install a NWGF at that level, and also consumers that would choose to switch to an alternative heating product rather than purchase and install a NWGF at that level.[191] The impacts for consumers that switch depend on the product that they choose (heat pump or electric furnace) and the NWGF that they would purchase in the no-new-standards case. The extent of projected product/fuel switching (in 2022) is shown in Table V.3 for each TSL for NWGFs. The degree of switching increases at higher-efficiency TSLs where the installed cost of a NWGF is very high for some consumers. As discussed in section IV.F.9, DOE also conducted sensitivity analysis using high and low switching estimates (based on paybacks of 2.5 and 4.5 years, respectively around the reference value of 3.5 years). Table V.4 presents the projected amount of switching in 2022 for the high and low switching scenarios, as well as the no switching and default switching scenarios. For the proposed standards (TSL 6), the total switching is 6.0% in the low case and 7.9% in the high case; the total switching in the default case in 6.9%. See appendix 8J of the SNOPR TSD for more details.

[191] DOE did not analyze switching for MHGFs because the installed cost differential is relatively small between condensing and non-condensing furnaces, so the incentive for switching is limited.

Table V.3 Results of Fuel Switching Analysis for Non-Weatherized Gas Furnaces in 2022 (% of consumers)

Consumer Option	Trial Standard Level								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Purchase NWGF at Standard Level	98.5%	96.6%	98.0%	95.9%	88.5%	93.2%	86.5%	91.6%	84.1%
Switch to Heat Pump*	1.2%	2.9%	1.6%	3.4%	9.7%	5.8%	11.6%	7.2%	13.6%
Switch to Electric Furnace*	0.3%	0.5%	0.5%	0.7%	1.8%	1.1%	2.0%	1.2%	2.4%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

*Includes switching from a gas water heater to an electric water heater.
Note: Components may not sum due to rounding.

Table V.4 Comparison of Results for Fuel Switching Scenarios for Non-Weatherized Gas Furnaces in 2022

TSL	Fraction of Consumers Switching to Heat Pump, %*				Fraction of Consumers Switching to Electric Furnace, %*			
	No	**Low**	**High**	**Ref.**	**No**	**Low**	**High**	**Ref.**
1	0.0%	0.9%	1.5%	1.2%	0.0%	0.3%	0.3%	0.3%
2	0.0%	2.4%	3.4%	2.9%	0.0%	0.5%	0.5%	0.5%
3	0.0%	1.3%	2.0%	1.6%	0.0%	0.5%	0.5%	0.5%
4	0.0%	2.8%	4.0%	3.4%	0.0%	0.7%	0.8%	0.7%
5	0.0%	8.6%	10.9%	9.7%	0.0%	1.5%	2.2%	1.8%
6	0.0%	5.0%	6.7%	5.8%	0.0%	1.0%	1.2%	1.1%
7	0.0%	10.5%	12.9%	11.6%	0.0%	1.7%	2.5%	2.0%
8	0.0%	6.5%	8.4%	7.2%	0.0%	1.1%	1.4%	1.2%
9†	0.0%	12.4%	15.2%	13.6%	0.0%	2.0%	3.0%	2.4%

*Includes switching from a gas water heater to an electric water heater.
Note: "No" means no switching scenario; Low means low switching scenario (2.5 year payback); High means high switching scenario (4.5 year payback); and Ref. means DOE's default switching case (3.5 year payback).

Table V.5 through Table V.8 show the LCC and PBP results for the TSL levels considered for each product class for AFUE standards. Table V.9 compares the average LCC savings, simple PBP, and percentage of consumers experiencing net cost at each AFUE efficiency level for the alternative product switching scenarios, as well as the no switching and DOE's default switching scenario. Table V.10 through Table V.13 show the LCC and PBP results for the TSLs considered for each product class for standby mode and off mode standards. The LCC and PBP results for NWGFs include both residential and commercial users. Results for all efficiency levels are reported in chapter 8 of the SNOPR TSD.

In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (see section IV.F.8 of this notice). The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase a product with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

Table V.5 Average LCC and PBP Results for Non-Weatherized Gas Furnace AFUE Standards

TSL	AFUE (%)	Average Costs (2015$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1	92/80*	2,375	652	10,512	12,887	6.1	21.5
2	92/80*	2,469	635	10,244	12,714	6.0	21.5
3	95/80**	2,552	625	10,108	12,661	6.4	21.5
4	92/80*	2,512	628	10,126	12,638	5.9	21.5
5	92†	2,635	612	9,859	12,493	6.4	21.5
6	92/80*	2,576	618	9,971	12,547	6.1	21.5
7	95†	2,742	597	9,608	12,350	6.5	21.5
8	95/80*	2,672	604	9,737	12,410	6.2	21.5
9	98 (Max-Tech)†	2,858	586	9,403	12,261	6.9	21.5

* The first number refers to the standard for large NWGFs; the second refers to the standard for small NWGFs. The input capacity threshold definitions for small NWGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 4: 60 kBtu/h
TSL 6: 55 kBtu/h
TSL 8: 55 kBtu/h.
** The first number refers to the efficiency level for the North; the second number refers to the efficiency level for the Rest of Country.

† Refers to national standards.
Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.6 Average LCC Savings Relative to the No-New-Standards Case for Non-Weatherized Gas Furnace AFUE Standards

TSL	AFUE %	Life-Cycle Cost Savings	
		Average LCC Savings (2015$)	Percentage of Consumers that Experience Net Cost
1	92/80*	676	2.1%
2	92/80*	730	4.7%
3	95/80**	597	6.7%
4	92/80*	741	6.6%
5	92†	617	17.1%
6	92/80*	692	11.1%
7	95†	561	22.2%
8	95/80*	609	15.2%
9	Max Tech†	506	34.2%

* The first number refers to the standard for large NWGFs; the second refers to the standard for small NWGFs. The input capacity threshold definitions for small NWGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 4: 60 kBtu/h
TSL 6: 55 kBtu/h
TSL 8: 55 kBtu/h
** The first number refers to the efficiency level for the North; the second number refers to the efficiency level for the Rest of Country.
† Refers to national standards.
Note: The savings represent the average LCC for affected consumers.

Table V.7 Average LCC and PBP Results for Mobile Home Gas Furnace AFUE Standards

TSL	AFUE (%)	Average Costs (2015$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1, 2, 4, 5, 6	92	1,667	698	10,924	12,591	1.7	21.5
3	95/80*	1,691	707	11,062	12,752	2.3	21.5
7, 8	95	1,800	680	10,643	12,443	2.7	21.5
9	96 (Max Tech)	1,846	677	10,599	12,445	3.1	21.5

* The first number refers to the efficiency level for the North; the second number refers to the efficiency level for the Rest of Country.

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.8 Average LCC Savings Relative to the No-New-Standards Case for Mobile Home Gas Furnace AFUE Standards

TSL	AFUE (%)	Life-Cycle Cost Savings	
		Average LCC Savings (2015$)	Percentage of Consumers that Experience Net Cost
1, 2, 4, 5, 6	92	1,049	8.2%
3	95/80*	1,275	5.0%
7, 8	95	1,020	13.8%
9	96 (Max Tech)	864	25.2%

* The first number refers to the efficiency level for the North; the second number refers to the efficiency level for the Rest of Country.
Note: The savings represent the average LCC for affected consumers.

Table V.9 Comparison of LCC Savings and PBP for Product Switching Scenarios for Non-Weatherized Gas Furnace AFUE Standards

TSL	Average LCC Savings				Simple Payback Period				% of Consumers Experiencing Net Cost			
	2015$				*Years*				*%*			
	No	Low	High	Ref.	No	Low	High	Ref.	No	Low	High	Ref.
1*	554	769	534	676	6.32	6.08	6.28	6.15	2.2%	2.0%	2.3%	2.1%
2*	561	801	610	730	6.28	5.91	6.16	5.99	5.2%	4.5%	5.0%	4.7%
3**	523	548	512	597	6.52	6.34	6.55	6.42	6.6%	6.5%	7.0%	6.7%
4*	575	794	649	741	6.27	5.87	6.09	5.93	7.2%	6.4%	6.9%	6.6%
5†	363	657	542	617	7.17	6.27	6.59	6.37	19.7%	16.8%	17.6%	17.1%
6*	476	730	620	692	6.60	6.00	6.23	6.07	12.7%	10.9%	11.5%	11.1%
7†	367	595	500	561	7.26	6.40	6.68	6.49	25.0%	21.8%	22.8%	22.2%
8*	451	641	550	609	6.70	6.11	6.33	6.18	16.9%	14.9%	15.8%	15.2%
9†	354	539	452	506	7.70	6.80	7.14	6.91	37.4%	33.6%	34.9%	34.2%

* Refers to TSLs with separate standards for small and large NWGFs. The input capacity threshold definitions for small NWGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 4: 60 kBtu/h
TSL 6: 55 kBtu/h
TSL 8: 55 kBtu/h
** Regional standards.
† Refers to national standards.
Note: The savings represent the average LCC for affected consumers. The PBP is measured relative to the baseline product. No means no switching scenario; Low means low switching scenario (2.5 year payback); High means high switching scenario (4.5 year payback); and Ref. means DOE's default switching case (3.5 year payback).

Table V.10 Average LCC and PBP Results for Non-Weatherized Gas Furnace Standby Mode and Off Mode Standards

TSL	Watts	Average Costs (2015$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1	9.5	2	10	152	153	1.2	21.5
2	9.2	17	10	147	164	9.1	21.5
3	8.5 (Max Tech)	18	9	135	154	7.0	21.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.11 Average LCC Savings Relative to the No-New-Standards Case for Mobile Home Gas Furnace Standby Mode and Off Mode Standards

TSL	Watts	Life-Cycle Cost Savings	
		Average LCC Savings* (2015$)	Percentage of Consumers that Experience Net Cost
1	9.5	22	2.4%
2	9.2	12	13.0%
3	8.5 (Max Tech)	19	8.1%

* The savings represent the average LCC for affected consumers.

Table V.12 Average LCC and PBP Results for Mobile Home Gas Furnace Standby Mode and Off Mode Standards

TSL	Watts	Average Costs (2013$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1	9.5	2	10	145	146	1.2	21.5
2	9.2	16	9	140	156	8.9	21.5
3	8.5 (Max Tech)	17	9	129	147	6.9	21.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.13 Average LCC Savings Relative to the No-New-Standards Case for Mobile Home Gas Furnace Standby Mode and Off Mode Standards

TSL	Watts	Life-Cycle Cost Savings	
		Average LCC Savings* (2015$)	Percentage of Consumers that Experience Net Cost
1	9.5	21	0.4%
2	9.2	12	1.0%
3	8.5 (Max Tech)	19	0.8%

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered AFUE TSLs on low-income households and senior-only households.[192] Table V.14 through Table V.15 compare the average LCC savings and simple PBP at each AFUE efficiency level for the two consumer subgroups, along with the average LCC savings for the entire consumer sample. Because the small furnace efficiency levels at TSLs 1, 2, 4, 6, and 8 and the Rest of Country efficiency level at TSL 3 are at the baseline, these tables only include results for large furnaces or the Northern region for these TSLs. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the SNOPR TSD presents the complete LCC and PBP results for the subgroups.

[192] DOE did not perform a subgroup analysis for the residential furnace standby mode and off mode efficiency levels. The standby mode and off mode analysis relied on the test procedure to assess energy savings for the considered standby mode and off mode efficiency levels. Because the analysis used the same test procedure parameters for all sample households, there is no difference in energy savings between the consumer subgroups and the full sample.

Table V.14 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households for Non-Weatherized Gas Furnace AFUE Standards

TSL	Average Life-Cycle Cost Savings (2015$)			Simple Payback Period (years)		
	Low-Income Households	Senior-Only Households	All Households	Low-Income Households	Senior-Only Households	All Households
1*	505	793	676	6.8	6.8	6.1
2*	572	750	730	5.7	5.7	6.0
3**	458	657	597	7.4	5.9	6.4
4*	647	905	741	5.7	5.7	5.9
5†	476	775	617	6.0	6.0	6.4
6*	611	890	692	5.7	5.7	6.1
7†	482	692	561	6.0	6.0	6.5
8*	592	770	609	5.7	5.7	6.2
9†	554	662	506	6.1	6.1	6.9

* Refers to TSLs with separate standards for small and large NWGFs. The input capacity threshold definitions for small NWGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 4: 60 kBtu/h
TSL 6: 55 kBtu/h
TSL 8: 55 kBtu/h
** Regional standards.
† Refers to national standards.
Note: The savings represent the average LCC for affected consumers. The PBP is measured relative to the baseline product.

Table V.15 Comparison of LCC Savings and PBP for Consumer Subgroups and All Households for Mobile Home Gas Furnace AFUE Standards

	Average Life-Cycle Cost Savings (2015$)			Simple Payback Period (years)		
TSL	Low-Income Households	Senior-Only Households	All Households	Low-Income Households	Senior-Only Households	All Households
1, 2, 4, 5, 6	771	642	1,049	3.0	3.3	1.7
3	1,344	1,040	1,275	3.3	3.4	2.3
3, 7, 8	782	609	1,020	4.0	4.5	2.7
9	649	486	864	4.4	5.0	3.1

Note: The savings represent the average LCC for affected consumers. The PBP is measured relative to the baseline product.

c. Rebuttable Presumption Payback Period

As discussed in section III.E.2, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. (42 U.S.C. 6295(o)(2)(B)(iii)) In calculating a rebuttable presumption payback period for each of the considered TSLs for NWGFs and MHGFs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedure for residential furnaces and boilers. Id. In contrast, the PBPs presented in section V.B.1.a of this SNOPR were calculated using distributions that reflect the range of energy use in the field.

Table V.16 and Table V.17 present the rebuttable-presumption payback periods for the considered AFUE and standby mode/off mode TSLs for NWGFs and MHGFs, respectively. The payback periods for all MHGF AFUE TSLs meet the rebuttable-presumption criterion, but the NWGF AFUE TSLs do not. While DOE examined the rebuttable-presumption criterion, DOE routinely conducts an economic analysis that considers the full range of impacts to the consumer, manufacturer, Nation, and environment under 42 U.S.C. 6295(o)(2)(B)(i). The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V.16 Rebuttable-Presumption Payback Periods (Years) for NWGF and MHGF AFUE Standards

TSL	Non-Weatherized Gas Furnaces	Mobile Home Gas Furnaces
1	3.28	0.91
2	3.56	0.91
3	3.08	1.50
4	3.65	0.91
5	3.88	0.91
6	3.74	0.91
7	4.03	1.43
8	3.89	1.43
9	4.45	1.50

Table V.17 Rebuttable-Presumption Payback Periods (years) for NWGF and MHGF Standby Mode and Off Mode Standards

TSL	Standby and Off Mode Electrical Power Consumption (Watts)	Non-Weatherized Gas Furnaces	Mobile Home Gas Furnaces
1	9.5	1.33	1.20
2	9.2	9.99	9.01
3	8.5	7.71	6.95

2. Economic Impacts on Manufacturers

DOE performed a manufacturer impact analysis to estimate the impact of an amended energy conservation standard on manufacturers of NWGFs and MHGFs. The following section describes the expected impacts on manufacturers at each analyzed TSL. DOE discusses the potential impacts of AFUE and standby mode/off mode standards independently. Chapter 12 of the SNOPR TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. Table V.18 through Table V.21 present the financial impacts of analyzed standards on NWGF and MHGF manufacturers represented by changes in INPV and free cash flow in the year before the standard takes effect as well by the conversion costs that DOE estimates NWGF and MHGF manufacturers would incur at each TSL. To evaluate the range of cash-flow impacts on the NWGF and MHGF industry, DOE modeled three markup scenarios that correspond to the range of anticipated market responses to amended standards. For AFUE standards, DOE modeled a preservation of gross margin markup scenario and a tiered markup scenario. For standby mode and off mode standards, DOE modeled a preservation of gross margin markup scenario and a per-unit preservation of operating profit markup scenario. Each scenario results in a unique set of cash flows and corresponding industry values at each TSL.

In the following discussion, the INPV results refer to the difference in INPV between the no-new-standards case and the standards cases, calculated by summing discounted cash flows from the reference year (2016) through the end of the analysis period (2051). Changes in INPV reflect the potential impacts on the value of the industry over the course of the analysis period as a result of implementing a particular TSL. The results also discuss the difference in cash flows between the no-new-standards case and the standards cases in the year before the compliance date for analyzed standards (2021). This difference in cash flow represents the size of the required conversion costs relative to the cash flow generated by the NWGF and MHGF industry in the absence of amended energy conservation standards.

