DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE–2014–BT–STD–0031]

RIN 1904–AD20

Energy Conservation Program: Energy Conservation Standards for Consumer Furnaces

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

ACTION: Notice of proposed rulemaking and request for comment.

SUMMARY: The Energy Policy and Conservation Act, as amended (''EPCA''), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including consumer furnaces. EPCA also requires the Department of Energy (''DOE'' or ''the Department'') to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would result in significant energy savings. In this notice of proposed rulemaking (''NOPR''), DOE proposes amended energy conservation standards for non-weatherized gas furnaces and mobile home gas furnaces, and also announces a public meeting webinar to receive comment on these proposed standards and associated analyses and results.

DATES:

Comments: DOE will accept comments, data, and information regarding this NOPR no later than September 6, 2022. See section VII, ''Public Participation,'' of this document for details.

Comments regarding the likely competitive impact of the proposed standard should be sent to the Department of Justice contact listed in the **ADDRESSES** section on or before August 22, 2022. DOE notes that the Department of Justice is required to transmit its determination regarding the competitive impact of the proposed standard to DOE no later than September 6, 2022. The determination and analysis by the Department of Justice will be published by DOE in the **Federal Register**. Commenters who want to have their comments considered by DOE as part of any future rulemaking resulting from this NOPR also should submit such comments to DOE in accordance with the procedures detailed in this proposed rulemaking.

Meeting: DOE will hold a public meeting via webinar on Wednesday, August 3, 2022, from 12:30 p.m. to 5:00 p.m. See section VII, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov.* Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2014–BT–STD–0031 and/or regulatory information number (''RIN'') 1904–AD20, by any of the following methods:

(1) *Federal eRulemaking Portal: www.regulations.gov.* Follow the instructions for submitting comments.

(2) *Email: ResFurnaces2014STD0031@ee.doe.gov.* Include the docket number EERE–2014–BT–STD–0031 in the subject line of the message.

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).

Although DOE has routinely accepted public comment submissions through a variety of mechanisms, including postal mail and hand delivery/courier, the Department has found it necessary to make temporary modifications to the comment submission process in light of the ongoing coronavirus (''COVID–19'') pandemic. DOE is currently suspending receipt of public comments via postal mail and hand delivery/courier. If a commenter finds that this change poses an undue hardship, please contact Appliance Standards Program staff at (202) 586–1445 to discuss the need for alternative arrangements. Once the COVID–19 pandemic health emergency is resolved, DOE anticipates resuming all of its regular options for public comment submission, including postal mail and hand delivery/courier.

Docket: The docket for this activity, which includes **Federal Register** notices, 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, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

The docket web page can be found at *www.regulations.gov/docket?D=EERE-2014-BT-STD-0031.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section VII (Public Participation) for information on how to submit comments through *www.regulations.gov.*

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 following the instructions at *www.RegInfo.gov.*

EPCA requires the U.S. Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. The U.S. Department of Justice (''DOJ'') 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 Antitrust Division at *energy.standards@usdoj.gov* in advance of the date specified in the **DATES** section. Please indicate in the ''Subject'' line of your email the title and Docket Number of this rulemaking.

FOR FURTHER INFORMATION CONTACT: Ms. Julia Hegarty, 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: (240) 597–6737. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–5827. Email: *Eric.Stas@hq.doe.gov.*

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting webinar, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Synopsis of the Notice of Proposed Rulemaking

Title III, Part B [1] of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] (42 U.S.C. 6291–6309) These products include non-weatherized gas furnaces (''NWGF'') and mobile home gas furnaces (''MHGF''), the subjects 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 DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) EPCA specifically provides that DOE must conduct two rounds of energy conservation standard rulemakings for NWGFs and MHGFs. (42 U.S.C. 6295(f)(4)(B) and (C)) The statute 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 determination that standards for the product do not need to be amended, or a notice of proposed rulemaking (''NOPR'') including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) This rulemaking is being undertaken pursuant to the statutorily-required second round of rulemaking for NWGFs and MHGFs, and once completed, it will also satisfy the statutorily-required 6-year-lookback review.

In accordance with these and other relevant statutory provisions discussed in this document, DOE is proposing amended and new energy conservation standards for the subject consumer furnaces (*i.e.,* NWGFs and MHGFs). In this document, DOE is proposing amended active mode energy conservation standards for NWGFs and MHGFs, which are expressed in terms of minimum annual fuel utilization efficiency (''AFUE''), and are shown in Table I.1 of this document. DOE is also proposing new standby mode and off mode energy standards for NWGFs and MHGFs, which are expressed in terms of watts, and are shown in Table I.2 of this document. These proposed standards would apply to all NWGFs and MHGFs manufactured in, or imported into, the United States starting on the date 5 years after the publication of the final rule for this rulemaking.

TABLE I.1—PROPOSED AFUE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Product class	AFUE (%)
Non-Weatherized Gas Furnaces	95
Mobile Home Gas Furnaces	95

TABLE I.2—PROPOSED STANDBY MODE AND OFF MODE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Product class	Standby mode standard: $P_{W,SB}$ (watts)	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 summarize DOE's evaluation of the economic impacts of the proposed AFUE standards and standby mode/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] The average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of both NWGFs and MHGFs, which is estimated to be 21.4 years (see section IV.F of this document).

TABLE I.3—IMPACTS OF PROPOSED AFUE ENERGY CONSERVATION STANDARDS ON CONSUMERS OF NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Product class	Average LCC savings (2020$)	Simple payback period (years)
Non-Weatherized Gas Furnaces	464	7.2
Mobile Home Gas Furnaces	526	7.5

[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 Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflects the last statutory amendments that impact Parts A and A–1 of EPCA.

[3] The average LCC savings refer to consumers that are affected by a standard and 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 new or amended standards (*see* section IV.F.10 of this NOPR). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (*see* section IV.C of this NOPR).

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

Product class	Average LCC savings (2020$)	Simple payback period (years)
Non-Weatherized Gas Furnaces	26	2.0
Mobile Home Gas Furnaces	27	1.7

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

B. Impact on Manufacturers

The industry net present value (''INPV'') is the sum of discounted industry cash flows starting with the publication year (2022) of the NOPR and extending over a 30-year period following the expected compliance date of the standards (2022 to 2058). The impacts of the AFUE standards are independently considered from the impacts of the standby mode and off mode standards, as manufacturers would utilize different technologies to meet these two standards. Using a real discount rate of 6.4 percent, DOE estimates that the INPV for manufacturers of NWGFs and MHGFs in the case without new or amended standards is $1,411.8 million in 2020$. Under the proposed AFUE standards, the change in INPV is estimated to range from −26.9 percent to −2.2 percent, which is a reduction of approximately −$380.3 million to −$30.5 million. Under the proposed standby mode and off mode standards, the change in INPV is estimated to range from −0.1 percent to 0.4 percent, which is a change of approximately −$2.1 million to $5.0 million. When evaluating the proposed AFUE and proposed standby mode and off mode standards together, the INPV impacts are additive. The combined change in INPV is estimated to range from −27.1 percent to −1.8 percent, which is a reduction of approximately −$382.4 million to −$25.5 million. In order to bring products into compliance with the proposed new and amended standards, DOE expects industry to incur total conversion costs of $150.6 million. DOE's analysis of the impacts of the proposed energy conservation standards on manufacturers is described in section IV.J of this document. The analytic results of the MIA are presented in section V.B.2 of this document.

C. National Benefits and Costs [4]

Benefits and costs for the proposed AFUE standards are presented and considered separately from benefits and costs for the proposed 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 for consumer furnaces and boilers, 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 mode 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 energy conservation standards for NWGFs and MHGFs would save a significant amount of energy. Relative to the case without amended AFUE standards, the lifetime energy savings for NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated year of compliance with the amended AFUE standards (2029–2058), are estimated to be amount to 5.48 quadrillion British thermal units (''Btu''), or ''quads.'' [5] This represents a savings of 3.5 percent relative to the energy use of these products in the case without amended or new standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the proposed standards for NWGFs and MHGFs ranges from $6.2 billion (at a 7-percent discount rate) to $21.6 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 2029–2058.

In addition, the proposed AFUE standards for NWGFs and MHGFs are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 363 million metric tons (''Mt'') [6] of carbon dioxide (''CO_2''), 0.8 million tons of nitrogen oxides (''NO_X''), and 5.1 million tons of methane (''CH_4''). The proposed standards would result in cumulative emission increases of 52 thousand tons of sulfur dioxide (''SO_2''), 0.3 thousand tons of nitrous oxide (''N_2O''), and 0.3 tons of mercury (''Hg'').[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases using four different estimates of the social cost of CO_2 (''SC–CO_2''), the social cost of methane (''SC–CH_4''), and the social cost of nitrous oxide (''SC–N_2O''). Together these represent the social cost of greenhouse gases (SC–GHG). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).[8] The derivation of these values is discussed in section IV.L of this document. For

[4] All monetary values in this document are expressed in 2020 dollars (2020$).

[5] This 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 IV.H.2 of this NOPR.

[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 reflects key assumptions in the *Annual Energy Outlook 2021* (''*AEO2021*''). *AEO2021* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.K for further discussion of *AEO2021* assumptions that effect air pollutant emissions. The increase in emissions of some pollutants is due to an increase in electricity consumption.

[8] *See* Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990, Washington, DC (February 2021) (Available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*) (Last accessed March 17, 2022).

presentational purposes, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are estimated to be $16.2 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.[9]

DOE also estimates health benefits from SO_2 and NO_X emissions reductions. DOE estimates the present value of the health benefits would be $5.9 billion using a 7-percent discount rate, and $19.3 billion using a 3-percent discount rate. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I.5 summarizes the monetized benefits and costs expected to result from the proposed AFUE standards for NWGFs and MHGFs. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

TABLE I.5—SUMMARY OF MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (TSL 8)

	Billion 2020$
3% discount rate	
Consumer Operating Cost Savings	29.7
Climate Benefits *	16.2
Net Health Benefits **	19.3
Total Benefits †	65.2
Consumer Incremental Product Costs ‡	8.2
Net Benefits	57.1
7% discount rate	
Consumer Operating Cost Savings	10.2
Climate Benefits *	16.2
Net Health Benefits **	5.9
Total Benefits †	32.2
Consumer Incremental Product Costs ‡	4.0
Net Benefits	28.2

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon ($SC–CO_2$), methane ($SC–CH_4$), and nitrous oxide ($SC–N_2O$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate), as shown in Table V.36, Table V.38, and Table V.40. Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. *See* section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates. See Table V.46 for net benefits using all four SC–GHG estimates.

‡ Costs include incremental equipment costs, as well as installation costs.

The benefits and costs of the proposed AFUE standards, for NWGFs and MHGFs sold in 2029–2058, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are: (1) the reduced consumer operating costs, minus (2) the increases in product purchase costs and installation costs, plus (3) the value of climate and health benefits of 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 and are measured for the lifetime of NWGFs and MHGFs shipped in 2029–2058. The health benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of NWGFs and MHGFs shipped in 2029–2058. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate. Estimates of SC–GHG values are presented for all four discount rates in section V.B.8 of this document. Table I.6 presents the total estimated monetized benefits and costs associated with the proposed AFUE standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the AFUE standards proposed in this rule is $524 million per year in increased equipment costs, while the estimated annual benefits would be

[9] On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

[10] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2029, 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.,* 2030), and then discounted the present value from each year to 2029. The calculation uses discount rates of 3 and 7 percent for all costs and benefits, as shown in Table I.6 of this document. 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.

$1,320 million in reduced equipment operating costs, $1,015 million in climate benefits, and $760 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $2,571 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed AFUE standards for NWGFs and MHGFs is $511 million per year in increased equipment costs, while the estimated annual benefits would be $1,865 million in reduced operating costs, $1,015 million in climate benefits, and $1,213 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit would amount to $3,581 million per year.

TABLE I.6—ANNUALIZED MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (TSL 8)

	Million 2020$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	1,865	1,891	1,937
Climate Benefits *	1,015	1,000	1,042
Health Benefits **	1,213	1,197	1,251
Total Benefits †	4,093	4,088	4,230
Consumer Incremental Product Costs ‡	511	508	461
Net Benefits	3,581	3,580	3,769
7% discount rate			
Consumer Operating Cost Savings	1,320	1,338	1,352
Climate Benefits *	1,015	1,000	1,042
Health Benefits **	760	751	780
Total Benefits †	3,095	3,089	3,173
Consumer Incremental Product Costs ‡	524	516	471
Net Benefits	2,571	2,573	2,702

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the global SC–GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. *See* section IV.L of this document for more details.

† Total benefits infor both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs, as well as installation costs.

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

2. Standby Mode and Off Mode Standards

For 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 year of compliance with the new standby mode and off mode standards (2029–2058), are estimated to be amount to 0.28 quads.[11] This represents a savings of 16 percent relative to the energy use of these products in the no-new-standards case.

The cumulative NPV of total consumer benefits of the proposed standby mode and off mode standards for NWGFs and MHGFs ranges from $1.1 billion (at a 7-percent discount rate) to $3.4 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 2029–2058.

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 standards would result in cumulative emission reductions (over the same period as for energy savings) of 9.6 Mt of CO_2, 4.5 thousand tons of SO_2, 13.5 thousand tons of NO_X, 65.9 thousand tons of CH_4, 0.1 thousand tons of N_2O, and 0.03 tons of mercury Hg.

DOE estimates the value of climate benefits from a reduction in greenhouse gases using four different estimates of the SC–CO_2, the SC–CH_4, and the SC–N_2O. Together these represent the SC–

[11] This quantity refers to 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 IV.H.2 of this NOPR.

GHG. DOE used interim SC–GHG values developed by an IWG on the Social Cost of Greenhouse Gases.[12] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are estimated to be $0.4 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.[13]

DOE also estimates health benefits from SO_2 and NO_X emissions reductions.[14] DOE estimates the present value of the health benefits would be $0.2 billion using a 7-percent discount rate, and $0.6 billion using a 3-percent discount rate. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I.7 summarizes the monetized benefits and costs expected to result from the proposed standby mode and off mode standards for NWGFs and MHGFs. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

TABLE I.7—SUMMARY OF MONETIZED 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)

	Billion 2020$
3% discount rate	
Consumer Operating Cost Savings	3.6
Climate Benefits *	0.4
Health Benefits **	0.6
Total Benefits †	4.6
Consumer Incremental Product Costs ‡	0.2
Net Benefits	4.4
7% discount rate	
Consumer Operating Cost Savings	1.2
Climate Benefits *	0.4
Health Benefits **	0.2
Total Benefits †	1.8
Consumer Incremental Product Costs ‡	0.1
Net Benefits	1.7

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate), as shown in Table V.37, Table V.39, Table V.41. Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. *See* section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates. See Table V.47 for net benefits using all four SC–GHG estimates.

‡ Costs include incremental equipment costs, as well as installation costs.

The benefits and costs of the proposed standby mode and off mode standards, for NWGFs and MHGFs sold in 2029–2058, can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are:

[12] *See* Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990, Washington, DC, February 2021. Available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf* (last accessed March 17, 2022).

[13] On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

[14] DOE estimated the monetized value of SO_2 and NO_X emissions reductions associated with site and electricity savings using benefit-per-ton estimates from the scientific literature. *See* section IV.L.2 of this document for further discussion.

(1) the reduced consumer operating costs, minus (2) the increases in product purchase prices, plus (3) the value of climate and health benefits of emission reductions, all annualized.[15]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of NWGFs and MHGFs shipped in 2029–2058. The health benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of NWGFs and MHGFs shipped in 2029–2058. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate. Estimates of SC–GHG values are presented for all four discount rates in section V.B.8 of this document. Table I.8 presents the total estimated monetized benefits and costs associated with the proposed standby and off mode standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $12.2 million per year in increased equipment costs, while the estimated annual benefits would be $160 million in reduced equipment operating costs, $23 million in climate benefits, and $25 million in health benefits. In this case, the net benefit would amount to $196 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $12.4 million per year in increased equipment costs, while the estimated annual benefits would be $224 million in reduced operating costs, $23 million in climate benefits, and $40 million in health benefits. In this case, the net benefit would amount to $275 million per year.

TABLE I.8—ANNUALIZED MONETIZED BENEFITS AND COSTS OF PROPOSED STANDBY MODE AND OFF MODE STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (TSL 3)

	Million 2020$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	224	214	251
Climate Benefits *	23	23	24
Health Benefits **	40	40	43
Total Benefits †	287	276	318
Consumer Incremental Product Costs ‡	12	12	13
Net Benefits	275	264	305
7% discount rate			
Consumer Operating Cost Savings	160	155	176
Climate Benefits *	23	23	24
Health Benefits **	25	25	27
Total Benefits †	208	203	227
Consumer Incremental Product Costs ‡	12	12	13
Net Benefits	196	190	214

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the global SC–GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs, as well as installation costs.

[15] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2029, 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.,* 2030), and then discounted the present value from each year to 2029. The calculation uses discount rates of 3 and 7 percent for all costs and benefits, as shown in Table I.8 of this document. 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.

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

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

DOE considers and evaluates these standards independently under EPCA and the analytical process outlined in DOE's Process Rule (as amended). However, DOE is also presenting the combined effects of these standards for the benefit of the public and in compliance with E.O. 12866, as shown in Table I.9. and Table I.10 of this document[16] The results under the primary estimate for Table I.10 are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standards in this rule is $536 million per year in increased equipment costs, while the estimated annual benefits would be $1,480 million in reduced equipment operating costs, $1,038 million in climate benefits, and $785 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions)., In this case, the net benefit amounts to $2,767 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards in this rule is $524 million per year in increased equipment costs, while the estimated annual benefits would be $2,089 million in reduced operating costs, $1,038 million in climate benefits, and $1,253 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit would amount to $3,856 million per year.

TABLE I.9—EMISSIONS REDUCTIONS OF AFUE (TSL 8) AND STANDBY MODE AND OFF MODE (TSL 3) STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Power Sector Emissions	
CO_2 (*million metric tons*)	327
SO_2 (*thousand tons*)	(48)
NO_X (*thousand tons*)	137
Hg (*tons*)	(0.3)
CH_4 (*thousand tons*)	0.6
N_2O (*thousand tons*)	(0.3)
Upstream Emissions	
CO_2 (*million metric tons*)	45
SO_2 (*thousand tons*)	(0.3)
NO_X (*thousand tons*)	696
Hg (*tons*)	0.0
CH_4 (*thousand tons*)	5,133
N_2O (*thousand tons*)	(0.05)
Total FFC Emissions	
CO_2 (*million metric tons*)	373
SO_2 (*thousand tons*)	(47)
NO_X (*thousand tons*)	833
Hg (*tons*)	(0.3)
CH_4 (*thousand tons*)	5,134
N_2O (*thousand tons*)	(0.2)

TABLE I.10—MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE (TSL 8) AND STANDBY MODE AND OFF MODE (TSL 3) STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

	Annualized (million 2020$/yr)	Total present value (billion 2020$)
3%		
Consumer Operating Cost Savings	2,089	33.3
Climate Benefits *	1,038	16.5
Health Benefits **	1,253	20.0
Total Benefits †	4,380	69.8
Consumer Incremental Product Costs ‡	524	8.3
Net Benefits	3,856	61.5
7%		
Consumer Operating Cost Savings	1,480	11.4
Climate Benefits *	1,038	16.5
Health Benefits **	785	6.1
Total Benefits †	3,303	34.0

[16] To obtain the combined results, DOE added the results for the proposed AFUE standards in Table I.6 of this document with the results for the proposed standby mode and off mode standards in Table I.8 of this document. Slight differences in totals may reflect the effects of rounding.

TABLE I.10—MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE (TSL 8) AND STANDBY MODE AND OFF MODE (TSL 3) STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES—Continued

	Annualized (million 2020$/yr)	Total present value (billion 2020$)
Consumer Incremental Product Costs ‡	536	4.1
Net Benefits	2,767	29.9

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the global SC–GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs, as well as installation costs.

DOE's analysis of the national impacts of the proposed standards is described 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 is technologically feasible and economically justified, and would result in significant conservation of energy. Specifically, with regards to technological feasibility, products achieving these standard levels are already commercially available for the product classes covered by the proposed standards. As for economic justification, DOE's analysis shows that the benefits of the proposed standards exceed, to a great extent, the burdens of the proposed standards. Using a 7-percent discount rate for consumer benefits and costs and health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standards in this rule is $536 million per year in increased equipment costs, while the estimated annual benefits are $1,480 million in reduced equipment operating costs, $1,038 million in climate benefits, and $785 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). The net benefit amounts to $2,767 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[17] For example, the United States rejoined the Paris Agreement on February 19, 2021. As part of that agreement, the United States has committed to reducing greenhouse (''GHG'') emissions in order to limit the rise in mean global temperature. As such, energy savings that reduce GHG emissions have taken on greater importance. Additionally, some covered products and equipment have substantial energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings of 5.76 quads and an estimated cumulative emissions reduction of 373 Mt of CO_2. The consumer benefit to the Nation (*i.e.,* cumulative net present value of total consumer savings less costs) is estimated to be between $7.3 billion and $25.0 billion (discounted at 7 percent and 3 percent, respectively) in 2020$. DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these tentative conclusions is contained in the remainder of this document and the accompanying TSD.

[17] Procedures, Interpretations, and Policies for Consideration in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment, 86 FR 70892, 70901 (Dec. 13, 2021).

DOE also considered more-stringent energy efficiency levels as potential standards, and the Department 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.

Based on consideration of the public comments DOE receives in response to this document and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this document 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 NOPR, as well as some of the relevant historical background related to the proposed standards for residential NWGFs and MHGFs.

A. Authority

The Energy Policy and Conservation Act, as amended, Public Law 94–163 (42 U.S.C. 6291–6317, as codified) authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles. These products include the consumer furnaces that are the subject of this document. (42 U.S.C. 6292 (a)(5)) EPCA prescribed energy conservation standards for these products (42 U.S.C. 6295(f)(1) and (2)), and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(f)(4)) EPCA further provides that, not later than six years after the 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))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

Federal energy efficiency requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c)) DOE may, however, grant waivers of Federal preemption in limited instances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. 42 U.S.C. 6297(d).

Subject to certain statutory criteria and conditions, DOE is required to develop test procedures that are reasonably designed to produce test results which measure the energy efficiency, energy use, or estimated annual operating cost of each covered product during a representative average use cycle and that are not unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) Manufacturers of covered products must use the prescribed Federal test procedure as the basis for: (1) certifying to DOE that their products comply with the applicable energy conservation standards adopted pursuant to EPCA and (2) making representations about the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 42 U.S.C. 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with the relevant energy conservation standards promulgated under 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 energy conservation standards for covered products. 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 42 U.S.C. 6295(o)(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, 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 after receiving views and comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven 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 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 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 the Secretary finds (and publishes such finding) that 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 that warrant separate product classes and energy conservation standards with a level of energy efficiency or energy use either higher or lower than that which would apply for such group of covered products which have the same function or intended use. DOE must specify a different standard level for a type or class of products 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 such a 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))

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)) 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 for all covered residential furnaces. DOE's energy conservation standards address standby mode and off mode energy use only for non-weatherized oil-fired and electric furnaces. 10 CFR 430.32(e)(1)(iii). In this NOPR, DOE is proposing to develop separate energy conservation standards that would address the standby mode and off mode energy use of NWGFs and MHGFs.

B. Background

1. Current Standards

EPCA established the energy conservation standards that apply to most consumer 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 (*i.e.,* those having an input of less than 45,000 Btu per hour). (42 U.S.C. 6295(f)(1)–(2)) Through a final rule published in the **Federal Register** on November 17, 1989, DOE initially established standards for small furnaces at the same level as furnaces generally (*i.e.,* a minimum AFUE of 78 percent). 54 FR 47916, 47944.

EPCA also required DOE to conduct two rounds of rulemaking to consider amended standards for consumer furnaces. (42 U.S.C. 6295(f)(4)(B)–(C)). In addition, EPCA requires a six-year-lookback review of energy conservation standards for all covered products. (42 U.S.C. 6295(m)(1)) In a final rule published in the **Federal Register** on November 19, 2007 (November 2007 final rule), DOE prescribed amended energy conservation standards for consumer 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 NWGFs, to 81-percent AFUE for weatherized gas furnaces, to 80-percent AFUE for MHGFs, and to 82-percent AFUE for non-weatherized oil-fired furnaces.[18] 72 FR 65136, 65169. Based on market assessment and the standard levels at issue, the November 2007 final rule established standards without regard to the certified input capacity of a furnace. *Id.*

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 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 final 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.

On June 27, 2011, DOE published a direct final rule (''DFR'') in the **Federal Register** (''June 2011 DFR'') amending the energy conservation standards for residential central air conditioners and consumer furnaces. (76 FR 37408) Subsequently, on October 31, 2011, DOE published a notice of effective date and compliance dates in the **Federal Register** (''October 2011 notice'') to confirm amended energy conservation standards and compliance dates contained in the June 2011 DFR. 76 FR 67037. The November 2007 final rule and the June 2011 DFR represented the first and the second rounds, respectively, of the two rulemakings required under 42 U.S.C. 6295(f)(4)(B)–(C) to consider amending the energy conservation standards for consumer 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 consumer furnaces (*i.e.,* NWGFs, MHGFs, and non-weatherized oil furnaces).[19] The existing standards were left in place for three classes of consumer furnaces (*i.e.,* weatherized oil-fired furnaces, mobile home oil-fired furnaces, and electric furnaces). For one class of consumer 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

[18] Although the November 2007 final rule did not explicitly state the standards for oil-fired furnaces were applicable only to non-weatherized oil-fired furnaces, the NOPR that preceded the final rule made clear that DOE did not perform analysis of and was not proposing standards for weatherized oil-fired furnaces or mobile home oil-fired furnaces. 71 FR 59203, 52914 (October 6, 2006). Thus, the proposed standards that were ultimately adopted in the November 2007 final rule only applied to non-weatherized oil-fired furnaces.

[19] For NWGFs and MHGFs, the standards were amended to a level of 80-percent AFUE nationally with a more-stringent 90-percent AFUE requirement in the Northern Region. For non-weatherized oil-fired furnaces, the standard was amended to 83-percent AFUE nationally. 76 FR 37408, 37410 (June 27, 2011).

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, 37547–37548 (June 27, 2011); 76 FR 67037, 67051 (Oct. 31, 2011). The amended energy conservation standards and compliance dates in the June 2011 DFR 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 [20] in the United States Court of Appeals for the District of Columbia Circuit (''D.C. Circuit'') to invalidate that rule as it pertained to NWGFs (as discussed further in section II.B.2 of this document). 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, the standards established by the June 2011 DFR for NWGFs and MHGFs did not go into effect, and thus, required compliance with the standards established in the November 2007 final rule for these products began on November 19, 2015. As stated previously, the AFUE 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. Further, the amended standard for non-weatherized oil furnaces were not subject to the Court order, and went into effect as specified in the June 2011 DFR.

The AFUE standards currently applicable to all residential furnaces, including the two product classes for which DOE is proposing amended standards in this NOPR, are set forth in DOE's regulations at 10 CFR 430.32(e)(1)(ii). Table II.1 presents the currently applicable standards for NWGF and MHGF and the date on which compliance with that standard was required.

TABLE II.1—CURRENT FEDERAL ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Product class	Minimum annual fuel utilization efficiency (%)	Compliance date
Non-weatherized Gas	80	11/19/2015
Mobile Home Gas	80	11/19/2015

2. History of Standards Rulemaking for Consumer Furnaces

Given the somewhat complicated interplay of recent DOE rulemakings and statutory provisions related to consumer furnaces, DOE provides the following regulatory history as background leading to this document. Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 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 the November 2007 final 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 final rule were to apply to furnaces manufactured or imported on and after November 19, 2015. 72 FR 65136 (Nov. 19, 2007). 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 72 FR 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). *Id.*

As described previously in section II.B.1 of this document, on June 27, 2011, DOE published in the **Federal Register** the 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 (June 27, 2011). 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 of this document, the June 2011 DFR amended the existing AFUE energy conservation standards for NWGFs, MHGFs, and non-weatherized oil furnaces, and amended the compliance

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

date (but left the existing standards in place) for weatherized gas furnaces. The June 2011 DFR also established electrical standby mode and off mode energy conservation 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 in the **Federal Register** 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 and APGA, 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 previously, 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).[21]

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.

Multiple parties suggested that DOE should create a separate product class for furnaces based on input capacity and set lower standards for ''small furnaces'' 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. 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 NWGF 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 NWGFs. *Id.* at 80 FR 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 a small NWGF product class. *Id.* at 80 FR 55042–55044. It also showed that national energy savings increased because fewer consumers switched to electric heat.[22] *Id.* at 80 FR 55308, 55044.

Therefore, DOE published a supplemental notice of proposed rulemaking (''SNOPR'') in the **Federal Register** on September 23, 2016 (September 2016 SNOPR) that proposed separate standards for small and large NWGF.[23] 81 FR 65720. For NWGF with input capacities of 55 kBtu/h or less, DOE proposed to maintain the standard at 80-percent AFUE. *Id.* at 81 FR 65852. For all other NWGF and for all MHGF, DOE proposed a standard of 92-percent AFUE. *Id.* As was the case in the September 2015 NODA, a small NWGF product class was shown to reduce the number of consumers experiencing net costs due to higher installation costs for condensing furnaces or switching to electric heat. In the September 2016 SNOPR, DOE initially determined that the combination of a 55 kBtu/h product class threshold and a 92-percent AFUE standard for all NWGF above that size appropriately balanced the costs and benefits. DOE also noted in that SNOPR that a 60 kBtu/h threshold may also be economically justified based on the analysis, and sought further comment regarding the particular size threshold proposed. 81 FR 65720, 65755 (Sept. 23, 2016).

In addition, for the March 2015 NOPR and September 2016 SNOPR, DOE analyzed energy conservation standards for the standby mode and off mode energy use of NWGF and MHGF, as required by EPCA. (42 U.S.C. 6295(gg)(3); 80 FR 13120, 13198; 81 FR 65720, 65759–65760) In both the March 2015 NOPR and the September 2016 SNOPR, DOE proposed a maximum energy use of 8.5 watts in both standby mode and off mode for NWGF and MHGF. 80 FR 13120, 13198 (March 12, 2015) and 81 FR 65720, 65852 (Sept. 23, 2016).

On January 15, 2021, in response to a petition for rulemaking[24] submitted by the American Public Gas Association, Spire, Inc., the Natural Gas Supply Association, the American Gas Association, and the National Propane Gas Association (the ''Gas Industry Petition''), DOE published a final interpretive rule (''the January 2021 final interpretive rule'') in the **Federal Register**, determining that, in the context of residential furnaces, commercial water heaters, and similarly-situated products/equipment, use of non-condensing technology (and associated venting) constitutes a performance-related ''feature'' under EPCA that cannot be eliminated through adoption of an energy conservation standard. 86 FR 4776. Correspondingly,

[21] This aligns with the direction provided in the final rule published in the **Federal Register** on December 13, 2021, regarding the procedures, interpretations, and policies for consideration in new or revised energy conservation standards and test procedures for consumer products and commercial/industrial equipment (''December 2021 Final Rule''). 86 FR 70892, 70922.

[22] In terms of full-fuel-cycle energy, switching from gas to electricity increases energy use because of the losses in thermal electricity generation.

[23] DOE initially provided 60 days for comment on the SNOPR, and subsequently reopened the comment period an additional 30 days. 81 FR 87493 (Dec. 5, 2016).

[24] DOE published the Gas Industry Petition in the **Federal Register** for comment on November 1, 2018. 83 FR 54838.

on the same day, DOE published in the **Federal Register** a notification withdrawing the March 2015 NOPR and the September 2016 SNOPR for NWGFs and MHGFs. 86 FR 3873 (Jan. 15, 2021).

On January 20, 2021, the White House issued Executive Order 13990, ''Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis.'' 86 FR 7037 (Jan. 25, 2021). Section 1 of that Order lists several policies related to the protection of public health and the environment, including reducing greenhouse gas emissions and bolstering the Nation's resilience to climate change. *Id.* at 86 FR 7037. Section 2 of the Order also instructs all agencies to review ''existing regulations, orders, guidance documents, policies, and any other similar agency actions (agency actions) promulgated, issued, or adopted between January 20, 2017, and January 20, 2021, that are or may be inconsistent with, or present obstacles to, [these policies].'' *Id.* Agencies are then directed, as appropriate and consistent with applicable law, to consider suspending, revising, or rescinding these agency actions and to immediately commence work to confront the climate crisis. *Id.* In light of E.O. 13990, DOE undertook a re-evaluation of the final interpretation and withdrawal of proposed rulemakings published in the **Federal Register** on January 15, 2021, and the Department published a proposed interpretive rule in the **Federal Register** on August 27, 2021, to once again address this matter. 86 FR 48049.

Following the re-evaluation of the January 2021 final interpretive rule and consideration of public comments, DOE published a final interpretive rule in the **Federal Register** on December 29, 2021 (''December 2021 final interpretive rule'') that returns to the Department's previous and long-standing interpretation (in effect prior to the January 15, 2021 final interpretive rule), under which the technology used to supply heated air or hot water is not a performance-related ''feature'' that provides a distinct consumer utility under EPCA. 86 FR 73947. Residential furnaces were one of the two primary focuses of the December 2021 final interpretive rule (along with commercial water heaters), and in that document, the Department offered an extensive explanation as to its rationale for why it does not view noncondensing technology and associated venting to be a performance-related feature warranting a separate product class for furnaces. Among these are the consumer utility of the product (*i.e.,* providing heat, irrespective of venting type) and the availability of technological alternatives for difficult installation situations (which are costs concerns properly addressed under consideration of a standard's economic justification). However, DOE has stated that it will consider any particular concerns regarding specific installation circumstances in the context of individual rulemakings, and the Department welcomes such comments in response to this NOPR.

Consistent with the December 2021 final interpretive rule, in conducting the analysis for this NOPR, DOE does not divide product classes based on condensing technologies and associated venting systems when analyzing potential energy conservation standards.