To assess the upper (less severe) bound of the range of potential impacts on NWGF and MHGF manufacturers, DOE modeled a preservation of gross margin markup scenario. This scenario assumes that in the standards cases, manufacturers would be able to fully pass on higher production costs required to produce more-efficient products to their consumers (i.e., absolute dollar markup would increase). Specifically, the industry would be able to maintain its average no-new-standards case gross margin (as a percentage of revenue) despite the higher product costs in the standards cases and upfront investments to bring products into compliance. DOE assumed the nonproduction cost markup – which includes SG&A expenses, research and development expenses, interest, and profit – to be 1.34 for NWGFs and 1.27 for MHGFs. These markups are consistent with the markups used in the engineering analysis. Typically, as product's price increases as a result of a standard, the less likely manufacturers are to maintain their gross margin percentage. It is unlikely to maintain the gross margin percentage because manufacturers would be fully marking up more expensive products, resulting in significantly higher consumer prices. Therefore, DOE assumes that this scenario represents the upper bound of industry profitability under an amended energy conservation standard.

To assess the lower (more severe) bound of the range of potential impacts of AFUE standards on NWGF and MHGF manufacturers, DOE modeled the tiered markup scenario. DOE implemented the tiered markup scenario because multiple manufacturers stated in interviews that they offer multiple tiers of product lines that are differentiated, in part, by efficiency level. The higher efficiency tiers typically earn premiums (for the manufacturer) over the baseline efficiency tier. Several manufacturers suggested that amended standards would lead to a reduction in premium markups and would reduce the profitability of higher efficiency products. During the MIA interviews, manufacturers provided information on the range of typical ELs in those tiers and the change in profitability at each level. DOE used this information to estimate markups for NWGFs and MHGFs under a tiered pricing strategy in the no-standards case. In the standards cases, DOE modeled the situation in which standards result in less product differentiation, compression of the markup tiers, and an overall reduction in profitability.

To assess the lower (more severe) bound of the range of potential impacts of standby mode and off mode standards on NWGF and MHGF manufacturers, DOE modeled a per-unit preservation of operating profit markup scenario. In this scenario, manufacturer markups are set so that operating profit one year after the compliance date of amended energy conservation standards (2022) is the same as in the no-new-standards case on a per-unit basis. Under this scenario, manufactures do not earn additional operating profit from increased manufacturer production costs and conversion costs incurred as a result of standards but are able to maintain the same operating profit that was earned in the no-new-standards case.

Cash-Flow Analysis Results for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces AFUE Standards.

Table V.18 and Table V.19 present the financial impacts of the analyzed AFUE standards on NWGF and MHGF manufacturers. These impacts are represented by changes in INPV and free cash flow (FCF) in the year before the standard (2021) as well as by the conversion costs that DOE estimates NWGF and MHGF manufacturers would incur at each TSL.

Table V.18 Manufacturer Impact Analysis: AFUE Standards Results for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces - Preservation of Gross Margin Percentage Markup Scenario

	Units	No-New-Standards Case	Trial Standard Level			
			1	2	3	4
INPV	2015$ millions	1,104.3	1,097.0	1,101.7	1,104.6	1,119.2
Change in INPV	2015$ millions	-	(7.3)	(2.7)	0.3	14.8
	%	-	(0.7)	(0.2)	0.0	1.3
FCF (2021)	2015$ millions	69.3	56.8	52.8	43.4	50.7
Change in FCF	%	-	(18.0)	(23.8)	(37.4)	(26.9)
Product Conversion Costs	2015$ millions	-	18.2	18.2	26.9	18.2
Capital Conversion Costs	2015$ millions	-	15.9	24.8	40.1	29.5
Total Conversion Costs	2015$ millions	-	34.1	43.0	67.0	47.8

	Units	Trial Standard Level				
		5	6	7	8	9
INPV	2015$ millions	1,118.0	1,142.8	1,126.8	1,147.1	1,100.0
Change in INPV	2015$ millions	13.7	38.5	22.5	42.8	(4.3)
	%	1.2	3.5	2.0	3.9	(0.4)
FCF (2021)	2015$ millions	44.3	47.6	25.1	31.2	(66.0)
Change in FCF	%	(36.0)	(31.4)	(63.7)	(55.0)	(195.2)
Product Conversion Costs	2015$ millions	18.2	18.2	26.9	26.9	77.4
Capital Conversion Costs	2015$ millions	43.7	36.5	80.7	67.3	250.4
Total Conversion Costs	2015$ millions	61.9	54.7	107.6	94.2	327.9

Note: Parentheses indicate negative values.

Table V.19 Manufacturer Impact Analysis: AFUE Standards Results for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces - Three-Tier Markup Scenario

	Units	No-New-Standards Case	Trial Standard Level			
			1	2	3	4
INPV	2015$ millions	1,104.3	1,031.6	1,005.8	846.8	1,007.0
Change in INPV	2015$ millions		(72.8)	(98.5)	(257.6)	(97.4)
	%		(6.6)	(8.9)	(23.3)	(8.8)
FCF (2021)	2015$ millions	69.3	56.8	52.8	43.4	50.7
Change in FCF	%	-	(18.0)	(23.8)	(37.4)	(26.9)
Product Conversion Costs	2015$ millions	-	18.2	18.2	26.9	18.2
Capital Conversion Costs	2015$ millions	-	15.9	24.8	40.1	29.5
Total Conversion Costs	2015$ millions	-	34.1	43.0	67.0	47.8

	Units	Trial Standard Level				
		5	6	7	8	9
INPV	2015$ millions	985.2	1,016.4	729.2	771.6	526.5
Change in INPV	2015$ millions	(119.2)	(88.0)	(375.2)	(332.8)	(577.9)
	%	(10.8)	(8.0)	(34.0)	(30.1)	(52.3)
FCF (2021)	2015$ millions	44.3	47.6	25.1	31.2	(66.0)
Change in FCF	%	(36.0)	(31.4)	(63.7)	(55.0)	(195.2)
Product Conversion Costs	2015$ millions	18.2	18.2	26.9	26.9	77.4
Capital Conversion Costs	2015$ millions	43.7	36.5	80.7	67.3	250.4
Total Conversion Costs	2015$ millions	61.9	54.7	107.6	94.2	327.9

Note: Parentheses indicate negative values.

At TSL 1, DOE estimates the change in INPV to range from -$72.8 million to -7.3 million, or a change of -6.6 percent to -0.7 percent. At this level, industry free cash flow in 2021 (the year before the compliance date) is estimated to decrease to $56.8 million, or a decrease of 18.0 percent compared to the no-new-standards case value of $69.3 million.

TSL 1 represents a national standard set at 92-percent AFUE for large NWGFs and all MHGFs, while small NWGFs remain at the current Federal minimum of 80-percent AFUE. At TSL 1, small NWGFs are defined as NWGFs with input capacities of 80 kBtu/hr or lower, which accounts for approximately 58 percent of NWGF shipments. Before the standard year, approximately 52 percent of NWGF shipments and ten percent of MHGF shipments are expected to be sold at condensing levels. At TSL 1, an additional 16 percent of NWGF shipments and 90 percent of MHGF shipments will be sold at condensing levels, requiring the industry to expand its production of secondary heat exchanger. In total, 19 percent of NWGF shipments and 90 percent of MHGF shipments would need to add a secondary heat exchanger or an increase in overall heat exchanger surface area in order to meet standards at TSL 1. Manufacturers will incur $15.9 million in capital conversion costs as manufacturers increase secondary heat exchanger production line capacity. Total conversion costs are expected to be $34.1 million for the industry.

TSLs 1, 2, 4, and 6 represent national standards set at 92-percent AFUE for large NWGFs and all MHGFs, while small NWGFs remain at the current Federal minimum of 80-percent AFUE. However, the capacity threshold used to classify small NWGFs changes at each TSL. Small NWGF furnaces are defined as units having an input capacity of 70 kBtu/hr or greater at TSL 2, 60 kBtu/hr or greater at TSL 4, and 55 kBtu/hr or greater at TSL 6. As the capacity threshold decreases from 80 kBtu/hr at TSL 1 down to 55 kBtu/hr at TSL 6, the number of NWGF shipments classified as large NWGFs, and subsequently the portion of shipments that must be condensing after the standard year, increases. Capital conversion costs increase as manufacturers add additional capacity to their secondary heat exchanger production lines. Capital conversion costs scale with the increased volume of shipments that require additional heat exchanger surface area. Manufacturers would also incur product conversion costs as they invest resources to develop cost-optimized 92-percent AFUE models that are competitive at lower price points. Manufacturers are expected to incur $18.2 million in product conversion costs at TSLs 1, 2, 4 and 6.

Furthermore, with a national standard of 92-percent AFUE for large NWGFs and all MHGFs, the industry would face some compression of markups. However, DOE believes industry would still able to maintain three tiers of markups, with efficiency as one differentiating attribute, in a market where the national standard is 92-percent AFUE. DOE characterizes these markups as “good,” “better,” and “best,” which correspond to 92-percent AFUE, 95-percent AFUE, and 98-percent AFUE, respectively.

At TSL 2, DOE estimates the change in INPV to range from -$98.5 million to -$2.7 million, or a change in INPV of -8.9 percent to -0.2 percent. At this level, free cash flow in 2021 is estimated to decrease to $52.8 million, or a decrease of 23.8 percent compared to the no-new-standards-case value of $69.3 million in the year 2021.

TSL 2 represents a national standard at 92-percent AFUE for large NWGFs and all MHGFs, while small NWGFs remain at the current federal minimum of 80-percent AFUE. Small NWGFs are defined as NWGFs with input capacities of 70 kBTU/hr or less and make up 31 percent of NWGF shipments. At TSL 2, an additional 29 percent of the NWGF market and an additional 90 percent of MHGF market moves from non-condensing to condensing efficiencies. In total, 33 percent of NWGF shipments and 90 percent of MHGF shipments would need to include secondary heat exchangers or increased overall heat exchanger surface area. Capital conversion costs increase from $15.9 million at TSL 1 to $24.8 million at TSL 2, as manufacturers increase secondary heat exchanger production line capacity. Total conversion costs are expected to be $43.0 million at TSL 2.

At TSL 3, DOE estimates the change in INPV to range from -$257.6 million to $0.3 million, or a change in INPV of -23.3 percent to an increase of less than one percent. At this level, free cash flow is estimated to decrease to $43.4 million, or a decrease of 37.4 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 3 represents a regional standard set at 95-percent AFUE for products sold in the North and 80-percent AFUE for products sold in the Rest of the Country. TSL 3 does not have a small furnace capacity threshold. At TSL 3, relative to the no-new-standards case, an additional 48 percent of NWGF shipments and 90 percent of MHGF shipments would shift to condensing levels and need a secondary heat exchanger. In total at TSL 3, 74 percent of NWGF shipments and 45 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Capital conversion costs are modeled to escalate from $24.8 million at TSL 2 to $40.1 million at TSL 3. Product conversion costs increase significantly from $18.2 million at TSLs 1 and 2 to $26.9 million at TSL 3, as manufacturers develop cost-optimized 95-percent AFUE large NWGF and MHGF models that are competitive at reduced markups. Total industry conversion costs would be expected to reach $67.0 million at TSL 3.

For products sold in the North that must achieve 95-percent AFUE, the industry faces a compression of markups that is particularly acute. Today, 95-percent AFUE products are premium offerings that can garner a significantly higher markup than baseline products. At TSL 3, 95-percent AFUE products become the minimum efficiency offering and would no longer command the same premium markups in the North. Furthermore, there is limited opportunity to differentiate product offerings based on efficiency. DOE models the industry as compressing from three tiers today (good, better, and best) to only having two tiers (good and better) of markups for products sold in the North at TSL 3.

At TSL 4, DOE estimates the change in INPV to range from -$97.4 million to $14.8 million, or a change in INPV of -8.8 percent to 1.3 percent. At this level, free cash flow is estimated to decrease to $50.7 million, or a decrease of 26.9 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 4 represents a national standard at 92-percent AFUE for large NWGFs and all MHGFs, while small NWGFs remain at the current Federal minimum of 80-percent AFUE. Small NWGFs are defined as NWGFs with input capacities of 60 kBTU/hr or less and make up 20 percent of NWGF shipments. At TSL 4, 40 percent of NWGF shipments and 90 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Capital conversion costs would increase from $24.8 million at TSL 2, the previous TSL with a national 92-percent AFUE standard and a capacity threshold for small furnaces, to $29.5 million at TSL 4 as manufacturers increase secondary heat exchanger production line capacity. Manufacturers would also incur product conversion costs driven by the development necessary to create compliant, cost-competitive products. Total industry conversion costs would be expected to reach $47.8 million at TSL 4. At 92-percent AFUE, DOE models the industry as maintaining three tiers of product in the tiered markup scenario.

At TSL 5, DOE estimates the change in INPV to range from -$119.2 million to $13.7 million, or a change in INPV of -10.8 percent to 1.2 percent. At this level, free cash flow is estimated to decrease to $44.3 million, or a decrease of 36.0 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 5 represents a national 92-percent AFUE standard where all covered NWGFs and all MHGFs are required to achieve 92-percent AFUE. TSL 5 does not have a small furnace capacity threshold. At TSL 5, 54 percent of NWGF shipments and 90 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Markups at TSL 5 are reduced, but the industry is still able to maintain three tiers of markups. Manufacturers would incur product conversion costs of $18.2 million at TSL 5, as manufacturers develop cost-optimized 92-percent AFUE large NWGF and MHGF models that are competitive at reduced markups. Capital conversion costs would total $43.7 million at TSL 5, as manufacturers add production capacity to have secondary heat exchangers for all NWGF and MHGF shipments sold into the domestic market.

TSLs 5, 7, and 9 represent national standards for all covered NWGFs and all MHGFs. In these TSLs, there is no separate standard level based on furnace input capacity. As the TSL increases from 5 to 9, the national standard increases, and DOE models a compression of markups in the tiered markup scenario. Compressed markups are significant driver of negative impacts to INPV in the tiered markup scenario.

At TSL 6, DOE estimates the change in INPV to range from -$88.0 million to $38.5 million, or a change in INPV of -8.0 percent to 3.5 percent. At this level, free cash flow is estimated to decrease to $47.6 million, or a decrease of 31.4 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 6 represents a national standard set at 92-percent AFUE for large NWGFs and all MHGFs, while small NWGFs remain at the current Federal minimum of 80-percent AFUE. Small NWGFs are defined as units with input capacities of 55 kBTU/hr or less and make up ten percent of NWGF shipments. At this level, 52 percent of NWGF shipments and 90 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Capital conversion costs would increase from $29.5 million at TSL 4, the previous TSL with a national 92-percent AFUE standard and a capacity threshold for small furnaces, to $36.5 million at TSL 6 as manufacturers increase secondary heat exchanger production line capacity. Manufacturers will also incur product conversion costs driven by the development necessary to create compliant, cost-competitive products. DOE estimates total industry conversion costs could reach $54.7 million at TSL 6. DOE expects the industry to be able to maintain three tiers of markups with efficiency as a differentiator at TSL 6.

At TSL 7, DOE estimates the change in INPV to range from -$375.2 million to $22.5 million, or a change in INPV of -34.0 percent to 2.0 percent. At this level, free cash flow is estimated to decrease to $25.1 million, or a decrease of 63.7 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 7 represents a national 95 percent AFUE standard for all covered NWGFs and all MHGFs. TSL 7 does not have a small capacity threshold. At TSL 7, 74 percent of NWGF shipments and 96 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Capital conversion costs would increase to $80.7 million at TSL 7. Total industry conversion costs could reach $107.6 million.

As 95 percent AFUE would become the baseline product efficiency, 98-percent AFUE products would become the only higher-efficiency products available on the market and manufacturers are unable to maintain three tiers of markups differentiated by efficiency. DOE models the industry as compressing from 3 tiers today (good, better, and best) to only having two tiers (good and better) at this level. Deterioration of premium markups and loss of product differentiation would have significant effects on industry profitability, and increases in industry conversion costs would be expected to result in a significant jump in INPV losses at TSL 7. Product conversion costs would total $26.9 million at TSL 7, as manufacturers develop cost-optimized 95-percent AFUE large NWGF and MHGF models that are competitive at reduced markups.

At TSL 8, DOE estimates the change in INPV to range from -$332.8 million to $42.8 million, or a change in INPV of -30.1 percent to 3.9 percent. At this level, free cash flow is estimated to decrease to $31.2 million, or a decrease of 55.0 percent compared to the no-new-standards case value of $69.3 million in the year 2021.

TSL 8 represents a national 95-percent AFUE standard for large NWGFs and all MHGFs, while small NWGFs remain at the current Federal minimum of 80-percent AFUE. At TSL 8, small NWGFs are defined as NWGFs with input capacities of 55 kBTU/hr or less and make up ten percent of NWGF shipments. At this level, 65 percent of NWGF shipments and 96 percent of MHGF shipments would need to include a secondary heat exchanger or increased overall heat exchanger surface area. Capital conversion costs would be expected to increase significantly to $67.3 million at TSL 8. Manufacturers would also incur product conversion costs, driven by the development necessary to create compliant, cost-competitive products. Total conversion costs could reach $94.2 million.

For large NWGFs, 98-percent AFUE products would become the only higher-efficiency products available on the market, and manufacturers would be unable to maintain three tiers of markups differentiated by efficiency. While manufacturers would still able to maintain three tiers of markups in the small capacity NWGF product classes, the vast majority of shipments would be sold at a reduced markup. For large NWGFs and MHGFs, DOE models the industry as compressing from 3 tiers today (good, better, and best) to two tiers (good and best). The reduction in premium product offerings and deterioration of markups coupled with increased conversion costs would be expected to result in a significant negative change in INPV at TSL 8.

At TSL 9, DOE estimates the change in INPV to range from -$577.9 million to -$4.3 million, or a change in INPV of -52.3 percent to -0.4 percent. At this level, free cash flow is estimated to decrease to -$66.0 million, or a decrease of 195.2 percent compared to the no-new-standards case value of $69.3 million in the year 2021. TSL 9 represents the max-tech standard level.

TSL 9 represents a national max-tech standard, where all product classes must achieve 98-percent AFUE. Less than 1 percent of NWGFs and MHGFs are sold at this level today. With a 98-percent AFUE standard, nearly all models must be redesigned. Manufacturers would incur $77.4 million in product conversion costs as they develop cost-optimized 98-percent AFUE large NWGF and MHGF models that are competitive with significantly reduced markups at this TSL. Manufacturers would also incur capital conversion costs of $250.4 million as manufacturers add the production capacity necessary to produce all NWGFs and MHGFs sold into the domestic market with 98-percent AFUE. Total conversion costs would be expected to reach $327.9 million for the industry.

Some manufacturers expressed great concern about the state of technology at max-tech. Specifically, those manufacturers had concerns about the ability to deliver cost-effectiveness of these products for their customers at such a high efficiency level. They also cited high conversion costs and large investment in R&D to produce all products at this level. Furthermore, manufacturers would lose efficiency as a differentiator between baseline and premium product offerings.

DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each AFUE standard TSL.

Cash-Flow Analysis Results for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Standby Mode and Off Mode Standards

Table V.20 and Table V.21 present the financial impacts of standby mode and off mode standards on NWGF and MHGF manufacturers. These impacts are represented by changes in INPV and free cash flow (FCF) in the year before the standard (2021) as well as by the conversion costs that DOE estimates NWGF and MHGF manufacturers would incur at each TSL. The impacts of standby mode and off mode features were analyzed for the same product classes as the amended AFUE standards, but at different efficiency levels, which correspond to a different set of technology options for reducing standby mode and off mode energy consumption. Therefore, the TSLs in the standby mode and off mode analysis do not correspond to the TSLs in the AFUE analysis.

DOE considered the impacts of standby mode and off mode features under two markup scenarios to represent the upper and lower bounds of industry impacts: (1) a preservation of gross margin percentage scenario, and (2) a per-unit preservation of operating profit scenario. The preservation of gross margin percentage scenario represents the upper bound of impacts (less severe), while the preservation of per-unit operating profit scenario represents the lower bound of impacts (more severe).

Table V.20. Manufacturer Impact Analysis: Standby Mode and Off Mode Standards Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standards - Preservation of Gross Margin Percentage Markup Scenario

	Units	No-New-Standards Case	Trial Standard Level		
			1	2	3
INPV	2015$ millions	1,104.3	1,104.1	1,108.5	1,110.1
Change in INPV	2015$ millions	-	(0.2)	4.1	5.7
	%	-	(0.0)	0.4	0.5
Product Conversion Costs	2015$ millions	-	1.5	1.6	2.1
FCF (2021)	2015$ millions	69.3	68.9	68.8	68.7
Change in FCF	%	-	(0.6)	(0.7)	(0.9)
Capital Conversion Costs	2015$ millions	-	-	-	-
Total Conversion Costs	2015$ millions	-	1.5	1.6	2.1

Note: Parentheses indicate negative values.

Table V.21. Manufacturer Impact Analysis: Standby Mode and Off Mode Standards Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standards – Per-Unit Preservation of Operating Profit Scenario

	Units	No-New-Standards Case	Trial Standard Level		
			1	2	3
INPV	2015$ millions	1,104.3	1,104.1	1,101.8	1,100.9
Change in INPV	2015$ millions		(0.2)	(2.5)	(3.4)
	%		(0.0)	(0.2)	(0.3)
FCF (2021)	2015$ millions	69.3	68.9	68.8	68.7
Change in FCF	%	-	(0.6)	(0.7)	(0.9)
Product Conversion Costs	2015$ millions		1.5	1.6	2.1
Capital Conversion Costs	2015$ millions		-	-	-
Total Conversion Costs	2015$ millions		1.5	1.6	2.1

Note: Parentheses indicate negative values.

At TSL 1, DOE estimates impacts on INPV for NWGF and MHGF manufacturers to decrease by less than one percent in both markup scenarios (preservation of gross margin and per-unit preservation of operating profit). At this potential standard level, industry free cash flow is estimated to decrease by less than one percent compared to the no-new-standards case value of $69.3 million in 2021. DOE expects conversion costs for standby mode and off mode to be $1.5 million.

At TSL 2, DOE estimates impacts on INPV for NWGF and MHGF manufacturers to range from a decrease of less than one percent to an increase of less than one percent. At this potential standard level, industry free cash flow is estimated to decrease by less than one percent compared to the no-new-standards case value of $69.3 million in 2021. DOE expects conversion costs for standby mode and off mode to be $1.6 million.

At TSL 3, DOE estimates impacts on INPV for NWGF and MHGF manufacturers to range from a decrease of less than one percent to an increase of less than one percent. At this potential standard level, industry free cash flow is estimated to decrease by less than one percent compared to the no-new-standards case value of $69.3 million in 2021. DOE expects conversion costs for standby mode and off mode to be $2.1 million.

DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each standby mode and off mode TSL.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the NWGF and MHGF industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. DOE used statistical data from the U.S. Census Bureau's 2014 Annual Survey of Manufacturers,[193] the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic direct employment levels. Labor expenditures related to manufacturing of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms throughout the analysis period. The total labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of MPCs.

The total labor expenditures in the GRIM were then converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the U.S. Census Bureau's 2014 Annual Survey of Manufacturers). The production worker estimates in this section only cover workers up to the line-supervisor level who are directly involved in fabricating and assembling a product within an original equipment manufacturer (OEM) facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking. The total direct employment impacts calculated in the GRIM are represented by changes in the total number of production workers between the no-new-standards case and the standards

[193] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (2014) (Available at http://www.census.gov/manufacturing/asm/index.html).

cases for NWGFs and MHGFs. Table V.22 shows the range of potential impacts of potential amended energy conservation standards on U.S. production workers involved in the manufacturing of NWGFs and MHGFs.

Table V.22 Potential Changes in the Total Number of Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Production Workers in 2022

	Trial Standard Level				
	No-New-Standards Case	1	2	3	4
Potential Domestic Production Workers in 2022	1,709	1,709 to 1,770	1,709 to 1,799	1,709 to 1,825	1,709 to 1,867
Potential Change in Domestic Production Workers in 2022*	-	(1,709) to 61	(1,709) to 90	(1,709) to 116	(1,709) to 158

	Trial Standard Level				
	5	6	7	8	9
Total Number of Domestic Production Workers in 2022 (without changes in production locations)	1,709 to 1,936	1,709 to 1,952	1,709 to 1,918	1,709 to 1,942	1,709 to 2,654
Potential Changes in Domestic Production Workers in 2022*	(1,709) to 227	(1,709) to 243	(1,709) to 209	(1,709) to 233	(1,709) to 945

Note: Numbers in parentheses indicate negative values.

In the absence of amended energy conservation standards, DOE estimates that the residential furnace industry would employ 1,709 domestic production workers in 2022. The upper end of the range estimates an increase in the number of domestic workers producing NWGF and MHGF after implementation of an amended energy conservation standard at each TSL. It assumes manufacturers would continue to produce the same scope of covered products within the United States and would require some additional labor to produce more-efficient products. To establish a conservative lower bound, DOE assumes the entire industry shifts production to foreign countries. Some large manufacturers are currently producing covered products in countries with lower labor costs, and an amended standard that necessitates large increases in labor content or large expenditures to re-tool facilities could cause other manufacturers to re-evaluate production siting options.

DOE notes that its estimates of the impacts on direct employment are based on the analysis of amended AFUE energy conservation standards only. Standby mode and off mode technology options considered in the engineering analysis would result in component swaps, which would not make the product significantly more complex and would not be difficult to implement. While some product development effort would be required, DOE does not expect the standby mode and off mode standard to significantly affect the amount of labor required in production. Therefore, DOE did not conduct a quantitative domestic manufacturing employment impact analysis for the proposed standby mode and off mode standards.

These employment impact conclusions are independent of conclusions regarding indirect employment impacts in the broader United States economy, which are discussed in chapter 15 of the SNOPR TSD.

c. Impacts on Manufacturing Capacity

According to manufacturer feedback, current production facilities may not be able to accommodate a large shift to condensing NWGFs, if such shift were required by an amended energy conservation standard. However, manufacturers would be able to add capacity and adjust product designs in the five year period between the announcement year of the standard and the compliance year of the standard. DOE interviewed manufacturers representing over 50 percent of industry sales. None of the interviewed manufacturers expressed concern over the industry's ability increase the capacity of production lines that meet required efficiency levels at TSLs 1 through 8 to meet consumer demand. At TSL 9, technical uncertainty was expressed by manufacturers that do not offer 98-percent AFUE products today, as they were unsure of what production lines changes would be needed to meet an amended standard set at max-tech.

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop an industry cash-flow estimate is not adequate for assessing differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost structure that differs substantially from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Specifically, DOE identified small businesses as a manufacturer subgroup that it believes could be disproportionally impacted by energy conservation standards and would require a separate analysis in the MIA. DOE did not identify any other adversely impacted manufacturer subgroups for this rulemaking based on the results of the industry characterization.

DOE analyzes the impacts on small businesses in a separate analysis in section VI.B of this SNOPR as part of the Regulatory Flexibility Analysis. In summary, the

Small Business Administration (SBA) defines a “small business” as having 1,250 employees or less for NAICS 333415, “Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.” Based on this identification, DOE found three domestic manufacturers in the industry that qualify as a small business. For a discussion of the impacts on the small business manufacturer subgroup, see the Regulatory Flexibility Analysis in section VI.B of this SNOPR and chapter 12 of the SNOPR TSD.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several recent or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. Multiple regulations affecting the same manufacturer can strain profits and can lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For the cumulative regulatory burden analysis, DOE examines other regulations that could affect NWGF and MHGF manufacturers that will take effect approximately three years before or after the 2022 compliance date or during the period between publication of the amended energy conservation standards for NWGF and MHGF and when compliance with such standards is required. In interviews, manufacturers cited Federal regulations on equipment other than NWGF and MHGF that contribute to their cumulative regulatory burden. The compliance years and expected industry conversion costs of relevant energy conservation standards are presented in Table V.23.

Table V.23 Compliance Dates and Expected Conversion Costs of Federal Energy Conservation Standards Affecting Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Manufacturers

Federal Energy Conservation Standards	Number of Manufacturers*	Number of Manufacturers from Today's Rule Affected**	Approx. Standards Year	Industry Conversion Costs	Industry Conversion Costs / Revenue***
Commercial Packaged Boilers† 81 FR 15835 (March 24, 2016)	45	2	2019	$27.5M (2014$)	2.3%
Commercial Water Heaters† 81 FR 34440 (May 31, 2016)	25	2	2019	$29.8M (2014$)	3.0%
Furnace Fans 79 FR 38129 (July 3, 2014)	38	13	2019	$40.6M (2013$)	1.6%
Residential Boilers 81 FR 2320 (January 15, 2016)	27	2	2021	$2.5M (2014$)	<1 %
Central Air Conditioners and Heat Pumps† 80 FR 52206 (August 25, 2015)	30	10	2023	342.6 (2015$)	<1%
Commercial Warm Air Furnaces 81 FR 2420 (January 15, 2016)	16	8	2023	$7.5M to $22.2M (2014$)	1.7% to 5.1%††
Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment 81 FR 2420 (January 15, 2016)	29	9	2018 and 2023‡	$520.8M (2014$)	4.9%

*This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.

**This column presents the number of manufacturers producing NWGF and MHGF that are also listed as manufacturers in the energy conservation standard contributing to cumulative regulatory burden.

***This column presents conversion costs as a percentage of cumulative revenue for the industry during the conversion period. The conversion period is the timeframe over which manufacturers must make conversion cost investments and lasts from the announcement year of the final rule to the year before the standards year of the final rule. This period typically ranges from 3 to 5 years, depending on the energy conservation standard.

†The final rule for this energy conservation standard has not been published. The compliance date and analysis of conversion costs have not been finalized at this time. Listed values are based on the proposed rule.
††Low and high conversion cost scenarios were analyzed as part of this Direct Final Rule. The range of estimated conversion expenses presented here reflects those two scenarios.
‡The direct final rule for Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment adopts an amended standard in 2018 and a higher amended standard in 2023. The conversion costs are spread over an eight-year conversion period ending in 2022, with over eighty percent of the conversion costs occurring between 2019 and 2022.

In addition to the Federal energy conservation standards listed in Table V.23, there are multiple appliance standards in progress that do not yet have a proposed rule or final rule. The compliance date, manufacturer lists, and analysis of conversion costs are not available at this time. These appliance standards include: Commercial Industrial Fans and Blowers, Residential Clothes Dryers, Residential Water Heaters, and Room Air Conditioners.

As noted in Table V.23, DOE published a final rule for energy conservation standards for furnace fans. 79 FR 38130 (July 3, 2014). For several reasons, the furnace fan rule creates a unique cumulative regulatory burden for manufacturers of NWGFs and MHGs. First, both today's SNOPR and the energy conservation standards furnace fan final rule both directly impact the design and manufacture of NWGFs and MHGFs. The two rulemakings affect products that share a common revenue stream. Second, all NWGF and MHGF manufacturers are affected by the July 2014 furnace fan final rule. Third, these requirements have effective dates within a short period of time, 2019 for furnace fans and 2022 for NWGFs and MHGFs. Fourth, the design changes resulting from this SNOPR are additive to the design changes needed to meet the furnace fan standard. In analyzing the combined impact of the two rules, DOE expects that the full costs of each rule will be incurred, with limited opportunity for cost savings to be achieved through coordinating the expenditures of the two rules.

DOE believes that manufacturers will likely redesign NWGFs to incorporate BPM motors and multi-staging technology, and redesign MHGFs to incorporate improved PSC motors. The furnace fan rule will lead to higher production costs and may require upfront investment by NWGF and MHGF manufacturers. The production cost and conversion cost impacts from the furnace fan rule and from today's rule are cumulative. To account for this in the GRIM, DOE incorporated relevant conversion costs from the furnace fan rule that occur between 2015 and 2019. Additionally, DOE accounts for the increase in MPCs and changes in working capital when the furnace fan standards goes into effect in 2019. Additional detail is provided in chapter 12 of the TSD.

DOE requests comments on the identified regulations and their contribution to cumulative regulatory burden. Additionally, DOE requests feedback on product-specific Federal regulations that take effect between 2017 and 2025 that were not listed, including identification of the specific regulations and data quantifying the associated burdens.

3. National Impact Analysis

This section presents DOE's estimates of the national energy savings and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended AFUE standards, as well as from each of the TSLs considered as potential standards for standby mode and off mode.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for NWGFs and MHGFs, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended or new standards (2022-2051). Table V.24 presents DOE's projections of the primary and FFC national energy savings for each AFUE TSL considered for NWGFs and MHGFs. National energy savings were calculated using the approach described in section IV.H of this notice.

Table V.24 Potential AFUE Standards: Cumulative National Energy Savings for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051 (Quads)

Energy Savings	Trial Standard Level								
	1	2	3	4	5	6	7	8	9
Primary energy	0.77	1.51	1.53	1.95	2.17	2.40	3.37	3.52	4.66
FFC energy	0.88	1.75	1.81	2.27	2.78	2.86	4.17	4.15	5.72

For the proposed standards (TSL 6), the FFC energy savings of 2.86 quads is the the FFC natural gas savings (5.10 quads) minus the increase in FFC energy use associated with higher electricity use due to switching to electric heating (2.24 quads).