As illustrated by the preceding discussion, the rulemaking for consumer furnaces has been subject to multiple rounds of public comment, including public meetings, and extensive records have been developed in the relevant dockets. (See Docket Number EERE–2011–BT–STD–0011). Consequently, the information obtained through those earlier rounds of public comment, information exchange, and data gathering have been considered in this rulemaking, and DOE is building upon the existing record through further analysis and further notice and comment. DOE has tentatively found that the relevant furnaces market has stayed sufficiently similar since the time of these past rulemakings such that much of the previously-collected feedback and data continue to be relevant. However, as discussed in section IV of this NOPR, DOE has updated analytical inputs in its analyses where appropriate and welcomes further data, information, and comments.

In the withdrawn September 2016 SNOPR, DOE preliminarily addressed the comments received in response to the March 2015 NOPR and September 2015 NODA. In response to the withdrawn September 2016 SNOPR, DOE received a number of written comments from interested parties during the comment period on that document. Table II.2 identifies those commenters. Although DOE withdrew the September 2016 SNOPR, DOE considered these comments, as well as comments from the September 2016 SNOPR public meeting, to the extent relevant in preparing this document.

TABLE II.2—INTERESTED PARTIES PROVIDING WRITTEN COMMENT ON THE WITHDRAWN SEPTEMBER 2016 SNOPR FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Name	Acronyms/abbreviation	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.	ACEEE, ASAP, & ASE	EA
American Council for an Energy-Efficient Economy, Appliance Standards Awareness Project, Alliance to Save Energy, Natural Resource Defense Council, Northeast Energy Efficiency Partnerships, Northwest Energy Efficiency Alliance.	Efficiency Advocates	EA
American Energy Alliance	AEA	EA
American Gas Association	AGA	U
American Public Gas Association	APGA	U
American Public Power Association	APPA	U

TABLE II.2—INTERESTED PARTIES PROVIDING WRITTEN COMMENT ON THE WITHDRAWN SEPTEMBER 2016 SNOPR FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES—Continued

Name	Acronyms/ abbreviation	Type
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, Georgia	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/Spire, Inc. **	Laclede/Spire	U
Law Offices of Barton Day, PLLC ***	Day	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

TABLE II.2—INTERESTED PARTIES PROVIDING WRITTEN COMMENT ON THE WITHDRAWN SEPTEMBER 2016 SNOPR FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES—Continued

Name	Acronyms/ abbreviation	Type
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		TA
Pennsylvania Department of Environmental Protection	PA DEP	G
Philadelphia Gas Works	PGW	U
Plumbing-Heating-Cooling Contractors	PHCC	C
Prime Energy Partners, LLC	Prime Energy Partners	EA
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; CR: Consumer Representative; CS: Component Supplier; 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.

** The Laclede Group, Inc. changed its name to Spire, Inc. during this rulemaking.

*** Representing Spire Inc., a gas utility.

† 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.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[25]

[25] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for NWGF and MHGF. (Docket No. EERE–2014–BT–STD–0031, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

3. Current Standards in Canada

Consumer furnaces are a regulated product in Canada and are subject to energy efficiency regulations. On December 24, 2008, Natural Resources Canada published regulations in the *Canada Gazette, Part II* amending the energy efficiency regulations for consumer furnaces, among other appliances and equipment.[26] The revised regulation, required on or after December 31, 2009, sets a minimum

[26] See *Canada Gazette, Part II,* Vol. 142, No. 26, pp. 2512–2570. (Available at: *www.gazette.gc.ca/rp-pr/p2/2008/2008-12-24/pdf/g2-14226.pdf*) (Last accessed Feb. 15, 2022).

efficiency of 90-percent AFUE for gas furnaces. This standard is applicable to gas furnaces, other than those with an integrated cooling component that are outdoor or through-the-wall gas furnaces, that have an input rate no greater than 65.92 kW (225,000 Btu/h), and that use single-phase electric current.

On June 12, 2019, Natural Resources Canada published regulations in the *Canada Gazette, Part II* amending the energy efficiency regulations for consumer furnaces, among other appliances and equipment.[27] The definition of gas furnaces was clarified to exclude gas furnaces for relocatable buildings (*e.g.,* MHGFs). The revised regulation, required on or after July 3, 2019, sets a minimum efficiency of 95-percent AFUE for gas furnaces. Furthermore, the revised regulation also sets a minimum efficiency of 80-percent AFUE for gas furnaces for relocatable buildings.[28]

C. Deviation From Appendix A

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''appendix A''), DOE notes that it is deviating from the provision in appendix A regarding the pre-NOPR stages for an energy conservation standards rulemaking. Section 6(a)(2) of appendix A states that if the Department determines it is appropriate to proceed with a rulemaking, the preliminary stages of a rulemaking to issue or amend an energy conservation standard that DOE will undertake will be a framework document and preliminary analysis, or an advance notice of proposed rulemaking. For the reasons that follow, DOE finds it necessary and appropriate to deviate from this step in appendix A and to instead publish this NOPR without once again conducting these preliminary stages. Completion of this furnaces rulemaking is overdue under the relevant statutory deadline, so DOE seeks to complete its statutory obligations as expeditiously as possible. Moreover, DOE finds that there would be little benefit in repeating the preliminary stages of this rulemaking. The earlier stages of a rulemaking are intended to introduce the various analyses DOE conducts during the rulemaking process, present preliminary results, and request initial feedback from interested parties to seek early input. Although the most recent rulemaking notices for NWGFs and MHGFs (the March 2015 NOPR and September 2016 SNOPR) have been withdrawn, as discussed in section II.B.2 of this document, this analysis builds upon the previous rulemaking stages. As DOE is using similar analytical methods in this NOPR (with differences described in the sections that follow), publication of a framework document, preliminary analysis, or ANOPR would be largely redundant of previously published documents. Stakeholders have previously provided numerous rounds of input on these methodologies in the most recent rulemaking. Further, as discussed in section II.A, EPCA provides that DOE must conduct two rounds of energy conservation standard rulemakings for NWGFs and MHGFs. (42 U.S.C. 6295(f)(4)(B) and (C)) The statute 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 determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) The energy conservation standards for NWGF and MHGF were last amended in the November 2007 final rule. Additionally, as discussed in section II.B.2 of this document, in settling the lawsuit filed by APGA following the June 2011 DFR (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)), DOE agreed to use best efforts to issue a NOPR within one year of the remand (*i.e.,* by April 24, 2015), 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 (*i.e.,* by April 24, 2016).[29] As it has been more than 8 years since the settlement agreement and over 6 years past the original target date for issuance of a final rule, DOE has determined that moving as expeditiously as is reasonably practical is the approach most consistent with the terms of the settlement agreement as well as the requirements of EPCA. As such, DOE is not publishing pre-NOPR documents. DOE has tentatively found that the portions of analysis done for previous rulemakings continue to apply to the current market for the furnaces at issue. However, as discussed in section IV of this NOPR, DOE has updated analytical inputs in its analyses where appropriate and welcomes submission of additional data, information, and comments.

Section 6(f)(2) of appendix A provides that the length of the public comment period for the NOPR will be at least 75 days. For this NOPR, DOE finds it necessary and appropriate to provide a 60-day comment period. As stated previously, DOE faces an overdue statutory deadline for this rulemaking and, furthermore, the analytical methods used for this NOPR are similar to those used in previous rulemaking notices. Consequently, DOE has determined it is necessary and appropriate to provide a 60-day comment period, which the Department has determined provides sufficient time for interested parties to review the NOPR and develop comments.

III. General Discussion

DOE developed this proposed rule after considering comments, data, and information from interested parties that represent a variety of interests. This NOPR addresses all relevant issues raised by commenters since the last published proposal in this rulemaking proceeding.

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 other performance-related features that justify differing standards. In making a determination whether a 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 determines are appropriate. (42 U.S.C. 6295(q))

In this proposed rule, DOE is only analyzing a subset of consumer furnace classes. 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, 13130–13132 (March 12, 2015). Therefore, in this proposed rule, DOE is only proposing amended standards for NWGFs and for MHGFs. For a detailed discussion of the product classes considered for this NOPR, see section IV.A.1 of this document.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test

[27] See *Canada Gazette, Part II,* Vol. 153, No. 12, pp. 2423–2517. (Available at: *www.gazette.gc.ca/rp-pr/p2/2019/2019-06-12/pdf/g2-15312.pdf*) (Last accessed Feb. 15, 2022).

[28] ''Gas furnace for relocatable buildings'' is defined in that regulation as a gas furnace that is intended for use in a temporary modular building that can be relocated from one site to another and is marked for use in relocatable buildings.

[29] DOE issued the March 2015 NOPR on February 10, 2015. 80 FR 13120, 13197. Therefore, the later of the two dates is April 24, 2016.

procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. (42 U.S.C. 6295(s)) DOE's current energy conservation standards for consumer furnaces are expressed in terms of AFUE (*see* 10 CFR 430.32(e)(1)). AFUE is an annualized fuel efficiency metric that accounts for fossil fuel consumption in active, standby, and off modes. The existing DOE test procedure for determining the AFUE of consumer furnaces is located at 10 CFR part 430, subpart B, appendix N. The DOE test procedure for consumer 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.

Since the initial adoption of the consumer furnaces test procedure, DOE has undertaken a number of additional rulemakings related to that test procedure, including ones to account for measurement of standby mode and off mode energy use (*see* 75 FR 64621 (Oct. 20, 2010); 77 FR 76831 (Dec. 31, 2012)) and to supply necessary equations related to optional heat-up and cool-down tests (*see* 78 FR 41265 (July 10, 2013)).

Most recently, DOE published a final rule in the **Federal Register** on January 15, 2016, that further amended the test procedure for consumer furnaces (January 2016 TP final rule). 81 FR 2628. The 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.

81 FR 2628, 2629–2630.

As such, the most current version of the test procedure (published in January 2016) has now been in place for several years and is available to commenters when considering the proposals presented in this NOPR.

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. *See* 10 CFR part 430, subpart C, appendix A (''Process Rule''), sections 6(b)(3)(i) and 7(b)(1).

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; (3) adverse impacts on health or safety; and (4) unique-pathway proprietary technologies. Sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5) of the Process Rule. Section IV.B of this document discusses the results of the screening analysis for NWGF and MHGF, 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 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 NOPR and in chapter 5 of the 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 amended or new standards (2029–2058).[30] The savings are measured over the entire lifetime of products purchased in the 30-year analysis 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 or new energy conservation standards.

DOE used its national impact analysis (''NIA'') spreadsheet models to estimate national energy savings (''NES'') from potential amended and new standards for NWGFs and MHGFs. The NIA spreadsheet model (described in section IV.H of this NOPR) 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 energy savings in terms of primary (source) energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. 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*'') currently *AEO 2021.* 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.[31] DOE's approach is based on

[30] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

[31] 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 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 NOPR.

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))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[32] For example, the United States has rejoined the Paris Agreement and will exert leadership in confronting the climate crisis.[33] Additionally, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. In evaluating the significance of energy savings, DOE considers differences in primary energy and FFC effects for different covered products and equipment when determining whether energy savings are significant. Primary energy and FFC effects include the energy consumed in electricity production (depending on load shape), in distribution and transmission, and in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, present a more complete picture of the impacts of energy conservation standards.

Accordingly, DOE is evaluating the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors. As discussed in section V.C of this document, DOE is proposing to adopt TSL 8 for AFUE, which would save an estimated 5.76 quads of energy (FFC) over 30 years, and TSL 3 for standby mode and off mode, which would save an estimated 0.28 quads over 30 years. Based on this amount of FFC savings, the corresponding reduction in emissions, and need to confront the global climate crisis, DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B).

E. Economic Justification

1. Specific Criteria

As noted previously, 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 potential amended standards on manufacturers, DOE conducts an MIA, as discussed in section IV.J of this document. 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) 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 product-specific regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and 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 LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national 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 analyses.

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. In general, 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 analyses, 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 analyses is discussed in further detail in section IV.F of this document.

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 IV.H of this document, DOE uses the NIA spreadsheet models to project national energy savings.

[32] The numeric threshold for determining the significance of energy savings, which was established in a final rule published in the **Federal Register** on February 14, 2020 (85 FR 8626, 8705), was subsequently eliminated in a final rule published in the **Federal Register** on December 13, 2021 (86 FR 70892, 70901–70906).

[33] *See* Executive Order 14008, ''Tackling the Climate Crisis at Home and Abroad,'' 86 FR 7619 (Feb. 1, 2021).

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 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 the **ADDRESSES** section for information to send comments to DOJ.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water 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 potential standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

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 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 of this document; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the monetized value of health benefits of certain emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

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 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 effect potential amended 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 of this proposed rule.

F. Other Issues

1. Furnace Sizing Requirements Based on ACCA Manual J and Manual S

On June 30, 2016, AGA presented information to DOE and the Office of Information and Regulatory Affairs (''OIRA'') that AGA asserted supports a 70 kBtu/h maximum capacity threshold for small furnaces.[34] Specifically, AGA submitted calculations performed by a consultant, HTR Engineering, that used the ACCA Manual J methodology to determine the heating load for various types of houses in various locations.[35] For each scenario, AGA submitted Microsoft Excel worksheets and PDF ''J1–ALP'' forms with the summary inputs, assumptions, and corresponding components of the overall heating load to DOE.[36] In addition to the Manual J results for each scenario, in its presentation, AGA also provided information on the appropriate furnace size for each scenario based on ACCA Manual S. DOE subsequently presented a slide at the October 2016 public meeting covering the September 2016 SNOPR that summarized the information provided by AGA for further discussion among all interested parties.[37] DOE noted that Manual S requires that furnaces be sized at between 1.0 and 1.4 times the Manual J calculated load, and the ''appropriate furnace size'' presented by AGA based on the Manual S requirement did not appear to be within that range, based on the Manual J data provided by AGA.

In their subsequent written comments, AGA stated that DOE misrepresented the information from the HTR Engineering furnace sizing study to support the proposed standard. First, AGA commented that DOE incorrectly described the data in the table presented at the SNOPR public meeting as AGA's data and AGA's methodology, even

[34] AGA presented this information in a PowerPoint slide deck titled, ''Additional Information for OIRA Staff DOE Furnace SNOPR'' (June 30, 2016). This presentation is located at the docket at: *www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0209.*

[35] AGA provided results for four building types at two levels of efficiency and in five locations. The four building types were: two-story townhome with basement; two-story townhome without basement; three-story townhome without basement; and small single family detached home. The two efficiency levels were a highly efficient home built to 2015 code and a highly inefficient home built to 1950s era practices and standards. The five locations were Atlanta, Chicago, Minneapolis, Salt Lake City, and Oklahoma City.

[36] *See: www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0209.*

[37] *See: www.regulations.gov/document/EERE-2014-BT-STD-0031-0236.*

though the analysis was done by a third-party consultant. Second, AGA stated that the numbers DOE presented in the public meeting only included the results from the building envelope efficiency assessment of the HTR study and excluded the load associated with the duct system efficiency assessment and the outdoor air requirements presented in the study, thereby significantly understating the actual building heating loads. Third, AGA asserted that due to the use of what it stated are the incorrect building load numbers, the calculated preferred output and input capacity, as presented by DOE, were also incorrect. Fourth, AGA commented that if DOE had used what AGA deemed to be the correct building load numbers, the ''AGA'' oversize factors (as presented by DOE) would reflect the 1.4 oversize factor from ACCA Manual S. AGA presented a revised version of the table shown in the public meeting with corrected values. Lastly, AGA asserted that if DOE were to use what AGA understood to be the correct building heating load, a 55,000 Btu/h NWGF would not be able to serve the heating needs of the type of home assessed. (AGA, No. 306–1 at pp. 13, 52–54) PHCC stated that the heating loads submitted by AGA and presented on DOE's slide 30 of the October 17, 2016 Public Meeting are understated. PHCC commented that it appears that infiltration losses and the possibility of unoccupied space may not have been fully accounted for in these calculations. As a result, PHCC stated that this analytical flaw puts in question the calculations used to justify the input capacity limit for exemption from the proposed standard. PHCC presented alternative calculations based on a 1,500 square foot townhouse, which it asserted show that a 1500 square foot townhouse similar to the one analyzed by AGA would not be a candidate for a 55,000 Btu/h furnace on a 25 °F day. (PHCC, No. 298 at p. 2)

In response, DOE notes that in the summary spreadsheets provided by AGA, the output from the Manual J load calculation, as listed on the J1–ALP forms, is used for the Manual S furnace sizing. In other words, Manual S specifies that the appropriate equipment size be based on the load calculation resulting from Manual J. When compared to the information presented by AGA regarding the appropriate furnace size for each scenario (Additional Information for OIRA Staff DOE Furnace SNOPR, June 30, 2016 presented in slide #7), these values imply an oversize factor of approximately 2, which is inconsistent with the Manual S requirement for an oversize factor of 1.0–1.4 for these buildings. In their written comments, AGA provided a table (AGA, No. 306–1 at p. 52) which includes heating load numbers (labeled Heating Load Numbers from HTR Furnace Sizing Study); however, these values were not previously provided as the basis for the furnace sizing requirements for the scenarios by AGA. More specifically, AGA did not provide information to DOE regarding its assumptions or calculations for the load associated with the duct system efficiency assessment or the outdoor air requirements. Therefore, DOE maintains that its characterization of the original data submittal compared to the presented data is appropriate.

However, when considering AGA's ''corrected'' version of the table, DOE notes that for the ranges presented in the column for ''ACCA Manual S preferred input capacity '' show that in most cases (all but one—Minneapolis), a 55,000 Btu/h furnace could meet the required load. While AGA's ''corrected'' table shows the ''Appropriate Furnace Size for a 1,500 s.f. Inefficient Townhouse presented in AGA slide deck to OMB (kBtu/h)'' is based on a 1.4 oversize factor, DOE notes that Manual S specifies that the factor can be anywhere from 1.0 to 1.4, and Manual S recommends sizing the furnace as close to 1.0 as possible. Thus, while oversizing a furnace up to 40 percent is acceptable, it is preferred to size it appropriately according to the calculated load in Manual S. Therefore, the ''preferred'' input capacity would be the low end of the range presented in AGA's table, which for four of the five scenarios presented is below 55,000 Btu/h (and in the fifth case is 62,200 Btu/h). Thus, based on the data submitted by AGA, a threshold of 55,000 Btu/h would alleviate impacts in the majority of situations, except in the most extreme cases (such as Minneapolis). Even in these situations, such as in Minneapolis, a 55,000 Btu/h furnace would likely be able to meet the majority of the heating load, with a small amount of supplemental heating required from other sources. Therefore, DOE maintains its position that 55 kBtu/h is appropriate for consideration as a potential threshold for defining small furnaces, and further discusses its decision with regard to this in sections IV.A.1.a and V.C.1 of this document. Furnaces at or above this threshold would represent approximately 86% of furnace shipments in the no-new-standards case. In response to PHCC, DOE notes that the files submitted by AGA do appear to account for infiltration losses, and some scenarios include unoccupied basement space. However, some of the assumptions used by PHCC in its calculations appear to differ from those made in the data submitted by AGA, including the dimensions of exterior walls and area and type of windows, among other parameters, which may account for the difference in results.

2. Compliance Date

As discussed in the withdrawn September 2016 SNOPR, missed deadlines in the furnace rulemaking history have resulted in ambiguity in terms of the applicable statutory compliance date for any potential amended standards that result from this rulemaking. 81 FR 65720, 65746 (Sept. 23, 2016). DOE explained that, in light of this ambiguity, it is informed by Congress's most recent direction regarding the lead time specific to furnace rulemakings (*i.e.,* 5 years) under the 6-year review requirement (42 U.S.C. 6295(m)(4)(A)(ii)). 81 FR 65720, 65747 (Sept. 23, 2016). DOE posited that 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), would be in alignment with the provision in the 6-year-lookback authority that 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); the relevant date being November 19, 2015—the compliance date of the last amendments applicable to NWGFs and MHGFs.) *Id.* Further, DOE asserted that the compliance date of the July 2014 Furnace Fan Final Rule [38] (*i.e.,* July 3, 2019) is not relevant to the minimum 6-year period required under 42 U.S.C. 6295(m)(4)(B), stating that furnace fan standards are to be treated as a separate covered product and are not to be understood as a standard on furnaces. *Id.* DOE continues to adhere to this view and is proposing a five-year lead time for compliance with any amended energy conservation standards for NWGFs and MHGFs, for the reasons that follow.

DOE interprets furnaces and furnace fans as separate products under EPCA. The 6-year period under 42 U.S.C. 6295(m)(4)(B) is applicable in the context of standards directly applicable to the product in question. As such, the standards for furnace fans are not a consideration when applying the 6-year period to new or amended standards for furnaces. DOE acknowledges that

[38] *See* 79 FR 38130 (July 3, 2014).

''furnace fan'' is not expressly defined by EPCA as a ''covered product.'' However, EPCA, and the relevant amending statutes, provide for the treatment of furnace fans as a product separate from furnaces, and DOE's standards for furnace fans are separate and distinct from the standards for furnaces. DOE is expressly authorized to establish energy conservation standards for electricity used for purpose of circulating air through duct work. (42 U.S.C. 6295(f)(4)(D)) An energy conservation standard is a performance standard ''which prescribes a minimum level of energy efficiency or a maximum quantity of energy use . . . for a covered product.'' (42 U.S.C. 6291(6)) DOE has interpreted EPCA as providing direction to the Department to establish an energy conservation standard for furnace fans, which are to be treated as a separate consumer product.

Further, the authority to establish such standards was added to EPCA by section 135, of the Energy Policy Act of 2005, which was titled ''Energy Conservation Standards for Other Products,'' again indicating that the standards are to be treated as standards applicable to a product separate from furnaces. Public Law 109–58, section 135 (August 8, 2005); 119 Stat. 594, 624. The establishment of such standards was made mandatory under section 304 of the Energy Independence and Security Act of 2007 (EISA 2007), which was titled ''Furnace Fan Standard Process,'' further indicating that furnace fans are to be considered as a covered product separate from furnaces. Public Law 110–140, section 304 (Dec. 19, 2007); 121 Stat. 1492, 1553.

The authority to establish energy conservation standards for ''electricity used for purposes of circulating air through duct work'' does not expressly reference furnaces. (*See* 42 U.S.C. 6295(f)(4)(D)) Where EPCA has required the establishment of standards for furnaces, it has done so expressly. ''Furnaces (other than furnaces designed solely for installation in mobile homes) manufactured on or after January 1, 1992, shall have an annual fuel utilization efficiency of not less than 78 percent[.]'' (42 U.S.C. 6295(f)(1)); ''Furnaces which are designed solely for installation in mobile homes and which are manufactured on or after September 1, 1990, shall have an annual fuel utilization efficiency of not less than 75 percent.'' (42 U.S.C. 6295(f)(2)); ''The Secretary shall publish a final rule no later than January 1, 1994, to determine whether the standards established by this subsection for furnaces (including mobile home furnaces) should be amended.'' (42 U.S.C. 6295(f)(4)(C)) Instead of directing DOE to establish furnace standards for electricity used for the purpose of circulating air, or standards for electricity used by furnaces for the purpose of circulating air through duct work, EPCA directs DOE to establish standards for electricity used for purposes of circulating air through duct work without reference to furnaces in that paragraph. Further, DOE has found that this language could be interpreted as encompassing electrically-powered devices used in any residential heating, ventilation, and air-conditioning (''HVAC'') product to circulate air through duct work, not just furnaces. 79 FR 500, 504 (Jan. 3, 2014).

Consistent with treating the furnace fan standards and the furnace standards as standards on separate products, EPCA established two separate timeframes for the furnace fan and furnace rulemakings. Section 304 of EISA 2007, Furnace Fan Standard Process, amended the provision regarding standards for electricity used for the purpose of circulating air through duct work by requiring DOE to establish such standards by December 31, 2013. EISA 2007, Public Law 110–140, section 304 (Dec. 19, 2007); 121 Stat. 1492, 1553; 42 U.S.C. 6295(f)(4)(D). In the section immediately following the Furnace Fan Standard Process section, EISA 2007 amended EPCA to establish the 6-year-lookback review requirement for energy conservation standards. EISA 2007, Public Law 110–140, section 305 (Dec. 19, 2007); 121 Stat. 1492, 1553; 42 U.S.C. 6295(m). EPCA required DOE to establish an amended final rule for furnaces no later than January 1, 2007, with a compliance date of January 1, 2012. (42 U.S.C. 6295(f)(4)(C)) As a result of the 6-year review provision added under EISA 2007, DOE had to either a publish a determination that no amendment of the furnace standards is needed or issue a notice of proposed rulemaking to amend the furnace standards by January 1, 2013. Instead of aligning the furnace fan rulemaking with the furnace rulemaking schedule, EPCA, as amended by EISA 2007, established a distinct December 1, 2013 deadline, further indicating that furnace fans are to be treated separately from furnaces.

As DOE acknowledged in a 2013 notice of proposed rulemaking for furnace fan energy conservation standards, standards for furnace fans may require manufacturers to redesign the furnaces in which the fans are installed. 78 FR 64068, 64103 (Oct. 25, 2013). However, the compliance date mandated by EPCA for amendments to standards under the 6-year review requirement does not permit DOE to account for standards applicable to other products, even if such standards for other products may impact the product subject to the amendment. (42 U.S.C. 6295(m)(4)) EPCA directs DOE to prescribe a compliance date in consideration of both the publication date of the final rule and the date of the last amended standards with which that product was required to comply. (42 U.S.C. 6295(m)(4)(A)–(B)) Standards with which furnaces are not required to comply are not a consideration under 42 U.S.C. 6295 (m)(4)(A)–(B) even if those standards have an impact on furnaces. As discussed, EPCA treats furnaces and furnace fans as two separate products. As such, DOE has not considered the furnace fan standards when establishing the compliance date of furnace standards under 42 U.S.C. 6295(m)(4)(A)–(B).

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 considered 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 projections 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/standards.aspx?productid=59&action=viewlive.* Additionally, DOE used output from *AEO 2021* 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) 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 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 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 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 section II.B.1 of this document, 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, 13130–13132 (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) for this NOPR.

At various rulemaking stages, interested parties have raised concerns pertaining to potential impacts of a national condensing standard on certain consumers as a result of either increased installation costs (due to the increased cost of the condensing furnace itself and/or related venting modifications) or switching to electric heat (potentially resulting in higher monthly bills). In response to these concerns, DOE first published the September 2015 NODA, which contained analyses examining the potential impacts of a separate product class for furnaces with a lower input capacity, one of the statutory bases for establishing a separate product class. Such an approach was suggested by stakeholders as a potential way to reduce negative impacts on some furnace consumers while maintaining the overall economic and environmental benefits of amended standards for consumer furnaces. 80 FR 55038, 55038–55039 (Sept. 14, 2015). In response to the September 2015 NODA, DOE received further comments from several stakeholders recommending that DOE establish separate product classes based on furnace capacity, in order to preserve the availability of non-condensing NWGF for buildings with lower heating loads, thereby helping to alleviate the negative impacts of the proposed standards. DOE responded to these comments in the withdrawn September 2016 SNOPR, in which the Department tentatively concluded that the establishment of a small furnace class would have merit. Accordingly, after considering energy savings and economic benefits of several potential input capacity thresholds, DOE proposed to establish a separate product class for small NWGF, defined as those furnaces with a certified input capacity of less than or equal to 55 kBtu/h, and the Department proposed to retain a minimum standard of 80-percent AFUE for this class. 81 FR 65720, 65752 and 65837 (Sept. 23, 2016).

For the current NOPR analysis, DOE again considered whether a ''small furnace'' product class is justified for NWGFs and MHGFs and evaluated several input capacity thresholds, including the 55 kBtu/h threshold that was proposed in the withdrawn 2016 SNOPR, along with several others. DOE analyzed a range of potential input capacity cut-offs and considered the benefits and burdens of each. However, as discussed in section V.C.1 of this document, after considering the benefits and burdens of the various approaches, DOE is not proposing to divide furnace product classes by capacity in this document.

b. Condensing and Non-Condensing Furnaces

DOE has recently considered whether different venting technologies should be considered a necessary feature. On January 15, 2021, in response to a petition for rulemaking [39] submitted by the American Public Gas Association, Spire, Inc., the Natural Gas Supply Association, the American Gas Association, and the National Propane Gas Association (the ''Gas Industry Petition''), DOE published the January 2021 final interpretive rule in the **Federal Register** determining that, in the context of residential furnaces, commercial water heaters, and similarly-situated products/equipment, use of non-condensing technology (and associated venting) constitutes a performance-related ''feature'' under EPCA that cannot be eliminated through adoption of an energy conservation standard. 86 FR 4776. Correspondingly, on the same day, DOE published in the **Federal Register** a notification withdrawing the March 2015 NOPR and the September 2015 SNOPR for NWGFs and MHGFs. 86 FR 3873 (Jan. 15, 2021).

However, as explained in section II.B.2 of this document, DOE subsequently published a final interpretive rule in the **Federal Register** that returns to the Department's previous and long-standing interpretation (in effect prior to the January 15, 2021 final interpretive rule), under which the technology used to supply heated air or hot water is not a performance-related ''feature'' that provides a distinct consumer utility under EPCA. 86 FR 73947 (Dec. 29, 2021). Accordingly, for purposes of the analyses conducted for this NOPR, DOE did not analyze separate equipment classes for non-condensing and condensing furnaces. However, as discussed in section IV.A.1.a of this document, the current analysis does consider various capacity thresholds to establish a separate product class for small NWGFs for which DOE would propose less stringent energy conservation standards. The

[39] DOE published the Gas Industry Petition in the **Federal Register** for comment on November 1, 2018. 83 FR 54883.

consideration of capacity-based product classes for MHGFs is discussed in section IV.A.1.c of this document.

c. Mobile Home Gas Furnaces

In response to the September 2016 SNOPR (subsequently withdrawn), some stakeholders requested that DOE establish a small furnace product class for MHGFs. MHI suggested that DOE should exempt all MHGFs from this rule, but it stated that if MHGFs are included, DOE should adopt a small furnace MHGFs product class with a threshold of 80 kBtu/h. Nortek and MHI commented that tight construction of manufactured homes reduces the structure's air leakage, which results in lower heating loads and negates the need for a more expensive 92-percent AFUE furnace in many climates, especially in the South. (Nortek, No. 300 at p. 2; MHI, No. 282 at p. 2) Nortek and MHI further stated that because the majority of manufactured home buyers are low- to median-income consumers, it is important that any increase in home cost resulting from new energy conservation standards be economically justified and not burden affordability by increasing up-front costs without mitigating resulting access barriers. Nortek stated that without a small MHGFs product class, potential homebuyers with modest incomes will be forced to purchase MHGFs that are unnecessary for their home. (Nortek, No. 300 at pp. 5–6; MHI, No. 282 at p. 4)

Mortex argued that the standard level for MHGFs should not be changed due to the small market size, and the commenter also stated that an input capacity threshold for MHGFs at any level does not make sense because it would create a smaller, less significant market size for each class (above and below the threshold). (Mortex, No. 305 at p. 2)

AHRI stated that DOE must reevaluate its analysis for MHGFs so as to set an appropriate breakpoint for such products that maintains a non-condensing option for that market. (AHRI, No. 303 at p. 1) AHRI and Nortek noted that in previous comments submitted by AHRI in response to the September 2015 NODA, AHRI had requested that DOE analyze potential separate standard levels for small and large MHGF in order to minimize potential negative aspects of the proposed standard in the (now withdrawn) March 2015 NOPR. (AHRI, No. 303 at p. 18; Nortek, No. 300 at p. 3) In particular, AHRI's comments responding to the September 2015 NODA expressed concerns regarding the number of consumers that would be negatively affected or would switch heating fuels if an AFUE standard set at a condensing level were adopted as the minimum efficiency standard for MHGFs. Furthermore, AHRI expressed its concerns with the tools utilized in the (now withdrawn) March 2015 NOPR analysis would apply equally to MHGFs. (AHRI, No. 195 at p. 1)

AHRI and Nortek also argued that DOE reached a number of incorrect conclusions in the September 2016 SNOPR, including: (1) that condensing gas furnaces in new mobile homes will cost about the same as non-condensing models; (2) that replacing an existing non-condensing MHGF with a condensing MHGF would not have a significant increased installation cost; and (3) that very few residents living in mobile homes will experience negative life cycle costs.[40] AHRI and Nortek stated that U.S. Department of Housing and Urban Development (''HUD'') regulations for the construction of mobile (manufactured) homes, require that a MHGF be installed such that it is isolated from the conditioned space of the mobile home, and that all combustion and ventilation air must be taken from the outdoors, and the vent system must vent vertically through a roof jack. Additionally, the commenters noted that the space in which a MHGF is installed is minimized to the smallest size that safety and performance considerations will allow because space is at a premium in mobile homes. (AHRI, No. 303 at pp. 18–19; Nortek, No. 300 at pp. 3–4)

After considering these comments regarding a ''small'' MHGF product class, DOE has preliminarily determined that that some of the potential negative outcomes for MHGF consumers could be mitigated by consideration of a separate standard for ''small'' MHGF similar to the analysis done for NWGF. Accordingly, DOE analyzed a separate standard for small MHGFs for this NOPR. However, as discussed in section IV.A.1.a of this document, after considering the benefits and burdens of potential capacity-based product classes, DOE has decided not to propose to establish classes based on capacity in this document. Section V.C.1 of this document contains discussion that explains DOE's weighting of the burdens and benefits of the potential new and amended energy conservation standards analyzed for this NOPR. Additionally, DOE does not agree that condensing MHGFs are necessarily larger than noncondensing MHGFs. Based on a review of product literature, it appears that noncondensing and condensing MHGFs are often designed with similar cabinet sizes, and, thus, DOE does not expect that replacing a noncondensing MHGF with a condensing MHGF would necessitate a larger footprint.

d. Standby Mode and Off Mode

As discussed in section II.A of this document, EPCA requires any final rule for new or amended energy conservation standards promulgated after July 1, 2010, to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Accordingly, this rulemaking considers standby mode and off mode energy consumption of NWGFs and MHGFs, and this notice includes proposed standards for these operational modes.