The above results reflect the use of the default product switching trend for NWGFs (as described in section IV.F.9). DOE also conducted a sensitivity analysis that considered scenarios with lower and higher rates of product switching, as compared to the default case. The results of these alternative cases are presented in Table V.25. In the low-product-switching case, the NES for the proposed standards (TSL 6) are 4 percent higher than in the default case. In the high-product-switching case, the NES is 9 percent lower than in the default case.

Table V.25 Potential AFUE Standards: Cumulative Full-Fuel-Cycle National Energy Savings for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022-2051); Product Switching Sensitivity Analysis (Quads)

Switching Case	Trial Standard Level								
	1	2	3	4	5	6	7	8	9
Default	0.88	1.75	1.81	2.27	2.78	2.86	4.17	4.15	5.72
No Switching	0.99	2.12	2.35	2.78	4.89	3.95	6.65	5.49	8.59
High	0.84	1.66	1.70	2.15	2.44	2.60	3.81	3.81	5.29
Low	0.89	1.79	1.86	2.32	3.05	2.98	4.43	4.28	6.01

Table V.26 presents DOE’s projections of the primary and FFC national energy savings for each standby mode and off mode TSL considered for NWGFs and MHGFs. National energy savings were calculated using the approach described in section IV.H of this notice.

Table V.26 Potential Standby Mode and Off Mode Standards: Cumulative National Energy Savings for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051 (Quads)

Energy Savings	Trial Standard Level		
	TSL 1	TSL 2	TSL 3
Primary energy	0.15	0.18	0.27
FFC energy	0.16	0.19	0.28

OMB Circular A-4[194] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine, rather than 30, years of product shipments. The choice of a nine-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[195] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to NWGFs and MHGFs. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period for the AFUE TSLs are presented in Table V.27.[196] The impacts are counted over the lifetime of NWGFs and MHGFs purchased in 2022–2030.

[194] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis" (Sept. 17, 2003) (Available at www.whitehouse.gov/omb/circulars_a004_a-4/).

[195] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6 year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some consumer products, the compliance period is 5 years rather than 3 years.

[196] DOE presents results based on a nine-year analytical period only for the AFUE TSLs; the percentage difference between nine-year and 30-year results for the standby mode and off mode TSLs is the same as for the AFUE TSLs.

Table V.27 Potential AFUE Standards: Cumulative National Energy Savings for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces; Nine Years of Shipments (2022–2030) (Quads)

Energy Savings	Trial Standard Level								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Primary energy	0.23	0.45	0.46	0.57	0.57	0.69	0.93	1.02	1.35
FFC energy	0.27	0.52	0.56	0.68	0.77	0.83	1.18	1.22	1.69

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for NWGFs and MHGFs. In accordance with OMB's guidelines on regulatory analysis,[197] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.28 shows the consumer NPV results for AFUE standards with impacts counted over the lifetime of products purchased in 2022–2051.

Table V.28 Potential AFUE Standards: Cumulative Net Present Value of Consumer Benefits for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

Discount Rate	Trial Standard Level								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	(billion 2015$)								
3 percent	6.3	12.9	15.7	17.0	23.8	21.7	31.8	29.0	39.5
7 percent	1.8	3.7	4.5	4.8	5.6	5.6	7.5	7.4	9.0

The above results reflect the use of the default product switching trend for NWGFs (as described in section IV.F.9). As previously discussed, DOE conducted a

[197] U.S. Office of Management and Budget, "Circular A-4: Regulatory Analysis," section E, (Sept. 17, 2003) (Available at www.whitehouse.gov/omb/circulars_a004_a-4/).

sensitivity analysis assuming higher and lower levels of product switching for NWGFs. The results of these alternative cases are presented in Table V.29Table V.25. In the low-product-switching case, the NPV for the proposed standards (TSL 6) are 5 percent higher than in the default case. In the high-product-switching case, the NPV is 9 percent lower than in the default case.

Table V.29 Potential AFUE Standards: Cumulative Net Present Value of Consumer Benefits for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022-2051); Product Switching Sensitivity Analysis (2015$)

Switching Case	Trial Standard Levels								
	1	2	3	4	5	6	7	8	9
3-percent Discount Rate									
Default	6.3	12.9	15.7	17.0	23.8	21.7	31.8	29.0	39.5
No Switching	6.1	12.5	13.8	16.1	24.7	21.7	34.0	30.3	43.2
High	6.3	12.7	14.9	16.5	20.8	20.4	28.9	27.8	35.7
Low	6.4	13.0	16.1	17.3	26.2	22.2	34.0	29.6	41.7
7-percent Discount Rate									
Default	1.8	3.7	4.5	4.8	5.6	5.6	7.5	7.4	9.0
No Switching	1.8	3.5	4.0	4.5	6.0	5.8	8.3	8.0	10.1
High	1.8	3.5	4.2	4.5	4.5	5.1	6.4	6.9	7.6
Low	1.9	3.7	4.7	4.9	6.5	5.9	8.3	7.7	9.8

Table V.30Table V.30 Potential Standby Mode and Off Mode Standards: Cumulative Net Present Value of Consumer Benefits for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051shows the consumer NPV results for standby mode and off mode standards with impacts counted over the lifetime of products purchased in 2022–2051.

Table V.30 Potential Standby Mode and Off Mode Standards: Cumulative Net Present Value of Consumer Benefits for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

Discount Rate	Trial Standard Level		
	1	2	3
	(billion 2015$)		
3 percent	2.5	2.5	4.0
7 percent	0.9	0.8	1.3

The NPV results for AFUE standards based on the aforementioned 9-year analytical period are presented in Table V.31.[198] The impacts are counted over the lifetime of products purchased in 2022–2030. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.31 Potential AFUE Standards: Cumulative Net Present Value of Consumer Benefits for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces; Nine Years of Shipments (2022–2030)

Discount Rate	Trial Standard Levels								
	1	2	3	4	5	6	7	8	9
	(billion 2015$)								
3 percent	2.1	4.2	5.2	5.5	6.9	6.7	9.3	8.9	11.4
7 percent	0.8	1.6	2.0	2.1	2.2	2.4	2.9	3.1	3.4

The above results reflect the use of the default, moderately decreasing price trend to estimate the change in product price for NWGFs and MHGFs over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a constant trend and one scenario with a slightly higher rate

[198] DOE presents results based on a nine-year analytical period only for the AFUE TSLs; the percentage difference between nine-year and 30-year results for the standby mode and off mode TSLs is the same as for the AFUE TSLs.

of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the SNOPR TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the constant price trend case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

DOE expects that amended energy conservation standards for NWGFs and MHGFs would reduce energy bills for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered in this rulemaking. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2022-2027), where these uncertainties are reduced.

The results suggest that the proposed standards would be likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the SNOPR TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in sections III.A and IV.B of this notice, DOE has tentatively concluded that the standards proposed in this SNOPR would not lessen the utility or performance of the NWGFs and MHGFs under consideration in this rulemaking. Manufacturers of these products currently offer units that meet or exceed the proposed standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.E.1.e, the Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination in writing to the Secretary, together with an analysis of the nature and extent of such impact. To assist the Attorney General in making this determination, DOE has provided DOJ with copies of this SNOPR and the accompanying TSD for review. DOE will consider DOJ's comments on the proposed rule in determining whether to proceed to a final rule, and if so, DOE will publish and respond to DOJ's comments in that document. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section for information to send comments to DOJ.

6. Need of the Nation to Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Chapter 15 in the SNOPR TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential standards for NWGFs and MHGFs is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.32 provides DOE's estimate of cumulative emissions reductions expected to result from the AFUE TSLs considered in this rulemaking. Table V.32 includes site and power sector emissions and upstream emissions. The increase in emissions of $SO_{2,}$ Hg, and N_2O is due to a fraction of NWGF consumers that are projected to switch from gas furnaces to electric heat pumps and electric furnaces in response to the potential standards. Table V.33 provides DOE's estimate of cumulative emissions reductions expected to result from the standby mode and off mode TSLs considered in this rulemaking. Table V.33 includes both power sector emissions and upstream emissions. All of the emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the SNOPR TSD.

Table V.32 Potential AFUE Standards: Cumulative Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

	Trial Standard Level								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Site and Power Sector Emissions									
CO_2 (million metric tons)	39.3	75.8	74.3	97.5	90.5	115	151	173	212
SO_2 (thousand tons)	(7.74)	(25.2)	(41.1)	(37.1)	(155)	(75.7)	(176)	(86.7)	(221)
NO_X (thousand tons)	66.9	136	144	177	251	232	359	329	486
Hg (tons)	(0.0)	(0.1)	(0.2)	(0.1)	(0.6)	(0.3)	(0.7)	(0.3)	(0.8)
CH_4 (thousand tons)	(0.1)	(1.25)	(3.04)	(2.13)	(15.3)	(6.04)	(16.4)	(6.09)	(20.1)
N_2O (thousand tons)	(0.1)	(0.3)	(0.6)	(0.4)	(2.46)	(1.06)	(2.70)	(1.14)	(3.36)
Upstream Emissions									
CO_2 (million metric tons)	6.84	14.7	16.8	19.6	35.6	27.7	47.5	37.7	63.0
SO_2 (thousand tons)	(0.1)	(0.4)	(0.6)	(0.5)	(2.43)	(1.14)	(2.73)	(1.29)	(3.43)
NO_X (thousand tons)	111	239	275	319	595	455	788	618	1,042
Hg (tons)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.01)	(0.0)	(0.0)
CH_4 (thousand tons)	669	1,451	1,678	1,939	3,668	2,783	4,841	3,764	6,400
N_2O (thousand tons)	0.01	0.01	0.001	0.01	(0.04)	(0.00)	(0.04)	0.01	(0.04)
Total FFC Emissions									
CO_2 (million metric tons)	46.1	90.5	91.1	117	126	143	198	211	275
SO_2 (thousand tons)	(7.84)	(25.6)	(41.7)	(37.6)	(157)	(76.8)	(179)	(88.0)	(225)
NO_X (thousand tons)	178	375	419	496	846	687	1,147	947	1,528
Hg (tons)	(0.03)	(0.1)	(0.2)	(0.1)	(0.6)	(0.3)	(0.7)	(0.3)	(0.8)
CH_4 (thousand tons)	669	1,450	1,675	1,937	3,653	2,777	4,825	3,758	6,380
CH_4 (million tons CO_2eq)*	18.7	40.6	46.9	54.2	102.3	77.7	135.1	105.2	178.6
N_2O (thousand tons)	(0.05)	(0.3)	(0.6)	(0.4)	(2.50)	(1.07)	(2.74)	(1.13)	(3.40)
N_2O (thousand tons CO_2eq)*	(12.6)	(71.9)	(147)	(114)	(664)	(283)	(727)	(300)	(900)

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
Note: Parentheses indicate negative values (an increase in emissions).

Table V.33 Potential Standby Mode and Off Mode Standards: Cumulative Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

	Trial Standard Level		
	1	2	3
Power Sector Emissions			
CO_2 (million metric tons)	8.58	10.3	15.4
SO_2 (thousand tons)	5.01	6.01	9.01
NO_X (thousand tons)	9.52	11.4	17.1
Hg (tons)	0.02	0.02	0.03
CH_4 (thousand tons)	0.7	0.9	1.30
N_2O (thousand tons)	0.1	0.1	0.2
Upstream Emissions			
CO_2 (million metric tons)	0.5	0.6	0.9
SO_2 (thousand tons)	0.1	0.1	0.2
NO_X (thousand tons)	7.14	8.57	12.8
Hg (tons)	0.0002	0.0002	0.0004
CH_4 (thousand tons)	39.5	47.4	71.0
N_2O (thousand tons)	0.0	0.0	0.0
Total FFC Emissions			
CO_2 (million metric tons)	9.07	10.9	16.3
SO_2 (thousand tons)	5.10	6.12	9.17
NO_X (thousand tons)	16.7	20.0	30.0
Hg (tons)	0.02	0.02	0.03
CH_4 (thousand tons)	40.2	48.2	72.3
CH_4 (thousand tons CO_2eq)*	1,126	1,351	2,025
N_2O (thousand tons)	0.1	0.1	0.2
N_2O (thousand tons CO_2eq)*	28.3	33.9	50.9

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).

As part of the analysis for this supplemental proposed rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the considered TSLs for NWGFs and MHGFs. As discussed in section IV.L of this document, for CO_2, DOE used the most recent values for the SCC developed by an interagency process. The four sets of SCC values for CO_2 emissions reductions in 2015 resulting from that process (expressed in 2015$) are represented by $12.4/metric ton (the average value from a distribution that uses a 5-percent discount rate), $40.6/metric ton (the average value from a distribution that uses a 3-percent discount rate), $63.2/metric ton (the average value from a distribution that uses a 2.5-

percent discount rate), and $118/metric ton (the 95th-percentile value from a distribution that uses a 3-percent discount rate). The values for later years are higher due to increasing damages (public health, economic, and environmental) as the projected magnitude of climate change increases.

Table V.34 presents the global value of CO_2 emissions reductions at each AFUE TSL. Table V.35 presents the global value of CO_2 emissions reductions at each standby mode and off mode TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values; these results are presented in chapter 14 of the SNOPR TSD.

Table V.34 Potential AFUE Standards: Estimates of Global Present Value of CO_2 Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

TSL	SCC Case*			
	5% Discount Rate, average	**3% Discount Rate, average**	**2.5% Discount Rate, average**	**3% Discount Rate, 95th percentile**
	(million 2015$)			
Site and Power Sector Emissions				
1	239	1,156	1,862	3,524
2	453	2,208	3,564	6,734
3	464	2,229	3,582	6,806
4	580	2,831	4,572	8,634
5	497	2,514	4,092	7,678
6	671	3,302	5,342	10,071
7	856	4,264	6,918	13,014
8	1,019	4,994	8,072	15,232
9	1,226	6,062	9,816	18,499
Upstream Emissions				
1	42.0	202	325	616
2	89.4	432	696	1,317
3	105	503	808	1,535
4	119	575	927	1,752
5	218	1,049	1,690	3,198
6	168	814	1,312	2,480
7	289	1,397	2,251	4,258
8	229	1,109	1,786	3,378
9	386	1,858	2,992	5,663
Total FFC Emissions				
1	281	1,358	2,188	4,140
2	542	2,640	4,260	8,050
3	569	2,733	4,391	8,341
4	699	3,406	5,499	10,387
5	715	3,564	5,783	10,875
6	839	4,116	6,653	12,551
7	1,145	5,662	9,169	17,272
8	1,248	6,103	9,858	18,610
9	1,612	7,920	12,808	24,162

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.4, $40.6, $63.2, and $118 per metric ton (2015$). The values are for CO_2 only (i.e., not CO_{2eq} of other greenhouse gases).

Table V.35 Potential Standby Mode and Off Mode Standards: Estimates of Global Present Value of CO_2 Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051

TSL	SCC Case*			
	5% Discount Rate, average	3% Discount Rate, average	2.5% Discount Rate, average	3% Discount Rate, 95th percentile
	(million 2015$)			
Power Sector Emissions				
1	51.8	251	404	764
2	62.1	301	485	917
3	93.1	451	728	1,375
Upstream Emissions				
1	2.96	14.4	23.3	44.0
2	3.56	17.3	28.0	52.8
3	5.33	26.0	42.0	79.2
Total FFC Emissions				
1	54.7	265	428	808
2	65.7	318	513	970
3	98.4	477	770	1,454

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.4, $40.6, $63.2, and $118 per metric ton (2015$). The values are for CO_2 only (i.e., not CO_{2eq} of other greenhouse gases).

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed on reduced CO_2 emissions in this rulemaking is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. Consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this proposed rule the most recent SCC values resulting from the interagency review process. DOE notes, however, that the proposed standards would be economically justified even without inclusion of monetized benefits of reduced CO_2 and NO_x emissions.

DOE also estimated the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from the considered TSLs for NWGFs and MHGFs. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.36 presents the cumulative present values for NO_X emissions reductions for each AFUE TSL calculated using 7-percent and 3-percent discount rates. Table V.37 presents the cumulative present values for NO_X emissions for each standby mode and off mode TSL calculated using 7-percent and 3-percent discount rates. These tables present values that use the low dollar-per-ton values, which reflect DOE's primary estimate. Results that reflect the range of NO_X dollar-per-ton values are presented in Table V.40.