''Standby mode'' and ''off mode'' energy use are defined in the DOE test procedure for residential furnaces and boilers (*i.e.,* ''Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers,'' 10 CFR part 430, subpart B, appendix N). In that test procedure, DOE defines ''standby mode'' for consumer furnaces and boilers as any mode in which the furnace or boiler is connected to a mains power source and offers one or more of the following space heating functions that may persist: (a) To facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including thermostat or remote control), internal or external sensors, or timer; and (b) Continuous functions, including information or status displays or sensor based functions. (10 CFR part 430, subpart B, appendix N, section 2.12) ''Off mode'' for consumer furnaces and boilers is defined as a mode in which the furnace or boiler is connected to a mains power source and is not providing any active mode or standby mode function, and where the mode may persist for an indefinite time. The existence of an off switch in off position (a disconnected circuit) is included within the classification of off mode. (10 CFR part 430, subpart B, appendix N, section 2.9) An ''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 2.10.) As discussed

[40] AHRI and Nortek also provided more specific arguments stating that: (1) replacing a non-condensing MHGF with a condensing MHGF is not a simple drop-in; (2) a condensing furnace, with the added heat exchanger needed to achieve condensing operation, may not be dimensionally the same as the original non-condensing furnace installed in the mobile home when it was manufactured; (3) rework may be needed to install the new PVC venting system; and (4) there will be the added cost of the labor to remove the old venting system.

previously, DOE does not currently prescribe standby mode or off mode standards for NWGFs and MHGFs. DOE's analysis of standby mode and off mode standards is discussed further in section IV.C of this document.

2. Technology Options

In the market analysis and technology assessment, DOE has identified 12 technology options that would be expected to improve the AFUE efficiency 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) premix burners; (9) burner de-rating; (10) insulation improvements; (11) off-cycle dampers; and (12) direct venting. 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. A detailed discussion of each technology option identified is contained in chapter 3 of the NOPR TSD.

DOE considered each technology further in the screening analysis (see section IV.B of this document or chapter 4 of the NOPR TSD) to determine which could be considered further in the analysis and which should be eliminated.

B. Screening Analysis

DOE uses the following five 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 impacts on the utility of the product to significant subgroups of consumers or would result in the unavailability of any covered product 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.

(5) *Unique-Pathway Proprietary Technologies.* If a design option utilizes proprietary technology that represents a unique pathway to achieving a given efficiency level, that technology will not be considered further due to the potential for monopolistic concerns. 10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b).

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

The subsequent sections include comments from interested parties 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

For this NOPR, DOE has screened out the following technologies: pulse combustion, burner de-rating, and control relay to depower BPM motors. Each of these will be discussed in turn.

As mentioned, DOE screened out the use of pulse combustion. 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. This technology option was screened out due to past reliability and safety issues, which has resulted in manufacturers generally not considering their use a viable option to improve efficiency. In addition, furnace 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.

DOE also screened 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 energy input, which increases efficiency. This technology option was screened out because it reduces the burner firing rate while maintaining the same heat exchanger geometry/surface area and fuel-air ratio, resulting in less heat being provided to the user than is provided using conventional burner firing rates.

Lastly, DOE screened out use of a control relay to depower BPM motors. For this 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. This technology option was screened out because manufacturer interviews previously indicated that using a control relay to depower BPM motors could reduce the lifetime of the motors.

It is noted that in earlier rulemaking analyses (*e.g.,* for the since withdrawn September 2016 SNOPR), DOE had screened out premix burners from further analysis because premix burners had not yet been successfully incorporated into a consumer furnace design, raising concerns about the technological feasibility of premix burners in furnaces. Incorporating this technology into furnaces on a large scale at that time would have required further research and development due to the technical constraints imposed by current furnace burner and heat exchanger design. However, in conducting the market and technology assessment and screening analysis for this NOPR, DOE has now identified NWGF furnaces with premix burners on the market and, therefore, has not screened this technology option out of its analysis, because the technological feasibility and practicability to manufacture such designs has been demonstrated. However, DOE notes that the premix burner designs observed on the market were implemented in ultra low NO_X [41] models, indicating that the development of premix burner designs has been primarily driven by NO_X requirements. The efficiencies of these models are the same as those achieved by more conventional non-premix burner designs used in furnaces. Therefore, while the use of premix burners was not screened out, it was not considered a primary driver for improving efficiency.

The technology options assumed to be implemented to achieve each efficiency

[41] ''Ultra low NO_X'' furnaces produce no more than 14 nanograms of NO_X per Joule.

level are discussed further in section IV.C.1 of this NOPR. Chapter 4 of the TSD includes additional information on the screening analysis.

Based on comments received in response to the September 2016 SNOPR from stakeholders who were concerned that raising standards to condensing levels would result in adverse impacts to safety (*see:* PHCC, No. 298 at pp. 1, 2; Lennox, No. 299 at pp. 19–20; Southern Company, No. 257 at pp. 10–11; Spire, No. 224 at pp. 27, 39; Efficiency Advocates, No. 285 at pp. 4–5), DOE carefully considered the safety of condensing furnaces for this NOPR. DOE notes that condensing furnaces have been in use for decades and have significant market share across the entire United States. These products have been demonstrated to be safe when installed and used in accordance with manufacturer instructions. Some commenters suggested that an increase in the number of condensing furnaces installed would lead to an increase in safety issues due to a higher likelihood of improper venting or use of heat tape. However, the reports cited by commenters, which suggest an increased prevalence of fires and deaths attributable to improper furnace installation, improper maintenance, and improper venting, do not distinguish between instances involving condensing furnaces and instances involving non-condensing furnaces and may encompass both types of units.[42] To the extent that any theoretical safety issues might arise due to inexperience with the installation of condensing furnaces, DOE once again notes that condensing furnaces have achieved substantial market penetration in both the northern and southern United States,[43] and installers will become more familiar with the proper installation methods for these products as their presence continues to increase in the market. The 5-year lead time before compliance is required with any standards arising from this rulemaking provides manufacturers and trade associations sufficient time to educate installers, particularly those less experienced with condensing furnaces, about how to safely install, operate, and repair them.

Commenters also suggested in response to the subsequently withdrawn 2016 SNOPR that the increased cost of furnace replacement could lead consumers to use alternate heat sources that they characterize as less safe, or to conduct an unsafe repair of a malfunctioning furnace rather than replace it. In response, DOE notes that furnace repairs are typically performed by contractors, so it is unlikely that a contractor would opt to repair a furnace in a manner that allows for unsafe operation. In most cases, to do so would be a breach of local codes that have negative consequences for the contractor. Regarding the possibility of a consumer choosing to use an alternate heating source such as a space heater, the reports cited by commenters state that the leading factors contributing to fires resulting from space heaters are the misuse of the product or improper maintenance of the product.[44] The standards proposed in this document do not require consumers to use alternate heating products such as space heaters, let alone use such products in an unsafe manner. Further, there is no indication that the proposed standards would make it more likely that consumers choosing to reply upon such products would do so in an unsafe manner.

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 of this document met all five screening criteria to be examined further as design options in DOE's 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; (9) direct venting; and (10) premix burners. 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 has 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 continues to find that all of the remaining technology options meet the other screening criteria (*i.e.,* practicable to manufacture/install/service, do not result in adverse impacts on consumer utility, product availability, health, or safety, and do not involve a proprietary technology that is a unique pathway to meeting a given efficiency level). For additional details, see chapter 4 of the TSD.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of NWGFs and MHGFs. There are two elements to consider in the engineering analysis: (1) the selection of efficiency levels to analyze (*i.e.,* the ''efficiency analysis'') and (2) the determination of product cost at each efficiency level (*i.e.,* the ''cost analysis''). In determining the performance of higher-efficiency NWGFs and MHGFs, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each furnace class analyzed for this NOPR, DOE estimates the baseline cost, as well as the incremental cost for the furnace at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

The methodology for the efficiency analysis and the cost analysis is described in detail in the following sections that immediately follow (sections IV.C.1 and IV.C.2, respectively, of this document). DOE uses its methodology, which consists of the engineering analysis and mark-ups analysis (see section IV.D of this document), to determine the final price of the furnace to the consumer for several reasons. The sales prices of furnaces currently seen in the marketplace, which include both a manufacturer production cost (''MPC'') and various mark-ups 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, MPC depends in part on the production volume. In general, for efficiency levels above the current baseline, the price to

---

[42] DOE also notes that a more recent report by the National Fire Protection Association (''NFPA'') does not attribute any deaths to fires resulting from heating tape between 2014 and 2018. *See* Richard Campbell, National Fire Protection Association Fire Analysis and Research Division, *Home Heating Fires Supporting Tables* (January 2021) p. 7 (Available at: *www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fire-causes/appliances-and-equipment/heating-equipment*) (Last accessed February 15, 2022).

[43] *See* section IV.F.9 of this document for further discussion of the efficiency distribution for the subject furnaces.

[44] FEMA, Heating Fires in Residential Buildings (2010–2012), Topical Fire Report Series (December 2014) p. 7 (Available at: *www.usfa.fema.gov/downloads/pdf/statistics/v15i7.pdf*) (Last accessed February 15 2022); See also, Richard Campbell, NFPA Fire Analysis and Research Division, *Home Heating Fires Supporting Tables* (January 2021) (Available at: *www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fire-causes/appliances-and-equipment/heating-equipment*) (Last accessed February 15, 2022).

the consumer 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.

DOE notes that the engineering analysis incorporated condensing furnaces without ''premium'' features, and condensing furnaces are more likely to be equipped with ''premium'' features in today's market. One would expect increased designs (and/or sales) with minimal ''premium'' features to cater to cost-sensitive consumers, as compared to the current market, and perhaps redesigns where possible, to minimize costs. In its analysis of AFUE levels, DOE sought to minimize or normalize the presence of additional designs or features that do not affect AFUE, as they can increase costs while not affecting the measured AFUE efficiency. In other words, DOE's analysis of the cost-efficiency relationship is for a product that provides only the basic utility (*i.e.,* heat) without other special features that consumers may find beneficial (*e.g.,* sound reduction or humidity control). Although it may be possible to identify prices for products without premium features, simply aggregating a collection of current furnace sales price information could lead to a higher consumer price than would be expected under an amended standards scenario, as many condensing products available on the market today are bundled with ''premium'' features but under an amended standards scenario, condensing products without as many ''premium'' features may become more common.

As described in section IV.D of this document, under a more-stringent standard, the mark-ups incorporated into the sales price may also change relative to current mark-ups. Therefore, DOE has tentatively concluded that basing the engineering analysis on prices of furnaces as currently seen in the marketplace would be a less accurate method of estimating future furnace prices following an amended standard than DOE's approach of conducting an engineering analysis and mark-ups analysis for this NOPR. (However, as noted in section IV.C.2 of this document, price surveys are sometimes required when other methods are infeasible.)

Furthermore, at earlier stages of the NWGF and MHGF rulemaking, some stakeholders performed cost-benefit analyses that relied on online retail pricing,[45] which raise additional concerns beyond the issues previously discussed (*i.e.,* the data likely includes prices for condensing furnaces with ''premium'' features and does not account for the likely change in designs, market, and pricing that would occur under an amended standard). Differences between online vendors with respect to mark-up and pricing practices could lead to online prices being unrepresentative for the overall market. In addition, manufacturers indicated during interviews (see section IV.C.2.f of this document) that the number of furnaces sold directly to consumers over the internet is very small, and, therefore, DOE questions whether such prices are representative of what most consumers actually pay for these products. For these reasons, it is unlikely that a collection of online price data is truly representative of what consumers are paying for furnaces currently, much less under an amended standards scenario.

Certain stakeholders also urged DOE to improve the transparency of the engineering analysis by releasing certain information currently not available within the public domain. (Spire No. 309–1 at pp. 66–67; APGA, No. 292–1 at p. 41) However, previously during this rulemaking, 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 bill of materials (''BOM'') from a complete teardown analysis of their product(s) being made available to the public. (Rheem, NOPR Public Meeting Transcript, No. 0044, at pp. 74–75)

In response, DOE's analysis and proposal are based, in part, on the aggregated data generated during the engineering analysis. The process by which the aggregated data have been generated is discussed in this document and is the result of the engineering analyses described in chapter 5 of the NOPR TSD. The primary inputs to the engineering analysis are data from the market and technology assessment, input from manufacturers, furnace specifications, and production cost estimates developed based on teardown analysis and consultation with manufacturers. DOE's contractor 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, and applies mark-ups to determine the expected sales price once a more-stringent standard is implemented. In addition, 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. DOE notes that manufacturers that participated in manufacturer interviews had access to the raw material and purchased part price data underlying the MPC estimates for those models at the time the interviews were conducted. The data resulting from the engineering analysis and which DOE has used as inputs to its modeling are available to the public for comment. Including manufacturer-specific information in the docket would raise serious concerns regarding the business confidentiality of that information and undermine the ability of the Department to gain access to key data based on such specific information going forward. 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))

In the present proceeding, as is generally the case in appliance standards rulemakings, manufacturer-specific and product-specific data are presented in aggregate. Given the potential for competitive harm, data are not released outside the aggregated form to DOE or its National Labs. Instead, 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, without fear of such sensitive data being released to the public. This approach allows manufacturers to provide candid and detailed feedback under NDA, thereby improving the quality of the analysis. The public is provided the opportunity to comment on the aggregated data that was provided to DOE (*i.e.,* the same data that DOE used in its analyses). Making manufacturer-specific data available would theoretically provide additional background on that data, but it would be merely supplemental to the data upon which DOE relied, and it would certainly have a chilling effect on manufacturers' willingness to share this crucial data going forward. Consequently, DOE plans to retain its

[45] As one example, consider the 2013 Furnace Price Guide, originally published on *www.furnacecompare.com. See: www.amazon.com/Furnace-Price-Guide-Chris-Brooks-ebook/dp/B00GR784IK.* The Gas Technology Institute (GTI) used these data for its report ''Technical Analysis of DOE Supplemental Notice of Proposed Rulemaking on Residential Furnace Minimum Efficiencies.'' (*See:* EERE–2014–BT–STD–0031–0301.)

current and long-standing approach to the engineering analysis.

1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) relying on observed efficiency levels in the market (*i.e.,* the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.,* the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing products (in other words, based on the range of efficiencies and efficiency level ''clusters'' that already exist on the market). Using the design option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a combination of these two approaches. For example, the efficiency-level approach (based on actual products on the market) may be extended using the design option approach to ''gap fill'' levels (*i.e.,* to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the max-tech level (particularly in cases where the max-tech level exceeds the maximum efficiency level currently available on the market).

DOE conducted separate engineering analyses for analyzing AFUE standards and standby mode/off mode standards for this rulemaking, because these are independent metrics that are improved via application of different technologies, and DOE had different sources of data for the two metrics. For the AFUE engineering analysis, DOE generally employed an efficiency level approach, which identified the intermediate efficiency levels (*i.e.,* levels between baseline and max-tech) for analysis based on the most common efficiency levels on the market. One exception is that DOE analyzed a 90-percent AFUE level for NWGFs and MHGFs despite relatively few models at that level, as it would serve as a minimum condensing level.

For the standby mode and off mode engineering analysis, DOE adopted a design option approach to identify the efficiency levels that would result from implementing certain design options for reducing energy use in standby mode and off mode. DOE decided on this approach because the Department does 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 NWGF and MHGF products.

a. Baseline Efficiency Level and Product Characteristics

For each product/equipment class, DOE generally selects a baseline model as a reference point for each class, and measures anticipated changes to the product resulting from potential energy conservation standards against the baseline. The baseline model in each product/equipment class represents the characteristics of a product/equipment typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

DOE selected baseline units for the NWGF and MHGF product classes that include characteristics typical of the least-efficient commercially-available consumer furnaces. The baseline unit in each product class represents the basic characteristics of products in that class. Baseline units serve as reference points, against which DOE measures changes resulting from potential amended energy conservation standards. Additional details on the selection of baseline units are in chapter 5 of the NOPR TSD.

AFUE

Table IV.1 presents the baseline AFUE levels identified for each product class of furnaces addressed by this rulemaking. The baseline AFUE levels analyzed are the same as the current Federal minimum AFUE standards for the subject 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.1—BASELINE RESIDENTIAL FURNACE AFUE EFFICIENCY LEVELS

Product class	AFUE (percent)
Non-Weatherized Gas Furnaces	80
Mobile Home Gas Furnaces	80

Standby Mode and Off Mode

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 because manufacturers do not currently report standby mode and off mode energy consumption of NWGFs and MHGFs, DOE ''assembled'' the most consumptive baseline components from the models selected for investigative testing to model the electrical system of a furnace with the expected maximum system standby mode and off mode energy use observed during testing of furnaces. Through reviewing product literature and discussions with manufacturers, DOE found that furnaces generally do not have a seasonal off switch that would be used to turn the product off during the off season. Further, if a switch is included with a product, it is typically 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. DOE found that such switch is typically used only as a service or repair switch. Therefore, DOE concluded that time spent in off mode is expected to be minimal, and the energy consumption in standby mode will always be greater than or equal to the energy consumption in off mode. Accordingly, in the analysis of potential standby mode and off mode energy conservation standards, DOE treated both the standby mode and the off mode energy use for residential furnaces as having the same level of energy consumption, which is typical of standby mode.

The components of the baseline standby mode and off mode energy use level used in this analysis are presented in Table IV.2 of this document.

TABLE IV.2—BASELINE STANDBY MODE AND OFF MODE ENERGY USE FOR NWGFS AND MHGFS

Component	Standby mode and off mode energy use (watts)
Transformer	4
BPM Blower Motor (includes controls)	3
Controls/Other	4
Total (Watts)	11

b. Higher Energy Efficiency Levels

AFUE

Table IV.3 and Table IV.4 show the efficiency levels DOE selected for analysis of amended AFUE standards for NWGFs and MHGFs, respectively, up to the maximum available efficiency level, along with a description of the typical technological change at each level. The maximum available efficiency level was the highest-efficiency unit available on the market when DOE began this analysis. DOE also defines a ''max-tech'' efficiency level to represent the maximum possible efficiency for a given product.

TABLE IV.3—AFUE EFFICIENCY LEVELS FOR NON-WEATHERIZED GAS FURNACES

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.4—AFUE EFFICIENCY LEVELS FOR MOBILE HOME GAS FURNACES

Efficiency level	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	96	EL3 + Increased heat exchanger area.

Standby/Off Mode

Table IV.5 shows the efficiency levels DOE selected for the analysis of standby mode and off mode standards in this NOPR, 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.5—STANDBY MODE AND OFF MODE EFFICIENCY LEVELS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Efficiency level (EL)	Standby mode and off mode energy use (watts)	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.

2. Cost Analysis

The cost analysis portion of the engineering analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated product, and the availability and timeliness of purchasing the product on the market. The available cost approaches are summarized as follows:

• *Physical teardowns:* Under this approach, DOE physically dismantles a commercially-available product, component-by-component, to develop a detailed bill of materials for the product.

• *Catalog teardowns:* In lieu of physically deconstructing a product, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the product.

• *Price surveys:* If a physical or catalog teardown is infeasible (*e.g.,* for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable), cost-prohibitive, or otherwise impractical (*e.g.* large commercial boilers), DOE conducts price surveys using publicly-available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

In the present case, DOE conducted its cost analysis using a combination of physical and catalog teardowns to assess how manufacturing costs change with increased product efficiency. Products were selected for physical teardown analysis that have characteristics of typical products on the market at a representative input capacity of 80,000 Btu/h (determined based on market data and discussions with manufacturers). Selections spanned the range of efficiency levels analyzed and included most manufacturers. The teardown analysis allowed the creation of detailed BOMs for each product torn down, 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 since withdrawn March 2015 NOPR, interviews were held with NWGF and MHGF manufacturers to gain insight into the residential furnace industry, and to request feedback on the engineering analysis. A second round of interviews were held in 2021 to review updates to the cost analysis since that prepared for the withdrawn March 2015 NOPR. DOE used the information gathered from these interviews, along with the information obtained through the teardown analysis, to develop its MPC estimates. For this NOPR, DOE used eight physical teardowns performed for prior rulemaking stages where the model torn down is still available on the current market by updating the BOM for that model to incorporate the most recent input data (*e.g.,* for raw materials, purchased components, labor). When incorporating teardowns from past analyses into the analysis for this NOPR, DOE only selected the units with designs and components that are the same as units currently on the market. DOE also performed an additional 23 physical teardowns in the spring of 2021 to update the analysis for this NOPR. DOE purposefully selected these particular units for use this NOPR, in an effort to ensure the analysis's representativeness of current furnace designs. For additional detail about the models used, see chapter 5 of the NOPR TSD

a. Teardown Analysis

To assemble BOMs and to calculate the manufacturing costs for the different components in residential furnaces, multiple units were disassembled into their base components, and DOE 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, each component was characterized according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it.

For supplementary catalog teardowns, product data were gathered such as dimensions, weight, and design features from publicly-available information, such as manufacturer catalogs. Such ''virtual teardowns'' allowed DOE to estimate the major physical differences between a product that was physically disassembled and a similar product that was not. For this NOPR, data from a total of 83 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 was 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.

As discussed in section IV.C.2.d of this document, DOE also performed several physical and catalog teardowns of units at input capacities other than the representative input capacity (*i.e.,* 40, 60, 100, and 120 kBtu/h in addition to 80 kBtu/h). These teardowns allowed DOE to develop cost-efficiency curves for NWGFs and MHGFs at different input capacities. For more detailed information on the teardown analysis, see chapter 5 of the NOPR 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 parts fabricated in-house, the prices of the underlying ''raw'' metals (*e.g.,* tube, sheet metal) are estimated on the basis of 5-year averages to smooth out spikes in demand. Other ''raw'' materials, such as plastic resins, insulation materials, etc., are estimated on a current-market basis. The costs of raw materials are based on manufacturer interviews, quotes from suppliers, and secondary research. Past results are updated periodically and/or inflated to present-day prices using indices from resources such as MEPS Intl.,[46] PolymerUpdate,[47] the U.S. geologic survey (''USGS''),[48] and the Bureau of Labor Statistics (''BLS'').[49] The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing.

c. Manufacturing Production Costs

DOE estimated the MPC at each efficiency level considered for each product class, from the baseline through the max-tech, and then calculated the fractions of the MPC (in percentages) attributable to each cost component (*i.e.,* materials, labor, depreciation, and overhead). These percentages were used to validate analytical inputs 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 MIA (see section IV.J of this document).

Table IV.6 and Table IV.7 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. DOE observed both in its market analysis and teardown analysis that products are available on the market across all efficiency levels with a mix of blower motor technologies, including permanent split capacitor (''PSC'') motors, constant torque brushless permanent magnet (''BPM'') motors, and constant airflow BPM motors. To account for the variety of blower motors available on the market, DOE developed cost adjustment factors (''adders'') for each type of blower motor and at each input capacity analyzed (*i.e.,* 40, 60, 80, 100, and 120 kBtu/h) to normalize the blower costs and allow for estimation of the cost differences between models with different blower technologies. DOE normalized the costs of the blower assemblies present in the teardown models when generating the industry-aggregate MPCs, with the exception of

[46] For more information on MEPS Intl, please visit: *www.mepsinternational.com/gb/en* (Last accessed Feb. 16, 2022).

[47] For more information on PolymerUpdate, please visit: *www.polymerupdate.com* (Last accessed Feb. 16, 2022).

[48] For more information on the USGS metal price statistics, please visit *www.usgs.gov/centers/national-minerals-information-center/commodity-statistics-and-information* (Last accessed Feb. 16, 2022).

[49] For more information on the BLS producer price indices, please visit: *www.bls.gov/ppi/* (Last accessed Feb. 16, 2022).

the max-tech level for NWGFs which was always assigned a constant airflow BPM motor. These adders are discussed in more detail in Chapter 5 of the TSD accompanying this notice. As discussed in section IV.F of this document, these adders were applied in the LCC analysis to represent the distribution of blower motor technologies expected on the market.

Similarly, in its market analysis and teardown analysis, DOE observed models across efficiency levels with single-stage, two-stage, and modulating operation. DOE, therefore, also developed a cost adder for two-stage and modulating combustion systems (as compared to single-stage models). 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. Similarly, the cost to change from a single-stage to a modulating combustion system includes the cost of a modulating gas valve, an upgraded inducer assembly, upgraded pressure switch/tubing assembly, and additional controls and wiring. These cost adders are discussed in more detail in Chapter 5 of the TSD. DOE normalized the burner stages when generating the industry-aggregate MPCs, with the exception of the max-tech level for NWGFs which was assumed to be modulating based on current furnace designs observed at the max-tech level.

Table IV.6 and Table IV.7 present costs for NWGF with a constant-torque BPM and single-stage combustion (except for the max-tech level which, as previously noted, includes a constant airflow BPM and modulating combustion), and for MHGF with an improved PSC and single-stage combustion, respectively. However, as discussed, DOE observed that a variety of products exist on the market that include various blower motor technologies and burner system stages, so the Department developed adders to translate MPCs across various technologies. DOE presents MPCs with these technologies because they are the technologies that DOE has observed are necessary to achieve minimum compliance with the 2014 furnace fan final rule, for which compliance was required beginning on July 3, 2019.[50] 79 FR 38130, 38151 (July 3, 2014). Therefore, DOE believes these designs are likely the most representative of furnaces on the current market, although DOE recognizes there are some exceptions.

TABLE IV.6—MANUFACTURER PRODUCTION COST FOR NON-WEATHERIZED GAS FURNACES AT THE REPRESENTATIVE INPUT CAPACITY OF 80 kBtu/h

Efficiency level	Efficiency level (AFUE) (%)	MPC * (2020$)	Incremental cost above baseline (2020$)
Baseline	80	317	....
EL1	90	403	86
EL2	92	411	94
EL3	95	422	105
EL4	98	539	222

* The MPCs for the NWGF efficiency levels from Baseline through EL3 include single-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.7—MANUFACTURER PRODUCTION COST FOR MOBILE HOME GAS FURNACES AT THE REPRESENTATIVE INPUT CAPACITY OF 80 kBtu/h

Efficiency level	Efficiency level (AFUE) (%)	MPC * (2020$)	Incremental cost above baseline (2020$)
Baseline	80	325	....
EL1	90	414	89
EL2	92	421	97
EL3	95	432	108
EL4	96	436	112

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

Table IV.8 presents DOE's estimates of the incremental MPCs of each standby mode/off mode efficiency level for this rulemaking, relative to the baseline efficiency level. For standby mode and off mode, 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. Therefore, the incremental MPC shown reflects the price to implement the component necessary to achieve the given efficiency level. DOE also considered whether other design changes would be necessary to accommodate the components at each efficiency level. Based on the LL–LTX designs DOE has reviewed and the furnace products observed during teardowns (which included numerous models across manufacturers and efficiencies), DOE believes that major redesign would not be required to accommodate these components. While it is possible that thicker metal may be required for the mounting brackets, DOE maintains that

[50] The furnace fans final 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 web page at: *www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/41.*

it is more likely that the current mounting brackets are sufficient to support the slight increase in weight and size of LL–LTX. DOE seeks further input on this issue.

TABLE IV.8—INCREMENTAL MANUFACTURER PRODUCTION COST FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES STANDBY MODE AND OFF MODE

Efficiency level	Standby mode and off mode energy use (watts)	Incremental MPC (2020$)
Baseline	11	0
EL1	9.5	0.52
EL2	9.2	1.44
EL3	8.5	2.65

Chapter 5 of the NOPR TSD presents more information regarding the development of DOE's estimates of the MPCs for this proposal. DOE seeks further comment on its estimates for the MPC of consumer furnaces under each standards scenario.

d. Cost-Efficiency Relationship

DOE created cost-efficiency curves representing the cost-efficiency relationships for the product classes that it examined (*i.e.,* 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 of this document, DOE performed several physical and catalog teardowns across a range of input capacities in order to develop cost-efficiency curves for NWGFs and MHGFs 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 NOPR TSD. For MHGFs, DOE performed physical teardowns of several MHGF models and compared them to NWGF teardowns from a common manufacturer and similar design, in order to determine the typical design differences between the two product classes. (A detailed description of the typical differences between MHGF and NWGF is provided in chapter 5 of the TSD.) 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 TSD.

As displayed in Table IV.6 and Table IV.7 of this document, the results indicate that cost-efficiency relationships are nonlinear. For both NWGF and MHGF, the cost increase between the non-condensing (80 percent AFUE) and condensing (90 percent AFUE) efficiency levels is due to the addition of a secondary heat exchanger, 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.

e. Manufacturer Mark-Up

DOE calculates the manufacturer selling price (''MSP'') by multiplying the MPC and the manufacturer markup. The MSP is the price the manufacturer charges its direct customer (*e.g.,* a wholesaler). The MPC is the cost for the manufacturer to produce a single unit of product, accounting for direct costs and overhead associated with the manufacturing facility. The manufacturer markup is a multiplier that accounts for manufacturers' production costs and revenue attributable to the product.

DOE initially developed an average manufacturer mark-up by examining the annual Securities and Exchange Commission (''SEC'') 10–K [51] reports filed by publicly-traded manufacturers primarily engaged in consumer furnace manufacturing and whose product range includes NWGFs and MHGFs. DOE refined its understanding of manufacturer mark-ups by using information obtained during manufacturer interviews. For additional detail on DOE's methodology to determine the no-new-standards case manufacturer markup, see chapter 5 of the NOPR TSD.

To meet new or amended energy conservation standards, manufacturers typically redesign their baseline products in ways that increase the MPC. 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. See chapter 12 of the NOPR TSD for a detailed description of the standards-case manufacturer mark-up calculation.

f. Manufacturer Interviews

Throughout the rulemaking process, DOE sought 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 manufacturer impact analysis for the since withdrawn March 2015 NOPR. During these 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 consumer furnace manufacturers. In 2021, DOE conducted a second series of interviews to obtain feedback on the updates to the cost analysis from the additional teardowns performed in spring 2021. 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 NOPR TSD.

3. Electric Furnaces

In addition to NWGFs and MHGFs, DOE also estimated 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.11 of this document 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.[52]

The MPCs of electric furnaces were developed by calculating a market share-weighted MPC of the three modular blower units that were torn

[51] U.S. Securities and Exchange Commission's Electronic Data Gathering, Analysis, and Retrieval system (''EDGAR'') database. (Available at: *www.sec.gov/edgar/search/*) (Last accessed Feb. 4, 2022).

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

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 40, 60, 80, 100, and 120 kBtu/h. These MPCs are presented in Table IV.9.

TABLE IV.9—ELECTRIC FURNACE MPCS

Input capacity (kBtu/h)	MPC (2020$)
40	261
60	279
80	305
100	316
120	342

Further details regarding the methodology used to estimate electric furnace MPCs are provided in chapter 5 of the NOPR TSD.

D. Mark-Ups Analysis

The mark-ups analysis develops appropriate mark-ups (*e.g.,* wholesalers, distributors, mechanical contractors, remodelers, builder, retailers, 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 analyses. At each step in the distribution channel, companies mark up the price of the product to cover costs. Before developing mark-ups, DOE defines key market participants and identifies distribution channels.

DOE characterized two distribution channel market segments to describe how NWGF and MHGF products pass from the manufacturer to residential and commercial consumers: [53]
(1) replacements and new owners [54] and
(2) new construction.

The NWGF and MHGF replacement/new owners market distribution channel is primarily characterized as follows:

Manufacturer → Wholesaler → Mechanical contractor → Consumer

Based on a 2019 BRG report,[55] 2019 Clear Seas Research HVAC contractor survey,[56] and Decision Analyst's 2019 American Home Comfort Study,[57] DOE determined that the retail distribution channel (including internet sales) has been growing significantly in the last five years (previously it was negligible). Based on these sources, DOE estimated that 15 percent of the replacement market distribution channel will be going through this market channel as follows (including some consumers that purchase directly and then have contractors install it): [58]

Manufacturer → Retailer → Mechanical contractor → Consumer

The NWGF new construction distribution channel is characterized as follows, where DOE assumes that for 25 percent of installations, a larger builder has an in-house mechanical contractor:

Manufacturer → Wholesaler → Mechanical contractor → Builder → Consumer

Manufacturer → Wholesaler → Builder → Consumer

The MHGF new construction distribution channel is characterized as follows:

Manufacturer → Mobile Home Manufacturer → Mobile Home Dealer → Consumer

For replacements, new owners, and new construction, DOE also considered the national accounts or direct from manufacturer distribution channel, where the manufacturer sells directly to a buyer (builder, mechanical contractor, or commercial consumer).[59]

Manufacturer → Wholesaler → Buyer → Consumer (National Account)

At each step in the distribution channel, companies mark up the price of the product to cover costs. DOE developed baseline and incremental mark-ups for each participant in the distribution chain to ultimately determine the consumer purchase cost. Baseline mark-ups are applied to the price of products with baseline efficiency, while incremental mark-ups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental mark-up is typically less than the baseline mark-up and is designed to maintain similar per-unit operating profit before and after new or amended standards.[60]

To estimate average baseline and incremental mark-ups, DOE relied on several sources, including: (1) the HARDI 2013 Profit Report [61] (for wholesalers); and (1) U.S. Census Bureau 2017 Economic Census data [62] 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 [63] to disaggregate the mechanical contractor mark-ups into replacement and new construction markets. DOE also used various sources for the derivation of the mobile home dealer mark-ups (see chapter 6 of the NOPR TSD).

Typically, contractors will mark up equipment and labor differently, with the labor mark-up being greater than the equipment mark-up. For the purposes of the analysis, DOE is treating the furnace installation work, including the equipment and labor components, as one job, and assumes that the mechanical contractors use the same mark-up to account for overhead and profit of the entire job. However, the determination of that overall markup accounts for the different components of

[53] DOE estimates that three percent of NWGFs are installed in commercial buildings. *See* section IV.G of this document for further discussion.