Table V.36 Potential AFUE Standards: Estimates of Present Value of NO_X Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051*

TSL	3% Discount Rate	7% Discount Rate
	(million 2015$)	
Site and Power Sector Emissions		
1	(24.5)	(9.29)
2	(78.7)	(29.6)
3	(126)	(46.8)
4	(116)	(43.3)
5	(479)	(179)
6	(235)	(87.7)
7	(545)	(203)
8	(269)	(100.5)
9	(684)	(254)
Upstream Emissions		
1	179	62.3
2	384	133
3	456	163
4	511	177
5	958	334
6	730	252
7	1,267	440
8	990	341
9	1,685	587
Total FFC Emissions		
1	155	53.1
2	305	103
3	330	116
4	396	133
5	480	155
6	495	165
7	722	237
8	720	241
9	1,000	333

* Results are based on the low benefit-per-ton values.
Note: Parentheses indicate negative values (an increase in emissions).

Table V.37 Potential Standby Mode and Off Mode Standards: Estimates of Present Value of NO_X Emissions Reduction for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces Shipped in 2022–2051*

TSL	3% Discount Rate	7% Discount Rate
	(million 2015$)	
Power Sector Emissions		
1	14.9	5.1
2	17.9	6.1
3	26.8	9.1
Upstream Emissions		
1	11.2	3.7
2	13.4	4.5
3	20.1	6.7
Total FFC Emissions		
1	26.0	8.8
2	31.2	10.6
3	46.8	15.8

* Results are based on the low benefit-per-ton values.

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) No other factors were considered in this analysis.

8. Summary of National Economic Impacts

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.38 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each AFUE TSL for NWGFs and MHGFs considered in this rulemaking, at both a 7-percent and 3-percent discount rate. Table V.39 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each standby mode and off mode TSL for NWGFs and MHGFs considered in this rulemaking, at both a 7-percent and 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the four sets of SCC values discussed above.

Table V.38 Potential AFUE Standards: Net Present Value of Consumer Savings Combined with Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions*

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Case $12.4/t ton and 3% Low NO_X Values	SCC Case $40.6/t and 3% Low NO_X Values	SCC Case $63.2/t and 3% Low NO_X Values	SCC Case $118/t and 3% Low NO_X Values
	(billion 2015$)			
1	6.78	7.86	8.69	10.6
2	13.8	15.9	17.5	21.3
3	16.6	18.7	20.4	24.4
4	18.1	20.8	22.9	27.8
5	25.0	27.8	30.1	35.1
6	23.0	26.3	28.8	34.7
7	33.7	38.2	41.7	49.8
8	30.9	35.8	39.6	48.3
9	42.1	48.4	53.3	64.6
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Case $12.4/t and 7% Low NO_X Values	SCC Case $40.6/t and 7% Low NO_X Values	SCC Case $63.2/t and 7% Low NO_X Values	SCC Case $118/t and 7% Low NO_X Values
	(billion 2015$)			
1	2.17	3.25	4.08	6.03
2	4.31	6.41	8.03	11.8
3	5.20	7.36	9.02	13.0
4	5.60	8.30	10.4	15.3
5	6.51	9.36	11.6	16.7
6	6.65	9.92	12.5	18.4
7	8.90	13.4	16.9	25.0
8	8.91	13.8	17.5	26.3
9	10.9	17.2	22.1	33.5

* The SCC case values represent the global SCC in 2015, in 2015$, for each case. The low NO_X value in 2022, in 2015$, is $3,814/ton in the 3-percent discount rate case and $3,476/ton in the 7-percent discount rate case. The high NO_X value in 2022, in 2015$, is $8695/ton in the 3-percent discount rate case and $7,837/ton in the 7-percent discount rate case.

Table V.39 Potential Standby Mode and Off Mode Standards: Net Present Value of Consumer Savings Combined with Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Case $12.4/t ton and 3% Low NO_X Values	SCC Case $40.6/t and 3% Low NO_X Values	SCC Case $63.2/t and 3% Low NO_X Values	SCC Case $118/t and 3% Low NO_X Values
	(billion 2015$)			
1	2.60	2.81	2.97	3.35
2	2.57	2.82	3.01	3.47
3	4.11	4.49	4.78	5.46
TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Case $12.4/t and 7% Low NO_X Values	SCC Case $40.6/t and 7% Low NO_X Values	SCC Case $63.2/t and 7% Low NO_X Values	SCC Case $118/t and 7% Low NO_X Values
	(billion 2015$)			
1	1.0	1.16	1.33	1.71
2	0.9	1.11	1.30	1.76
3	1.42	1.80	2.09	2.77

* The SCC case values represent the global SCC in 2015, in 2015$, for each case. The low NO_X value in 2022, in 2015$, is $3,814/ton in the 3-percent discount rate case and $3,476/ton in the 7-percent discount rate case. The high NO_X value in 2022, in 2015$, is $8,695/ton in the 3-percent discount rate case and $7,837/ton in the 7-percent discount rate case.

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products. The national operating cost savings are measured for the lifetime of NWGFs and MHGFs shipped in 2022–2051 and include savings that accrue from such products after 2051. The benefits associated with reduced carbon emissions achieved as a result of the proposed standards are also calculated based on the lifetime of NWGFs and MHGFs shipped between 2022 and 2051. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values for emissions in future years reflect future CO_2-emissions impacts that continue through 2300. In addition, the CO_2 reduction is a benefit that accrues globally.

C. Conclusion

When considering new or amended energy conservation standards, the standards that DOE adopts for any type (or class) of covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

For this SNOPR, DOE considered the impacts of new and amended standards for NWGFs and MHGFs at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next-most-efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of: (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE’s current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forgo the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the SNOPR TSD. However, DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[199]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[200] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

[199] P.C. Reiss and M.W. White, Household Electricity Demand, Revisited, Review of Economic Studies (2005) 72, 853–883.
[200] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory (2010). (Available at http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf.)

1. Benefits and Burdens of TSLs Considered for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace AFUE Standards

Table V.40 and Table V.41 summarize the quantitative impacts estimated for each AFUE TSL for NWGFs and MHGFs. The national impacts are measured over the lifetime of NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2022–2051). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results, and include the impacts of projected fuel switching discussed in section IV.F.9 and chapter 8 of the SNOPR TSD. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.40 Summary of Analytical Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace AFUE TSLs: National Impacts

	Trial Standard Level								
	1	2	3	4	5	6	7	8	9
Cumulative FFC Energy Savings (quads)	0.9	1.7	1.8	2.3	2.8	2.9	4.2	4.1	5.7
NPV of Consumer Costs and Benefits (2015$ billion)									
3% discount rate	6.3	12.9	15.7	17.0	23.8	21.7	31.8	29.0	39.5
7% discount rate	1.8	3.7	4.5	4.8	5.6	5.6	7.5	7.4	9.0
Cumulative FFC Emissions Reduction									
CO_2 (million metric tons)	46.1	90.5	91.1	117	126	143	198	211	275
SO_2 (thousand tons)	(7.84)	(25.6)	(41.7)	(37.6)	(157)	(76.8)	(179)	(88.0)	(225)
NO_X (thousand tons)	178	375	419	496	846	687	1,147	947	1,528
Hg (tons)	(0.03)	(0.1)	(0.2)	(0.1)	(0.6)	(0.3)	(0.7)	(0.3)	(0.8)
CH_4 (thousand tons)	669	1,450	1,675	1,937	3,653	2,777	4,825	3,758	6,380
CH_4 (million tons CO_2eq)*	18.7	40.6	46.9	54.2	102.3	77.7	135.1	105.2	178.6
N_2O (thousand tons)	(0.05)	(0.3)	(0.6)	(0.4)	(2.50)	(1.07)	(2.74)	(1.13)	(3.40)
N_2O (thousand tons CO_2eq)*	(12.6)	(71.9)	(147)	(114)	(664)	(283)	(727)	(300)	(900)
Value of FFC Emissions Reduction									
CO_2 (2015$ billion)**	0.281 to 4.140	0.542 to 8.050	0.569 to 8.341	0.699 to 10.387	0.715 to 10.875	0.839 to 12.551	1.145 to 17.272	1.248 to 18.610	1.612 to 24.162
NO_X – 3% discount rate (2015$ million)	154.6 to 352.5	305.1 to 695.7	330.4 to 753.3	395.9 to 902.6	479.7 to 1093.8	495.3 to 1129.2	722.3 to 1646.9	720.1 to 1641.8	1000.5 to 2281.1
NO_X – 7% discount rate (2015$ million)	53.1 to 119.6	103.1 to 232.5	115.8 to 261.0	133.2 to 300.4	155.2 to 350.0	164.7 to 371.3	236.8 to 533.9	240.9 to 543.1	332.9 to 750.7

Note: Parentheses indicate negative (-) values.
* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.
Note: The standards for NWGFs and MHGFs for each TSL are as follows (and can also be found in Table V.1):
TSL 1: NWGF (80% AFUE at or below and 92% AFUE above 80 kBtu/h) and MHGF (92% AFUE);
TSL 2: NWGF (80% AFUE at or below and 92% AFUE above 70 kBtu/h) and MHGF (92% AFUE);
TSL 3: NWGF (80% AFUE in the South and 95% AFUE in the North) and MHGF (92% AFUE);
TSL 4: NWGF (80% AFUE at or below and 92% AFUE above 60 kBtu/h) and MHGF (92% AFUE);
TSL 5: NWGF and MHGF (92% AFUE);
TSL 6: NWGF (80% AFUE at or below and 92% AFUE above 55 kBtu/h) and MHGF (92% AFUE);
TSL 7: NWGF and MHGF (95% AFUE);
TSL 8: NWGF (80% AFUE at or below and 95% AFUE above 55 kBtu/h) and MHGF (95% AFUE);

TSL 9: NWGF (98% AFUE) and MHGF (96% AFUE)

Table V.41 Summary of Analytical Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace AFUE TSLs: Manufacturer and Consumer Impacts

Category	Trial Standard Level								
	1	2	3	4	5	6	7	8	9
Manufacturer Impacts									
Industry NPV (2015$ million) (no-new-standards case INPV = 1,104.3)	1,032 to 1,097	1,006 to 1,102	847 to 1,105	1,007 to 1,119	985 to 1,118	1,016 to 1,143	729 to 1,127	772 to 1,147	526 to 1,100
Industry NPV (% change)	(6.6) to (0.7)	(8.9) to (0.2)	(23.3) to 0.0	(8.8) to 1.3	(10.8) to 1.2	(8.0) to 3.5	(34.0) to 2.0	(30.1) to 3.9	(52.3) to (0.4)
Consumer Average LCC Savings (2015$)									
Non-Weatherized Gas Furnaces	676	730	597	741	617	692	561	609	506
Mobile Home Gas Furnaces	1,049	1,049	1,275	1,049	1,049	1,049	1,020	1,020	864
Shipment-Weighted Average*	682	735	608	746	624	698	568	615	512
Consumer Simple PBP (years)									
Non-Weatherized Gas Furnaces	6.1	6.0	6.4	5.9	6.4	6.1	6.5	6.2	6.9
Mobile Home Gas Furnaces	1.7	1.7	2.3	1.7	1.7	1.7	2.7	2.7	3.1
Shipment-Weighted Average*	6.1	5.9	6.3	5.9	6.3	6.0	6.4	6.1	6.8
Consumer LCC Impacts: Percentage of Consumers that Experience a Net Cost									
Non-Weatherized Gas Furnaces	2.1%	4.7%	6.7%	6.6%	17.1%	11.1%	22.2%	15.2%	34.2%
Mobile Home Gas Furnaces	8.2%	8.2%	5.0%	8.2%	8.2%	8.2%	13.8%	13.8%	25.2%
Shipment-Weighted Average*	2.2%	4.7%	6.7%	6.6%	17.0%	11.1%	22.0%	15.2%	34.0%

* Weighted by shares of each product class in total projected shipments in 2022.
Note: Parentheses indicate negative (-) values.
Note: The standards for NWGFs and MHGFs for each TSL are as follows (can also be found in Table V.1):
TSL 1: NWGF (80% AFUE at or below and 92% AFUE above 80 kBtu/h) and MHGF (92% AFUE);
TSL 2: NWGF (80% AFUE at or below and 92% AFUE above 70 kBtu/h) and MHGF (92% AFUE);
TSL 3: NWGF (80% AFUE in the South and 95% AFUE in the North) and MHGF (92% AFUE);
TSL 4: NWGF (80% AFUE at or below and 92% AFUE above 60 kBtu/h) and MHGF (92% AFUE);
TSL 5: NWGF and MHGF (92% AFUE);
TSL 6: NWGF (80% AFUE at or below and 92% AFUE above 55 kBtu/h) and MHGF (92% AFUE);
TSL 7: NWGF and MHGF (95% AFUE);

TSL 8: NWGF (80% AFUE at or below and 95% AFUE above 55 kBtu/h) and MHGF (95% AFUE);
TSL 9: NWGF (98% AFUE) and MHGF (96% AFUE)

DOE first considered the AFUE standards at TSL 9, which represents the max-tech efficiency levels. TSL 9 would save 5.7 quads of energy, an amount DOE considers significant. Under TSL 9, the NPV of consumer benefit would be $9.0 billion using a discount rate of 7 percent, and $39.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 9 are 275 Mt of CO_2, 1,528 thousand tons of NO_X, and 6,380 thousand tons of CH_4. Projected emissions show an increase of 225 thousand tons of SO_2, 3.40 thousand tons of N_2O, and 0.8 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces under standards at TSL 9. The estimated monetary value of the CO_2 emissions reduction at TSL 9 ranges from $1.612 million to $24.162 million.

At TSL 9, the average LCC impact on affected consumers is a savings of $506 for NWGFs and $864 for MHGFs. The simple payback period is 6.9 years for NWGFs and 3.1 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 33.3 percent for NWGFs and 25.2 percent for MHGFs.

At TSL 9, the projected changes in INPV range from a decrease of $577.9 million to a decrease of $4.3 million. If the larger decrease is reached, TSL 9 could result in a net loss of 52.3 percent in INPV. Industry conversion costs total $327.9 million at this TSL.

In the period from 2019 to 2021, the time period with the greatest risk for negative cash-flow impacts due to impacts from the furnace fan final rule and today's proposed standard, the industry's annual cash-flow drops below zero for the entire three year period. A negative industry cash-flow suggests that some manufacturers would need to access cash reserves or raise money in the capital markets to fund operations for the year. Manufacturers that have lower cash reserves, more difficulty raising capital, or a greater portion of products that require redesign would experience more business risk than their competitors in the industry.

The Secretary tentatively concludes that at TSL 9 for NWGFs and MHGFs AFUE standards, the benefits of energy savings, positive NPV of consumer benefits at both 3-percent and 7-percent discount rates, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on a significant share of consumers, and the impacts on manufacturers, including the conversion costs and profit margin impacts that could result in a large reduction in INPV. Consequently, the Secretary has tentatively concluded that TSL 9 is not economically justified.

DOE then considered the AFUE standards at TSL 8. TSL 8 would save 4.15 quads of energy, an amount DOE considers significant. Under TSL 8, the NPV of consumer benefit would be $7.4 billion using a discount rate of 7 percent, and $29.0 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 8 are 211 Mt of CO_2, 947 thousand tons of NO_X, and 3,758 thousand tons of CH_4. Projected emissions show an increase of 88.0 thousand tons of SO_2, 1.13 thousand tons of N_2O, and 0.3 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces under standards at TSL 8. The estimated monetary value of the CO_2 emissions reduction at TSL 8 ranges from $1.248 million to $18.610 million.

At TSL 8, the average LCC impact on affected consumers is a savings of $609 for NWGFs and $1,020 for MHGFs.[201] The simple payback period for affected consumers is 6.2 years for NWGFs and 2.7 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 15.2 percent for NWGFs, and 13.8 percent for MHGFs.

At TSL 8, the projected changes in INPV range from a decrease of $332.8 million to an increase of $42.8 million. If the larger decrease is reached, TSL 8 could result in a net loss of 30.1 percent in INPV. Industry conversion costs total $94.2 million at TSL 8. In the period from 2019 to 2021, the time period with the greatest risk for negative cash-flow impacts due to impacts from the furnace fan final rule and this proposed standard, the industry's annual cash-flow remains positive.

The Secretary tentatively concludes that at TSL 8 for NWGFs and MHGFs AFUE standards, the benefits of energy savings, positive NPV of consumer benefits at both 3-percent and 7-percent discount rates, emission reductions, and the estimated monetary

[201] Because consumers using small NWGFs are not affected by the standard at this TSL, the results reflect only consumers using large NWGFs.

value of the emissions reductions would be outweighed by the economic burden on some consumers, and the impacts on manufacturers, including the reduction in INPV. Consequently, the Secretary has tentatively concluded that TSL 8 is not economically justified.

DOE then considered the AFUE standards at TSL 7. TSL 7 would save 4.1 quads of energy, an amount DOE considers significant. Under TSL 7, the NPV of consumer benefit would be $7.7 billion using a discount rate of 7 percent, and $32.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 7 are 198 Mt of CO_2, 1,147 thousand tons of NO_X, and 4,825 thousand tons of CH_4. Projected emissions show an increase of 179 thousand tons of SO_2, 2.74 thousand tons of N_2O, and 0.7 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces under standards at TSL 7. The estimated monetary value of the CO_2 emissions reduction at TSL 7 ranges from $1.145 million to $17.272 million.

At TSL 7, the average LCC impact on affected consumers is a savings of $561 for NWGFs, and $1,020 for MHGFs. The simple payback period for affected consumers is 6.5 years for NWGFs and 2.7 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 22.2 percent for NWGFs and 13.8 percent for MHGFs.

At TSL 7, the projected changes in INPV range from a decrease of $375.2 million to an increase of $22.5 million. If the larger decrease is reached, TSL 7 could result in a net loss of 34.0 percent in INPV. Industry conversion costs total $107.6 million at this TSL. In the period from 2019 to 2021, the time period with the greatest risk for negative cash-flow impacts due to impacts from the furnace fan final rule and this proposed standard, the industry's annual cash-flow remains positive.

The Secretary tentatively concludes that at TSL 7 for NWGFs and MHGFs AFUE standards, the benefits of energy savings, positive NPV of consumer benefits at both 3-percent and 7-percent discount rates, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on some consumers, and the impacts on manufacturers, including the reduction in INPV. Consequently, the Secretary has tentatively concluded that TSL 7 is not economically justified.

DOE then considered the AFUE standards at TSL 6. TSL 6 would save 2.8 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $5.6 billion using a discount rate of 7 percent, and $21.6 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 143 Mt of CO_2, 687 thousand tons of NO_X, and 2,777 thousand tons of CH4. Projected emissions show an increase of 76.8 thousand tons of SO_2, 1.07 thousand tons of N_2O, and 0.3 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces under standards at TSL 6. The estimated monetary value of the CO_2 emissions reduction at TSL 6 ranges from $0.839 million to $12.551 million.

At TSL 6, the average LCC impact on affected consumers is a savings of $692 for NWGFs and $1,049 for MHGFs.[202] The simple payback period for affected consumers is 6.1 years for NWGFs, and 1.7 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 11.1 percent for NWGFs and 8.2 percent for MHGFs.

At TSL 6, the projected changes in INPV ranges from a decrease of $88.0 million to an increase of $38.5 million. If the larger decrease is reached, TSL 6 could result in a net loss of 8.0 percent of INPV. Industry conversion costs total $54.7 million at this TSL. In the period from 2019 to 2021, the time period with the greatest risk for negative cash-flow impacts due to impacts from the furnace fan final rule and this proposed standard, the industry's annual cash-flow remains positive. DOE notes that there is a significant reduction in potential negative impacts to industry at TSL 6 relative to TSLs 7 through 9.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that at TSL 6 for NWGFs and MHGFs AFUE standards, the benefits of energy savings, positive NPV of consumer benefits at both 3-percent and 7-percent discount rates, emission reductions, the estimated monetary value of the emissions reductions, positive average LCC savings, and favorable PBPs would outweigh the negative impacts on some consumers and on manufacturers. Accordingly, the Secretary has tentatively concluded that TSL 6 would offer the maximum improvement in efficiency that is technologically feasible and economically justified, and

[202] Because consumers using small NWGFs are not affected by the standard at this TSL, the results reflect only consumers using large NWGFs.

would result in the significant conservation of energy. DOE notes that this tentative conclusion holds regardless of whether DOE considers the environmental benefits expected to result from the proposed standards.

Therefore, based on the above considerations, DOE proposes to adopt the AFUE energy conservation standards for NWGFs and MHGFs at TSL 6. The proposed amended AFUE energy conservation standards for NWGFs and MHGFs are presented in Table V.42. However, DOE notes that TSL 4, which is the same as TSL 6 except that the small furnace threshold is at 60 kBtu/hr instead of 55 kBtu/hr, reduces the fuel switching impacts considerably relative to TSL 6 (see Table V.3), and has a significantly lower fraction of consumers who would be negatively impacted than at TSL 6 (see Table V.41). For this reason, DOE is also seriously considering TSL 4 and requests additional data and comment on the merits of adopting TSL 4 in place of TSL 6. (DOE is considering TSL 4 rather than TSL 5 because TSL 5 is the approach outlined in the March 2015 NOPR, which DOE is no longer considering for the reasons described above.)

If DOE were to conclude that the costs of TSL 6 outweighed the benefits of TSL 6, then DOE could consider factors in TSL 4 such as the national energy savings of 2.3 quads, the NPV of $4.8 to $17.0 billion, and CO_2 emission reductions of 117 million metric tons over the analysis period. Under TSL 4, NWGF consumers would experience an average life-cycle cost savings of $741, with 6.6 percent of consumers negatively impacted (3.1 percent of low-income consumers), and 4.1 percent of shipments would be impacted by product switching.

Table V.42 Proposed Amended AFUE Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Product Class	AFUE
Non-Weatherized Gas Furnaces	92% (> 55 kBtu/h) 80% (≤ 55 kBtu/h)
Mobile Home Gas Furnaces	92%

2. Benefits and Burdens of TSLs Considered for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standby Mode and Off Mode Standards

Table V.43 and Table V.44 summarize the quantitative impacts estimated for each standby mode and off mode TSL for NWGFs and MHGFs. The national impacts are measured over the lifetime of NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated year of compliance with new standards (2022–2051). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.43 Summary of Analytical Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standby Mode and Off Mode TSLs: National Impacts

	Trial Standard Level		
	1	2	3
Cumulative FFC Energy Savings (quads)	0.16	0.19	0.28
NPV of Consumer Costs and Benefits (2015$ billion)			
3% discount rate	2.52	2.47	3.96
7% discount rate	0.89	0.78	1.31
Cumulative FFC Emissions Reduction			
CO_2 (million metric tons)	9.07	10.9	16.3
SO_2 (thousand tons)	5.10	6.12	9.17
NO_X (thousand tons)	16.7	20.0	30.0
Hg (tons)	0.019	0.023	0.034
CH_4 (thousand tons)	40.2	48.2	72.3
CH_4 (thousand tons CO_2eq)*	1,126	1,351	2,025
N_2O (thousand tons)	0.107	0.128	0.192
N_2O (thousand tons CO_2eq)*	28.3	33.9	50.9
Value of FFC Emissions Reduction			
CO_2 (2015$ million)**	0.055 to 0.808	0.066 to 0.970	0.098 to 1.454
NO_X – 3% discount rate (2015$ million)	26.0 to 59.4	31.2 to 71.2	46.8 to 106.8
NO_X – 7% discount rate (2015$ million)	8.8 to 19.8	10.6 to 23.8	15.8 to 35.7

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).

** Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

Table V.44 Summary of Analytical Results for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace Standby Mode and Off Mode TSLs: Manufacturer and Consumer Impacts

Category	Trial Standard Level		
	1	2	3
Manufacturer Impacts			
Industry NPV (2015$ million) (no-new stds case INPV = 1,104.3)	1,104.1	1,101.8 to 1,108.5	1,100.9 to 1,110.1
Industry NPV (% change)	(0.0)	(0.3) to 0.4	(0.3) to 0.5
Consumer Average LCC Savings (2015$)			
Non-Weatherized Gas Furnaces	22	12	19
Mobile Home Gas Furnaces	21	12	19
Shipment-Weighted Average*	22	12	19
Consumer Simple PBP (years)			
Non-Weatherized Gas Furnaces	1.2	9.1	7.0
Mobile Home Gas Furnaces	1.2	8.9	6.9
Shipment-Weighted Average*	1.2	9.1	7.0
Consumer LCC Impacts: Percentage of Consumers that Experience a Net Cost			
Non-Weatherized Gas Furnaces	2.4%	13.0%	8.1%
Mobile Home Gas Furnaces	0.4%	1.0%	0.8%
Shipment-Weighted Average*	2.4%	12.8%	8.0%

* Weighted by shares of each product class in total projected shipments in 2022.
Note: Parentheses indicate negative values.

DOE first considered TSL 3, which represents the max-tech efficiency levels. TSL 3 would save 0.28 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $1.31 billion using a discount rate of 7 percent, and $3.96 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 16.3 Mt of CO_2, 9.17 thousand tons of SO_2, 30.0 thousand tons of NO_X, 0.034 tons of Hg, 72.3 thousand tons of CH_4, and

0.192 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 3 ranges from $0.098 million to $1.454 million.

At TSL 3, the average LCC impact on affected consumers is a savings of $19 for NWGFs and $19 for MHGFs. The simple payback period is 7.0 years for NWGFs and 6.9 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 8.1 percent for NWGFs and 0.8 percent for MHGFs.

At TSL 3, INPV is projected to decrease by $0.2 million, which corresponds to a decrease of less than one percent, in both markup scenarios.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that at TSL 3 for NWGFs and MHGFs standby mode and off mode standards, the benefits of energy savings, positive NPV of consumer benefits at both 3-percent and 7-percent discount rates, emission reductions, the estimated monetary value of the emissions reductions, positive average LCC savings, and favorable PBPs would outweigh the negative impacts on some consumers and on manufacturers. Accordingly, the Secretary has tentatively concluded that TSL 3 would offer the maximum improvement in efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE notes that this tentative conclusion holds regardless of whether DOE considers the environmental benefits expected to result from the proposed standards.

Therefore, based on the above considerations, DOE proposes to adopt the standby mode and off mode energy conservation standards for NWGFs and MHGFs at TSL 3. The proposed new standby mode and off mode energy conservation standards for NWGFs and MHGFs are presented in Table V.45.

Table V.45 Proposed Standby Mode and Off Mode Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Product Class	$P_{W,SB}$ (watts)	$P_{W,OFF}$ (watts)
Non-Weatherized Gas Furnaces	8.5	8.5
Mobile Home Gas Furnaces	8.5	8.5

3. Summary of Annualized Benefits and Costs of the Proposed Standards

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is the sum of: (1) the annualized national economic value (expressed in 2015$) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, which is another way of representing consumer NPV), and (2) the annualized monetary value of the benefits of CO_2 and NO_X emission reductions.[203]

[203] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (2020, 2030, etc.), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year that yields the same present value.

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products. The national operating cost savings are measured for the lifetime of NWGFs and MHGFs shipped in 2022–2051, and include savings that accrue from such products after 2051. The benefits associated with reduced carbon emissions achieved as a result of the proposed standards are also calculated based on the lifetime of NWGFs and MHGFs shipped in 2022-2051. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values for emissions in future years reflect future CO_2-emissions impacts that continue through 2300.The CO_2 reduction is a benefit that accrues globally.

Table V.46 shows the annualized values for NWGF and MHGF AFUE standards under TSL 6, expressed in 2015$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for benefits and costs other than CO_2 reductions (for which DOE used a 3-percent discount rate along with the average SCC series corresponding to a value of $40.6/metric ton in 2015 (2015$)), the estimated cost of the proposed AFUE standards for NWGFs and MHGFs is $500 million per year in increased equipment costs, while the estimated benefits are $1,138 million per year in reduced equipment operating costs, $243 million per year in CO_2 reductions, and $18.6 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $900 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of $40.6/metric ton in 2015 (2015$), the estimated cost of the proposed AFUE standards for NWGFs and MHGFs is $504 million per year in increased equipment costs, while the estimated annual benefits are $1,785 million per year in reduced operating costs, $243 million per year in CO_2 reductions, and $29.3 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $1,553 million per year.

Table V.46 Annualized Benefits and Costs of Proposed AFUE Standards for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace (TSL 6)

	Discount Rate (%)	Primary Estimate*	Low-Net-Benefits Estimate*	High-Net-Benefits Estimate*
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7	1,138	1,007	1,353
	3	1,785	1,548	2,157
CO_2 Reduction (using mean SCC at 5% discount rate)**	5	69.7	62.2	80.8
CO_2 Reduction (using mean SCC at 3% discount rate)**	3	243	217	283
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5	360	320	418
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3	742	661	862
NO_x Reduction†	7	18.6	16.8	47.9
	3	29.3	26.3	76.8
Total Benefits†	7 plus CO_2 range	1,226 to 1,899	1,086 to 1,684	1,482 to 2,263
	7	1,400	1,240	1,684
	3 plus CO_2 range	1,884 to 2,557	1,636 to 2,235	2,315 to 3,096
	3	2,058	1,791	2,517
Costs				
Consumer Incremental Installed Costs	7	500	554	452
	3	504	559	460
Net Benefits				
Total†	7 plus CO_2 range	726 to 1,399	531 to 1,130	1,030 to 1,811
	7	900	686	1,232
	3 plus CO_2 range	1,380 to 2,052	1,077 to 1,676	1,855 to 2,637
	3	1,553	1,231	2,057

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051.The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015

Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a constant price trend in the Low-Net-Benefits Estimate, and a high decline rate for projected product price trends in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.
** The CO_2 reduction benefits are calculated using four different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.
†† Total Benefits for both the 3-percent and 7-percent cases are presented using only the average SCC with a 3-percent discount rate. In the rows labeled "7 percent plus CO_2 range" and "3 percent plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

Table V.47 presents the annualized values for NWGF and MHGF standby mode and off mode standards under TSL 3, expressed in 2015$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for benefits and costs other than CO_2 reductions (for which DOE used a 3-percent discount rate along with the average SCC series corresponding to a value of $40.6/metric ton in 2015 (2015$)), the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $40.7 million per year in increased equipment costs, while the estimated benefits are $188 million per year in reduced equipment operating costs, $28.2 million per year in CO_2 reductions, and $1.79 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $178 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of $40.6/metric ton in 2015 (2015$), the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $41.4 million per year in increased equipment costs, while the estimated annual benefits are $276 million per year in reduced operating costs, $28.2 million per year in CO_2 reductions, and $2.77 million per year in reduced NO_X emissions. In this case, the net benefit would amount to $265 million per year.

Table V.47 Annualized Benefits and Costs of Proposed Standby Mode and Off Mode Standards for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace (TSL 3)

	Discount Rate %	Primary Estimate*	Low-Net-Benefits Estimate*	High-Net-Benefits Estimate*
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7	188	169	219
	3	276	246	329
CO_2 Reduction (using mean SCC at 5% discount rate)**	5	8.2	7.4	9.2
CO_2 Reduction (using mean SCC at 3% discount rate)**	3	28.2	25.5	31.8
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5	41.6	37.6	46.9
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3	86.0	77.8	96.9
NO_x Reduction†	7	1.8	1.6	4.5
	3	2.8	2.5	7.1
Total Benefits†	7 plus CO_2 range	198 to 276	178 to 249	233 to 321
	7	218	197	255
	3 plus CO_2 range	287 to 365	256 to 326	345 to 433
	3	307	274	368
Costs				
Consumer Incremental Installed Costs	7	40.7	37.2	45.4
	3	41.4	37.5	46.5
Net Benefits				
Total†	7 plus CO_2 range	157 to 235	141 to 212	187 to 275
	7	178	159	210
	3 plus CO_2 range	245 to 323	218 to 288	298 to 386
	3	265	236	321

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051.The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in

preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015 Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a constant price trend in the Low-Net-Benefits Estimate, and a high decline rate for projected product price trends in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using four different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1 for more details.

† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.

†† Total Benefits for both the 3-percent and 7-percent cases are presented using only the average SCC with a 3-percent discount rate. In the rows labeled "7 percent plus CO_2 range" and "3 percent plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

To provide a complete picture of the overall impacts of this SNOPR, the following combines and summarizes the benefits and costs for both the amended AFUE standards and the new standby mode and off mode standards for NWGFs and MHGFs. Table V.48 shows the combined annualized benefit and cost values for the proposed AFUE standards and the standby mode and off mode standards for NWGFs and MHGFs.[204] The results under the primary estimate are as follows.

Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the average SCC series that has a value of $40.6/metric ton in 2015 (2015$)), the estimated cost of the NWGFs and MHGFs standards proposed in this rule is $541 million per year in increased equipment costs, while the estimated benefits are $1,326 million per year in reduced equipment

[204] To obtain the combined results, DOE added the results for the AFUE standards in Table V.46 with the results for the standby mode and off mode standards in Table V.47.

operating costs, \$272 million per year in CO_2 reductions, and \$20 million per year in reduced NO_X emissions. In this case, the net benefit would amount to \$1,077 million per year.

Using a 3-percent discount rate for all benefits and costs and the average SCC series corresponding to a value of \$40.6/metric ton in 2015 (2015\$), the estimated cost of the proposed NWGFs and MHGFs standards is \$546 million per year in increased equipment costs, while the estimated benefits are \$2,061 million per year in reduced operating costs, \$272 million per year in CO_2 reductions, and \$32 million per year in reduced NO_X emissions. In this case, the net benefit would amount to \$1,819 million per year.