[54] New owners are new furnace installations in buildings that did not previously have a NWGF or MHGF or existing NWGF or MHGF owners that are adding an additional consumer furnace. They primarily consist of households that add or switch to NWGFs or MHGFs during a major remodel.

[55] BRG Building Solutions, The North American Heating & Cooling Product Markets (2020 Edition) (Available at: *www.brgbuildingsolutions.com/reports-insights*) (Last accessed February 15, 2022).

[56] Clear Seas Research, 2019 Unitary Trends (Available at: *clearseasresearch.com/?attachment_id=2311*) (Last accessed February 15, 2022).

[57] Decision Analyst, 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/syndicated/homecomfort/*) (Last accessed February 15, 2022).

[58] The Do-It-Yourself (''DIY'') market is very small (only represents about 1–2% of the whole gas furnace market) and is not analyzed by DOE in this analysis.

[59] The national accounts channel where the buyer is the same as the consumer is mostly applicable to NWGFs installed in small to mid-size commercial buildings, where on-site contractors purchase equipment directly from wholesalers at lower prices due to the large volume of equipment purchased, and perform the installation themselves. Overall, DOE's analysis assumes that approximately 15 percent of NWGFs installed in the residential and commercial sector use national accounts.

[60] Because the projected price of standards-compliant products is typically higher than the price of baseline products, using the same mark-up for the incremental cost and the baseline cost would result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive, it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

[61] Heating, Air Conditioning & Refrigeration Distributors International (''HARDI''), *2013 HARDI Profit Report* (Available at: *www.hardinet.org/*) (Last accessed February 15, 2022).

[62] U.S. Census Bureau, *2017 Economic Census Data* (Available at *www.census.gov/econ/*) (Last accessed February 15, 2022).

[63] Air Conditioning Contractors of America (''ACCA''), *Financial Analysis for the HVACR Contracting Industry (2005)* (Available at: *www.acca.org/store*) (Last accessed February 15, 2022).

the job. After reviewing the available 2017 economic census data,[64] DOE adjusted the mechanical contractor mark-up to take into account that a fraction of the fringe costs related to the direct construction labor are part of the labor cost. This better matches the approach used in RS Means [65] and other cost books [66] on how the overall contractor mark-up is determined. Based on this methodology, the average baseline mark-up for mechanical contractors is 1.47 for replacements and 1.38 for new construction, while the incremental mark-up for mechanical contractors is 1.27 for replacements and 1.20 for new construction. The overall baseline mark-up is 2.68 for NWGFs and 2.48 for MHGFs, while the incremental mark-up is 1.98 for NWGFs and 1.88 for MHGFs. See chapter 6 of the NOPR TSD for more details.

In addition to the mark-ups, DOE obtained State and local taxes from data provided by the Sales Tax Clearinghouse.[67] 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.

DOE acknowledges that there is uncertainty regarding the appropriate mark-ups to use, so the Department conducted a sensitivity analysis in which the same average mark-up is applied to baseline and higher-efficiency products. Appendix 6B of the NOPR TSD describes this analysis and how the associated LCC results differ from the results using the incremental mark-up approach. The relative comparison of the different efficiency levels remains similar, however, and the proposed energy conservation standard level remains economically justified regardless of which mark-up scenario is utilized.

Chapter 6 of the NOPR TSD provides details on DOE's development of mark-ups 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, mobile homes, 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 specific energy efficiency levels across a range of climate zones, building characteristics, and heating applications. The annual energy consumption includes the natural gas, liquid petroleum gas (''LPG''), and electricity used by the furnace.

Chapter 7 of the NOPR TSD provides details on DOE's energy use analysis for NWGFs and MHGFs.

1. Building Sample

To determine the field energy use of residential furnaces used in homes, DOE established a sample of households using NWGFs and MHGFs from EIA's 2015 Residential Energy Consumption Survey (''RECS 2015'').[68] DOE assumed that furnaces in residential buildings smaller than 10,000 sq. ft. are consumer furnaces subject to this rulemaking. 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 analyses. DOE projected household weights and household characteristics in 2029, 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 2015 that were built after 2000.

On November 2016, AHRI provided regional shipment data (North vs. Rest of Country) up to 2015, and DOE also used HARDI shipments data by State and region from 2013–2020.[69] Based on these recent shipments data and the updated shipments analysis (as explained in section IV.G of this document), DOE determined shipment weights for the North and Rest of Country, projected to 2029. For NWGFs, 57 percent of shipments are projected to be in the North and 43 percent in the Rest of Country. For MHGFs, 51 percent of shipments are projected to be in the North and 49 percent in the Rest of the Country. Further details about the development of these numbers is available in appendix 7A of the NOPR TSD.

Based on DOE's shipments model, DOE estimated that 19 percent of NWGF installations in 2029 would be in new construction and that 81 percent would be for replacement and new owners. DOE further estimated that 43 percent of MHGF installations in 2029 would be in new construction and that 57 percent would be for replacement and new owners. See section IV.G of this document and chapter 9 of the NOPR TSD for further details.

To determine the field energy use of NWGFs used in commercial buildings, DOE established a sample of buildings using NWGFs from EIA's 2012 Commercial Building Energy Consumption Survey (''CBECS 2012''), which is the most recent such survey that is currently available.[70] See appendix 7A of the NOPR TSD for details about the CBECS 2012 sample.

2. Furnace Sizing

DOE assigned an input capacity for the existing NWGF or MHGF of each housing unit based on an algorithm that correlates the heating square footage provided by RECS 2015 or CBECS 2012 and the outdoor design temperature for heating,[71] based on the estimated location of the RECS 2015 household or CBECS 2012 building, with the distribution of input capacities of furnaces based on a reduced set of models from DOE's 2021 Compliance

[64] U.S. Census Bureau, *2017 Economic Census Data* (Available at: *www.census.gov/econ/*) (Last accessed February 15, 2022).

[65] RS Means Company Inc., *2021 RS Means Mechanical Cost Data. Kingston,* MA (2021) (Available at: *www.rsmeans.com/products/books/*) (Last accessed February 15, 2022).

[66] Craftsman Book Company, 2021 National Construction Estimator, CA (2021) (Available at: *craftsman-book.com/books-and-software/shop-by-type/shop-estimating-books*) (Last accessed February 15, 2022).

[67] Sales Tax Clearinghouse Inc., *State Sales Tax Rates Along with Combined Average City and County Rates* (February 8, 2021) (Available at: *www.thestc.com/STrates.stm*) (Last accessed February 15, 2022).

[68] Energy Information Administration (''EIA''), 2015 Residential Energy Consumption Survey (''RECS'') (Available at: *www.eia.gov/consumption/residential/*) (Last accessed Feb. 15, 2022).

[69] Heating, Air-conditioning and Refrigeration Distributors International (''HARDI''), DRIVE portal (HARDI Visualization Tool managed by D+R International), Gas Furnace Shipments Data from 2013–2020 (Available at: *www.drintldata.com*) (Last accessed Feb. 15, 2022).

[70] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2012) (Available at: *www.eia.gov/consumption/commercial/data/2012/index.php?view=microdata*) (Last accessed Feb. 15, 2022). EIA has published building characteristics data for the 2018 CBECS. However, DOE utilizes the energy consumption microdata for the energy use analysis. The 2018 CBECS energy consumption microdata are expected to be fully released later in 2022. Until that time, 2012 CBECS remains the most recent full data release. For future analyses, DOE plans to consider using the complete CBECS 2018 microdata when available.

[71] This is the temperature that is exceeded by the 30-year minimum average temperature one percent of the time.

Certification Management System database for furnaces[72] and from AHRI's 2021 residential furnace certification directory.[73] DOE assumed that for the new furnace installation, the output capacity would remain similar to the output capacity for the existing furnace. DOE distributed the NWGF input capacities based on shipments data by input capacity bins provided by AHRI from 1995–2014,[74] HARDI shipments data by capacity and region from 2013–2020,[75] and manufacturer input from manufacturer interviews. The shipments data by input capacity was further disaggregated into 5-kBtu/h bins using the reduced set of models.

DOE further refined the methodology to capture the degree of insulation type and other household characteristics by adding ACCA Manual J calculation methods to more accurately determine the design heating load requirements of each household based on all available RECS 2015 household characteristics. The households' calculated design heating load values are then rank ordered to match actual shipments distributions to determine the assigned furnace input capacity. This improved methodology, applied to both NWGFs and MHGFs, allows for older, less-insulated homes to be assigned larger furnaces compared to similar newly-built homes.

The ACCA Manual J process is the most widely accepted method to calculate heating and cooling requirements for the house by using well-documented values and building codes, based on experimental data and extreme conditions (worst-case assumptions). For the NOPR analysis, the actual sizing in the field is accomplished by matching the household Manual J heating load calculations to actual shipments data by capacity. This methodology takes into account the actual field conditions where some households have a greater oversizing factor than recommended by ACCA, which could occur due to old furnaces being replaced by a much more efficient furnace and/or improvements to the building shell since the last furnace installation. This methodology also accounts for regional differences in building shells, which show that, on average, Southern homes are not as well insulated as Northern homes. Regional differences in peak heating load are also captured in the sizing methodology by using the outdoor design temperature that best matches the household location and climate characteristics. Regarding the use of factors for adjusting the annual heating load (such as heating degree day, or ''HDD,'' adjustment to average climate conditions, HDD trends based on climate change, and the adjustment based on the building shell index), DOE notes that these are only used to adjust the annual heating load to account for changes in the energy use required for heating in a given year. In contrast, the furnace size is determined by calculating the design heating load, which is based on outdoor design temperature and other household characteristics which are not adjusted by these annual heating load factors.

DOE also accounted for the air conditioning sizing when determining the input capacity size of the furnace. DOE acknowledges that currently, there are few low-input-capacity furnace models with large furnace fans. For some installations, particularly in the South, a large furnace fan is required to meet the cooling requirements. DOE accounted for the fact that some furnace installations in the South have a larger input capacity than determined by the peak heating load calculations by calculating the size of the furnace fan required to meet the cooling requirements of the household by using the AHRI shipments data[76] and the HARDI furnace shipments by input capacity and region.[77] DOE notes that this will primarily affect furnaces located in warmer areas of the country (with higher cooling loads), which potentially lead to a 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 primarily using 2013–2020 HARDI regional shipments data by capacity. DOE notes that the Federal furnace fan standards that took effect in July 2019 require fan motor designs that can more efficiently adjust 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 both the heating and cooling requirements of the house. DOE acknowledges that in the future, there might be greater availability of small furnaces with larger furnace fans, but for this NOPR, DOE made a conservative assumption that larger furnace input capacities will be necessary to satisfy these cooling requirements. See chapter 7 of the NOPR TSD for further detail.

3. Furnace Active Mode Energy Use

To estimate the annual energy consumption in active mode of furnaces meeting the considered efficiency levels, DOE first calculated the annual household/building heating load using the RECS 2015 and CBECS 2012 estimates of household or building furnace annual energy consumption,[78] 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 or more furnaces, with the heating load split evenly between them. The estimation of furnace capacity is discussed in the previous section. The AFUE of the existing furnaces was estimated using the furnace vintage (the year of installation) provided by RECS and historical data on the market share of furnaces by AFUE by region (see section IV.F.10 of this document). DOE then used the household/building heating load to calculate the burner operating hours at each considered efficiency level, which were then used to calculate the fuel and electricity consumption based on the DOE residential furnace test procedure.

a. Adjustments to Energy Use Estimates

DOE adjusted the energy use estimates in RECS 2015 (for the year 2015) and in CBECS 2012 (for the year 2012) to ''normal'' weather using long-term heating degree-day (''HDD'') data for each geographical region.[79] For this

[72] U.S. Department of Energy, Compliance Certification Management System (Available at: *www.regulations.doe.gov/certification-data/*) (Last accessed Feb. 15, 2022).

[73] AHRI, Directory of Certified Product Performance: Residential Furnaces (Available at: *www.ahridirectory.org/Search/QuickSearch?category=8&searchTypeId=3&producttype=32*) (Last visited Feb. 15, 2022).

[74] AHRI, Attachment A: Percentage of Residential Gas Furnace Shipments by Input Ranges, 20 Year Average (1995–2014) (October 14, 2015) (Available at: *www.regulations.gov/comment/EERE-2014-BT-STD-0031-0181*) (Last accessed Feb. 15, 2022).

[75] Heating, Air-conditioning and Refrigeration Distributors International (''HARDI''), DRIVE portal (HARDI Visualization Tool managed by D+R International), Gas Furnace Shipments Data from 2013–2020 (Available at: *www.drintldata.com*) (Last accessed Feb. 15, 2022).

[76] AHRI, Attachment A: Percentage of Residential Gas Furnace Shipments by Input Ranges, 20 Year Average (1995–2014) (Oct. 14, 2015) (Available at: *www.regulations.gov/comment/EERE-2014-BT-STD-0031-0181*) (Last accessed Feb. 15, 2022).

[77] Heating, Air-conditioning and Refrigeration Distributors International (''HARDI''), DRIVE portal (HARDI Visualization Tool managed by D+R International), Gas Furnace Shipments Data from 2013–2020 (Available at: *www.drintldata.com*) (Last accessed Feb. 15, 2022).

[78] EIA estimated the equipment's annual energy consumption from the household's utility bills using conditional demand analysis.

[79] National Oceanic and Atmospheric Administration (NOAA), NNDC Climate Data

Continued

NOPR, DOE then applied an HDD correction factor from *AEO2021* [80] that accounts for projected population migrations across the Nation and continues any realized historical changes in degree days at the State level.

DOE accounted for changes in building shell efficiency between 2015 (for RECS 2015) or 2012 (for CBECS 2012) and the compliance year by applying the shell integrity indexes associated with *AEO2021.* The indexes consider projected improvements in building shell efficiency due to improvements in home insulation and other thermal efficiency practices. EIA provides separate indexes for new buildings and existing buildings for a given year, for both residential homes and commercial buildings. For the year 2029, the factor applied for homes is 0.98 for residential replacements and 0.97 for residential new construction. The factor applied for commercial building replacements depend on building type and Census Division, ranging from 0.81 to 0.97 (on average 0.91). For new construction commercial buildings, the factor used ranged from 0.31 to 0.86, depending on building type and Census Division (on average 0.63). See chapter 7 of the NOPR TSD for more details.

Building codes and building practices vary widely across the U.S. For example, as of November 2021, more than half of the States were still under the 2009 International Energy Conservation Code (''IECC'') or older codes instead of the 2012 IECC, 2015 IECC, or 2018 IECC.[81] EIA's building shell index for new construction takes into account regional differences in building codes and building practices by including both homes that meet IECC requirements and homes that are built with the most efficient shell components, as well as non-compliant homes that fail to meet IECC requirements. It is uncertain how these building codes and building practices will change over time, so EIA uses technical and economic factors to project change in the building shell integrity indexes. For new home construction, EIA determined the building shell efficiency by using the relative costs and energy bill savings in conjunction with the building shell attributes. For commercial buildings, the shell efficiency factors vary by building type and region, and they take into account significant improvements to the commercial building shell, particularly in new commercial buildings.

4. Furnace Electricity Use

DOE's analysis of furnace electricity consumption takes into account the electricity used by the furnace's electrical components (such as blower, the draft inducer, and the ignitor). DOE determined furnace fan electricity consumption using field data on static pressures of duct systems and furnace fan performance data from manufacturer literature. As noted in section IV.C of this document, the furnace designs used in DOE's analysis incorporate furnace fans that meet the energy conservation standards for those covered products that took effect in 2019.[82] DOE accounted for furnace fan energy use during heating mode, as well as for the difference in furnace fan electricity use between a baseline furnace (80-percent AFUE) and a more efficient furnace during cooling and continuous fan circulation. DOE also accounted for increased furnace fan energy use in condensing furnaces to produce the equivalent airflow output compared to a similar non-condensing furnace, since condensing furnaces tend to have a more restricted airflow path than non-condensing furnaces due to the presence of a 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 furnaces test procedure,[83] as well as in DOE's 2021 reduced furnace model dataset and manufacturer product literature. The electricity consumption of condensing furnaces also reflects the use of condensate pumps and heat tape.

DOE accounts for the increased electricity use of condensing furnaces in heating, cooling, and continuous fan circulation due to larger internal static pressure (a more restricted airflow path due to the presence of a secondary heat exchanger). DOE notes that the furnace fan energy conservation standards that took effect in 2019 (for both non-condensing and condensing NWGFs [84]) can be met using constant-torque brushless permanent magnet (''BPM'') motors, which do not require increasing the size of an undersized duct since the speed of the motor is kept constant with increased static pressure. DOE also accounts for higher energy use for a fraction of installations that include a constant airflow BPM (variable speed motor) that can increase the speed of the motor to compensate for high static pressures. See appendix 7C of the NOPR TSD for more details.

As stated previously, a condensing furnace uses more electricity than an equivalent non-condensing furnace but uses significantly less natural gas or LPG. DOE accounted for the additional heat released by the furnace fan motor, which must be compensated by the central air conditioner during the cooling season, based on the 2014 furnace fan final rule analysis.[85] DOE also accounted for additional electricity use by the furnace fan during continuous fan operation throughout the year.

5. Standby Mode and Off Mode

DOE calculated annual standby mode energy use by multiplying the standby power consumption at each efficiency level by the number of standby mode hours, for each technology option identified in the engineering analysis. DOE assumed that furnaces are not usually equipped with an off mode, so only standby mode energy use was considered. To calculate the annual number of standby mode hours for each sampled 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. It is noted that DOE did account for the additional electricity use of brushless permanent magnet motors in standby mode. Chapter 7 of this NOPR TSD describes this methodology in more detail.

F. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for NWGFs and MHGFs. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in

Online (Available at: *www.ncdc.noaa.gov/cdo-web/search*) (Last accessed Feb. 15, 2022).

[80] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2021* (Available at: *www.eia.gov/outlooks/aeo/*) (Last accessed Feb. 15, 2022).

[81] DOE Building Energy Codes Program, Status of State Energy Code Adoption (Available at: *www.energycodes.gov/status*) (Last accessed Feb. 15, 2022).

[82] *See* 10 CFR 430.32(y).

[83] Found in 10 CFR part 430, subpart B, appendix N, section 10.

[84] The furnace fan energy conservation standards relevant to condensing and non-condensing MHGFs can be met using improved PSC motors and, therefore, these considerations do not apply.

[85] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy, Energy Conservation Program for Consumer Products: Technical Support Document: Energy Efficiency Standards for Consumer Products: Residential Furnace Fans Including: Regulatory Impact Analysis (July 2014) (Available at: *www.regulations.gov/document/EERE-2010-BT-STD-0011-0111*) (Last accessed Feb. 15, 2022).

operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

• *Life-cycle cost* (LCC) 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 mark-ups, 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.

• *Payback period* (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 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.

1. General Method

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 RECS 2015 and CBECS 2012. For each sample household, DOE determined the energy consumption of the furnace and the appropriate natural gas, LPG, and 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, product price projections, 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 installation cost, repair and maintenance, product lifetime, and discount rates, with probabilities attached to each value, to account for their uncertainty and variability. In addition, DOE established the efficiency in the no-new-standards case using a distribution of furnace efficiency values.

The computer model DOE uses to calculate the LCC and PBP relies on Monte Carlo simulations to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and NGWF and MHGF user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[86] The model calculated the LCC and PBP for products at each efficiency level for 10,000 furnace installations 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.

DOE calculated the LCC and PBP for all consumers of NWGFs and MHGFs as if each were to purchase a new product in the first year of required compliance with new or amended standards. Any amended standards would apply to NWGFs and MHGFs manufactured 5 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(f)(4)(C)) For the reasons described previously, DOE used 2029 as the first year of compliance with amended or new standards for NWGFs and MHGFs.

DOE recognizes the uncertainties associated with some of the parameters used in the analysis. To assess these uncertainties, DOE has performed sensitivity analyses for key parameters such as energy prices, condensing furnace market penetration, consumer discount rates, lifetime, installation costs, downsizing criteria, and product switching criteria. DOE notes that the analysis is based on a Monte Carlo simulation approach, which uses the Crystal Ball™ add-on as a tool to more easily apply probability distributions to various parameters in the analysis. See appendix 8B of the NOPR TSD and relevant analytical sections of this document for further details about uncertainty, variability, and sensitivity analyses in the LCC analysis.

DOE's LCC analysis results at a given efficiency level account for the households that will not install condensing NWGFs unless the standard is changed, based on the no-new-standards case efficiency distribution described in section IV.F.9 of this document. This approach reflects the fact that some consumers may purchase products with efficiencies greater than the baseline levels.

DOE's analysis models the expected product lifetime, 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, 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.12 of this document, in its LCC analysis, DOE considered the possibility that some consumers may switch to alternative heating systems under a standard that requires condensing technology in its

[86] Crystal Ball™ is a commercially-available software tool to facilitate the creation of these types of models by generating probability distributions and summarizing results within Excel (Available at: *www.oracle.com/technetwork/middleware/crystalball/overview/index.html*) (Last accessed Feb. 15, 2022).

LCC analysis. 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.

As part of the determination of whether a potential standard is economically justified, EPCA directs DOE to consider, to the greatest extent practicable, 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 imposition of the standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) EPCA does not expressly limit consideration of the covered product or covered products likely to result under an amended standard to the covered product type (or class) of that would be subject to the amended standard (*i.e.,* no prohibition on consideration of the potential for product switching due to new or amended standards). EPCA indicates that the timeframe of the LCC analysis is based on the estimated average life of the covered product subject to the standard under consideration for amendment. (*Id.*) However, the use of ''covered products'' in the plural for what is to be considered as resulting from an amended standard suggests that DOE could consider covered products other than that subject to the standard. In the present case, were DOE not to consider the potential for consumers switching products in response to an amended standard, the analysis would not capture what could be expected to occur in actual practice. Given that understanding, DOE performed a sensitivity analysis without product switching for the LCC analysis (presented in section V.B.1.a of this document and in appendix 8J of the NOPR TSD) and for the NIA as well (presented in section V.B.3.a of this document, section V.B.3.b and in appendix 10E of the NOPR TSD). The economic justifications for the proposed energy conservation standards for NWGFs and MHGFs are similar with either no product switching or with product switching, and the relative comparison between the TSLs remains similar.

EPCA also establishes, as noted above in section III.E.2 of this document, 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. (42 U.S.C. 6295(o)(2)(B)(iii)) As with the LCC analysis, accounting for the potential for switching in the PBP analysis provides a payback that is representative across consumers.

Table IV.10 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 TSD for this NOPR and its appendices.

TABLE IV.10—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSES

Inputs	Source/method
Product Cost	Derived by multiplying MPCs by manufacturer, wholesaler, and contractor mark-ups 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 2021 RS Means. Assumed variation in cost with efficiency level.
Annual Energy Use	Total annual energy use based on the annual heating load, derived from the building samples. Electricity consumption based on field energy use data. Variability: Based on the RECS 2015 and CBECS 2012.
Energy Prices	Natural Gas: Based on EIA's Natural Gas Navigator data for 2020 and RECS 2015 billing data. Propane: Based on EIA's State Energy Data System (''SEDS'') for 2019. Electricity: Based on EIA's Form 861 data for 2020 and RECS 2015 billing data. Variability: Regional energy prices determined for 30 regions for residential applications and 9 regions for commercial applications. Marginal prices used for natural gas, propane, and electricity prices.
Energy Price Trends	Based on *AEO2021* price projections.
Repair and Maintenance Costs	Based on 2021 RS Means data and other sources. Assumed variation in cost by efficiency.
Product Lifetime	Based on shipments data, multi-year RECS, American Housing Survey, American Home Comfort Survey data. Mean lifetime of 21.4 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	2029.

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

2. Consumer Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the mark-ups described in section IV.D of this document (along with sales taxes). DOE used different mark-ups for baseline products and higher-efficiency products, because DOE applies an incremental mark-up to the increase in MSP associated with higher-efficiency products.

For the default price trend for residential furnaces, DOE derived an experience rate based on an analysis of long-term historical data. 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 2020.[87] 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

[87] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices Series ID PCU333415333415C (Available at: *www.bls.gov/ppi/*) (last accessed Feb. 15, 2022).

cumulative shipments of residential furnaces, based on a corresponding series for total shipments of residential furnaces (see section IV.G of this document for discussion of shipments data). Using the most recent data available, DOE fitted a power-law function to the deflated warm air furnace PPI and cumulative furnace shipments time series data between 1990 and 2020. The resulting power-law model has an R-square of 84 percent, indicating that the model explains 84 percent of the variability of the observations around the mean. DOE then derived a price factor index, with the price in 2020 equal to 1, to forecast prices in 2029 for the LCC and PBP analyses, and, for the NIA, for each subsequent year through 2058. 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 in the no-new-standards case determined for the NIA (see section IV.H of this document).

DOE's learning curve methodology was developed by examining the literature on accounting for technological change and empirical studies of energy technology learning rates.[88] DOE utilized the most extensive time series data available specific to residential furnaces.

Furnace prices can be affected by a variety of factors, and the cost of commodity materials is one of them. The nominal commodity PPI data for copper wire and cable, iron and steel, and aluminum wire and cable indicate that the nominal indices rose substantially between the early 2000s and 2011, which is primarily attributed to an increasing demand for such commodities from rapid industrialization in China, India, and other emerging economies. During the same period, the nominal warm air furnace PPI increased by 16 percent. However, these commodity indices have trended downward since 2011, and the nominal warm air furnace PPI has steadily trended upward during this period. Based on these observations, DOE contends that even though the warm air furnace PPI, to a certain extent, is influenced by commodity indices, other factors impact furnace prices. In addition, due to the long-term nature of DOE's analysis, it would be inappropriate to make assumptions based on recent, short-term trends only.

The learning curve methodology implemented in this proposed rule is based on sound economic theory, empirical evidence, and historical data. Based on the historical PPI data, the cost of commodity materials can only partially explain the furnace price trend, particularly when considering the recent trend observed in commodity and furnace price indices. The experience curve model that DOE developed, using the most recent data available, shows strong explanatory power and high statistical significance. DOE welcomes information that could support improvement in its methodology.

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 and MHGFs 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 a decline in the cost of condensing furnaces. However, DOE could not find detailed data that would allow for a price trend projection for condensing NWGFs and MHGFs that may differ from non-condensing NWGFs and MHGFs. Thus, for this NOPR, it used the same price trend projection for condensing and non-condensing NWGFs and MHGFs. Although DOE was not able to find information or data regarding price trends related to different furnace technologies, DOE is exploring ways to estimate learning rates for different technologies.[89]

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

DOE requests data and information on the price trend for condensing NWGFs as compared to the trend for non-condensing NWGFs.

3. Installation Cost

The installation cost is the cost to the consumer of installing the furnace, in addition to the cost of the furnace itself. The cost of installation covers all labor, overhead, and material costs associated with the replacement of an existing furnace or the installation of a furnace in a new home, as well as delivery of the new furnace, removal of the existing furnace, and any applicable permit fees. Higher-efficiency furnaces may require one to incur additional installation costs. DOE's analysis of installation costs estimated specific installation costs for each sample household based on building characteristics given in RECS 2015. For this NOPR, DOE used 2021 RS Means data for the installation cost estimates, including labor costs.[90] [91] [92] [93] DOE's analysis of installation costs accounted for regional differences in labor costs by aggregating city-level labor rates from RS Means into 30 distinct State or multi-State regions to match RECS 2015 data and into the nine Census Divisions to match CBECS 2012 data.

DOE conducted a detailed analysis of installation costs for all potential installation cases, including when a non-condensing gas furnace is replaced with a non-condensing gas furnace, and when a non-condensing gas furnace is replaced with a condensing gas furnace. For the latter, particular attention was 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 additional installation costs (''adders'') for new construction installations. These are described below.

a. Basic Installation Costs

DOE's analysis estimated basic installation costs for replacement, new owner, and new home applications. These costs, which apply to both condensing and non-condensing gas furnaces, include furnace set-up and transportation, gas piping, ductwork, electrical hook-up, permit and removal/disposal fees, and where applicable, additional labor hours for an attic installation.

DOE's installation costs account for cases where significant ductwork redesign is required, including when

[88] 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: *eta-publications.lbl.gov/sites/default/files/lbnl-6195e_.pdf*) (Last accessed Feb. 15, 2022).

[89] 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: *eta-publications.lbl.gov/sites/default/files/lbnl-6195e_.pdf*) (Last accessed Feb. 15, 2022).

[90] RS Means Company Inc., *RS Means Mechanical Cost Data.* Kingston, MA (2021) (Available at: *www.rsmeans.com/products/books/2021-cost-data-books*) (Last accessed Sept. 9, 2021).

[91] RS Means Company Inc., *RS Means Residential Repair & Remodeling Cost Data. Kingston,* MA (2021) (Available at: *www.rsmeans.com/products/books/2021-cost-data-books*) (Last accessed Feb. 15, 2022).

[92] RS Means Company Inc., *RS Means Plumbing Cost Data.* Kingston, MA (2021) (Available at: *www.rsmeans.com/products/books/2021-cost-data-books*) (Last accessed Feb. 15, 2022).

[93] RS Means Company Inc., *RS Means Electrical Cost Data.* Kingston, MA (2021) (Available at: *www.rsmeans.com/products/books/2021-cost-data-books*) (Last accessed Feb. 15, 2022).

furnaces with variable speed motors are utilizing undersized ducts. DOE notes that this cost is applicable to variable speed motors installed in either condensing or non-condensing furnaces. Variable speed furnace blowers will try to maintain the same air flow at high static pressure (especially if the variable speed blower is designed with a high cut-off or no cut-off static pressure),[94] which could lead to noise issues in smaller ducts due to the increased speed of moving the air. However, the Federal furnace fan standard that took effect in 2019 requires constant torque furnace fans (with X13 motors), which have similar performance curves as PSC motors.[95]

DOE notes that asbestos presents a safety hazard that must be properly abated for all retrofit installations where it is present. As explained above, DOE recognizes that potential ductwork modifications typically occur due to the furnace fan requirements and not necessarily due to the installation of a condensing furnace. DOE included the cost of asbestos abatement for a fraction of both non-condensing and condensing NWGF installations. See appendix 8D of the NOPR TSD for more details.

b. Additional Installation Costs for Non-Weatherized Gas Furnaces

For replacement applications, DOE included a number of 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 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.

Replacement Installations: Non-Condensing to Non-Condensing Non-Weatherized Gas Furnace

For non-condensing non-weatherized gas furnace replacements, DOE added additional costs to a small fraction of installations that involve updating flue vent connectors, vent resizing, and chimney relining. These costs are most commonly applied to older furnace installations, such as natural draft furnace installations, furnaces not installed according to the current codes, and furnace installations that do not meet manufacturers' installation requirements. In total, these costs for vent resizing or chimney relining are applied to less than 5 percent of non-condensing to non-condensing furnace replacement installations in 2029, with an average cost of $755. In addition, DOE estimated that 24 percent of installations of non-condensing to non-condensing furnace replacement installations in 2029 would require updating flue vent connectors, with an average cost of $284.

Replacement Installations: Non-Condensing to Condensing Non-Weatherized Gas Furnace

DOE assumed that condensing furnaces that replace non-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. In determining these installation costs, DOE takes into account vent length, vent diameter, vent termination, the potential need to create openings in walls or floors for the vent system, additional vent costs for housing units with shared walls, vent resizing in the case of an orphaned water heater, and concealment work cost increases in some installations.

Appendix 8D in the TSD for this NOPR describes the methodology used to determine the installation costs for all of the issues described in the paragraphs that follow.

(a) Flue Venting

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. Accordingly, DOE determined whether a condensing furnace is horizontally or vertically vented based on the shortest vent length. DOE's analysis estimated that 70 percent of condensing furnaces will be installed with a horizontal vent.

DOE assumed that vent length varies depending on where a suitable wall is located relative to the furnace. In addition, when applicable, DOE accounts for use of a snorkel termination 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. In DOE's analysis, snorkel termination is more frequently needed in situations where the furnace is below the snow line (such as in basements or crawl spaces). 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 might be easier and cheaper to change the furnace location, but this would require both gas line extensions and ductwork modifications, which were not modeled in DOE's installation cost analysis. 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 and the cost of concealment work in some installations.

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. For a fraction of installations, DOE increased the vent diameter in order to be able to extend the vent length according to manufacturer specifications.

(b) Common Venting Issues (Including Orphaned Water Heaters)

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,[96] and the water heater becomes ''orphaned.'' The existing vent may need to be modified to safely vent the orphaned water heater, while a new vent is installed for the condensing NWGF. DOE accounted for a fraction of installations that would require chimney relining or vent resizing for the orphaned water heater,

[94] Newer variable speed motors are designed with lower cut-off static pressures to deal with this issue. In addition, the installer can easily decrease the airflow to address the issue by changing the airflow speed control setting (tap) on the furnace motor.

[95] For further details, see the Technical Support Document for the July 2014 final rule for furnace fans. (Available at: *www.regulations.gov/document/EERE-2010-BT-STD-0011-0111*) (Last accessed Feb. 15, 2022).

[96] The ANSI Z223.1/NFPA 54 Natural Fuel Gas Code (''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. The 2021 Edition is available at *www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=54* (Last accessed Feb. 15, 2022).

including updating flue vent connectors, resizing vents, or relining chimneys when applicable based upon the age of the furnace and the home.

DOE accounted for the probability that in some cases, replacing a non-condensing furnace with a condensing furnace may require significant modifications to the existing vent system for the commonly-vented gas water heater. DOE accounted for costs related to updating the vent connector, relining the chimney, and resizing the vent, which would satisfy the installation requirements of the Natural Fuel Gas Code. DOE understands that a potential option would be to install either a storage or tankless power-vented water heater to avoid the cost of a chimney or metal flue vent modification just for the gas water heater, or to switch to an electric storage water heater. DOE recognizes that the frequency of chimney relining and vent resizing may decrease slightly due to the increase in adoption of high-efficiency gas water heaters. However, DOE did not find any additional information or data [97] to project the market share of high-efficiency water heaters in 2029 or the decrease in the fraction of installations with common vents. Therefore, DOE did not consider the power-vented gas storage or other higher-efficiency water heater options. Instead, DOE either added additional installation costs associated with venting a Category I water heater, such that the orphaned water heater could be vented through the chimney, or accounted for the installation of an electric storage water heater as an alternative. For new owners 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.