Table V.48 Annualized Benefits and Costs of Proposed AFUE (TSL 6) and Standby Mode and Off Mode (TSL 3) Energy Conservation Standards for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces*

	Discount Rate (%)	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		(million 2015$/year)		
Benefits				
Consumer Operating Cost Savings	7	1326	1176	1572
	3	2061	1794	2486
CO_2 Reduction (using mean SCC at 5% discount rate)**	5	78	70	90
CO_2 Reduction (using mean SCC at 3% discount rate)**	3	272	242	315
CO_2 Reduction (using mean SCC at 2.5% discount rate)**	2.5	401	358	465
CO_2 Reduction (using 95th percentile SCC at 3% discount rate)**	3	828	739	959
NO_X Reduction†	7	20	18	52
	3	32	29	84
Total Benefits‡	7 plus CO_2 range	1424 to 2175	1264 to 1933	1715 to 2584
	7	1618	1437	1939
	3 plus CO_2 range	2171 to 2921	1892 to 2561	2660 to 3529
	3	2364	2065	2884
Costs				
Consumer Incremental Product Costs	7	541	592	497
	3	546	597	506
Net Benefits				
Total‡	7 plus CO_2 range	884 to 1634	673 to 1342	1217 to 2086
	7	1077	845	1442
	3 plus CO_2 range	1625 to 2375	1295 to 1964	2154 to 3023
	3	1819	1468	2378

* This table presents the annualized costs and benefits associated with NWGFs and MHGFs shipped in 2022−2051. These results include benefits to consumers which accrue after 2051 from the products shipped in 2022−2051.The incremental installed costs include incremental equipment cost as well as installation costs. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the AEO 2015 Reference case, Low-Economic-Growth case, and High-Economic-Growth case, respectively. In addition, incremental product costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a constant price trend in the Low-Net-Benefits Estimate, and a high decline rate for projected product price trends in the High-Net-Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

** The CO_2 reduction benefits are calculated using four different sets of SCC values. The first three use the average SCC calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The fourth represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The SCC values are emission year specific. See section IV.L.1 for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.2 for further discussion. For the Primary Estimate and Low-Net-Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High-Net-Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.
†† Total Benefits for both the 3-percent and 7-percent cases are presented using only the average SCC with a 3-percent discount rate. In the rows labeled "7 percent plus CO_2 range" and "3 percent plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that the proposed standards set forth in this SNOPR are intended to address are as follows:

1) Insufficient information and the high costs of gathering and analyzing relevant information leads some consumers to miss opportunities to make cost-effective investments in energy efficiency.

In some cases, the benefits of more-efficient equipment are not realized due to misaligned incentives between purchasers and users. An example of such a case is when the equipment purchase decision is made by a building contractor or building owner who does not pay the energy costs.

There are external benefits resulting from improved energy efficiency of appliances and equipment that are not captured by the users of such products. These benefits include externalities related to public health, environmental protection, and national energy security that are not reflected in energy prices, such as reduced emissions of air pollutants and greenhouse gases that impact human health and global warming. DOE attempts to quantify some of the external benefits through use of social cost of carbon values.

The Administrator of the Office of Information and Regulatory Affairs (OIRA) in the OMB has determined that the proposed regulatory action is a significant regulatory action under section (3)(f) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(B) of the Order, DOE has provided to OIRA: (i) The text of the draft regulatory action, together with a reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need; and (ii) An assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate. DOE has included these documents in the rulemaking record.

In addition, the Administrator of OIRA has determined that the proposed regulatory action is an "economically" significant regulatory action under section (3)(f)(1) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(C) of the Order, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011. 76 FR 3281 (Jan. 21, 2011). Executive Order 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

DOE emphasizes as well that Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, OIRA has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE believes that this SNOPR is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, “Proper Consideration of Small Entities in Agency Rulemaking,” 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel’s website (http://energy.gov/gc/office-general-counsel). DOE has prepared the following IRFA for the products that are the subject of this rulemaking.

For manufacturers of NWGFs and MHGFs, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as “small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121.[205] Manufacturing of NWGFs and MHGFs is classified under NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." The SBA sets a threshold of 1,250 employees or less for an entity to be considered as a small business for this category.

1. Description of Reasons Why Action is Being Considered and Legal Basis

Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (NAECA; Public Law 100-12) established EPCA's original energy conservation standards for furnaces, consisting of the minimum AFUE levels described above for mobile home furnaces and for all other furnaces except "small" gas furnaces. (42 U.S.C. 6295(f)(1)-(2)) Pursuant to 42 U.S.C. 6295(f)(1)(B), in November 1989, DOE adopted a mandatory minimum AFUE level for "small" furnaces. 54 FR 47916 (Nov. 17, 1989). The standards established by NAECA and the November 1989 final rule for "small" gas furnaces are still in effect for mobile home oil-fired furnaces, weatherized oil-fired furnaces, and electric furnaces.

[205] The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.

Under EPCA, DOE was required to conduct two rounds of rulemaking to consider amended energy conservation standards for furnaces. (42 U.S.C. 6295(f)(4)(B) and (C)) In satisfaction of this first round of amended standards rulemaking under 42 U.S.C. 6295(f)(4)(B), as noted above, DOE published a final rule in the Federal Register on November 19, 2007 that revised these standards for most furnaces, but left them in place for two product classes (i.e., mobile home oil-fired furnaces and weatherized oil-fired furnaces). The standards amended in the November 2007 Rule were to apply to furnaces manufactured or imported on and after November 19, 2015. 72 FR 65136. The energy conservation standards in the November 2007 final rule consist of a minimum AFUE level for each of the six classes of furnaces. Id. at 65169. As previously noted, based on the market analysis for the November 2007 final rule and the standards established under that rule, the November 2007 final rule eliminated the distinction between furnaces based on their certified input capacity, i.e., the standards applicable to "small' furnaces were established at the same level as the corresponding class of furnace generally.

Following DOE's adoption of the November 2007 final rule, several parties jointly sued DOE in the United States Court of Appeals for the Second Circuit (Second Circuit), seeking to invalidate the rule. Petition for Review, State of New York, et al. v. Department of Energy, et al., Nos. 08– 0311–ag(L); 08–0312–ag(con) (2d Cir. filed Jan. 17, 2008). The petitioners asserted that the standards for residential furnaces promulgated in the November 2007 Rule did not reflect the ''maximum improvement in energy efficiency'' that ''is technologically feasible and economically justified'' under 42 U.S.C. 6295(o)(2)(A). On April 16, 2009, DOE filed with the Court a motion for voluntary remand that the petitioners did not oppose. The motion did not state that the

November 2007 rule would be vacated, but indicated that DOE would revisit its initial conclusions outlined in the November 2007 Rule in a subsequent rulemaking action. DOE also agreed that the final rule would address both regional standards for furnaces, as well as the effects of alternate standards on natural gas prices. The Second Circuit granted DOE's motion on April 21, 2009.

On June 27, 2011, DOE published a direct final rule (June 2011 DFR) revising the energy conservation standards for residential furnaces pursuant to the voluntary remand in State of New York, et al. v. Department of Energy, et al. 76 FR 37408. In the June 2011 DFR, DOE considered the amendment of the same six product classes considered in the November 2007 final rule analysis plus electric furnaces. The June 2011 DFR amended the existing energy conservation standards for NWGFs, MHGFs, and non-weatherized oil furnaces, and amended the compliance date (but left the existing standards in place) for weatherized gas furnaces. The June 2011 DFR also established electrical standby mode and off mode standards for NWGFs, non-weatherized oil furnaces, and electric furnaces. DOE confirmed the standards and compliance dates promulgated in the June 2011 final rule in a notice of effective date and compliance dates published on October 31, 2011. 76 FR 67037.

As noted earlier, following DOE's adoption of the June 2011 DFR, APGA filed a petition for review with the United States Court of Appeals for the District of Columbia Circuit, seeking to invalidate the DOE rule as it pertained to NWGFs. Petition for Review, American Public Gas Association, et al. v. Department of Energy, et al., No. 11-1485 (D.C. Cir. filed Dec. 23, 2011). On April 24, 2014, the Court granted a motion that vacated in part, DOE's rule and remanded the matter, consistent with a settlement agreement reached between DOE, APGA, and the various intervenors in the case, in which DOE agreed to a remand of the NWGFs and MHGFs portions of the June 2011 direct final rule in order to conduct further notice-and-comment rulemaking. Accordingly, the Court's order vacated the June 2011 DFR in part (i.e., those portions relating to NWGFs and MHGFs) and remanded to the agency for further rulemaking. As part of the settlement, DOE agreed to use best efforts to issue a notice of proposed rulemaking within one year of the remand, and to issue a final rule within the later of two years of the issuance of remand, or one year of the issuance of the proposed rule, including at least a ninety-day public comment period.

2. Description and Estimated Number of Small Entities Regulated

DOE reviewed the proposed energy conservation standards for NWGFs and MHGFs considered in this SNOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. DOE conducted a market survey using available public information to identify potential domestic small manufacturers. DOE's research involved DOE's Compliance Certification Database,[206] industry trade association membership directories (including AHRI[207]), individual company websites, and market research tools (e.g., Hoovers reports[208]) to create a list of companies that manufacture or sell the NWGF and MHGF

[206] DOE's Compliance Certification Management System, http://www.regulations.doe.gov/certification-data/ (last accessed Aug. 19, 2014).
[207] AHRI Directory, https://www.ahridirectory.org/ahridirectory/pages/home.aspx (last accessed Aug. 19, 2014).
[208] Hoovers | Company Information | Industry Information | Lists, http://www.hoovers.com/) (last accessed Aug 26, 2014).

products covered by this rulemaking. DOE also asked industry representatives if they were aware of any other small manufacturers during manufacturer interviews. DOE reviewed publicly available data and contacted domestic companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered NWGF and MHGF products. DOE screened out companies that do not meet the definition of a "small business" or are completely foreign-owned and operated. DOE initially identified a total of 13 potential companies that sell NWGFs and MHGFs in the United States. After reviewing publicly available information on these potential residential furnace businesses, DOE determined that 10 were either large businesses or businesses that were completely foreign owned and operated. DOE determined that the remaining three companies were small businesses that manufacturer NWGFs or MHGFs in the United States.

Before issuing this SNOPR, DOE attempted to contact all the small domestic business manufacturers of NWGFs and MHGFs it had identified. None of the small businesses consented to formal MIA interviews. DOE also attempted to obtain information about small business impacts while interviewing large manufacturers.

3. Description and Estimate of Compliance Requirements

a. Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces AFUE Standards

Of the three small domestic manufacturers identified, one small business manufactures only NWGFs, one small business only manufacturers MHGFs, and one small business manufactures NWGFs and MHGFs. DOE made several key assumptions to estimate the conversion costs for small NWGF and MHGF manufacturers. First, DOE assumed capital conversion costs are proportionate with sales volume. Using model listings as a proxy for market share, DOE scaled industry capital conversion costs down to a small manufacturer level based on percentage of industry model listings. Second, DOE assumed that product conversion costs are proportionate to the number of models requiring redesign and that manufacturers would redesign all failing models. DOE scaled industry product conversion costs down to small manufacturer level based on percentage of failing models. Additionally, DOE obtained company revenue information pulled from the business information databases Hoovers[209] and Glassdoor.[210] Relying on these assumptions and information, DOE estimated the conversion costs relative to small manufacturer revenue.

The small domestic manufacturer that manufactures both NWGFs and MHGFs accounts for just under one percent of all NWGF listings and approximately four percent of all MHGF listings in the DOE Certification Compliance Database. This small manufacturer has condensing furnace product offerings, with 93 percent of its NWGF models and 71 percent of its MHGF models meeting the 92-percent AFUE standard at TSL 6. DOE estimates that conversion costs incurred to comply with the AFUE standard at TSL 6 would account for 0.1 percent of revenues over the 5-year conversion period for this company.

[209] www.hoovers.com.
[210] www.glassdoor.com.

The small domestic manufacturer that only manufactures NWGFs accounts for five percent of the listings in the DOE Certification Compliance Database. This domestic small manufacturer has condensing NWGF offerings, with 22 percent of its models meeting the proposed 92-percent AFUE standard for large NWGFs at TSL 6. DOE estimates that conversion costs incurred to comply with the AFUE standard at TSL 6 would account for 2.8 percent of revenues over the 5-year conversion period for this company.

The small domestic manufacturer that only manufactures MHGFs accounts for approximately 17 percent of listings in the DOE Certification Compliance Database. This domestic small manufacturer does not offer condensing MHGFs, and none of their products would meet the proposed standard. DOE estimates that conversion costs incurred to comply with the AFUE standard at TSL 6 would account for 0.5 percent of revenues over the 5-year conversion period for this company.

b. Weatherized Gas Furnaces and Mobile Home Gas Furnaces Standby Mode and Off Mode Standards

The engineering analysis suggests that the design paths required to meet the standby mode and off mode requirements consist of relatively straight-forward component swaps. Additionally, the INPV and short-term cash flow impacts of the standby mode and off mode requirements are dwarfed by the impacts of the AFUE standard. In general, the impacts of the standby and off mode standard are significantly smaller than the impacts of the AFUE standard. For this reason, the IRFA focuses on the impacts of the AFUE standard.

DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their market shares by product class. DOE also requests comment on its assumptions that capital conversion costs for small businesses scale with shipment volumes, the assumption that product conversion costs scale with models that require redesign, and the assumption that small manufacturers would redesign all failing models to meet the new standard. Lastly, DOE requests comment on the potential impacts of the proposed AFUE standards and standby mode and off mode standards on small manufacturers.

4. Identification of Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the proposed rule.

5. A Description of Significant Alternatives to the Rule

The discussion in section Table VI.1 analyzes impacts on small businesses that would result from DOE's proposed rule. In reviewing alternatives to the proposed rule, DOE examined energy conservation standards set at higher and lower efficiency levels;

TSL 9, TSL 8, TSL 7, TSL 5, TSL 4, TSL 3, TSL 2 and TSL1. Table V.14 presents a comparison of the net present value (NPV) of consumer benefits, energy savings, carbon dioxide emissions, and small business conversion costs between the proposed standard, TSL 6, and each of the analyzed TSLs. The differences between the analyzed TSL and the proposed TSL are characterized as percentages.

Table VI.1 Significant Alternatives to TSL 6

		Trial Standard Level								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
NPV of Consumer Costs and Benefits	3% discount rate (2015$ billion)	6.3	12.9	16.1	17	23.8	**21.6**	32.5	28.9	39.5
	difference from TSL 6	(15.3)	(8.7)	(5.5)	(4.6)	2.2	-	10.9	7.3	17.9
	7% discount rate (2015$ billion)	1.8	3.7	4.6	4.8	5.6	**5.6**	7.7	7.4	9
	difference from TSL 6	(3.8)	(1.9)	(1.0)	(0.8)	0.0	-	2.1	1.8	3.4
Cumulative FFC Energy Savings	Quads	0.9	1.7	1.7	2.3	2.8	**2.9**	4	4.2	5.7
	difference from TSL 6	(2.0)	(1.2)	(1.2)	(0.6)	(0.1)	-	1.1	1.3	2.8
Carbon Dioxide Emissions Savings	million metric tons	46.1	90.5	86.1	117	126	**143**	187	211	275
	% change from TSL 6	(96.9)	(52.5)	(56.9)	(26.0)	(17.0)	-	44.0	68.0	132.0
Average Small business Conversion Costs	(2015$ millions)	0.6	0.6	1	0.6	0.6	**0.6**	1	1	3
	difference from TSL 6	0.0	0.0	0.4	0.0	0.0	-	0.4	0.4	2.4

* Parentheses indicate negative values

DOE considered TSL 7 through 9. The manufacturer impact analysis for the rule showed significantly higher burden for industry at these levels than at the proposed level. Furthermore, these levels would have required a greater upfront investment from small manufacturers to update product designs and production lines to comply with an amended standard.

DOE also considered TSLs 1 through 4. However, each of these standard levels would have resulted in lower energy savings, fewer consumer benefits, or high upfront investments from manufacturers. DOE believes that establishing standards at TSL 6 balances the benefits of the energy savings created at TSL 6 with the potential burdens placed on NWGF and MHGF manufacturers, including small businesses. Accordingly, DOE is declining to adopt one of the other TSLs, or the other policy alternatives detailed as part of the regulatory impacts analysis included in chapter 17 of the SNOPR TSD.