DOE acknowledges that multi-family buildings may require additional measures to replace non-condensing furnaces with condensing furnaces. Such measures include the vent length, existing common vents, and horizontal venting. For this NOPR, DOE assigned additional venting installation costs (on average $248) for a quarter of replacement installations [98] in multi-family buildings to account for modifying the existing vent systems to accommodate a condensing furnace installation.

(c) New Venting Technologies

To address certain difficult installation situations, new venting technologies are being developed to vent a condensing residential furnace and an atmospheric combustion water heater through the same vent by reusing the existing metal vent or masonry chimney with a new vent cap and appropriate liner(s).[99] [100] In 2015, the FasNSeal 80/90 venting system was introduced commercially by M&G DuraVent, a new venting system that uses a unique, pipe-within-a-pipe design to vent a condensing furnace and a natural draft water heater.[101] FasNSeal 80/90 is UL-approved. An additional venting solution known as EntrainVent is available as a pre-commercial prototype by Oak Ridge National Laboratory.[102] DOE conducted a sensitivity analysis to estimate the impact of such technologies on the installation cost of a condensing NWGF, but did not include the technologies in the primary analysis.

DOE recognizes that there are currently limitations to DuraVent's new FasNSeal 80/90 venting technology related to venting in masonry chimneys and that currently there are limited field performance data.[103] Because of the uncertainty regarding applicability of FasNSeal 80/90 and other new venting technologies, DOE only considered using this option in a sensitivity analysis. DOE conducted two additional sensitivity analyses: (1) the FasNSeal 80/90 option is applied to installations that can currently meet the FasNSeal 80/90 installation requirements (metal vents only); and (2) all new venting technology options are applied to installations that could meet the respective installation requirements (metal vents and masonry chimney installations, including installations with more horizontal sections). DOE notes that while new venting technologies could lower installation costs, DOE must base its approach on currently available data rather than make assumptions as to future developments in advanced venting technologies. DOE welcomes any available data on the use of new venting technologies.

(d) Combustion Air Venting

DOE's analysis accounts for the additional cost associated with direct vent installations that use combustion air intake. Direct vent or sealed combustion is not required for condensing installations, but it is recommended for any condensing furnace to utilize ''sealed combustion.'' All condensing furnaces come with this feature (which requires an opening for the intake combustion air pipe/vent). Condensing furnaces will often be installed as direct vent furnaces since it offers significant energy savings [104] and safety [105] advantages.[106] [107]

DOE's analysis assumes that two-thirds of condensing furnaces will be installed with the direct vent feature. Typically, the combustion air intake pipe will go in the same direction of the flue vent or can be in a concentric vent.

(e) Condensate Withdrawal

DOE accounted for the cost of condensate removal for condensing

[97] Data from the residential water heater final rule were used in this analysis. 75 FR 20112 (April 16, 2010).

[98] This fraction accounts for buildings without common venting; buildings where all/most furnaces are replaced at the same time (many rentals/HOA situations); smaller multi-family units/smaller number of floors; and situations where disconnecting one furnace from the common vent does not impact the common venting for remaining furnaces. This fraction is also based on 2015 RECS data regarding the number of apartments/units and the number of stories per multi-family building.

[99] Oak Ridge National Laboratory, Condensing Furnace Venting Part 1: The Issue, Prospective Solutions, and Facility for Experimental Evaluation (October 2014) (Available at: *web.ornl.gov/sci/buildings/docs/Condensing-Furnace-Venting-Part1-Report.pdf*) (Last accessed Feb. 15, 2022).

[100] Oak Ridge National Laboratory, Condensing Furnace Venting Part 2: Evaluation of Same-Chimney Vent Systems for Condensing Furnaces and Natural Draft Water Heaters (February 2015) (Available at: *web.ornl.gov/sci/buildings/docs/Condensing-Furnace-Venting-Part2-Report.pdf*) (Last accessed Feb. 15, 2022).

[101] M&G DuraVent's FasNSeal 80/90 Combination Cat I and Cat IV gas vent system is UL listed to applicable portions of ULC S636/UL1738, UL1777, and UL441 (Available at: *www.duravent.com/fasnseal-80–90/*) (Last accessed Feb. 15, 2022).

[102] Oak Ridge National Laboratory, Condensing Furnace Venting Part 2: Evaluation of Same-Chimney Vent Systems for Condensing Furnaces and Natural Draft Water Heaters (February 2015) (Available at: *web.ornl.gov/sci/buildings/docs/Condensing-Furnace-Venting-Part2-Report.pdf*) (Last accessed Feb. 15, 2022).

[103] Oak Ridge National Laboratory, Furnace and Water Heater Venting Field Demonstration (May, 2019) (Available at: *www.ornl.gov/publication/furnace-and-water-heater-venting-field-demonstration*) (Last accessed Feb. 15, 2022).

[104] A non-direct vent furnace increases the air infiltration that the house experiences since for every cubic foot of air that leaves the house, another cubic foot of air comes in. Thus, a direct vent furnace avoids using heated indoor air for combustion.

[105] By separating the combustion air from indoor household air, the furnace is not affected by other home appliances in a tight home. A direct vent furnace reduces the danger of any potential backdrafts (pulling exhaust gases down the chimney), as well as reducing the danger of foreign gases in the combustion air. For example, a furnace could be damaged by vapors from laundry products, as these vapors can mix with indoor combustion air to corrode furnace components.

[106] DOE, Technology Fact Sheer. Combustion Equipment Safety: Provide Safe Installation for Combustion Appliances (October 2000) (DOE/GO–102000–0784) (Available at: *www1.eere.energy.gov/buildings/publications/pdfs/building_america/26464.pdf*) (Last accessed Feb. 15, 2022).

[107] DOE, Furnace and Boilers (Available at: *www.energy.gov/energysaver/home-heating-systems/furnaces-and-boilers*) (Last accessed Feb. 15, 2022).

NWGF installations, including, when applicable, a condensate drain, condensate pump, freeze protection (heat tape),[108] drain pan, condensate neutralizer, and an additional electric outlet for the condensate pump.

DOE acknowledges that condensate management can be costly for some installations (*e.g.,* multi-family units) and very difficult in rare cases. DOE's current installation cost approach accounts for these costs. However, DOE added a sensitivity analysis with additional condensate costs.

The use of heat tape to prevent condensate pipes from freezing is standard installation practice.[109][110] DOE's analysis accounts for the use of heat tape typical in unconditioned attic installations, which are more likely to face freezing conditions. DOE acknowledges that other unconditioned locations could also face freezing, but it is far less common.[111] DOE also included heat tape to installations in additional non-conditioned spaces such as crawl spaces, non-conditioned basements, and garages that are in regions that could be exposed to freezing conditions. DOE accounted for the additional installation cost and energy use of the heat tape. Additionally, because it is recommended practice that heat tape be plugged into a ground fault circuit interrupter (''GFCI'') circuit, DOE included the cost of adding a GFCI circuit for the fraction of households that do not have one available. DOE also conducted a sensitivity analysis with an additional fraction of installations necessitating the use of heat tape.

To address situations where condensate must be treated before disposal (*e.g.,* due to a local regulation), DOE assumed that a fraction of installations require condensate neutralizer for condensate withdrawal. As discussed in appendix 8D of the TSD for this NOPR, the fraction of installations that require condensate neutralizer used in the analysis is representative of the current use. DOE includes the cost of using non-corrosive drains for an additional fraction of installations. Additionally, DOE conducted a sensitivity analysis assuming a high fraction of installations use condensate neutralizer or are installed with a non-corrosive drain.

(f) Difficult Installations

DOE considered the potential need for additional vent length to reach a suitable location on an outside wall where the vent termination could be located, as well as the potential need for wall penetrations and/or concealing of flue vents in conditioned spaces.

DOE used the best available information and data to characterize the likely nature and cost of installations of a condensing furnace as a replacement for a non-condensing furnace in its consumer sample. DOE estimates that 51 percent of replacements could be labeled as ''difficult'' installations,[112] with an average incremental installation cost of $1,003 relative to the baseline 80 percent AFUE NWGF (compared to an incremental cost of $262 for all other replacement installations).

DOE is not aware of any physical limitations or building code issues that would preclude the installation of a condensing NWGF in multi-family buildings, townhomes, and row houses.

DOE sought any information or data regarding potential physical limitations when installing a new condensing furnace. In consumer [113] and contractor [114] surveys, relocation was not mentioned as an issue for furnace installation.[115] DOE recognizes that in some cases, homeowners could elect to relocate their furnace when replacing a non-condensing NWGF with a condensing NWGF, especially if the relocation is part of a planned remodel of the home. In such cases, the cost of relocation is likely to be comparable to the costs that DOE estimated for difficult installations.

(g) Emergency Replacements

DOE acknowledges that installation costs could increase for condensing furnaces in an unplanned emergency situation for the reasons that follow. While it is not possible to estimate the share of installations that would constitute an emergency (unplanned during the heating season), Decision Analyst's 2019 American Home Comfort Study (''AHCS'') [116] reported that unplanned replacements accounted for one third of gas furnace installations. For this NOPR, DOE included labor costs for unplanned replacements to account for additional contractor labor needed to finish the installation, factoring in the difficulty of accessing the roof during periods of snow or ice accumulation. In addition, to address periods without heat during the replacement, DOE considered the costs of the temporary use of small electric resistance space heaters or secondary/back-up heaters.

(h) Incremental Installation Cost for Condensing Furnaces

DOE estimated that the incremental retrofit installation cost for condensing furnaces was $644. For new construction and new owners, the incremental installation cost was estimated to be, on average, −$647.[117] Since 26 percent of shipments were assumed to be in the new construction and new owners market, the resulting average incremental installation cost was $301. The incremental installation cost estimates reflect labor cost and installation material cost data from 2021 RS Means.

(i) New Construction or New Owner Installations

It is common practice in new construction, when possible, to avoid vertical venting in order to limit roof penetrations and reduce potential liability issues (*e.g.,* water leakage through new roof penetrations).[118] Condensing furnaces have the flexibility of being vented either horizontally or vertically. When presented with this option in new construction, it is reasonable to conclude that most

[108] Heat tape is also referred to as heating cable and provides electric heating.

[109] ICP, Installation Instructions for Condensate Freeze Protection Kit (2012) (Available at: *www.icptempstarparts.com/mdocs-posts/naha00201hh-condensate-freeze-protection-kit-installation-instructions/*) (Last accessed Feb. 15, 2022).

[110] Bryant, Installation Instructions: Condensate Drain Protection (2008) (Available at: *www.questargas.com/ForEmployees/qgcOperationsTraining/Furnaces/Bryant_355AAV.pdf*) (Last accessed Feb. 15, 2022).

[111] Brand, L. and W. Rose, Strategy Guideline: Accurate Heating and Cooling Load Calculations. Partnership for Advanced Residential Retrofits (October 2012) (Available at: *www.nrel.gov/docs/fy13osti/55493.pdf*) (Last accessed Feb. 15, 2022).

[112] DOE considered an installation to be ''difficult'' if there is an orphaned water heater, a long PVC vent connection though multiple walls, or in households with condensate issues (*e.g.,* ones requiring heat tape or a condensate pump).

[113] Decision Analyst, Homeowner ''Spotlight'' Report: Equipment Switching, Repair Profile and Energy Efficiency (August 2011). (*www.decisionanalyst.com/*) (Last accessed Feb. 15, 2022).

[114] Decision Analyst, Contractor ''Spotlight'' Report: Energy Efficiency and Installation Profile (August 2011). (*www.decisionanalyst.com/*) (Last accessed Feb. 15, 2022).

[115] This finding is supported by an expert consultant (EER Consulting).

[116] Decision Analysts, 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/syndicated/homecomfort/*) (Last accessed Feb. 15, 2022).

[117] DOE calculated that on average condensing NWGF installation costs are lower in the new construction market compared to non-condensing NWGFs, since high-efficiency NWGF can be vented either horizontally or vertically (whichever is most cost-effective), and, therefore, a vertical buildout with roof penetration is not required. *See* appendix 8D of the TSD for this NOPR for more details regarding new construction installation costs.

[118] Lekov A., V. Franco, G. Wong-Parodi, J. McMahon, P. Chan, Economics of residential gas furnaces and water heaters in US new construction market,. Energy Efficiency (September 2010) Volume 3, Issue 3, pp 203–222 (Available at: *link.springer.com/article/10.1007/s12053-009-9061-y*) (Last accessed Feb. 15, 2022).

designers, architects, builders, contractors, and/or homeowners would opt for the most cost-effective installation. Current building practices are likely to evolve as the market changes in response to any amended energy conservation standards for the subject furnaces.

For new owner and new construction installations, DOE applied an incremental venting cost if the owner/builder had been planning to install a commonly-vented non-condensing furnace and water heater.

c. Additional Installation Costs for Mobile Home Gas Furnaces

DOE included the same basic installation costs for MHGFs as described previously for NWGFs. DOE also included costs for venting and condensate removal. Protection from freezing (heat tape), a condensate pipe, condensate neutralizer, and an additional electrical connection are accounted for in the cost of condensate removal, where applicable.

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. DOE notes that most of the MHGF models at the proposed standard level of 95-percent AFUE are similar in size to the existing non-condensing MHGFs. However, some condensing furnaces in the manufacturer literature are wider and shorter than existing non-condensing furnaces. Accordingly, DOE increased the installation costs for a fraction of installations to address the impacts related to space constraints or condensate withdrawal that may be encountered when a condensing MHGF replaces an older mobile-home-specific furnace. DOE also adjusted the installation cost for the dedicated vent system for condensing MHGFs by including an additional cost to remove the old venting system. Mobile homes must be approved, as required by the U.S. Department of Housing and Urban Development, to ensure compliance with the HUD Code (24 CFR 3282.203), which requires special sealed combustion venting for MHGFs that cannot be commonly vented with other gas-fired equipment (such as a gas-fired water heater). DOE also adjusted the condensate withdrawal installation costs to account for a fraction of installations that encounter difficulty installing the condensate drain.

d. Contractor Survey and DOE's Sources

AHRI and Carrier commented that DOE dismissed industry survey data (the ACCA/AHR/PHCC contractor survey), and that such dismissal is unreasonable, arbitrary and capricious. These commenters stated that DOE was unreasonable to rely on eight websites in lieu of over 700 contractors with experience in the field, and that the websites relied upon, in fact, indicate that the cost of a new furnace installation is much higher than DOE estimates. These commenters stated that a survey seeking average installation costs for the purposes of information collection, rather than lead-generation, is implicitly more reliable that what amounts to online advertisements. AHRI and Carrier also stated that the estimated costs presented by these websites suggest that furnace installation is far more expensive that DOE estimates, with incremental costs potentially ranging from $800 to $4,500. (AHRI, No. 303 at p. 12; Carrier, No. 302 at pp. 6–7) Lennox also criticized DOE for failing to consider data from the contractor survey and commented that the sources DOE quotes in its analysis actually support much higher installation costs and require further review and analysis. (Lennox, No. 299 at pp. 13–14, 30)

AHRI continues to object to the methodology used by DOE to determine installation costs, which it asserts is disassociated from actual costs. AHRI also stated that the differences between the installation costs developed by DOE and those from the marketplace as measured by the ACCA/AHRI/PHCC contractor survey are huge. (AHRI, No. 303 at p. 41) Spire suggested that DOE should rely on actual field installation costs rather than estimating the installation cost. (Spire, September 2016 SNOPR Public Meeting Transcript, No. 243 at p. 88) Spire stated that there is nothing in the record to show what input DOE's consultants actually sought or obtained on installation costs, and that the only manufacturer input that is available on the record is comments from manufacturers stating that DOE's installed cost estimates are gross underestimates of actual installed costs. (Spire, No. 309–1 at p. 92) HARDI stated that DOE should not rely on installation information available on the internet, but rather should speak with installing contractors across diverse sections of the country, in addition to contractor organizations, to assess and verify the information obtained online. HARDI also stated that the online lead generation and price quoting mechanisms cited by DOE are responsible for less than five percent of sales amongst HARDI's customers and are not reflective of industry norms, and the quality and reliability of participants are unknown. Instead, HARDI urged DOE to consult the comments by PHCC, ACCA, and AHRI to assess true installation costs. (HARDI, No. 271 at p. 3)

Rheem asserted that the installation cost data referenced by DOE in the September 2016 SNOPR were incomplete and vague, that the data did not always differentiate between condensing and non-condensing NWGFs, and that the cited costs ranged wildly. Rheem also stated that applications were mixed between furnace only and furnace and central air conditioners (''CAC'') combinations. (Rheem, No. 307 at pp. 7–8)

In response, DOE notes that its focus for installation costs is to estimate the incremental cost between different efficiency levels. However, DOE used the results of the contractor survey to validate its estimates of the average total installed cost for condensing furnaces in replacement applications, as well as the average incremental installation cost. DOE examined the ACCA/AHRI/PHCC survey of contractors but was unable to use the data directly in the LCC analysis because only aggregate values were reported. The ACCA/AHRI/PHCC survey results are binned in wide bins of $250, and the sample is heavily weighted towards the north (339 responses in the North and 181 in the South). As noted previously, installation costs vary widely for different contractors and areas of the country. The installation costs in the Northern region will tend to be much higher than those reported in the Rest of the Country (as defined in the LCC analysis). For this NOPR, DOE revised its installation cost methodology to account for various factors affecting both non-condensing and condensing NWGFs, such as: the cost of ductwork upgrades; baseline electrical installation costs; additional labor required for baseline installations; the cost of relining, resizing, and/or other adjustments of metal venting for baseline installations; premium installation costs for emergency replacements; and other premium installation costs for comfort-related features (*e.g.,* advanced thermostats, zoning, hypoallergenic filters, humidity controls). For this NOPR, DOE also compared its average estimates to the AHRI/ACCA/PHCC contractor survey report and other sources such as Home Advisor,[119] ImproveNet,[120] Angie's

[119] Home Advisor, How Much Does a New Gas Furnace Cost? (Available at: *www.homeadvisor.com/cost/heating-and-cooling/gas-furnace-prices/*) (Last accessed February 15, 2022).

[120] *www.improvenet.com/* (Last accessed Feb. 15, 2022).

List,[121] HomeWyse,[122] Cost Helper,[123] Fixr,[124] CostOwl,[125] and Gas Furnace Guide,[126] and also consulted with RS Means staff. In addition, DOE was able to obtain installation costs disaggregated for households installing only a furnace versus installing both a furnace and air conditioner from the 2016 AHCS. For this NOPR, the average incremental installation cost for a condensing NWGF in a retrofit installation was $644 (in 2020$), which is consistent with the AHRI/ACCA/PHCC contractor survey and data provided by SoCalGas, as well as the other sources listed above. Therefore, DOE concludes that the industry-supplied data support its installation cost methodology.

e. Summary of Installation Costs

Table IV.12 shows the fraction of installations impacted and the average cost for each of the installation cost adders in replacement applications (not including new owners). The estimates of the fraction of installations impacted were based on the furnace location (primarily derived from information in RECS 2015) and a number of other sources that are described in chapter 8 of this NOPR TSD.

TABLE IV.12—ADDITIONAL INSTALLATION COSTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES IN REPLACEMENT APPLICATIONS

Installation cost adder	NWGFs		MHGFs	
	Replacement installations impacted (percent)	Average cost (2020$)	Replacement installations impacted (percent)	Average cost (2020$)
Non-Condensing Furnaces				
Updating Vent Connector	24	284		
Updating Flue Vent *	5	751	100	195
Condensing Furnaces				
New Flue Venting (PVC)	100	301	100	47
Combustion Air Venting (PVC)	57	298	100	47
Concealing Vent Pipes	7	551		
Orphaned Water Heater	18	747		
Condensate Removal	100	95	100	201
Multi-Family Adder	4	248		
Mobile Home Adder			25	236

* For a fraction of installations, this cost includes the commonly-vented water heater vent connector, chimney relining, and vent resizing. For mobile home gas furnaces, DOE assumed that flue venting has to be upgraded for all replacement installations.

Table IV.13 shows the estimated fraction of new home installations impacted and the average cost for each of the adders.

TABLE IV.13—ADDITIONAL INSTALLATION COSTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES IN NEW CONSTRUCTION AND NEW OWNER APPLICATIONS

Installation cost adder	NWGFs		MHGFs	
	New installations impacted (percent)	Average cost (2020$)	New installations impacted (percent)	Average cost (2020$)
Non-Condensing Furnaces				
New Flue Vent (Metal) *	100	$1,520	100	$259
Condensing Furnaces				
New Flue Venting (PVC)	100	167	100	23
Combustion Air Venting (PVC)	57	162	100	23
Concealing Vent Pipes *	2	209		
Orphaned Water Heater	47	1,150		
Condensate Removal	100	66	100	111

* Applied to new owner installations only.

[121] Angie's List, How Much Does it Cost to Install a New Furnace (Available at: *www.angieslist.com/articles/how-much-does-it-cost-install-new-furnace.htm*) (Last accessed Feb. 15, 2022).

[122] HomeWyse, Cost to Install a Furnace (Available at: *www.homewyse.com/services/cost_to_install_furnace.html*) (Last accessed Feb. 15, 2022).

[123] Cost Helper, How Much Does a Furnace Cost? (Available at: *home.costhelper.com/furnace.html*) (Last accessed Feb. 15, 2022).

[124] FIXr, Gas Central Heating Installation Cost (Available at: *www.fixr.com/costs/gas-central-heating-installation*) (Last accessed Feb. 15, 2022).

[125] *CostOwl.com,* How much Does a New Furnace Cost? (Available at: *www.costowl.com/home-improvement/hvac-furnace-replacement-cost.html*) (Last accessed Feb. 15, 2022).

[126] Gas Furnace Guide, Gas Furnace Prices and Installation Cost Comparison (Available at: *www.gasfurnaceguide.com/compare/*) (Last accessed Feb. 15, 2022).

4. Annual Energy Consumption

For each sampled residential furnace installation, DOE determined the energy consumption for a NWGF or MHGF at different efficiency levels using the approach described above in section IV.E of this document.

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. At the same time, consumers benefit from increased utilization of products due to rebound. Overall consumer surplus (taking into account additional costs and benefits) is generally understood to increase from rebound. DOE examined a 2009 review of empirical estimates of the rebound effect for various energy-using products.[127] 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 paper [128] and a 2013 paper by Thomas and Azevedo.[129] Both of these publications examined the same studies that were reviewed by Sorrell, as well as Greening *et al.,*[130] 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 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, DOE used a 15-percent rebound effect for NWGFs and MHGFs. This rebound is the same as assumed in EIA's National Energy Modeling System (''NEMS'') for residential space heating.[131] However, for commercial applications DOE applied no rebound effect, consistent with other recent energy conservation standards rulemakings.[132] [133] [134]

The LCC analysis is an analysis that does not account for consumer behavior; as a result, DOE does not include the rebound effect in the LCC. Some households may increase their furnace use in response to increased efficiency, and as a result, not all households will realize the LCC savings represented in section V.B of this document. DOE does include rebound in the NIA for a conservative estimate of national energy savings and the corresponding impact to consumer NPV. See section IV.H of this document.

EPCA requires that in its evaluation of proposed energy conservation standards, DOE must 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. (42 U.S.C. 6295(o)(2)(B)(i)(II)) That is, DOE must consider the savings resulting from operating a covered product that the consumer would purchase under the proposed standard and the costs that the consumer would realize from operating such a product, as compared to the costs that the consumer would realize from operating a product under the current standard. This consideration is to inform the determination of whether an amended standard would be economically justified. EPCA does not prohibit this consideration from monetizing additional benefits that the consumer may receive from a covered product that complies with a proposed improvement in efficiency.

EPCA directs DOE to consider ''savings in operating costs'' with no reference as to how DOE is to consider any potential increase in value provided to the consumer under a proposed standard. (*See,* 42 U.S.C. 6295(o)(2)(B)(i)(II)) In evaluating potential changes in the operating costs, DOE has considered the useful output of a furnace provided to the consumer. The rebound effect does not capture an external benefit, but reflects a benefit directly realized by the consumer in the form of increased comfort. Were DOE to adopt an approach that did not include a value for the additional comfort provided by a more-efficient furnace, the economic benefits from the proposed standard would have been underestimated. DOE's evaluation of the economic impact of a proposed standard would include the cost of additional fuel consumption resulting from the rebound effect, but would fail to recognize the additional welfare provided directly to the consumer from a NWGF or MHGF that complies at the proposed efficiency level.

In addition to the consideration required by 42 U.S.C. 6295(o)(2)(B)(i)(II), EPCA directs DOE to consider the economic impact of the standard on manufacturers and on the consumers of the products subject such standard. (42 U.S.C. 6295(o)(2)(B)(i)(I)) The economic impact is not narrowly defined to include only costs related to energy consumption. The occurrence of a rebound effect demonstrates that consumers value the additional output (*i.e.,* heat) as they are paying for the additional heat, and resulting increase in comfort, reflected in their energy bills. To quantify the effects of rebound, DOE estimates the economic and energy savings impact in the NIA. See chapter 10 of the NOPR TSD for more details.

5. Energy Prices

A marginal energy price reflects the cost or benefit of adding or subtracting one additional unit of energy consumption. Marginal electricity prices more accurately capture the incremental savings associated with a change in energy use by higher-efficiency products and provide a better representation of incremental change in consumer costs than average electricity prices. Therefore, DOE applied average electricity prices for the energy use of the product purchased in the no-new-standards case and marginal electricity prices for the incremental change in energy use associated with the other efficiency levels considered.

[127] Steven Sorrell, *et al.,* Empirical Estimates of the Direct Rebound Effect: A Review*,* 37 *Energy Policy* 1356–71 (2009) (Available at *www.sciencedirect.com/science/article/pii/S0301421508007131*) (Last accessed Feb. 15, 2022).

[128] Steven Nadel, ''The Rebound Effect: Large or Small?'' ACEEE White Paper (August 2012) (Available at *www.aceee.org/files/pdf/white-paper/rebound-large-and-small.pdf*) (Last accessed Feb. 15, 2022).

[129] Brinda Thomas and 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*) (Last accessed Feb. 15, 2022).

[130] Lorna A. Greening, *et al.,* Energy Efficiency and Consumption—The Rebound Effect—A Survey, 28 *Energy Policy* 389–401 (2002) (Available at *www.sciencedirect.com/science/article/pii/S0301421500000215*) (Last accessed Feb. 15, 2022).

[131] *See: www.eia.gov/outlooks/aeo/nems/documentation/residential/pdf/m067(2020).pdf* (Last accessed May 19, 2022).

[132] DOE. Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards for Small, Large, and Very Large Air-Cooled Commercial Package Air Conditioning and Heating Equipment and Commercial Warm Air Furnaces; Direct final rule. 81 FR 2419 (Jan. 15, 2016) (Available at *www.regulations.gov/document/EERE-2013-BT-STD-0021-0055*) (Last accessed Feb. 15, 2022).

[133] DOE. Energy Conservation Program: Energy Conservation Standards for Residential Boilers; Final rule. 81 FR 2319 (Jan. 15, 2016) (Available at *www.regulations.gov/document/EERE-2012-BT-STD-0047-0078*) (Last accessed Feb. 15, 2022).

[134] DOE. Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers; Final Rule. 85 FR 1592 (Jan. 10, 2020) (Available at *www.regulations.gov/document/EERE-2013-BT-STD-0030-0099*) (Last accessed Feb. 15, 2022).

DOE derived average monthly marginal residential and commercial electricity, natural gas, and LPG prices for each state using data from EIA.[135] [136] [137] DOE calculated marginal monthly regional energy prices by: (1) first estimating an average annual price for each region; (2) multiplying by monthly energy price factors, and (3) multiplying by seasonal marginal price factors for electricity, natural gas, and LPG. The analysis used historical data up to 2020 for residential and commercial natural gas and electricity prices and historical data up to 2019 for LPG prices. Further details may be found in chapter 8 of the NOPR TSD.

DOE compared marginal price factors developed by DOE from the EIA data to develop seasonal marginal price factors for 23 gas tariffs provided by the Gas Technology Institute for the 2016 residential boilers energy conservation standards rulemaking.[138] DOE found that 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 from 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.

DOE notes that within a State, there could be significant variation in the marginal price factors, including differences between rural and urban rates. In order to take this to account, DOE developed marginal price factors for each individual household using RECS 2015 billing data. These data are then normalized to match the average State marginal price factors, which are equivalent to a consumption-weighted average marginal price across all households in the State. For more details on the comparative analysis and updated marginal price analysis, see appendix 8D of this NOPR TSD.

To estimate energy prices in future years, DOE multiplied the 2020 energy prices by the projection of annual average price changes for each of the nine Census Divisions from the Reference case in *AEO2021,* which has an end year of 2050.[139] To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2045 through 2050. DOE also conducted sensitivity analyses using lower and higher energy price projections. The impact of these alternative scenarios is shown in appendix 8K of the NOPR TSD.

6. Maintenance and Repair Costs

Maintenance costs are associated with maintaining the operation of the product, while repair costs are associated with repairing or replacing product components that have failed in an appliance.

DOE estimated maintenance costs for residential furnaces at each considered efficiency level using a variety of sources, including 2021 RS Means,[140] manufacturer literature, and information from expert consultants. DOE estimated the frequency of annual maintenance using data from RECS 2015 and the 2019 American Home Comfort Study.[141] DOE accounted for the likelihood that condensing furnaces require more maintenance and repair than non-condensing furnaces by adding costs to check the secondary heat exchanger and condensate system (including regular replacement of the condensate neutralizer). For repair costs, DOE included repair of the ignition, gas valve, controls, and inducer fan, as well as the furnace fan blower. For condensing repair costs, DOE assumed higher material repair costs for the ignition, gas valve, controls, and inducer fan, as well as a higher fraction of BPM furnace fans compared to non-condensing furnaces. To determine the service lifetime of various components, DOE used a Gas Research Institute (''GRI'') study.[142] For the considered standby mode and off mode standards, DOE assumed that no additional maintenance or repair is required.

In order to validate DOE's approach, DOE did a review of maintenance and repair costs available from a variety of sources, including online resources. Overall, DOE found that the maintenance and repair cost estimates applied in its analysis fall within the typical range of published maintenance and repair charges.

For more details on DOE's methodology for calculating repair costs, including all online resources reviewed, see appendix 8F of the TSD for this NOPR.

7. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE conducted an analysis of furnace lifetimes based on the methodology described in a recent journal paper.[143] For this analysis, DOE relied on RECS 1990, 1993, 2001, 2005, 2009, and 2015.[144] DOE also used the U.S. Census's biennial American Housing Survey (''AHS''), from 1974–2019, which surveys all housing, noting the presence of a range of appliances.[145]

[135] U.S. Department of Energy-Energy Information Administration, Form EIA–861M (formerly EIA–826) detailed data (2020) (Available at: *www.eia.gov/electricity/data/eia861m/*) (Last accessed Feb. 15, 2022).

[136] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2020) (Available at: *www.eia.gov/naturalgas/data.php*) (Last accessed Feb. 15, 2022).

[137] U.S. Department of Energy-Energy Information Administration, 2019 State Energy Data System (''SEDS'') (2019) (Available at: *www.eia.gov/state/seds/*) (Last accessed Feb. 15, 2022).

[138] GTI provided a reference located in the docket of DOE's 2016 rulemaking to develop energy conservation standards for residential boilers. (Docket No. EERE–2012–BT–STD–0047–0068) (Available at: *www.regulations.gov/document/EERE-2012-BT-STD-0047-0068*) (Last accessed Feb. 15, 2022).

[139] U.S. Department of Energy–Energy Information Administration, *Annual Energy Outlook 2021* (Available at: *www.eia.gov/outlooks/aeo/*) (Last accessed Feb. 15, 2022).

[140] RS Means Company Inc., *RS Means Facilities Maintenance & Repair Cost Data* (2021) (Available at: *www.rsmeans.com/*) (Last accessed Feb. 15, 2022).

[141] Decision Analysts, 2019 American Home Comfort Study: Online Database Tool (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed Feb. 15, 2022).

[142] 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.gti.energy/software-and-reports/*) (Last accessed Feb. 15, 2022).

[143] 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 Feb. 15, 2022).

[144] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey (''RECS''),* Multiple Years (1990, 1993, 1997, 2001, 2005, 2009, and 2015) (Available at: *www.eia.gov/consumption/residential/*) (Last accessed Feb. 15, 2022).

[145] 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, 2011, 2013, 2015, 2017, and 2019)

DOE used the appliance age data from these surveys, as well as the historical furnace shipments, to generate an estimate of the survival function. The survival function provides a lifetime range from minimum to maximum, as well as an average lifetime. DOE estimates the average product lifetime to be 21.4 years for NWGFs and MHGFs. This estimate is consistent with the range of values identified in a literature review, which included values from 16 years to 23.6 years.

To better account for differences in lifetime due to furnace utilization, DOE determined separate lifetimes for the North and Rest of Country (as identified in the shipments analysis) but only based on the difference in operating hours in the two regions. DOE assumed that equipment operated for fewer hours will have a longer service lifetime. DOE developed regional lifetime estimates by using regional shipments, RECS survey data, and AHS survey data and applying the methodology described above. More specifically, these data include AHRI shipments in the North and Rest of Country regions from 2010–2015,[146] 2015 RECS data,[147] and 2015–2019 AHS data survey data.[148] DOE also incorporated lifetime data from Decision Analyst's AHCS from 2006, 2008, 2010, 2013, 2016, and 2019.[149] The average lifetime used in this NOPR is 22.5 years in the North and 20.2 years in the Rest of Country for both NWGFs and MHGFs (national average is 21.4 years). Consumer furnaces located in the North are generally higher capacity to meet the higher heating load, and thus can have lower operating hours. Additionally, furnace replacements in the Rest of Country are more likely to be linked to a paired central air conditioner. For these reasons, the consumer furnace lifetimes in the two regions differ slightly. DOE also conducted sensitivity analyses using a median lifetime of 16 years (low lifetime scenario) and 27 years (high lifetime scenario) for NWGFs and MHGFs (see appendix 8G in the TSD for this NOPR).

There is significant variation in the distribution of furnace lifetime and DOE uses a Weibull distribution to account for this distribution of product failure. DOE accounts for this variation by projecting energy cost savings and health benefits through the final year of furnace lifetime for all products shipped in 2058 (*i.e.,* through 2113). Given the length of time horizon needed to account for the furnaces shipped in the 30-year analysis, DOE seeks comment on its analysis of benefits that accrue beyond the year 2070.

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

8. 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 consumer financing costs and the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[150] DOE notes that the LCC does not analyze the appliance purchase decision, so the implicit discount rate is not relevant in this model. The LCC estimates net present value over the lifetime of the product, and, therefore, the appropriate discount rate will reflect the general opportunity cost of household funds, taking into account the time scale of the product lifetime. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative magnitude of the interest rates available for debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

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. 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 (''SCF'') for 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019.[151] 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.

DOE notes 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 debts 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, therefore, 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 additionally discounting the stream of future benefits. A consumer might pay for an appliance with cash, thereby forgoing investment of those funds into one of the interest earning assets to which they might have access.[152] Alternatively, a consumer

(Available at: *www.census.gov/programs-surveys/ahs/*) (Last accessed Feb. 15, 2022).

[146] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Regional Gas Furnace Shipments for 2010–2015, Confidential Data Provided to Navigant Consulting (Nov. 26, 2016).

[147] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey (''RECS'')* (2015) (Available at: *www.eia.gov/consumption/residential/*) (Last accessed Feb. 15, 2022).

[148] U.S. Census Bureau: Housing and Household Economic Statistics Division, *American Housing Survey,* Multiple Years (2015–2019) (Available at: *www.census.gov/programs-surveys/ahs/*) (Last accessed Feb. 15, 2022).

[149] Decision Analysts, 2006, 2008, 2010, 2013, 2016, and 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed Feb. 15, 2022).

[150] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; and interest rates at which a consumer is able to borrow or lend.

[151] The Federal Reserve Board, *Survey of Consumer Finances* (1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019) (Available at: *www.federalreserve.gov/econres/scfindex.htm*) (last accessed Feb. 15, 2022).

[152] Decision Analyst's 2019 American Home Comfort Study (Available at: *www.decisionanalyst.com/syndicated/homecomfort/*) (Last accessed Feb. 15, 2022) shows that for HVAC purchases, consumers used cash or debit cards 58 percent of the time, a credit card 23

Continued

might pay for the initial purchase by going into debt, subject to the cost of capital at the interest rate relevant for that purchase. However, a consumer will also receive a stream of future benefits in terms of annual operating cost 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 of these interest rates are relevant in the context of the LCC analysis, as they all reflect direct costs of borrowing, or opportunity costs of money either now or in the future. Additionally, while a furnace itself is not a readily tradable commodity, the money used to purchase it and the annual operating 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.* Therefore, the weighted-average interest rate on debts and assets provides a reasonable estimate for a household's opportunity cost (and discount rate) relevant to future costs and savings. 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 modeled 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. The average rate in this NOPR analysis across all types of household debt and equity and across all income groups, weighted by the shares of each type, is 4.2 percent for NWGFs and 4.7 percent for MHGFs.

To establish commercial discount rates for the small fraction of NWGFs installed in commercial buildings, DOE estimated the weighted-average cost of capital using data from Damodaran Online.[153] 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. DOE's commercial discount rate approach is based on the methodology described in a LBNL report, and the distribution varies by business activity.[154] The average rate for NWGFs used in commercial applications in this NOPR analysis, across all business activity, is 6.7 percent.

See chapter 8 of this NOPR TSD for further details on the development of consumer and commercial discount rates.

9. Energy 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 under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards). This approach reflects the fact that some consumers may purchase products with efficiencies greater than the baseline levels.

a. Condensing Furnace Market Share in Compliance Year

To estimate the efficiency distribution of NWGFs and MHGFs in 2029, DOE considered the market trends regarding increased sales of high-efficiency furnaces (including any available incentives). DOE relied on data provided by AHRI on historical shipments for each product class. DOE reviewed AHRI data from 1992 and 1994–2003 (which includes both NWGF and MHGF shipments data), detailing the market shares of non-condensing[155] and condensing (90-percent AFUE and greater) furnaces by State.[156] AHRI also provided data for non-condensing and condensing furnace shipments by region for 2004–2009[157] and nationally for 2010–2014.[158] AHRI additionally submitted proprietary data including shipments of condensing and non-condensing furnaces in the North and Rest of Country regions from 2010 to 2015.[159] DOE also obtained 2013–2020 HARDI shipments data by efficiency for most States.[160] AHRI and HARDI data capture different fractions of the market. Using the shipments data from AHRI and HARDI, DOE derived historical trends for each State. DOE used the HARDI State-level data (2013–2020) to project the trends and estimate the condensing furnace market share in 2029. This excludes years with a Federal tax incentive[161][162] in order to better reflect the trends of the current market. The maximum share of condensing furnace shipments for each region was assumed to be 95 percent, in order to reflect a small fraction of the market that would continue to install non-condensing furnaces. The national average condensing NWGFs market share in 2029 was estimated to be 58.0 percent, with an anticipated market share of 75.6 percent in the North and 34.3 percent in the Rest of Country. The national average condensing market share for MHGFs in 2029 was estimated to be 31.4 percent, with an anticipated market share of 37.8 percent in the North and 21.1 percent in the Rest of

percent of the time, and other financing options the remaining 18 percent of the time.

[153] Damodaran Online, Data Page: Costs of Capital by Industry Sector (2021) (Available at: *pages.stern.nyu.edu/~adamodar/*) (Last accessed Feb. 15, 2022).

[154] Fujita, S., Commercial, Industrial, and Institutional Discount Rate Estimation for Efficiency Standards Analysis: Sector-Level Data 1998–2018 (Available at: *ees.lbl.gov/publications/commercial-industrial-and*) (Last accessed Feb. 15, 2022).

[155] 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. AHRI also provided national shipments data (not disaggregated by region) by efficiency for 1975, 1978, 1980, 1983–1991, and 1993.

[156] Air-Conditioning, Heating, and Refrigeration Institute (formerly Gas Appliance Manufacturers Association), *Updated Shipments Data for Residential Furnaces and Boilers* (April 25, 2005) (Available at: *www.regulations.gov/document/EERE-2006-STD-0102-0138*) (Last accessed Feb. 15, 2022).

[157] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Regional Gas Furnace Shipments for 2004–2009 Data Provided to DOE (July 20, 2010).

[158] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Gas Furnace Shipments for 2010–2014 (Available at: *www.regulations.gov/document/EERE-2014-BT-STD-0031-0052*) (Last accessed Feb. 15, 2022).

[159] Air-Conditioning, Heating, and Refrigeration Institute, Non-Condensing and Condensing Regional Gas Furnace Shipments for 2010–2015, Confidential Data Provided to Navigant Consulting (Nov. 26, 2016).

[160] Heating, Air-conditioning and Refrigeration Distributors International (HARDI), DRIVE portal (HARDI Visualization Tool managed by D+R International), Gas Furnace Shipments Data from 2013–2020 (Available at: *www.drintldata.com*) (Last accessed Feb. 15, 2022).

[161] DOE did not use the data for 2008–2011 because these data appear to be influenced by incentives. AHRI also stated the period from 2008 through 2011 was an outlier. (AHRI, No. 303 at pp. 23–25)

[162] The Energy Policy Act of 2005 established the tax credit for energy improvements to existing homes. The credit was originally limited to purchases made in 2006 and 2007, with an aggregate cap of $500 for all qualifying purchases made in these two years combined. For improvements made in 2009 and 2010, the cap was increased to $1,500. This coincides with a sharp increase in condensing furnace shipments. This credit has since been renewed several times, but the credit was reduced to its original form and original cap of $500 starting in 2011. More information is available at *www.energy.gov/savings/dsire-page* (Last accessed Feb. 15, 2022).

Country, overall about half the fraction of NWGFs.

Additionally, DOE developed a sensitivity analysis incorporating a higher and lower market share for condensing NWGFs and MHGFs. See appendix 8I of the TSD for this NOPR for further information on the derivation of the efficiency distribution projections and sensitivity analysis results.

b. Market Shares of Different Condensing Furnace Efficiency Levels

DOE used data on the shipments by efficiency from the 2013–2020 HARDI shipments to disaggregate the condensing furnace shipments among the different condensing efficiency levels. Based on stakeholder input, DOE assumed that the fraction of furnace shipments of 95-percent or higher AFUE in the replacement market would be double the fraction in the new construction market. DOE also assumed that the fraction of furnace shipments of 95-percent or higher AFUE would be higher in the North compared to the South, because the threshold for ENERGY STAR designation in the North is 95-percent AFUE compared to 90-percent AFUE in the South. The resulting distributions were then used to assign the new furnace AFUE for each sampled household or building in the no-new-standards case, both in the replacement and new construction markets, and in each of the 30 RECS regions and 9 CBECS Census Divisions. The resulting national distribution for condensing NWGFs in 2029 is expected to be 0.3 percent for 90-percent AFUE, 16.5 percent for 92-percent AFUE, 40.3 percent for 95-percent AFUE, and 0.9 percent for 98-percent AFUE. For condensing MHGFs in 2029, the national distribution is expected to be 8.9 percent for 92-percent AFUE, 21.3 percent for 95-percent AFUE, and 1.3 percent for 96-percent AFUE. See appendix 8I of the TSD for this NOPR for further details.

c. Assignment of Furnace Efficiency to Sampled Households

For the September 2016 SNOPR (since withdrawn), the assignment of furnace efficiency to each household or building was random within each of the disaggregated distributions (*i.e.,* in each of the 30 RECS regions and 9 CBECS Census Division regions, and in the new construction and replacement markets).

A number of stakeholders objected to DOE's approach to assigning furnace efficiency in the no-new-standards case. AHRI stated that DOE's decision model assumes that consumers ignore economic factors such as climate when choosing a non-condensing or condensing NWGF. (AHRI, No. 303 at pp. 9–10) AHRI stated that DOE is assuming that consumers behave randomly in their consideration of energy efficiency absent new standards, a position that AHRI believes is arbitrary and capricious. AHRI commented that none of the studies cited by DOE support the proposition that consumer behavior is completely irrational. AHRI stated that most of the academic studies cited by DOE are based on home appliances (*e.g.,* refrigerators), or they focus on information gaps in consumer knowledge. AHRI stated that none of these have any relevance to furnaces because furnace selection is heavily influenced by installing contractors, who have the knowledge and experience to present consumers with accurate economic analyses of their potential choices. (AHRI, No. 303 at pp. 31–34)

APGA contended that DOE offers the unsupported proposition that random assignment, while admittedly not based on economics, ''may simulate actual behavior as well as assigning furnace efficiency based solely on imputed cost-effectiveness.'' APGA contended that DOE relies on working papers for the proposition that consumers do not always act in a perfectly economically rational fashion, but the fact that there are market failures does not undermine reliance on economic decision-making as the best representation of consumer behavior. APGA stated that rejecting economic decision-making demonstrates agency bias to reach a preordained outcome. (APGA, No. 292–1 at pp. 23–25) AGA stated that DOE's methodology lacks any regard to consumer costs and benefits—even to consumers for whom the first cost of the more-efficient condensing furnace is lower than the first cost of the non-condensing furnace. (AGA, No. 306–1 at p. 11) Lennox, Carrier, and Spire commented that DOE's analysis ignores the logical behavior of consumers when purchasing residential furnace products. (Lennox, No. 299 at p. 5; Carrier, No. 302 at p. 4; Spire, No. 309–1 at pp. 5–6) Additionally, Lennox commented that based on U.S. contractor survey data, factors such as installation difficulty, high first cost, or the diminishment of air conditioning performance in regions with milder climates drive consumers to the most economical decision, which in many cases is an 80-percent AFUE NWGF. (Lennox, No. 299 at p. 6) SoCalGas expressed concern that DOE did not revise its model for assigning furnace efficiency in the no-new-standards case in accordance with stakeholder comments on the NOPR and NODA. (SoCalGas, No. 304–3 at p. 5) The City of Rocky Mount, Austin Utilities, Gas Authority, Dickson Gas, and the Jefferson Cocke Utility District stated that the random assignment of furnace efficiency in the no-new-standards case, rather than relying on economic decision making, produces irrational outcomes. (City of Rocky Mount, No. 254 at p. 2; Austin Utilities, No. 255 at p. 1; Gas Authority, No. 256 at pp. 1–2; Dickson Gas, No. 276 at p. 2; Jefferson Cocke Utility District, No. 289 at p. 2)

The GTI report on the (since withdrawn) September 2016 SNOPR submitted by APGA stated that the random assignment of furnace efficiency in the no-new-standards case does not consider any individual building's characteristics in a given region. (APGA, No. 292–2 at pp. 60–61) APGA argued that despite a disaggregation by region, there is still a misallocation of furnaces within a region on a building-specific basis as a result of DOE's failure to use economic decision-making to assign furnaces. (APGA, No. 292–1 at p. 21) Spire stated that despite randomly assigning the right percentage of condensing and non-condensing furnaces to each region, there remains a break in the link between consumer decision-making and individual economics. Spire stated that consumer behavior can be modeled in a way that reflects a degree of economic decision-making that would be reasonably consistent with observed consumer behavior, which GTI did in its analysis of the September 2016 SNOPR. (Spire, No. 309–1 at pp. 60–61) The GTI report on the September 2016 SNOPR submitted by APGA stated that the shipment projections only affect the number of impacted buildings on a per region and per building type basis, not the LCC savings per impacted building within a certain region and building type. For a given region and building type, the LCC savings per impacted building will be the same regardless of the condensing NWGF shipment projections. The report stated that the inherent result of the random assignment methodology is a finding of LCC savings in any region where LCC savings are present on average, whether or not the shipment projections include a very high or very low condensing NWGF market share in the no-new-standards case. (APGA, No. 292–2 at p. 61) APGA and AGA noted that the GTI report on the September 2016 SNOPR shows that it is possible to monetize non-economic factors to consumer decision making, including product performance or reliability, manufacturer reputation, intangible societal benefits, and perceived risks and rewards associated with the decision. (APGA, No. 292–1 at pp. 25–26; AGA, No. 306–1 at pp. 23–24) SoCalGas recommended that the DOE use building-specific data (*e.g.,* heating load) when assigning furnace efficiency to improve accuracy. (SoCalGas, No. 304–3 at p. 4) AHRI stated that survey data are widely recognized in consumer research as significantly overstating actual consumer behavior, in this case their willingness to pay a premium for more energy-efficient products. (AHRI, No. 303 at pp. 31–34)

In contrast to the preceding comments, the Efficiency Advocates stated that, given the lack of data to incorporate economic and non-economic factors, DOE's current approach for assigning efficiency in the no-new-standards case is reasonable because DOE's approach is more likely to capture actual consumer behavior than a model that assumes all consumers are strictly rational economic actors. (Efficiency Advocates, No. 285 at p. 5)

Several stakeholders contended that DOE's decision to not use economic criteria in assigning furnace efficiency is at odds with its use of economic criteria in other parts of the analysis. AGA stated that DOE's assumption that, in the absence of a new standard, consumers will make random rather than at least somewhat rational economic decisions is in conflict with DOE's assumptions used for other LCC analysis and decision making algorithms. (AGA, No. 306–1 at p. 27) Spire stated that despite DOE's assumption that consumers never consider economics when purchasing NWGFs, DOE assumes for the purposes of its product switching analysis that consumers always consider both initial cost and payback economics in deciding whether to switch from a NWGF to an electric alternative. (Spire, No. 309–1 at p. 31) AHRI noted that DOE relies on a pure theory of competition, which is related to economically rational choice theory, to justify its use of incremental mark-ups; according to the commenter, DOE does not explain why it is appropriate to consider rational choice in this context but not when considering consumer behavior. (AHRI, No. 303 at p. 31) APGA stated that unavailability of perfect information on consumer behavior is not a valid reason for not using the available data to assign furnace efficiency, noting by contrast that DOE used available data in the consumer choice model underlying the product switching analysis. (APGA, No. 292–1 at p. 27) Lennox questioned what it understood as DOE's contradictory characterization of consumers—assuming when determining the appropriate discount rate that consumers have sufficient understanding to rebalance debt, yet when projecting consumer purchases of furnaces, assuming consumers do not include economic considerations. Lennox commented that DOE must articulate the basis for its seemingly contradictory assumptions regarding consumer behavior. (Lennox, No. 299 at p. 11) The GTI report on the September 2016 SNOPR submitted by APGA argued that DOE's assertion that a random approach to furnace efficiency assignment is as accurate as a methodology based solely on estimated cost-effectiveness is inconsistent with other parts of the LCC model that incorporate rational economic decisions by various stakeholders. (APGA, No. 292–2 at p. 67) APGA and AGA commented that even though DOE does not have site-specific information regarding product switching and downsizing, it still relied on ''consumer choice'' models that do not account for the potential illogical consumer behavior. (APGA, No. 292–1 at p. 26; AGA, No. 306–1 at pp. 23–24)

In response, for this NOPR, DOE continued to assign furnace efficiency to households in the no-new-standards case in two steps, first at the state level, then at the building-specific level. However, DOE's approach was modified to include other household characteristics. The market share of each efficiency level at the State level is based on historical shipments data (from the 2013–2020 HARDI data) and an estimated projection of trends between 2020 and the compliance year. The furnace efficiency distribution is then allocated to specific RECS households or CBECS, according to the market shares generated for each State. If a household is assigned a condensing furnace in the no-new-standards case, the replacement furnace is assumed to be condensing as well.

To assign the efficiency at the building-specific level, DOE carefully considered any available data that might improve assignment of furnace efficiency in the LCC analysis. First, DOE examined the 2013–2020 HARDI data of gas furnace input capacity by efficiency level and region. DOE did not find a significant correlation between input capacity and condensing furnace market share in a given region, a correlation which might be expected *a priori* since buildings with larger furnace input capacity are more likely to be larger and have greater energy consumption. DOE next considered the GTI data for 21 Illinois households, which included the efficiency of the furnace (AFUE), size of the furnace (input capacity), square footage of the house, and annual energy use.[163] Recognizing the relatively small sample size, DOE notes that these data exhibit no significant correlations between furnace efficiency and other household characteristics (with most furnace installations in this sample being non-condensing furnaces with high energy use). DOE also considered other data of furnace efficiency compared to household characteristics for other parts of the country, including the NEEA Database and permit data (see appendix 8I of the TSD for this NOPR for more details). These data also suggest fairly weak correlation between furnace efficiency and household characteristics or economic factors. Finally, DOE considered the 2019 AHCS survey data.[164] This survey includes questions to recent purchasers of HVAC equipment regarding the perceived efficiency of their equipment (Standard, High, and Super High Efficiency), as well as questions related to various household and demographic characteristics. From these data, DOE did find a statistically significant correlation: Households with larger square footage exhibited a higher fraction of High- or Super-High efficiency equipment installed. DOE used the AHCS data to adjust its furnace efficiency distributions as follows: (1) the market share of condensing equipment for households under 1,500 sq. ft. was decreased by 5 percentage points; and (2) the market share of condensing equipment for households above 2,500 sq. ft. was increased by 5 percentage points.

While DOE acknowledges that economic factors may play a role when consumers, commercial building owners, or builders decide on what type of furnace to install, assignment of furnace efficiency for a given installation, based solely on economic measures such as life-cycle cost or simple payback period most likely would not fully and accurately reflect actual real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions with respect

[163] Gas Technology Institute (''GTI''), Empirical Analysis of Natural Gas Furnace Sizing and Operation, GTI–16/0003 (Nov. 2016) (Available at: *www.regulations.gov/document/EERE-2014-BT-STD-0031-0309*) (Last accessed Feb. 15, 2022).

[164] Decision Analysts, 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed Feb. 15, 2022).

to energy efficiency are unlikely to be perfectly correlated with energy use, as described further down. DOE maintains that the method of assignment, which is in part random, is a reasonable approach, one that simulates behavior in the furnace market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, more realistically than relying only on apparent cost-effectiveness criteria derived from the limited information in CBECS or RECS. DOE further emphasizes that its approach does not assume that all purchasers of furnaces make economically irrational decisions (*i.e.,* the lack of a correlation is not the same as a negative correlation). As part of the random assignment, some homes or buildings with large heating loads will be assigned higher efficiency furnaces, and some homes or buildings with particularly low heating loads will be assigned baseline furnaces, which aligns with the available data. By using this approach, DOE acknowledges the uncertainty inherent in the data and minimizes any bias in the analysis by using random assignment, as opposed to assuming certain market conditions that are unsupported given the available evidence.

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.[165] There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as furnaces. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives available, and how they're presented for any given choice scenario.[166] The same consumer or decision maker may make different choices depending on the characteristics of the decision context (*e.g.,* the timing of the purchase, competing demands for funds), which have nothing to do with the characteristics of the alternatives themselves or their prices. Consumers or decision makers also face a variety of other behavioral phenomena including loss aversion, sensitivity to information salience, and other forms of bounded rationality.[167] Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.[168] These characteristics describe almost all purchasing situations of appliances and equipment, including furnaces. The installation of a new or replacement furnace is done very infrequently, as evidenced by the mean lifetime of 21.4 years for NWGFs and MHGFs. Additionally, it would take at least one full heating season for any impacts on operating costs to be fully apparent. Further, if the purchaser of the furnace is not the entity paying the energy costs (*e.g.,* a building owner and tenant), there may be little to no feedback on the purchase. Additionally, there are systematic market failures that are likely to contribute further complexity to how 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 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 what furnace to install, whereas the renter is responsible for paying energy bills. In the LCC sample, 25.7 percent of households with a NWGF and 26.5 percent of households with a MHGF are renters. These fractions are significantly higher for low-income households (see section IV.I.1 of this document). In new construction, builders influence the type of furnace used in many homes but do not pay operating costs. 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 efficiency made by consumers. Davis and Metcalf[169] conducted an experiment demonstrating that the nature of the information available to consumers from EnergyGuide labels posted on air conditioning equipment results in an inefficient allocation of energy efficiency across households with different usage levels. Their findings indicate that households are likely to make decisions regarding 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 consumers 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[170] show that consumers tend to underestimate the energy use of large energy-intensive appliances, but overestimate the energy use of small appliances. Therefore, it is likely that 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[171] 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.

There are market failures relevant to furnaces installed in commercial

[165] 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. (Available at: *www.sciencedirect.com/science/article/abs/pii/S0301421510009171*) (Last accessed Feb. 15, 2022).

[166] Thaler, R.H., Sunstein, C.R., and Balz, J.P. (2014). ''Choice Architecture'' in *The Behavioral Foundations of Public Policy,* Eldar Shafir (ed).

[167] Thaler, R.H., and Bernartzi, S. (2004). ''Save More Tomorrow: Using Behavioral Economics in Increase Employee Savings,'' *Journal of Political Economy* 112(1), S164–S187. *See also* Klemick, H., et al. (2015) ''Heavy-Duty Trucking and the Energy Efficiency Paradox: Evidence from Focus Groups and Interviews,'' *Transportation Research Part A: Policy & Practice,* 77, 154–166. (providing evidence that loss aversion and other market failures can affect otherwise profit-maximizing firms).

[168] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

[169] Davis, L.W., and G.E. Metcalf (2016): ''Does better information lead to better choices? Evidence from energy-efficiency labels,'' *Journal of the Association of Environmental and Resource Economists,* 3(3), 589–625. (Available at: *www.journals.uchicago.edu/doi/full/10.1086/686252*) (Last accessed Feb. 15, 2022).

[170] 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 (Available at: *www.pnas.org/content/107/37/16054*) (Last accessed Feb. 15, 2022).

[171] Houde, S. (2018): ''How Consumers Respond to Environmental Certification and the Value of Energy Information,'' *The RAND Journal of Economics,* 49 (2), 453–477 (Available at: *onlinelibrary.wiley.com/doi/full/10.1111/1756-2171.12231*) (Last accessed Feb. 15, 2022).

applications as well. It is often assumed that because commercial and industrial customers are businesses that have trained or experienced individuals making decisions regarding investments in cost-saving measures, some of the commonly observed market failures present in the general population of residential customers should not be as prevalent in a commercial setting. However, there are many characteristics of organizational structure and historic circumstance in commercial settings that can lead to underinvestment in energy efficiency.

First, a recognized problem in commercial settings is the principal-agent problem, where the building owner (or building developer) selects the equipment and the tenant (or subsequent building owner) pays for energy costs.[172] [173] Indeed, more than a quarter of commercial buildings in the CBECS 2012 sample are occupied at least in part by a tenant, not the building owner (indicating that, in DOE's experience, the building owner likely is not responsible for paying energy costs). Additionally, some commercial buildings have multiple tenants. There are other similar misaligned incentives embedded in the organizational structure within a given firm or business that can impact the choice of a furnace. For example, if one department or individual within an organization is responsible for capital expenditures (and therefore equipment selection) while a separate department or individual is responsible for paying the energy bills, a market failure similar to the principal-agent problem can result.[174] Additionally, managers may have other responsibilities and often have other incentives besides operating cost minimization, such as satisfying shareholder expectations, which can sometimes be focused on short-term returns.[175] Decision-making related to commercial buildings is highly complex and involves gathering information from and for a variety of different market actors. It is common to see conflicting goals across various actors within the same organization as well as information asymmetries between market actors in the energy efficiency context in commercial building construction.[176]

Second, the nature of the organizational structure and design can influence priorities for capital budgeting, resulting in choices that do not necessarily maximize profitability.[177] Even factors as simple as unmotivated staff or lack of priority-setting and/or a lack of a long-term energy strategy can have a sizable effect on the likelihood that an energy efficient investment will be undertaken.[178] U.S. tax rules for commercial buildings may incentivize lower capital expenditures, since capital costs must be depreciated over many years, whereas operating costs can be fully deducted from taxable income or passed through directly to building tenants.[179]

Third, there are asymmetric information and other potential market failures in financial markets in general, which can affect decisions by firms with regard to their choice among alternative investment options, with energy efficiency being one such option.[180] Asymmetric information in financial markets is particularly pronounced with regard to energy efficiency investments.[181] There is a dearth of information about risk and volatility related to energy efficiency investments, and energy efficiency investment metrics may not be as visible to investment managers,[182] which can bias firms towards more certain or familiar options. This market failure results not because the returns from energy efficiency as an investment are inherently riskier, but because information about the risk itself tends not to be available in the same way it is for other types of investment, like stocks or bonds. In some cases energy efficiency is not a formal investment category used by financial managers, and if there is a formal category for energy efficiency within the investment

[172] Vernon, D., and Meier, A. (2012). ''Identification and quantification of principal–agent problems affecting energy efficiency investments and use decisions in the trucking industry,'' *Energy Policy,* 49, 266–273.

[173] Blum, H. and Sathaye, J. (2010). ''Quantitative Analysis of the Principal-Agent Problem in Commercial Buildings in the U.S.: Focus on Central Space Heating and Cooling,'' Lawrence Berkeley National Laboratory, LBNL–3557E. (Available at: *escholarship.org/uc/item/6p1525mg*) (Last accessed January 20, 2022).

[174] Prindle, B., Sathaye, J., Murtishaw, S., Crossley, D., Watt, G., Hughes, J., and de Visser, E. (2007). ''Quantifying the effects of market failures in the end-use of energy,'' Final Draft Report Prepared for International Energy Agency. (Available from International Energy Agency, Head of Publications Service, 9 rue de la Federation, 75739 Paris, Cedex 15 France).

[175] Bushee, B.J. (1998). ''The influence of institutional investors on myopic R&D investment behavior,'' *Accounting Review,* 305–333. DeCanio, S.J. (1993). ''Barriers Within Firms to Energy Efficient Investments,'' *Energy Policy,* 21(9), 906–914. (explaining the connection between short-termism and underinvestment in energy efficiency).

[176] International Energy Agency (IEA). (2007). Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency. OECD Pub. (Available at: *www.iea.org/reports/mind-the-gap*) (Last accessed Jan. 20, 2022)

[177] DeCanio, S.J. (1994). ''Agency and control problems in US corporations: the case of energy-efficient investment projects,'' *Journal of the Economics of Business,* 1(1), 105–124.

Stole, L.A., and Zwiebel, J. (1996). ''Organizational design and technology choice under intrafirm bargaining,'' *The American Economic Review,* 195–222.

[178] Rohdin, P., and Thollander, P. (2006). ''Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden,'' *Energy,* 31(12), 1836–1844.

Takahashi, M. and Asano, H. (2007). ''Energy Use Affected by Principal-Agent Problem in Japanese Commercial Office Space Leasing,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Visser, E. and Harmelink, M. (2007). ''The Case of Energy Use in Commercial Offices in the Netherlands,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Bjorndalen, J. and Bugge, J. (2007). ''Market Barriers Related to Commercial Office Space Leasing in Norway,'' In *Quantifying the Effects of Market Failures in the End-Use of Energy.* American Council for an Energy-Efficient Economy. February 2007.

Schleich, J. (2009). ''Barriers to energy efficiency: A comparison across the German commercial and services sector,'' *Ecological Economics,* 68(7), 2150–2159.

Muthulingam, S., et al. (2013). ''Energy Efficiency in Small and Medium-Sized Manufacturing Firms,'' *Manufacturing & Service Operations Management,* 15(4), 596–612. (Finding that manager inattention contributed to the non-adoption of energy efficiency initiatives).

Boyd, G.A., Curtis, E.M. (2014). ''Evidence of an 'energy management gap' in US manufacturing: Spillovers from firm management practices to energy efficiency,'' *Journal of Environmental Economics and Management,* 68(3), 463–479.

[179] Lovins, A. (1992). Energy-Efficient Buildings: Institutional Barriers and Opportunities. (Available at: *rmi.org/insight/energy-efficient-buildings-institutional-barriers-and-opportunities/*) (Last accessed January 20, 2022).

[180] Fazzari, S.M., Hubbard, R.G., Petersen, B.C., Blinder, A.S., and Poterba, J.M. (1988). ''Financing constraints and corporate investment,'' *Brookings Papers on Economic Activity,* 1988(1), 141–206.

Cummins, J.G., Hassett, K.A., Hubbard, R.G., Hall, R.E., and Caballero, R.J. (1994). ''A reconsideration of investment behavior using tax reforms as natural experiments,'' *Brookings Papers on Economic Activity,* 1994(2), 1–74.

DeCanio, S.J., and Watkins, W.E. (1998). ''Investment in energy efficiency: do the characteristics of firms matter?'' *Review of Economics and Statistics,* 80(1), 95–107.

Hubbard R.G. and Kashyap A. (1992). ''Internal Net Worth and the Investment Process: An Application to U.S. Agriculture,'' *Journal of Political Economy,* 100, 506–534.

[181] Mills, E., Kromer, S., Weiss, G., and Mathew, P.A. (2006). ''From volatility to value: analysing and managing financial and performance risk in energy savings projects,'' *Energy Policy,* 34(2), 188–199.

Jollands, N., Waide, P., Ellis, M., Onoda, T., Laustsen, J., Tanaka, K., and Meier, A. (2010). ''The 25 IEA energy efficiency policy recommendations to the G8 Gleneagles Plan of Action,'' *Energy Policy,* 38(11), 6409–6418.

[182] Reed, J.H., Johnson, K., Riggert, J., and Oh, A.D. (2004). ''Who plays and who decides: The structure and operation of the commercial building market,'' U.S. Department of Energy Office of Building Technology, State and Community Programs. (Available at: *www1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/who_plays_who_decides.pdf*) (Last accessed January 20, 2022).

portfolio options assessed by financial managers, they are seen as weakly strategic and not seen as likely to increase competitive advantage.[183] This information asymmetry extends to commercial investors, lenders, and real-estate financing, which is biased against new and perhaps unfamiliar technology (even though it may be economically beneficial).[184] Another market failure known as the first-mover disadvantage can exacerbate this bias against adopting new technologies, as the successful integration of new technology in a particular context by one actor generates information about cost-savings, and other actors in the market can then benefit from that information by following suit; yet because the first to adopt a new technology bears the risk but cannot keep to themselves all the informational benefits, firms may inefficiently underinvest in new technologies.[185]

In sum, the commercial and industrial sectors face many market failures that can result in an under-investment in energy efficiency. This means that discount rates implied by hurdle rates [186] and required payback periods of many firms are higher than the appropriate cost of capital for the investment.[187] The preceding arguments for the existence of market failures in the commercial and industrial sectors are corroborated by empirical evidence. One study in particular showed evidence of substantial gains in energy efficiency that could have been achieved without negative repercussions on profitability, but the investments had not been undertaken by firms.[188] The study found that multiple organizational and institutional factors caused firms to require shorter payback periods and higher returns than the cost of capital for alternative investments of similar risk. Another study demonstrated similar results with firms requiring very short payback periods of 1–2 years in order to adopt energy-saving projects, implying hurdle rates of 50 to 100 percent, despite the potential economic benefits.[189] A number of other case studies similarly demonstrate the existence of market failures preventing the adoption of energy-efficient technologies in a variety of commercial sectors around the world, including office buildings,[190] supermarkets,[191] and the electric motor market.[192]

The existence of market failures in the residential and commercial sectors is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned furnace efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the building sample would not reflect any of the market failures or behavioral factors above. DOE thus concludes such a distribution would not be representative of the furnace market. Further, even if a specific household/building/organization is not subject to the market failures above, the purchasing decision of furnace efficiency can be highly complex and influenced by a number of factors not captured by the building characteristics available in the RECS or CBECS samples. These factors can lead to households or building owners choosing a furnace efficiency that deviates from the efficiency predicted using only energy use or economic considerations such as life-cycle cost or payback period (as calculated using the information from RECS 2015 or CBECS 2012). However, DOE intends to investigate this issue further, and it welcomes suggestions as to how it might improve its assignment of furnace efficiency in its analyses.