Additional compliance flexibilities may be available through other means. For example, EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standards. (42 U.S.C. 6295(t)) Additionally, Section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent "special hardship, inequity, or unfair distribution of burdens" that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and part 1003 for additional details.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of NWGFs and MHGFs must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for NWGFs and MHGFs, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including NWGFs and MHGFs. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the proposed rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR Part 1021, App. B, B5.1(b); 1021.410(b) and App. B, B(1)–(5). The proposed rule fits within this category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an

Environmental Assessment or Environmental Impact Statement for this proposed rule. DOE's CX determination for this proposed rule is available at http://energy.gov/nepa/categorical-exclusion-cx-determinations-cx/.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C.

1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.

Although this supplemental proposed rule, which proposes amended energy conservation standards for residential furnaces, does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by NWGF and MHGF manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency NWGFs and MHGFs, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the proposed rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this SNOPR and the TSD for this supplementary proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the proposed rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(d), (f), and (o), 6313(e), and 6316(a), this proposed rule would establish amended AFUE energy conservation standards and new standby mode and off mode energy conservation standards for NWGFs and MHGFs that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this proposed rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 15, 1988), DOE has determined that this proposed rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this SNOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has tentatively concluded that this regulatory action, which proposes amended AFUE energy conservation standards and new standby mode and off mode energy conservation standards for NWGFs and MHGFs, is not a significant energy action because the proposed standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on this proposed rule.

L. Information Quality

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the analyses underlying the energy conservation standards rulemaking are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." Id. at FR 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a Peer Review Report that describes that peer review.[211] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. DOE has determined that the peer-reviewed analytical process continues to reflect current practice, and the Department

[211] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at the following website: http://energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.

followed that process for developing energy conservation standards in the case of the present NWGFs and MHGFs rulemaking.

This peer review covered the basic analytical methods and models that DOE has used in the present NWGFs and MHGFs rulemaking. In addition, prior to the publication of the March 2015 NOPR, DOE provided a number of opportunities for stakeholders to understand and review the analytical tools used in the NWGFs and MHGFs rulemaking. Table VI.2 provides a complete listing of interactions with stakeholders related to DOE's analysis in the present rulemaking. The paragraphs below describe several key opportunities for discussion and review of DOE's analysis.

On November 13-14, 2012, DOE had interactions with representatives of the Gas Technology Institute (GTI) to describe and discuss the LCC and PBP analysis methodology and the details of implementation of the method in the LCC and PBP analysis spreadsheet. The meeting focused on key parts of the analysis, including the furnace installation model, energy prices, furnace lifetime, and product switching in response to standards, and also on the need for data to improve these aspects of the analysis. GTI subsequently developed and conducted a survey of furnace contractors and homebuilders to gain insight into product switching. The results of this survey were used by DOE in its analysis for the March 2015 NOPR (see appendix 8J of the NOPR TSD). GTI also provided energy price data, which DOE subsequently used to validate its marginal price methodology (see appendix 8C of the NOPR TSD).

On November 7, 2014, DOE held a public meeting and webinar to discuss the analytical tools and the data gathered and analyzed by the agency in support of the proposed rule. The meeting covered the LCC and PBP analysis spreadsheet, the NIA spreadsheet, and the MIA spreadsheet (described in section IV of this preamble). The information presented at the meeting, which included explanations in response to questions, facilitated subsequent detailed review of the analytical tools and data by several stakeholders. Based on their reviews of and comments on the analytical tools and input assumptions that formed the basis of the the March 2015 NOPR, DOE refined its analyses and included these updates in the September 2015 NODA, which evaluated the potential impacts of creating a separate product class for furnaces based on input capacity and setting lower standards for the "small furnaces" product class. AHRI also provided updated shipments data for non-condensing and condensing furnaces, which were used by DOE in the analysis supporting the NODA and also the current SNOPR (see appendix 8J of the SNOPR TSD).

Finally, stakeholders provided further review of the analysis tools and data through comments on the September 2015 NODA. Among other topics, the comments covered the methodology for furnace sizing and the potential for downsizing of new furnaces in response to a small furnace standard. DOE considered these comments, along with the comments on the March 2015 NOPR, in preparation of this SNOPR (see chapter 8 of the SNOPR TSD).

As such, DOE's analysis, including the product switching analysis that is central to this rulemaking and was not included in the 2007 Peer Review Report, is not entirely inconsistent with the transparency and reproducibility requirements of OMB's government-wide Information Quality Guidelines, including pre-dissemination review requirements. Specifically, we encourage readers to look at section IV.F.9 of this preamble for a discussion of the key assumptions underlying the product switching model and the sensitivity analyses undertaken in order to characterize the uncertainty inherent in the product switching analysis, and at section V.B.1.a, V.B.3.a, and V.B.3.b for discussion of the sensitivity of the results to assumptions about product switching behavior.

Table VI.2 Record of Interactions with Stakeholders in Residential Furnaces Rulemaking

Document Name	Date	Notes	Link
Ex Parte Meeting Record	09/12/14	Meeting between AGA and DOE to discuss fuel switching impact model	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0004
Preliminary Spreadsheets	09/22/14	Various preliminary spreadsheets DOE put out for stakeholders prior to issuance of the NOPR	LCC: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0002 GRIM: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0006 NIA: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0005
AGA Workshop on Condensing v. Noncondensing Appliances	10/9/14	AGA workshop held for stakeholders to discuss DOE's furnace rule	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0010
AGA Marginal Cost & Fuel Switching Analysis	10/21/14	Posted after AGA workshop; independent	Marginal Cost Analysis: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0012 Fuel Switching

Document Name	Date	Notes	Link
		AGA analysis	Analysis: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0013
GTI Fuel Switching Analysis	10/21/14	Independent GTI analysis	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0011
Ex Parte Meeting Record	10/23/14	Meeting between AGA, APGA, GTI, and DOE to discuss fuel switching	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0014
Notice of Public Meeting	10/30/14	Notice for meeting to discuss DOE's analytical tools	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0015
Public Meeting	11/07/14	Public meeting where DOE discussed analytical tools	Presentation Slides: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0016 Attendance List: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0139 Transcript: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0017
Correspondence between APGA and DOE Counsel	11/14/14	DOE answers to APGA follow-up questions from the Nov. 7, 2014 public meeting	APGA Request: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0029 DOE Response: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0030
NOPR Spreadsheets	02/05/15, 02/11/15	DOE spreadsheets revised for NOPR; put out ahead of NOPR issuance	NIA+Standby: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0024 Inputs: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0020 NIA: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0022 NIA+Standby (revised 2/10):https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0023 GRIM: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0019 LCC & PBP: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0021
Summary of Changes to Analytical Tools	02/12/15 & 02/24/15	Summarizes changes DOE made to analytical tools in light of meetings	February 12: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0025 February 24: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0026
NOPR Public Meeting	03/27/15	Public meeting to discuss March 2015	Slides: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0042 Attendance

Document Name	Date	Notes	Link
		NOPR	record: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0048 Transcript: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0044
Correspondence between DOE and APGA/AGA	04/23/15	DOE answers to questions from APGA/AGA on shipments data presented at the NOPR public meeting	https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0046

VII. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify the Appliance and Equipment Standards Staff at (202) 586-6636 or by email: Appliance_Standards_Public_Meetings@ee.doe.gov.

Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. If a foreign national wishes to participate in the public meeting, please inform DOE of this fact as soon as possible by contacting Ms. Regina Washington at (202) 586-1214 or by e-mail (Regina.Washington@ee.doe.gov) so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the Forrestal Building. Any person wishing to bring these devices into the building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding identification (ID) requirements for individuals wishing to enter Federal buildings from specific States and U.S. territories. As a result, driver's licenses from several States or territory will not be accepted for building entry, and instead, one of the alternate forms of ID listed below will be required. DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington. Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the States of Minnesota, New York, or Washington (Enhanced licenses issued by these States are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government-issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website at https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=59. Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA. (42 U.S.C. 6306) A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the Docket section at the beginning of this notice and will be accessible on the DOE website. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via www.regulations.gov. The www.regulations.gov webpage will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to www.regulations.gov information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through www.regulations.gov cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section below.

DOE processes submissions made through www.regulations.gov before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that www.regulations.gov provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or mail. Comments and documents submitted via email, hand delivery/courier, or mail also will be posted to www.regulations.gov. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery/courier two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person that would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

It is DOE’s policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. DOE’s weighing of the benefits and burdens of the small NWGF product class approach and whether a cut-off of 60 kBtu/h (or other capacity) would be

more appropriate than 55 kBtu/h, particularly in light of the consumer economic benefits of such a product class (see section III.A).

2. The technological feasibility of using BPM control relays to reduce the energy consumption of furnaces in standby/off mode. In particular, DOE seeks feedback regarding the energy savings benefits of this technology option, as well as potential impacts on the reliability and lifetime of furnace components (see section IV.A.2).
3. The appropriateness of treating standby and off mode energy consumption as equal (see section IV.C.1.a).
4. Potential future furnace functions that would operate in standby/off mode, as well as the energy consumption level of furnaces incorporating such functions in relation to the baseline standby/off mode energy consumption level used in the analyses for this SNOPR (see section IV.C.1.a).
5. Furnace design changes which may be required in order to accommodate the implementation of LL-LTX as a technology option for reducing the energy consumption of furnaces in standby/off mode (see section IV.C.1.b).
6. The technological feasibility of achieving the proposed standby/off mode max-tech efficiency level of 8.5 watts (see section IV.C.1.b).
7. The anticipated percentage of NWGF models which could achieve the efficiency levels promulgated by the 2014 furnace fans rule via implementation of a constant-torque BPM motor paired with single-stage combustion, rather than being paired with two-stage combustion (see section IV.C.2.c).

8. The MPCs and incremental MPCs developed for the AFUE efficiency levels analyzed in this SNOPR (see section IV.C.2.c).
9. The electric furnace MPC estimates and methodology (see section IV.C.3).
10. The installation costs for condensing NWGFs and MHGFs. Specifically, the estimated fraction of houses that would see a large impact for installing a condensing furnace because of venting and/or condensate withdrawal issues (see section IV.F.2).
11. The costs associated with modifying the existing vent systems and managing condensate withdrawal to accommodate condensing gas furnaces in multi-family buildings (see section IV.F.2).
12. DOE's approach for sizing furnace equipment (see section IV.E.1.a).
13. DOE's approach for furnace downsizing in the standards cases with a small furnace standard (see section IV.E.1.a).
14. The reasonableness of its assumption to apply a decreasing trend to the manufacturer selling price (in real dollars) of NWGFs and MHGFs, as well as any information that would support the use of alternative assumptions (see section IV.F.1).
15. DOE's approach for determining discount rates in the LCC analysis (see section IV.F.7).
16. DOE's approach for determining NWGF and MHGF lifetime distribution (see section IV.F.6).

17. DOE's current approach for calculating the fraction of NWGF consumers that would be expected to switch to other products in the standards cases (see section IV.F.9).
18. The estimated market share of condensing NWGFs and MHGFs in 2022 in the absence of amended AFUE energy conservation standards (see section IV.F.8).
19. The estimated market share of NWGFs and MHGFs that are used at each standby efficiency level in 2022 in the absence of amended energy conservation standards (see section IV.F.8).
20. The methodology and data sources used for projecting the future shipments of NWGFs and MHGFs in the absence of amended energy conservation standards (see section IV.G).
21. The potential impacts on product shipments related to fuel and product switching (see section IV.G.2).
22. The reasonableness of the value that DOE used to characterize the rebound effect with higher-efficiency NWGFs and MHGFs (see section IV.E.1.d).
23. The approach for conducting the emissions analysis for NWGFs and MHGFs (see section IV.K).
24. DOE's approach for estimating monetary benefits associated with emissions reductions (see section IV.L).
25. DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each AFUE standard TSL. (See section V.B.2.a)

26. DOE requests comments on the identified regulations and their contribution to cumulative regulatory burden. Additionally, DOE requests feedback on product-specific Federal regulations that take effect between 2017 and 2025 that were not listed, including identification of the specific regulations and data quantifying the associated burdens. (See section V.B.2.e) DOE seeks comments, information, and data on the number of small businesses in the industry, the names of those small businesses, and their role in the market. DOE also requests data on the market share of small manufacturers in the NWGF and MHGF markets and information on the conversion costs small manufacturers expect to invest.
27. DOE requests comment on the potential impacts of the proposed AFUE standards and standby mode and off mode standards on small manufacturers. (see section VI.B).

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Small businesses.

Issued in Washington, DC, on September 2, 2016.

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David J. Friedman
Acting Assistant Secretary
Energy Efficiency and Renewable Energy

For the reasons set forth in the preamble, DOE proposes to amend parts 429 and 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 429— CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

2. Section 429.18 is amended by revising paragraphs (a)(2)(vii) and (b)(2)(i) to read as follows:

§429.18 Residential furnaces.

(a) * * *

(2) * * *

(vii) Reported Values. The represented value of annual fuel utilization efficiency must be truncated to the one-tenth of a percentage point and the representative value of standby and off mode electrical power consumption must be rounded up to the next tenth of one watt.

(b) * * *

(2) * * *

(i) Residential furnaces and boilers: The annual fuel utilization efficiency (AFUE) in percent (%) and the input capacity (nameplate maximum fuel input rate) in British thermal units per hour (Btu/h). For non-weatherized oil-fired furnaces (including mobile home oil furnaces) and electric furnaces, the standby and off mode electrical power consumption in watts (W). On or after [*date 5 years after the publication of the final rule*], certification reports for non-weatherized gas furnaces (including mobile home gas furnaces) must also include the standby and off mode electrical power consumption in watts (W).

* * * * *

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

4. Section 430.32 is amended by:

a. Revising paragraph (e)(1)(ii);

b. Redesignating paragraph (e)(1)(iii) as (e)(1)(iv);

c. Adding a new paragraph (e)(1)(iii); and

d. Revising newly redesignated paragraph (e)(1)(iv).

The additions and revisions read as follows:

§ 430.32 Energy and water conservation standards and their compliance dates.

* * * * *

(e) * * *

(1) * * *

(ii) The AFUE for non-weatherized gas furnaces (not including mobile home gas furnaces) manufactured on or after November 19, 2015, but before [*date 5 years after publication of the final rule*]; mobile home gas furnaces manufactured on or after November 19, 2015, but before [*date 5 years after publication of the final rule*]; non-weatherized oil-fired furnaces (not including mobile home furnaces) manufactured on or after May 1, 2013, mobile home oil-fired furnaces manufactured on or after January 1, 2015; weatherized oil-fired furnaces manufactured on or after January 1, 2015; weatherized oil-fired furnaces manufactured on or after January 1, 1992; and electric furnaces manufactured on or after January 1, 1992; shall not be less than indicated in the table below:

Product class	AFUE[1]
(A) Non-weatherized gas furnaces (not including mobile home furnaces)	80.0
(B) Mobile home gas furnaces	80.0
(C) Non-weatherized oil-fired furnaces (not including mobile home furnaces)	83.0
(D) Mobile home oil-fired furnaces	75.0
(E) Weatherized gas furnaces	81.0
(F) Weatherized oil-fired furnaces	78.0
(G) Electric furnaces	78.0

[1]Annual Fuel Utilization Efficiency, as determined in § 430.23(n)(2) of this part.

(iii) The AFUE for non-weatherized gas (not including mobile home gas furnaces) manufactured on and after [*date 5 years after publication of the final rule*]; and mobile home gas furnaces manufactured on and after [*date 5 years after publication of the final rule*], shall not be less than indicated in the table below:

Product class	AFUE[1]
(A) Non-weatherized gas furnaces (not including mobile home gas furnaces) with a certified input capacity of greater than 55 kBtu/hr	92.0

(B) Non-weatherized gas furnaces (not including mobile home gas furnaces) with a certified input capacity of less than or equal to 55 kBtu/hr	80.0
(C) Mobile home gas furnaces	92.0

[1]Annual Fuel Utilization Efficiency, as determined in § 430.23(n)(2) of this part.

(iv) Furnaces manufactured on and after the compliance date listed in the table below shall have an electrical standby mode power consumption ($P_{W,SB}$) and electrical off mode power consumption ($P_{W,OFF}$) not more than the following:

Product class	Maximum standby mode electrical power consumption, ($P_{W,SB}$) (watts)	Maximum off mode electrical power consumption, ($P_{W,OFF}$) (watts)	Compliance date
(A) Non-weatherized oil-fired furnaces (including mobile home oil-fired furnaces)	11.0	11.0	May 1, 2013
(B) Electric furnaces	10.0	10.0	May 1, 2013
(C) Non-weatherized gas furnaces (including mobile home gas furnaces)	8.5	8.5	*Date 5 years after the publication of final rule*

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