The estimated market shares for the no-new-standards case for NWGFs and MHGFs in 2029 are shown in Table IV.14 and Table IV.15 of this document, respectively. See chapter 8 and appendix 8I of the NOPR TSD for further information on the derivation of the efficiency distributions.

TABLE IV.14—AFUE EFFICIENCY DISTRIBUTION IN THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACES

Efficiency, AFUE (percent)	2029 Market share in percent				
	National	North, repl	North, new	South, repl	South, new
Residential Market					
80	40.0	23.7	13.1	73.0	33.5
90	0.3	0.4	0.6	0.1	0.4
92	16.5	18.5	20.8	9.5	27.2
95	41.1	55.5	63.1	15.9	35.0
98	2.0	1.9	2.5	1.6	3.9
Commercial Market					
80	35.1	17.3	15.0	64.5	30.8
90	0.0	0.0	0.0	0.0	0.0

[183] Cooremans, C. (2012). ''Investment in energy efficiency: do the characteristics of investments matter?'' *Energy Efficiency,* 5(4), 497–518.

[184] Lovins 1992, op. cit. The Atmospheric Fund. (2017). Money on the table: Why investors miss out on the energy efficiency market. (Available at: *taf.ca/publications/money-table-investors-energy-efficiency-market/*) (Last accessed January 20, 2022).

[185] Blumstein, C. and Taylor, M. (2013). Rethinking the Energy-Efficiency Gap: Producers, Intermediaries, and Innovation. Energy Institute at Haas Working Paper 243. (Available at: *haas.berkeley.edu/wp-content/uploads/WP243.pdf*) (Last accessed April 6, 2022).

[186] A hurdle rate is the minimum rate of return on a project or investment required by an organization or investor. It is determined by assessing capital costs, operating costs, and an estimate of risks and opportunities.

[187] DeCanio 1994, op. cit.

[188] DeCanio, S.J. (1998). ''The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investments,'' *Energy Policy,* 26(5), 441–454.

[189] Andersen, S.T., and Newell, R.G. (2004). ''Information programs for technology adoption: the case of energy-efficiency audits,'' *Resource and Energy Economics,* 26, 27–50.

[190] Prindle 2007, op. cit. Howarth, R.B., Haddad, B.M., and Paton, B. (2000). ''The economics of energy efficiency: insights from voluntary participation programs,'' *Energy Policy,* 28, 477–486.

[191] Klemick, H., Kopits, E., Wolverton, A. (2017). ''Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration,'' *Journal of Benefit-Cost Analysis,* 8(1), 115–145.

[192] de Almeida, E.L.F. (1998). ''Energy efficiency and the limits of market forces: The example of the electric motor market in France'', *Energy Policy,* 26(8), 643–653. Xenergy, Inc. (1998). United States Industrial Electric Motor Systems Market Opportunity Assessment. (Available at: *www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf*) (Last accessed January 20, 2022).

TABLE IV.14—AFUE EFFICIENCY DISTRIBUTION IN THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACES—Continued

Efficiency, AFUE (percent)	2029 Market share in percent				
	National	North, repl	North, new	South, repl	South, new
92	16.6	14.4	21.7	10.9	30.8
95	45.7	64.4	61.7	22.7	35.9
98	2.6	3.8	1.7	1.8	2.6
All					
80	39.9	23.6	13.2	72.7	33.4
90	0.3	0.4	0.5	0.1	0.4
92	16.5	18.4	20.9	9.5	27.3
95	41.2	55.7	63.0	16.1	35.0
98	2.1	1.9	2.4	1.6	3.9

“Repl” means “replacement.”

TABLE IV.15—AFUE EFFICIENCY DISTRIBUTION IN THE NO-NEW-STANDARDS CASE FOR MOBILE HOME GAS FURNACES

Efficiency, AFUE (percent)	2029 Market share in percent				
	National	North, repl	North, new	South, repl	South, new
80	70.4	61.7	62.9	79.0	78.9
90	0.0	0.0	0.0	0.0	0.0
92	8.4	10.5	11.3	6.0	5.7
95	19.7	27.4	25.3	12.5	12.6
96	1.5	0.4	0.4	2.6	2.7

“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.16 of this document, DOE estimated that 66 percent of the affected market for NWGFs and 32 percent of the affected market for MHGFs would be at the baseline level in 2029, according to data from 18 furnace models from a field study conducted in Wisconsin[193] and data from DOE laboratory tests (see appendix 8I of the NOPR TSD).

TABLE IV.16—STANDBY MODE AND OFF MODE NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION IN 2029 FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Efficiency level	Standby mode/ off mode in watts	NWGF market share in percent	MHGF market share in percent
Baseline	11.0	61.6	31.5
1	9.5	0.0	0.0
2	9.2	16.6	8.9
3	8.5	21.8	59.6

10. Alternative Size Thresholds for Small Consumer Gas Furnaces

DOE analyzed potential separate energy conservation standards for small and large NWGFs and MHGFs, with varying capacity thresholds for a small NWGF or MHGF. The examined thresholds had a maximum input rate that ranged from less than or equal to 40 kBtu/h to 100 kBtu/h, which were assessed in 5 kBtu/h increments.

DOE assigned an input capacity to existing furnaces based on data from RECS 2015 and CBECS 2012. It is common industry practice to oversize furnaces to ensure that they can meet the house heating load in extreme temperature conditions. Under a scenario which envisions a separate energy conservation standard for small NWGFs and MHGFs set at a level which does not require condensing technology, DOE expects that some consumers who would otherwise install a typically-oversized furnace[194] may choose to downsize in order to be able to purchase a less-expensive non-condensing furnace.

DOE identified households from the NWGF and MHGF sample that might downsize at each of the considered standard levels. In identifying these households, DOE first determined whether a household would install a non-condensing furnace with an input

[193] Scott Pigg, Electricity Use by New Furnaces: A Wisconsin Field Study, Seventh Wave (formerly Energy Center of Wisconsin) (2003) (Available at: *www.proctoreng.com/dnld/WIDOE2013.pdf*) (Last accessed Feb. 15, 2022).

[194] By typical oversizing, DOE refers to a value of 1.7, as specified in ASHRAE 103, ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers'', which is incorporated by reference in the DOE residential furnace and boiler test procedure at 10 CFR part 430, subpart B, appendix N.

capacity greater than the small furnace size limit in the no-new-standards case, based on the assigned input capacity (which reflects historical oversizing) and efficiency. DOE relied on the ASHRAE 103–1993 test procedure, ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' (incorporated by referenced in the DOE residential furnace and boiler test procedure)[195] to estimate that the typical oversize factor used to size furnaces was 70 percent (*i.e.,* the furnace capacity is 70 percent greater than required to heat the home under heating outdoor design temperature (''ODT'') conditions). DOE assumed that if the input capacity of the furnace using a reduced oversize factor of 35 percent (half of the 70-percent oversize factor) is less than or equal to the input capacity limit for small furnaces, the consumer would downsize the furnace accordingly. DOE has tentatively concluded that an oversize factor of 35 percent is realistic, given that ACCA recommends a maximum oversize factor of 40 percent.[196]

DOE has found that the available data regarding oversizing of furnaces in the existing stock indicate that an average oversizing in past installations of 70 percent is likewise reasonable.[197 198 199 200 201 202 203] DOE acknowledges that the oversizing varies among furnace installations. For this NOPR, DOE assigned an oversizing factor for each household, which varied from 0 percent to 180 percent (76 percent on average).

AHRI stated that DOE severely overestimated the number of consumers who would downsize their NWGF to avoid the higher cost of a condensing NWGF. AHRI argued that DOE's downsizing estimate is speculation, unsupported by historical shipment data or any documented field study. (AHRI, No. 303 at p. 16) Consequently, AHRI urged DOE to be much more conservative in its downsizing analysis because if the downsizing estimates are incorrect, the proposed rule will harm many more consumers and negatively affect the industry. (AHRI, September 2016 SNOPR Public Meeting Transcript, No. 243 at pp. 145–146) Ingersoll Rand likewise argued that the oversizing factor is limited in practice to 40 percent and, therefore, that DOE's downsizing approach substantially overestimates the number of consumers that would be able to install a lower capacity furnace, resulting in an underestimation of the percentage of consumers who would experience an increased cost due to the new standard. (Ingersoll Rand, No. 297 at p. 10) Rheem similarly stated that it is not reasonable to assume that the primary heating source will be downsized. In Rheem's experience, consumers and installers are reluctant to risk an investment in a replacement NWGF that may not provide adequate heat in extreme weather conditions or allow for quick recovery from their thermostat setback (*i.e.,* raising the thermostat from a lowered temperature to the desired temperature). (Rheem, No. 307 at pp. 9–10)

Lennox strongly disagreed with DOE's assumption that a significant shift in furnace sizing would occur with an 80-percent AFUE standard for small NWGFs. Lennox stated that NWGFs are sized to meet the heat load of the home according to local climate conditions; therefore, consumers and contractors are not expected to shift their sizing practices, as downsizing equipment creates the risk of not providing adequate heat to the dwelling. (Lennox, No. 299 at p. 30) Lennox stated that DOE used a flawed downsizing methodology without any market data to support the agency's assumption. Lennox stated that DOE failed to mention the negative impacts of downsizing, such as a loss of utility, consumer comfort, and a shortened life of the furnace due to an increase in operating time, as well as the need for consumers to supplement their heating needs in extreme conditions with less-efficient options than the use of a properly-sized NWGF. (Lennox, No. 299 at p. 18) Along these same lines, Goodman stated that downsizing would occur for only a small percentage of applications. (Goodman, No. 308 at p. 10) The GTI report on the September 2016 SNOPR submitted by APGA stated that DOE's downsizing decision approach ignores other utility functions of a furnace and the range of consumer risk tolerances regarding known variability in design calculations and accommodation of their own behavior. (APGA, No. 292–2 at p. 68) Spire stated that NWGFs must be oversized to be able to satisfy peak heating demands; encouraging downsizing would leave many low-income consumers desperate to minimize initial costs with NWGFs that are inadequate to meet their peak heating needs. Spire commented that DOE has not analyzed the loss of utility downsizing would impose on consumers. (Spire, No. 309–1 at pp. 46–47)

In contrast, the Efficiency Advocates stated that data from RECS 2009 imply that a 55,000 Btu/h or even a 50,000 Btu/h NWGF would be sufficient for many households. Based on this analysis, the Efficiency Advocates stated that DOE's assumption of downsizing to an oversize factor of 35 percent is reasonable and might even be too conservative, as they would expect some furnaces to be downsized even more to take advantage of the 80-percent AFUE standard for small NGWFs. (Efficiency Advocates, No. 285 at p. 3) NEAA stated that downsizing as a result of a separate standard for small NWGFs is logical. (NEEA, September 2016 SNOPR Public Meeting Transcript, No. 243 at p. 158)

In response to these comments, DOE continues to expect that in the case of an energy conservation standard that allows small furnaces to use non-condensing technology, some consumers would have a financial incentive to downsize their furnace. Even without oversizing, a furnace installation should be designed to handle dry-bulb temperatures that will occur 99 percent of the time. Therefore, handling nearly all extreme conditions is already accounted for when selecting the unit, so a 35-percent oversizing should provide ample allowance for the most extreme conditions that might occur. Thus, DOE reasons that there would be no loss of utility or comfort under DOE's proposed approach. DOE acknowledges that there could be cases where downsizing might not be advantageous. Therefore, for this NOPR, DOE assumed that not all consumers

[195] 10 CFR part 430, subpart B, appendix N.

[196] ACCA recommends oversizing by a maximum of 40 percent. ACCA. *See* Manual S—Residential Equipment Selection (2nd Edition) (Available at: *www.acca.org/*) (Last accessed Feb. 15, 2022).

[197] City of Fort Collins, Evaluation of New Home Energy Efficiency: Summary Report (June 2002) (Available at: *www.fcgov.com/utilities/img/site_specific/uploads/newhome-eval.pdf*) (Last accessed Feb. 15, 2022).

[198] Pigg, Scott, What you need to know about residential furnaces, air conditioners and heat pumps if you're NOT an HVAC professional (Feb. 2017) (Available at: *www.duluthenergydesign.com/Content/Documents/GeneralInfo/PresentationMaterials/2017/Day2/What-You-Need-Pigg.pdf*) (Last accessed Feb. 15, 2022).

[199] Energy Center of Wisconsin, Electricity Use by New Furnaces: A Wisconsin Field Study (2003) (Available at: *www.proctoreng.com/dnld/WIDOE2013.pdf*) (Last accessed Feb. 15, 2022).

[200] Burdick, Arlan, Strategy Guideline: Accurate Heating and Cooling Load Calculations. Ibacos, Inc. (June 2011) (Available at: *www.nrel.gov/docs/fy11osti/51603.pdf*) (Last accessed Feb. 15, 2022).

[201] Ecovent, When Bigger is not Better (August 2014) (Available at: *docplayer.net/13225631-When-bigger-isn-t-better.html*) (Last accessed Feb. 15, 2022).

[202] Energy Center of Wisconsin, Central Air Conditioning in Wisconsin (May 2008) (Available at: *www.focusonenergy.com/sites/default/files/centralairconditioning_report.pdf*) (Last accessed Feb. 15, 2022).

[203] Washington State University, Efficient Home Cooling (2003) (Available at: *www.energy.wsu.edu/documents/AHT_Energy%20Efficient%20Home%20Cooling.pdf*) (Last accessed Feb. 15, 2022).

would downsize when the oversize factor of 35 percent is less than or equal to the assumed input capacity limit for small furnaces. In addition, DOE conducted several sensitivity analyses of its downsizing methodology, assuming no downsizing as well as higher and lower levels of downsizing. See appendix 8M of this NOPR TSD for further details.

AHRI requested that DOE analyze the alternative concept of separate standard levels for small and large mobile home gas furnaces for the same purpose of minimizing these potential negative outcomes, as was done for NWGFs. (AHRI, No. 202, p. 18) For this NOPR, DOE analyzed the potential for similar separate energy conservation standards for small and large MHGFs, as it did for NWGFs.

Goodman stated that the rational downsizing methodology is inconsistent with the random furnace sizing methodology and furnace efficiency assignment in the no-new-standards case. (Goodman, No. 308 at p. 10) In response, DOE notes that the furnace efficiency assignment in the no-new-standards case methodology has been revised for this NOPR to include some economic criteria (see section IV.F.9.c of this document).

a. Accounting for Impacts of Downsized Equipment

The estimated degree of downsizing anticipated in the case of a non-condensing standard for small NWGFs and MHGFs is presented in Table IV.17 under the criteria of various ''small furnace'' definitions. For further details regarding this downsizing methodology, see appendix 8M of the TSD for this NOPR. This appendix also presents sensitivity analysis results.

TABLE IV.17—SHARE OF LCC SAMPLE HOUSEHOLDS MEETING SMALL FURNACE DEFINITION IN 2029

Small furnace definition	NWGFs		MHGFs	
	Without amended standards (percent)	With separate small furnace standard and with downsizing (percent)	Without amended standards (percent)	With separate small furnace standard and with downsizing (percent)
≤40 kBtu/h	4.3	11.3	8.3	23.9
≤45 kBtu/h	6.6	15.9	16.8	32.6
≤50 kBtu/h	9.3	19.3	21.7	36.5
≤55 kBtu/h	11.3	21.6	21.7	38.8
≤60 kBtu/h	23.6	31.4	46.7	57.1
≤65 kBtu/h	25.4	34.3	46.7	57.7
≤70 kBtu/h	35.3	42.7	60.3	67.5
≤75 kBtu/h	44.9	50.9	72.1	76.3
≤80 kBtu/h	59.2	62.9	89.3	91.0
≤85 kBtu/h	60.6	64.4	90.1	91.8
≤90 kBtu/h	67.2	70.4	91.8	94.7
≤95 kBtu/h	67.2	70.7	91.8	94.8
≤100 kBtu/h	83.0	84.3	99.3	99.4

11. Accounting for Product Switching Under Potential Standards

DOE considered the potential for a standard level to impact the choice between various types of heating products, for residential new construction, new owners, and the replacement of existing products. Because home builders are sensitive to the initial 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 in the no-new-standards case. Such an amended standard level may also induce some homeowners to replace their existing furnace at the end of its useful life with a different type of heating product.

a. Product Switching Resulting From Standards for Non-Weatherized Gas Furnaces

DOE developed a consumer choice model to estimate the switching response of builders and homeowners in residential installations to potential amended AFUE standards for NWGFs. DOE analyzed product switching scenarios that represent the most common combinations of space conditioning and water heating products. The model considers three options available for each sample home when installing a heating product: (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, DOE took into consideration the age of the existing central air conditioner, if one exists. If the existing air conditioner is not very old, it is unlikely that the consumer would opt to install a heat pump, which can also provide cooling.

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 for each sample household or building. The operating costs take into account the space heating load and the water heating load for each household, as well as the energy prices over the lifetime of the available product options.[204] DOE accounted for any additional installation 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. For switching to occur, the total installed cost of the electric option must be less than the NWGF standards case option.

DOE used updated CAC and heat pump prices from the 2016 CAC and heat pump final rule,[205] assuming

[204] Electric furnaces are estimated to have the same lifetime as NWGFs (21.4 years); however, heat pumps have an estimated average lifetime of 19 years. 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.

[205] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy, Residential

implementation of the CAC/HP minimum standards scheduled to take effect in 2023. 82 FR 1786 (Jan. 6, 2017). These heat pump prices include the manufacturer production costs, shipping costs, markups, and installation costs determined in the 2016 final rule. These costs were updated to 2020$ and the installation costs were updated using the same labor costs as discussed in section IV.F.3 of this document. DOE additionally updated the decreasing price trend for heat pumps derived in the 2016 final rule with the latest price data available. This trend suppresses the cost of heat pumps over time for the analysis period in this rulemaking. The consumer choice model assumes that if a consumer switches to a heat pump, it is to a minimally compliant heat pump (SEER 14). DOE requests comment on DOE's heat pump cost estimates, including any decreases in price likely to be experienced during the analysis period as a result of increased heat pump shipments and scale in the market due to decarbonization policies and increased domestic supply of heat pumps. DOE estimated the price of electric furnaces in the engineering analysis (see section IV.C.3 of this document). For water heaters, DOE used efficiency and consumer prices for models that meet the amended energy conservation standards that took effect on April 16, 2015. (10 CFR 430.32(d); 75 FR 20112 (April 16, 2010).) DOE estimated the price of gas and electric storage water heaters based on the 2010 heating products final rule. 75 FR 20112 (April 16, 2010).[206] 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 the cost of upgrading the electrical service panel for a fraction of households.

The decision criterion in DOE's model was based on proprietary survey data from Decision Analyst, collected from four separate surveys conducted between 2006 and 2019.[207] Each survey involved approximately 30,000 homeowners. For a representative sample of consumers, the surveys identified consumers' willingness to purchase more-efficient space-conditioning systems. 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. From these data, as well as RECS billing data to determine average annual space heating energy costs, DOE determined that consumers considering replacing their gas furnace would require, on average, a payback period of 3.5 years or less in order to purchase a condensing furnace rather than switch to an electric space heating option.

The consumer choice model calculates the PBP between the condensing 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 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 relative to the electric heating option is negative.[208] In the case of switching to an electric heating option, the model selects the most economically beneficial product. DOE requests comment on the consumer's willingness to switch heating options, especially for heat pumps.

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 because the data reflect a trade-off between first cost and ongoing savings, it is reasonable to expect that the payback criterion is broadly reflective of the potential consumer behavior regarding switching. Furthermore, the fuel switching results from DOE's analysis match the overall findings from the GTI Fuel Switching Study[209] (see appendix 8J of this NOPR TSD), which surveyed both contractors and home builders. In addition to the primary estimate, DOE conducted sensitivity analyses using higher and lower levels of switching, as well as a scenario with no switching. 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).

DOE's analysis also takes into account propane NWGFs when considering product switching. For the proposed standard, the switching fraction of propane NWGF consumers is 15.1 percent, and the switching fraction of propane MHGF consumers is 17.6 percent.

The GTI report on the 2016 SNOPR submitted by APGA stated that the DOE product switching model should exclude product switching in cases where there is a first-cost advantage for the electric technology when comparing to an 80-percent AFUE NWGF, as well as when there is an operating cost advantage for the electric technology compared to the proposed TSL for NWGFs. According to the comment, these cases would likely cause product switching without an amended rule and would be considered as ''No Impact'' cases when using Consumer Economic Decision criteria proposed by GTI. GTI contends that DOE's approach results in overstated LCC savings compared to rational product switching under a Consumer Economic Decision framework methodology. (APGA, No. 292–2 at p. 25) In response, for the 2016 September SNOPR, DOE's product switching methodology was primarily dependent on a first-cost comparison between an alternative electric option and the standards-compliant NWGF option. As a result, DOE estimated that switching could occur when the first cost of an alternative electric option is lower than the baseline NWGF (80 percent AFUE) and the operating cost of the alternative electric option is less than the standards-compliant NWGF option. For this NOPR, DOE adopted a more conservative approach and excluded these households from the product switching methodology.

b. Switching Resulting From Standards for Mobile Home Gas Furnaces

For the September 2016 SNOPR (since withdrawn), DOE concluded that fuel switching would be unlikely for MHGFs. 81 FR 65720, 65793 (Sept. 23, 2016).

Nortek and MHI stated that DOE must consider product switching in the MHGF market. (Nortek, No. 300 at p. 3; MHI, No. 282 at p. 1) Nortek and MHI stated that the proposed rule will lead to increased switching from MHGFs to less-efficient electric heating options

Central Air Conditioners and Heat Pumps Technical Support Document (Available at: *www.regulations.gov/document/EERE-2014-BT-STD-0048-0098*) (Last accessed Feb. 15, 2022).

[206] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy, Heating Products Final Rule (Available at: *www.regulations.gov/document?D=EERE-2006-STD-0129-0005*) (Last accessed Feb. 15, 2022).

[207] Decision Analysts, 2006, 2008, 2010, 2013, 2016, and 2019 American Home Comfort Studies (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed Feb. 15, 2022). Non-proprietary data of a similar nature were not available.

[208] The PBP is negative when the electric heating option has lower operating cost compared to the condensing NWGF option.

[209] Gas Technology Institute (''GTI''), Fuel Switching Study (Available at: *www.aga.org/research/reports/gas-technology-institute--fuel-switching-study/*) (Last accessed Feb. 15, 2022).

because in many instances, it is impractical, if not impossible, to install a condensing furnace due to a manufactured home's structural framework. MHI cited a survey from AGA showing that 20 percent of mobile homes utilizing non-condensing MHGFs would not be able to install a condensing furnace because of the home's framework or other issues. MHI argued that these consumers would switch to less-efficient electric heating equipment. (MHI, No. 282 at p. 5) Nortek and MHI stated that 68 percent of the 8.5 million existing manufactured homes are located in the South, where condensing MHGFs are not cost-effective for the consumer, adding that these homeowners would likely switch to alternative forms of energy for heating. (Nortek, No. 300 at pp. 7–8; MHI, No. 282 at p. 5) The GTI report on the September 2016 SNOPR submitted by APGA stated that MHGF consumers tend to have lower incomes and are even more sensitive to first cost than NWGF consumers. The GTI report noted that it would be simple to switch to electric resistance heaters, including low-cost space heaters. The GTI report stated that the installed cost difference is high enough for MHGFs that in only 20 percent of the cases is the simple payback period for a 92-percent AFUE MHGF less than 3.5 years, which indicates a high probability of product switching in the MHGF market. (APGA, No. 292–2 at pp. A–31—A–33)

For this NOPR, DOE added product switching in its analysis for MHGFs. The MHGF product switching methodology is similar to the product switching methodology for NWGFs, except that there is no switching from gas storage water heaters to electric storage water heaters, since MHGFs and gas storage water heaters do not share common vents. See appendix 8J of the TSD for this NOPR for more details regarding the product switching model for MHGFs.

12. Accounting for Furnace Repair as an Alternative to Replacement Under Potential Standards

Several stakeholders commented that when facing the costly installation of a condensing furnace, consumers will likely delay the replacement of their existing furnace by repairing it to extend the lifetime. (ACCA, No. 265 at p. 2; HARDI, No. 271 at p. 3; Carrier, No. 302 at pp. 4–6; PGW, No. 273 at p. 4; SoCalGas, No. 304–3 at p. 5; Rheem, No. 307 at pp. 14, 15; Goodman, No. 308 at pp. 11–12; AHRI, No. 303 at pp. 7–9; Lennox, No. 299 at pp. 16–17, Multifamily Associations, No. 260 at p. 2) AHRI stated that DOE has not provided a reasoned basis for excluding the repair option, other than the difficulty of including the potential for repair in the consumer choice model DOE is currently using. AHRI characterized this as an arbitrary and unsupported decision, particularly since in other rulemakings, DOE has taken a very different approach. (AHRI, No. 303 at pp. 7–9) Lennox offered a similar comment. (Lennox, No. 299 at pp. 16–17) Carrier stated that DOE did not analyze the repair vs. replace option, disregarding stakeholders' comments that increased product and installation costs will drive up the frequency of both product switching and repair. (Carrier, No. 302 at pp. 4–6) SoCalGas recommended that DOE should account for extended repairs, as this may be the most economical option for some retrofit consumers who need a NWGF with a capacity above the small NWGF threshold but for whom switching to electric products would be expensive. (SoCalGas, No. 304–3 at p. 5) Goodman stated that the majority of respondents to an HVAC survey conducted by Parks Associates would replace a system if the repair cost is half the total cost of new equipment. (Goodman, No. 308 at pp. 11–12) Rheem commented that homeowners will most likely repair an old furnace and replace components for as long as possible before switching products. (Rheem, No. 307 at p. 15) Spire stated that according to informal interviews it conducted with Canadian gas utilities, many homeowners have continued repairing their older, lower-efficiency NWGFs to avoid having to replace them with condensing NWGFs. (Spire, No. 309–1 at p. 17) The Multifamily Associations stated that rather than replace an aging, inefficient NWGF with a new, efficient model, multifamily property owners will typically repair the existing NWGF. (Multifamily Associations, No. 260 at p. 2)

In contrast, the Efficiency Advocates stated that few contractors will repair major malfunctions, such as a failed heat exchanger or failed air handler, because the repair costs are a large percentage of the purchase price of a new unit. They also commented that very few consumers will make a major investment in a repair when such repair cost is a large percentage of a new unit's cost. The Efficiency Advocates noted that Canada has had a condensing furnace standard for several years without reporting a substantial increase in repairs. (Efficiency Advocates, No. 285 at p. 4)

For this NOPR, DOE added a repair option into its consumer choice model. Because repair is likely to be considered first by consumers facing furnace replacement, DOE evaluated this option before the product switching options.

To estimate the fraction of consumers in a standards case that would choose to repair their existing furnace rather than replace it or switch to an alternative product, DOE used a price elasticity parameter, which relates the incremental total installed cost to total gas furnace shipments, and an efficiency elasticity parameter, which relates the change in the operating cost to gas furnace shipments. Both types of elasticity relate changes in demand to changes in the corresponding characteristic (price or efficiency). A regression analysis estimated these terms separately from each other and found that the price elasticity of demand for several appliances is on average –0.45.[210] Thus, for example, a price increase of 10 percent would result in a shipments decrease of 4.5 percent, all other factors held constant. The same regression analysis found that the efficiency elasticity is estimated to be on average 0.2 (*i.e.,* a 10-percent efficiency improvement, equivalent to a 10-percent decrease in operating costs, would result in a shipments increase of 2 percent, all else being equal). From these two parameters, DOE derived a probability that a given household will not purchase a furnace, which is interpreted as the household repairing rather than replacing the furnace. The regression analysis included a range for the elasticity parameters. The price elasticity parameter was adjusted by income such that the higher elasticity was assigned to lower-income households and the lower elasticity assigned to higher-income households, resulting in a greater probability of repairing existing equipment for lower-income households. Households that are designated as doing a repair rather than replacement are not considered in the subsequent switching analysis. DOE also conducted sensitivity analyses using higher and lower rates of repair. See appendix 8J of the TSD for this NOPR for more details on the repair vs. replace consumer choice model for NWGFs and MHGFs.

13. Payback Period Analysis

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.

[210] Fujita, S., Estimating Price Elasticity using Market-Level Appliance Data. LBNL–188289 (August 2015) (Available at: *eta-publications.lbl.gov/sites/default/files/lbnl-188289.pdf*) (Last accessed Feb. 15, 2022).

Payback periods that exceed the life of the product mean that the increase in 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.

As noted previously in section III.E.2 of this document, 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 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 projection 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 projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, net present value (''NPV''), and future manufacturer cash flows.[211] 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.

DOE developed shipment projections based on historical data and an analysis of key market drivers for each product. DOE estimated NWGF and MHGF shipments by projecting shipments in three market segments: (1) replacement of existing consumer furnaces; (2) new housing; and (3) new owners in buildings that did not previously have a NWGF or MHGF or existing NWGF or MHGF owners that are adding an additional consumer furnace.[212] DOE also considered whether standards that require more-efficient consumer furnaces would have an impact on consumer furnace shipments, as discussed in section IV.G.2 of this NOPR.

a. Historical Shipments Data

DOE assembled historical shipments data for NWGFs and MHGFs from Appliance Magazine for 1954–2012,[213] AHRI from 1996–2020,[214] HARDI from 2013–2020,[215] and BRG from 2007–2019.[216] DOE also used the 1992 and 1994–2003 shipments data by state provided by AHRI [217] and 2004–2009 and 2010–2015 shipments data by North and Rest of Country regions provided by AHRI [218] as well as HARDI shipments data that is disaggregated by region and most states to disaggregate shipments by region. DOE also used CBECS 2012 data and BRG shipments data to estimate the commercial fraction of shipments.[219] Disaggregated shipments for MHGFs are not available, so DOE disaggregated MHGF shipments from the total by using a combination of data from the U.S. Census,[220] [221] American Housing Survey (AHS),[222] RECS,[223] and a 2014 MHGF shipments estimate by Mortex.[224]

b. Shipment Projections in No-New Standards Case

As stated previously, DOE estimated NWGF and MHGF shipments by projecting shipments in three market segments: (1) replacement of existing furnaces; (2) new housing; and (3) new owners in buildings that did not previously have a NWGF or MHGF or existing NWGF or MHGF owners that are adding an additional consumer furnace. These projections reflect equipment switching that is occurring without standards and additions to homes without central heating.

To project furnace replacement shipments, DOE developed retirement functions from furnace lifetime estimates and applied them to the existing products in the housing stock, which are tracked by vintage. DOE calculated replacement shipments using historical shipments and the lifetime estimates (average 21.4 years). In addition, DOE adjusted replacement shipments by taking into account demolitions, using the estimated changes to the housing stock from *AEO2021.*

To project shipments to the new housing market, DOE utilized a forecast of new housing construction and historic saturation rates of furnaces in new housing. DOE used the *AEO2021* housing starts and commercial building floor space projections and data from U.S. Census Characteristics of New

[211] 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.

[212] The new owners primarily consist of households that add or switch to NWGFs or MHGFs during a major remodel. Because DOE calculates new owners as the residual between its shipments model compared to historical shipments, new owners also include shipments that switch away from NWGFs or MHGFs.

[213] Appliance Magazine. *Appliance Historical Statistical Review: 1954–2012* (2014).

[214] Air-Conditioning, Heating, & Refrigeration Institute, *Furnace Historical Shipments Data.* (1996–2020) (Available at: *www.ahrinet.org/resources/statistics/historical-data/furnaces-historical-data*) (Last accessed Feb. 15, 2022).

[215] Heating, Air-conditioning and Refrigeration Distributors International (''HARDI''). DRIVE portal (HARDI Visualization Tool managed by D+R International), Gas Furnace Shipments Data from 2013–2020 (Available at: *www.drintldata.com*) (Last accessed Feb. 15, 2022).

[216] BRG Building Solutions. The North American Heating & Cooling Product Markets (2020 Edition) (Available at: *www.brgbuildingsolutions.com/reports-insights*) (last accessed Feb. 15, 2022).

[217] Air-Conditioning, Heating, and Refrigeration Institute (formerly Gas Appliance Manufacturers Association). *Updated Shipments Data for Residential Furnaces and Boilers,* April 25, 2005 (Available at: *www.regulations.gov/document/EERE-2006-STD-0102-0138*) (Last accessed Feb. 15, 2022).

[218] Air-Conditioning, Heating, and Refrigeration Institute. Non-Condensing and Condensing Regional Gas Furnace Shipments for 2004–2009 and 2010–2015 Data Provided to DOE contractors, July 20, 2010 and November 26, 2016.

[219] The results derived from RECS 2015 and CBECS 2012 in this NOPR show there are 45.0 and 1.5 million NWGFs in residential and commercial buildings (excluding weatherized gas furnaces and MHGFs), respectively. DOE assumed that the share of shipments is similar to the share in the stock. BRG shipments data shows a similar fraction. See chapter 9 for further details.

[220] U.S. Census Bureau, Manufactured Homes Survey: Annual Shipments to States from 1994–2020 (Available at: *www.census.gov/data/tables/time-series/econ/mhs/shipments.html*) (Last accessed Feb. 15, 2022).

[221] U.S. Census Bureau, Manufactured Homes Survey: Historical Annual Placements by State from 1980–2013 (Available at: *www.census.gov/data/tables/time-series/econ/mhs/historical-annual-placements.html*) (Last accessed Feb. 15, 2022).

[222] U.S. Census Bureau—Housing and Household Economic Statistics Division, American Housing Survey, multiple years from 1973–2019 (Available at: *www.census.gov/programs-surveys/ahs/data.html*) (Last accessed Feb. 15, 2022).

[223] Energy Information Administration (''EIA''). Residential Energy Consumption Survey (RECS), multiple years from 1979–2015 (Available at: *www.eia.gov/consumption/residential/*) (last accessed Feb. 15, 2022).

[224] Mortex estimated that the total number of MHGFs manufactured in 2014 was about 54,000, and about two-thirds were sold to the replacement market. Mortex also stated that MHGF sales have not been growing. (Mortex, No. 0157 at p. 3) (Available at: *www.regulations.gov/document/EERE-2014-BT-STD-0031-0157*) (Last accessed Feb. 15, 2022).

Housing,[225] [226] Home Innovation Research Labs Annual Builder Practices Survey,[227] RECS 2015, AHS 2019, and CBECS 2012 to estimate new construction saturations. DOE also estimated future furnace saturation rates in new single-family housing based on a weighted-average of values from the U.S. Census Bureau's Characteristics of New Housing from 1990 through 2020.[228]

To project shipments to the new owners market, DOE estimated the new owners based on the residual shipments from the calculated replacement and new construction shipments compared to historical shipments in the last 5 years (2016–2020 for this NOPR). DOE compared this with data from Decision Analysts' 2002 to 2019 American Home Comfort Study,[229] 2019 BRG data, and AHRI's estimated shipments in 2000,[230] which showed similar historical fractions of new owners. DOE assumed that the new owner fraction would be the 10-year average in 2029 and then decrease to zero by the end of the analysis period (2058). If the resulting fraction of new owners is negative, DOE assumed that it was primarily due to equipment switching or non-replacement and added this number to replacements (thus reducing the replacements value).

Table IV.18 shows the fraction of shipments for the replacement, new construction, and new owner markets. See chapter 9 for more details on the shipments analysis.

TABLE IV.18—TOTAL AND FRACTION OF NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPMENTS BY MARKET SEGMENT (REPLACEMENTS, NEW CONSTRUCTION, AND NEW OWNERS) IN 2029

Product class	Market segment	North		Rest of country		Total	
		Million	Percentage	Million	Percentage	Million	Percentage
NWGF (Residential)	Replacements *	1.565	84	1.059	77	2.624	81
	New Construction	0.293	16	0.319	23	0.611	19
	Total	1.857	100	1.378	100	3.235	100
NWGF (Commercial)	Replacements *	0.043	68	0.031	68	0.074	68
	New Construction	0.020	32	0.014	32	0.035	32
	Total	0.064	100	0.045	100	0.109	100
MHGF	Replacements *	0.026	62	0.012	48	0.038	57
	New Construction	0.015	38	0.013	52	0.029	43
	Total	0.041	100	0.025	100	0.066	100

* Includes new owners.
Notice: percentages may not add up to 100% due to rounding.

Assumptions regarding future policies encouraging electrification of households (such as in the states of California, Maryland, Washington, New York) or electric heating that decrease furnace shipments are speculative at this time, so such policies were not incorporated into the shipments projection. In regards to the proposed California 2016 AQMP,[231] which targets the ozone depleting NO_X emissions, DOE notes that the proposed control measure has two components: (1) implementing the existing Rule 1111 emission limit of NO_X for residential space heaters; and (2) incentivizing the replacement of older space heaters with more efficient low NO_X products, and/or ''green technologies'' such as solar heating or heat pumps. Incentivizing heat pumps is only one of the proposed approaches to reduce NO_X emissions that were offered in the plan, but it is unclear how this would trigger actual market and/or policy changes in the future. Current requirements in many parts of California for low NO_X and ultra low NO_X furnaces could also increase the cost of these furnaces, but it is currently unclear if it will be enough to drive shipments towards other heating options (including heat pumps). Thus, it is very uncertain to what extent installations of heat pumps would increase.

2. Impact of Potential Standards on Shipments

a. Impact of Equipment Switching

DOE applied the consumer choice model described in section IV.F.12 of this document to estimate the impact on NWGF shipments of product switching that may be incentivized by potential standards. 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.[232]

As applied in the LCC and PBP analyses, the consumer choice 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 (2029–2058). To do so, DOE estimated the switching in the first year of the analysis period (2029) and derived trends from 2029 to 2058. First, DOE applied the NWGF product price trend described in section IV.F.2 of this document to project prices in 2058. DOE used the appropriate energy prices over the lifetime of products installed in each year.

[225] U.S. Census. Characteristics of New Housing from 1999–2020 (Available at: *www.census.gov/construction/chars/*) (Last accessed Feb. 15, 2022).

[226] U.S. Census. Characteristics of New Housing (Multi-Family Units) from 1973–2020 (Available at: *www.census.gov/construction/chars/mfu.html*) (Last accessed Feb. 15, 2022).

[227] Home Innovation Research Labs (independent subsidiary of the National Association of Home Builders (''NAHB''). Annual Builder Practices Survey (2015–2019) (Available at: *www.homeinnovation.com/trends_and_reports/data/new_construction*) (Last accessed Feb. 15, 2022).

[228] U.S. Census Bureau, Characteristics of New Housing (Available at: *www.census.gov/construction/chars/*) (Last accessed Feb. 15, 2022).

[229] Decision Analysts, 2002, 2004, 2006, 2008, 2010, 2013, 2016, and 2019 American Home Comfort Study (Available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (Last accessed Feb. 15, 2022).

[230] AHRI (formerly GAMA), Furnace and Boiler Shipments data provided to DOE for Furnace and Boiler ANOPR (Jan. 23, 2002).

[231] South Coast Air Quality Management District. 2016 Air Quality Management Plan (''AQMP'') (Available at: *www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/final-2016-aqmp*) (Last accessed Feb. 15, 2022).

[232] 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.

Although the inputs vary, the decision criteria 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.

b. Impact of Repair vs. Replace

In the September 2016 SNOPR, DOE did not include the option of repairing rather than replacing the furnace or switching to a heat pump or electric furnace in the consumer choice model described in section IV.F.12 of this document.

Ingersoll Rand stated that not considering the option of consumers repairing rather than replacing a failed NWGF leads to overestimating the NES and NPV impacts of the proposed standards. (Ingersoll Rand, No. 297 at pp. 6, 12)

As discussed in IV.F.12, for this NOPR, DOE estimated a fraction of both NWGF and MHGF replacement installations that choose to repair their equipment, rather than replace their equipment or switch to a heat pump or electric furnace, in the new standards case. The approach captures not only a decrease in NWGF and MHGF replacement shipments, but also the energy use from continuing to use the existing furnace and the cost of the repair. DOE assumes that the demand for space heating is inelastic and, therefore, that no household or commercial building will forgo either repairing or replacing their equipment (either with a new NWGF of MHGF or a suitable space-heating alternative).

Because measures to limit standby mode and off mode energy use 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 and MHGF 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, product and fuel switching, and the repair option, see chapter 9 of the NOPR TSD.

H. National Impact Analysis

The NIA assesses NES and the national 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.[233] ("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.[234] For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of NWGFs and MHGFs sold from 2029 through 2058.

DOE evaluates the impacts of new or amended 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. In the standards cases, a small fraction of households will replace the furnace a second time within the 30-year analytical period of the NIA. For these households, the additional installation cost adders for going from a non-condensing furnace to a condensing furnace are not applied in the standards cases for the second replacement, as the household already has a condensing furnace.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. *AEO2021* is the source of the energy price trends as well as other inputs to the NIA such as projected housing starts and new commercial building floor space, heating and cooling degree day projections, and building shell efficiency projections. 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 this NOPR. Discussion of these inputs and methods follows the table. See chapter 10 of the TSD for this NOPR for further details.

TABLE IV.19—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2029.
Efficiency Trends	No-New-Standards case: Based on historical data. Standard cases: Roll-up in the compliance year (except for EL 1, 90 percent AFUE for NWGFs as described below) 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. Incorporates projection of future energy use based on *AEO2021* projections for HDD/CDD and building shell efficiency index.

[233] The NIA accounts for impacts in the 50 States and U.S. territories.

[234] For the NIA, DOE adjusts the installed cost data from the LCC analysis to exclude sales tax, which is a transfer.

TABLE IV.19—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS—Continued

Inputs	Method
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.
Repair and Maintenance Cost per Unit.	Annual weighted-average values vary by efficiency level.
Energy Prices	*AEO2021* projections (to 2050) and extrapolation thereafter. Natural gas and electricity marginal prices based on EIA and RECS 2015 billing data.
Energy Site-to-Primary and FFC Conversion.	A time-series conversion factor based on *AEO2021.*
Discount Rate	Three and seven percent.
Present Year	2021.

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.10 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case for each of the considered product classes for the year of anticipated compliance with an amended or new standard (2029). To project the trend in efficiency absent amended standards for NWGFs and MHGFs over the entire shipments projection period, DOE extrapolated the historical trends in efficiency that were described in section IV.F.10 of this document. These trends are based on industry shipment data from AHRI and HARDI and include a near 100 percent saturation of condensing furnaces in the North region. For this NOPR, DOE estimated that the national market share of condensing products would grow from 58 percent in 2029 to 62 percent by 2058 for NWGFs, and from 31 percent to 43 percent for MHGFs. The market shares of the different condensing efficiency levels (*i.e.,* 90-, 92-, 95-, and 98-percent AFUE for NWGFs and 92-, 95-, and 97-percent AFUE for MHGFs) are maintained in the same proportional relationship as in 2029. For standby mode and off mode energy use, DOE estimated that the efficiency distribution would remain the same throughout the forecast period. The approach is further described in appendix 8I and chapter 10 of the TSD for this NOPR.

Lennox stated that DOE underestimated the market share of condensing NWGFs in the absence of standards, which results in the energy savings of the proposed rule being overstated by taking credit for energy savings from condensing NWGFs that would already be purchased without amended standards. (Lennox, No. 299 at p. 7)

DOE agrees that there is some uncertainty associated with estimating of condensing furnace shipments in the future. As stated in section IV.F.10 of this document, DOE's methodology is based on the latest available data. DOE developed for this NOPR a sensitivity analysis that captures some of this uncertainty. The scenario resulting in significant lower condensing shipment projections does not change the conclusion that the proposed standards are economically justified (see appendix 10E of the TSD for this NOPR for the condensing shipments projection comparison, NES, and NPV results).

To reduce the uncertainty associated with shipment projections for this product class, DOE requests data for shipments of condensing furnaces.

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 (2029). 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. In the standards case with a 90-percent AFUE national standard, DOE estimated that many consumers will purchase a 92-percent AFUE NWGF 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. To develop standards case efficiency trends after 2029, DOE estimated growth in shipment-weighted efficiency in the standards cases, except in the max-tech standards case.

DOE did not have a basis on which to predict a change in efficiency trend for standby mode and off mode energy use, so DOE assumed that the efficiency distribution would not change after the first year of compliance.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each potential trial 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 the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2021.* 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 3 percent in the heating load from 2029 to 2058, and the climate index, which results in a decline of 9 percent in the heating load. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

DOE incorporated a rebound effect for NWGFs and MHGFs by reducing the site energy savings (and the associated FFC energy savings) in each year by 15 percent. However, for commercial applications DOE applied no rebound effect in order to be consistent with other recent standards rulemakings (see section IV.F.4 of this document).

In the standards cases, there are fewer shipments of NWGFs or MHGFs compared to the no-new-standards case because of product switching and repair vs. replaced, 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 analyses (based on the specific sample households that switch to these products) into the NIA model.

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 FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's NEMS is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [235] 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 10A of TSD for this NOPR.

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 projection period.

As discussed in section IV.F.2 of this document, DOE developed NWGF and MHGF price trends based on historical PPI data. DOE applied the same trends to project prices for each product class at each considered efficiency level. DOE's projection of product prices is described in appendix 10C of the NOPR TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price projections on the consumer NPV for the considered TSLs for NWGFs and MHGFs. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a high price decline case based on PPI data from 2015–2020 and (2) a constant price trend case. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR TSD.

As described in section IV.H.2 of this document, DOE assumed a 15-percent rebound from an increase in utilization of the product arising from the increase in efficiency (*i.e.,* the direct rebound effect). In considering the economic impact on consumers due to the direct rebound effect, DOE accounted for change in consumer surplus attributed to additional heating/comfort from the purchase of a more-efficient unit. Overall consumer surplus is generally understood to be enhanced from rebound. The net consumer impact of the rebound effect is included in the calculation of operating cost savings in the consumer NPV results. See appendix 10G of the NOPR TSD for details on DOE's treatment of the monetary valuation of the rebound effect. DOE requests comments on its approach to monetizing the impact of the rebound effect in both the NIA and the LCC analysis.

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 projection of annual national-average residential energy price changes in the Reference case from *AEO2021,* which has an end year of 2050. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2045 through 2050. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2021* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10D of the NOPR TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPR, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (''OMB'') to Federal agencies on the development of regulatory analysis.[236] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. 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.

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. For this NOPR, DOE analyzed the impacts of the considered standard levels on two subgroups: (1) low-income households and (2) senior-only households. The analysis used subsets of the RECS 2015 sample composed of households that meet the criteria for the considered subgroups. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. Chapter 11 in the NOPR TSD describes the consumer subgroup analysis.

1. Low-Income Households

Low-income households are significantly more likely to be renters or live in subsidized housing units, compared to home owners. DOE notes that in these cases the landlord purchases the equipment and may pay the gas bill as well. RECS 2015 includes data on whether a household pays for the gas bill, allowing DOE to categorize households appropriately in the analysis.[237] For this consumer subgroup

[235] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009). (Available at: *www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2018).pdf*) (Last accessed Feb. 15, 2022).

[236] United States Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) Section E (Available at: *www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf*) (Last accessed Feb. 15, 2022).

[237] RECS 2015 includes a category for households that pay only some of the gas bill. For the low-income consumer subgroup analysis, DOE assumes that these households pay 50 percent of the gas bill, and, therefore, would receive 50 percent of

Continued

analysis, DOE considers the impact on the low-income household narrowly, excluding any costs or benefits that are accrued by either a landlord or subsidized housing agency. This allows DOE to determine whether low-income households are disproportionately affected by an amended energy conservation standard in a more representative manner. DOE takes into account a fraction of renters that face product switching (when landlords switch to products that have lower upfront costs but higher operating costs, which will be incurred by tenants). Table IV.1920 summarizes the low-income statistics and potential impacts compared to DOE's LCC analysis results.

TABLE IV.19—SUMMARIZED LOW-INCOME STATISTICS AND POTENTIAL NET BENEFITS COMPARED TO DOE'S LCC ANALYSIS RESULTS

Type of household * (pay for gas?) **	Percentage of low-income sample *		Impact on energy bill	Impact of first cost
	NWGF	MHGF		
Renters (Pay for Gas Bill)	52.2	46.9	Full/Partial savings	None. ***
Renters (Do Not Pay for Gas Bill)	9.9	0.0	None	None. ***
Owners (Pay for Gas Bill)	37.4	49.6	Full/Partial savings	Full.
Owners (Do Not Pay for Gas Bill)	0.5	3.5	None	Full.

* RECS 2015 lists three categories: (1) Owned or being bought by someone in your household (here classified as "Owners" in this table); (2) Rented (here classified as "Renters" in this table); (3) Occupied without payment of rent (also classified as "Renters" in this table). Therefore, renters include occupants in subsidized housing including public housing, subsidized housing in private properties, and other households that do not pay rent RECS 2015 does not distinguish homes in subsidized or public housing.

** RECS 2015 lists four categories: (1) Household is responsible for paying for all used in this home; (2) All used in this home is included in the rent or condo fee; (3) Some is paid by the household, some is included in the rent or condo fee; and (4) Paid for some other way. "Pay for Gas Bill" includes only category (1), all other categories are included in "Don't Pay for Gas Bill".

*** For occupants in public housing and other households that do not pay rent the impact of first cost would be none.

The majority of low-income households that experience a net cost at TSL 8 are homeowner households, as opposed to renters. These households either have a smaller capacity NWGF or MHGF, or a lower building heating load due to the local climate, such that the reduction in operating costs does not offset the higher total installed cost of a higher-efficiency furnace. Unlike renters, homeowners would bear the full cost of installing a new furnace. For these households, a potential rebate program to reduce the total installed costs would be effective in lowering the percentage of low-income consumers with a net cost. DOE understands that the landscape of low-income consumers with a furnace may change before the compliance date of amended energy conservation standards, if finalized. For example, point-of-sale rebate programs are being considered that may moderate the impact on low-income consumers to help offset the total installed cost of a condensing furnace, particularly given the lower total installed cost of smaller capacity NWGFs and MHGFs, or offset the costs of switching to an electric heating systems. Currently, DOE is noticing State or utility program rebates in the Northeast, for example, that support additional heat pump deployment as a result of decarbonization policy goals. Point-of-sale rebates or weatherization programs could also reduce the total number of low-income consumers that would be impacted because the household no longer has a furnace to upgrade. DOE is particularly interested in seeking comment around the landscape of heating replacements leading up to 2029, which may impact the low-income consumer economics being presented and considered in this proposed rulemaking.

Measures of energy insecurity provide another accounting of the number of households that are affected by cost changes due to rules for heating equipment energy efficiency in addition to the senior-only and low-income categories used by DOE in this analysis. Energy insecurity in the 2020 RECS quantifies the households reporting one or more of the metrics for energy insecurity, including that they that are foregoing basic necessities to pay for energy, and that they leave their home at an unhealthy temperature due to energy cost. The energy insecurity data are disaggregated by heating equipment type, income category, race, ethnicity, presence of children, presence of seniors, regional distribution, and ownership/rental status. DOE has determined that the energy insecure designation captures more households than the low-income and seniors-only categories used for distributional analysis. Similar PBP and net savings/net cost analysis applied to energy insecure households could result in larger impacts than for the categories DOE chose to analyze and may be more directly interpreted in terms of welfare changes that can be disaggregated by the factors already listed. DOE seeks comment on conducting distributional analysis for energy insecure households in addition to, or instead of, the low-income and seniors-only categories currently analyzed and described in the NOPR.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to determine the financial impact of proposed new and amended energy conservation standards on manufacturers of NWGFs and MHGFs and to estimate the potential impacts of such standards on domestic direct 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

operating cost benefits of an amended energy conservation standard.

impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM,[238] 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 (*i.e.,* TSLs). 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 Federal product-specific regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the NOPR 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 manufacturing 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; R&D expenses; and tax rates). DOE used public sources of information, including company SEC 10–K filings,[239] corporate annual reports, the U.S. Census Bureau's Annual Survey of Manufactures (''ASM''),[240] and prior NWGF and MHGF rulemakings, as well as subscription-based market research tools, to conduct this analysis.

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 interview guides 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's contractor conducted structured, detailed interviews with NWGF and MHGF manufacturers. These interviews covered engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM. The interviews also solicited information about manufacturers' views of the industry as a whole and their key concerns regarding this rulemaking. DOE's contractor conducted manufacturer interviews for the withdrawn March 2015 NOPR. DOE's contractor conducted additional abridged interviews in October 2021 for the purposes of updating analyses.

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 of this document, ''Review under the Regulatory Flexibility Act'' and in chapter 12 of the NOPR TSD.

2. Government Regulatory Impact Model 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 calculates a series of annual cash flows beginning with the reference year of the analysis, 2022, and continuing to the terminal year of the analysis, 2058. 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 NOPR TSD.

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 NOPR TSD). The GRIM analysis incorporates the increases in MPCs and changes in manufacturer 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

[238] A copy of the GRIM spreadsheet tool is available on the DOE website for this rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=59&action=viewlive.*

[239] U.S. Securities and Exchange Commission's Electronic Data Gathering, Analysis, and Retrieval system (''EDGAR'') database (Available at: *www.sec.gov/edgar/search/*) (Last accessed Feb. 4, 2022).

[240] U.S. Census Bureau's Annual Survey of Manufactures: 2018–2019 (Available at *www.census.gov/programs-surveys/asm/data/tables.html*) (Last accessed Oct. 19, 2021).

standby mode and off mode standard are substantially smaller than the 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 of this document. Additional details about the GRIM, discount rate, and other financial parameters can be found in chapter 12 of the NOPR TSD.

a. 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. For a complete description of the MPCs, see chapter 5 of the NOPR TSD.

b. Shipments Projections

DOE used the GRIM to estimate industry revenues based on total unit shipment forecasts and the distribution of these values by efficiency level and product class. 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 from 2022 (the reference year) to 2058 (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 4, shipment values in the GRIM are broken down by region, North and Rest of Country, for the NWGF and MHGF 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 of this document and chapter 9 of the NOPR TSD.

c. 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. Manufacturer data was aggregated to better reflect the industry as a whole and to protect confidential information. DOE then scaled up the capital conversion cost feedback from interviews to estimate total industry capital conversion costs.

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.

Industry conversion costs for the proposed AFUE standard total $149.0 million. It consists of $107.8 million in capital conversion costs and $41.2 in product conversion costs.

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 a final rule and the compliance year. The conversion cost figures used in the GRIM for the proposed standby and off mode standard total $1.6 million. For additional information on the estimated capital and product conversion costs, see chapter 12 of the NOPR TSD.

d. Manufacturer Mark-Up Scenarios

As discussed in section IV.C.2.e of this document, MSPs include manufacturer production costs 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 manufacturer markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. For the MIA, DOE modeled three standards-case 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 percentage scenario; (2) a preservation of per-unit operating profit scenario; and (3) a tiered scenario. 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 of this document present the impacts of the upper and lower bound markup scenarios on INPV. For the proposed AFUE standards, the preservation of gross margin percentage scenario represents the upper bound scenario, and the tiered scenario represents the lower bound scenario for INPV impacts. For the proposed standby and off mode standards, preservation of gross margin percentage scenario represents the upper bound scenario, and the per-unit preservation of operating profit scenario represents the lower bound scenario for INPV impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' 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 per-unit dollar profit will increase. Based on publicly-available financial information for NWGF and MHGF manufacturers, as well as comments from manufacturer interviews, DOE assumed average gross margin percentages of 25.3% for NWGFs and 21.3% for MHGF.[241] Manufacturers noted that this scenario represents the upper bound of the NWGF and MHGF industry's profitability in the standards case because manufacturers can fully pass on additional costs due to standards to consumers.

In the preservation of operating profit scenario, as the cost of production increases in the standards case, manufacturers reduce their manufacturer markups to a level that maintains per-unit operating profit in the year after the standard goes into effect. In this scenario, the industry maintains its operating profit in absolute dollars but not on a percentage basis. 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. In percentage terms, the operating margin is reduced between the no-new-standards case and the standards cases. This scenario is the lower bound of the proposed standby mode and off mode standards.

DOE also modeled a tiered scenario, which reflects the industry's ''good, better, best'' pricing structure. DOE implemented the tiered markup scenario because several manufacturers stated in interviews that they offer multiple tiers of product lines that are differentiated, in part, by efficiency level. Manufacturers further noted that tiered pricing encompasses additional differentiators such as comfort features, brand, and warranty. To account for this nuance in the GRIM, DOE's tiered mark-up structure incorporates both AFUE and combustion systems (*e.g.,* single-stage, two-stage, and modulating combustion systems) into its ''good, better, best'' markup analysis.

Multiple manufacturers suggested that amended standards could lead to a compression of overall mark-ups and reduce the profitability of higher-efficiency products. During interviews, manufacturers provided information on the range of typical manufacturer mark-ups in the ''good, better, best'' tiers. DOE used this information to estimate manufacturer mark-ups 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 mark-up tiers, and an overall reduction in profitability.

3. Manufacturer Interviews

DOE contractors interviewed manufacturers representing approximately 65 percent of industry shipments. The information gathered during interviews enabled DOE to tailor the GRIM to reflect the unique characteristics of the gas-fired consumer furnace industry.

In interviews, DOE asked manufacturers to describe their major concerns regarding this rulemaking. The following section highlights manufacturer concerns that helped inform the projected potential impacts of an amended standard on the industry. Manufacturer interviews are conducted under non-disclosure agreements (''NDAs''), so DOE does not document these discussions in the same way that it does public comments.

a. Product Switching

Several manufacturers stated that, depending on the level of the amended energy conservation standard, gas-fired consumer furnaces may not be economically justified for certain consumers. These consumers may be forced to seek alternatives with lower up-front costs. Manufacturers expressed concern that consumers may opt to buy alternative products, such as heat pumps, water heater systems, or electric space heaters. Such substitutions could decrease shipments of gas-fired furnaces, which in turn would reduce industry revenue.

b. High Installation Costs for Some Consumers

Multiple manufacturers noted that an energy conservation standard set above 80-percent AFUE would make it difficult for substantial portions of the install base to replace their existing consumer furnaces. They noted the potential for significant installation and home renovation costs when replacing non-condensing furnaces with condensing furnaces due to the challenges of managing condensate from furnaces with efficiencies above 80 percent AFUE.

c. Negative Impacts on Industry Profitability

During interviews, manufacturers agreed that if DOE set amended energy conservation standards too high, increased standards could limit their ability to differentiate consumer furnace products based on efficiency. As the standard approaches max-tech, manufacturers stated that there would be fewer performance differences and operating cost savings between baseline and premium products. They were concerned the drop in differentiation would lead to an erosion of manufacturer mark-ups (and profitability).

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 other gases due to ''upstream'' activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion.

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions factors intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the NOPR TSD. The analysis presented in this notice uses projections from *AEO2021.*

Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the

[241] The gross margin percentages correspond to manufacturer markups of 1.34 for NWGFs and 1.27 for MHGFs.

Environmental Protection Agency (''EPA'').[242]

The on-site operation of certain consumer furnaces requires combustion of fossil fuels and results in emissions of CO_2, NO_X, SO_2, CH_4, and N_2O where these products are used. Site emissions of these gases were estimated using Emission Factors for Greenhouse Gas Inventories and, for NO_X and SO_2, emissions intensity factors from an EPA publication.[243]

FFC upstream emissions, which include emissions from fuel combustion during extraction, processing, and transportation of fuels, and ''fugitive'' emissions (direct leakage to the atmosphere) of CH_4 and CO_2, are estimated based on the methodology described in chapter 15 of the NOPR TSD.

The emissions intensity factors are expressed in terms of physical units per megawatt-hour (''MWh'') or million British thermal units (''MMBtu'') of site energy savings. For power sector emissions, specific emissions intensity factors are calculated by sector and end use. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO2021,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2021* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2021,* including the emissions control programs discussed in the following paragraphs.[244]

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 (''DC''). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[245] *AEO2021* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016, 81 FR 74504 (Oct. 26, 2016).[246] Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, for States subject to SO_2 emissions limits under CSAPR, 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 another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 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 are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *T*o continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Because of the emissions reductions under the MATS, 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 another regulated EGU. Therefore, energy conservation standards that decrease electricity generation would generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2021.*

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NOx emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards might reduce NOx emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Energy conservation standards would be expected to reduce NO_X emissions in the States not covered by CSAPR.[247]

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would be expected to slightly reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2021,* which incorporates the MATS.

DOE welcomes any additional comments on the approach for

[242] Available at: *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (Last accessed Feb. 15, 2022).

[243] U.S. Environmental Protection Agency, External Combustion Sources, In *Compilation of Air Pollutant Emission Factors.* AP–42. Fifth Edition. Volume I: Stationary Point and Area Sources. Chapter 1 (Available at *www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors*) (Last accessed Feb. 15, 2022).

[244] For further information, see the Assumptions to *AEO2021* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. (Available at: *www.eia.gov/outlooks/aeo/assumptions/*) (Last accessed Feb. 15, 2022).

[245] CSAPR requires states to address annual emissions of SO_2 and NO_X, precursors to the formation of fine particulate matter (''$PM_{2.5}$'') pollution, in order to address the interstate transport of pollution with respect to the 1997 and 2006 $PM_{2.5}$ National Ambient Air Quality Standards (''NAAQS''). CSAPR also requires certain states to address the ozone season (May-September) emissions of NO_X, a precursor to the formation of ozone pollution, in order to address the interstate transport of ozone pollution with respect to the 1997 ozone NAAQS. 76 FR 48208 (August 8, 2011). EPA subsequently issued a supplemental rule that included an additional five states in the CSAPR ozone season program; 76 FR 80760 (Dec. 27, 2011) (Supplemental Rule), and EPA issued the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

[246] In Sept. 2019, the DC Court of Appeals remanded the 2016 CSAPR Update to EPA. In April 2021, EPA finalized the 2021 CSAPR Update which resolved the interstate transport obligations of 21 states for the 2008 ozone NAAQS. 86 FR 23054 (April 30, 2021); *see also,* 86 FR 29948 (June 4, 2021) (correction to preamble). The 2021 CSAPR Update became effective on June 29, 2021. The release of *AEO 2021* in February 2021 predated the 2021 CSAPR Update. On April 6, 2022, EPA issued a Proposed Rule that seeks to resolve the interstate transport obligations of 26 states under the Clean Air Act's ''good neighbor provision'' for the 2015 ozone NAAQS, by issuing federal implementation plan (''FIP'') requirements for these states. 87 FR 20036, 20038. EPA proposes to establish NOx emission budgets that will require fossil fuel-fired power plants in 25 states to participate in an ''allowance-based ozone season trading program beginning in 2023'' and NO_X emissions limits ''for certain other industrial stationary sources in 23 states with an earliest possible compliance date of 2026.'' *Id.* at 87 FR 20036.

[247] *See* footnote 245.

conducting the emissions analysis for furnaces.

L. Monetizing Emissions Impacts

As part of the development of this proposed rule, for the purpose of complying with the requirements of Executive Order 12866, DOE considered the estimated monetary benefits from the reduced emissions of CO_2, CH_4, N_2O, NO_X, and SO_2 that are expected to result from each of the TSLs considered. In order 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 projection period for each TSL. This section summarizes the basis for the values used for monetizing the emissions benefits and presents the values considered in this NOPR.

On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law. DOE requests comment on how to address the climate benefits of the proposal.

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the SC of each pollutant (*e.g.,* SC–CO_2). These estimates represent the monetary value of the net harm to society associated with a marginal increase in emissions of these pollutants in a given year, or the benefit of avoiding that increase. These estimates are intended to include (but are not limited to) climate-change-related changes in net agricultural productivity, human health, property damages from increased flood risk, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. DOE exercises its own judgment in presenting monetized climate benefits as recommended by applicable Executive Orders, and DOE would reach the same conclusion presented in this notice in the absence of the social cost of greenhouse gases, including the February 2021 Interim Estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases.

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC–GHGs) using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 published in February 2021 by the IWG.[248] The SC–GHGs is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, SC–GHGs includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC–GHGs therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC–GHGs is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O and CH_4 emissions. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD), the DOE agrees that the interim SC–GHG estimates represent the most appropriate estimate of the SC–GHG until revised estimates have been developed reflecting the latest, peer-reviewed science.

The SC–GHGs estimates presented here were developed over many years, using transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, that included the DOE and other executive branch agencies and offices was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC–CO_2) values used across agencies. The IWG published SC–CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity—a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016 the IWG published estimates of the social cost of methane (SC–CH_4) and nitrous oxide (SC–N_2O) using methodologies that are consistent with the methodology underlying the SC–CO_2 estimates. The modeling approach that extends the IWG SC–CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC–CH_4 and SC–N_2O estimates were developed by Marten *et al.*[249] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC–CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC–CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and recommended specific criteria for future updates to the SC–CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[250] Shortly thereafter,

[248] See Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990, Washington, DC, February 2021 (Available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*) (Last accessed Jan. 18, 2022).

[249] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold, and A. Wolverton. Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC–CO2 estimates. *Climate Policy.* 2015. 15(2): pp. 272–298.

[250] National Academies of Sciences, Engineering, and Medicine. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.*

Continued

in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC–CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

On January 20, 2021, President Biden issued Executive Order 13990, which re-established the IWG and directed it to ensure that the U.S. Government's estimates of the social cost of carbon and other greenhouse gases reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the SC–GHG estimates currently used in Federal analyses and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including by taking global damages into account. The interim SC–GHG estimates published in February 2021 are used here to estimate the climate benefits for this proposed rulemaking. The E.O. instructs the IWG to undertake a fuller update of the SC–GHG estimates by January 2022 that takes into consideration the advice of the National Academies (2017) and other recent scientific literature.

The February 2021 SC–GHG TSD provides a complete discussion of the IWG's initial review conducted under E.O. 13990. In particular, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways. First, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to fully capture many climate impacts that affect the welfare of U.S. citizens and residents, and those impacts are better reflected by global measures of the SC–GHG. Examples of effects omitted from the E.O. 13783 estimates include direct effects on U.S. citizens, assets, and investments located abroad, supply chains, U.S. military assets and interests abroad, and tourism, and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. If the United States does not consider impacts on other countries, it is difficult to convince other countries to consider the impacts of their emissions on the United States. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the U.S. and its citizens—is for all countries to base their policies on global estimates of damages. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with this assessment and, therefore, in this proposed rule DOE centers attention on a global measure of SC–GHG. This approach is the same as that taken in DOE regulatory analyses from 2012 through 2016. A robust estimate of climate damages that accrue only to U.S. citizens and residents does not currently exist in the literature. As explained in the February 2021 TSD, existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. As noted in the February 2021 SC–GHG TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating a U.S.-specific SC–GHG value, and explore ways to better inform the public of the full range of carbon impacts. As a member of the IWG, DOE will continue to follow developments in the literature pertaining to this issue.

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC–GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context (IWG 2010, 2013, 2016a, 2016b),[251] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

Furthermore, the damage estimates developed for use in the SC–GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A–4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC–GHG. DOE agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. DOE also notes that while OMB Circular A–4, as published in 2003, recommends using 3 percent and 7 percent discount rates as ''default'' values, Circular A–4 also reminds agencies that ''different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.'' On discounting, Circular A–4 recognizes that ''special ethical considerations arise when comparing benefits and costs across generations,'' and Circular A–4 acknowledges that analyses may appropriately ''discount

2017. The National Academies Press: Washington, DC.

[251] Interagency Working Group on Social Cost of Carbon. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. 2010. United States Government. (Available at: *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf*) (Last accessed April 15, 2022.); Interagency Working Group on Social Cost of Carbon. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. 2013. (Available at: *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact*) (Last accessed April 15, 2022.); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. August 2016. (Available at: *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf*) (Last accessed January 18, 2022.); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. (Available at: *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf*) (Last accessed January 18, 2022).

future costs and consumption benefits . . . at a lower rate than for intragenerational analysis.'' In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that ''Circular A–4 is a living document'' and ''the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A–4 itself.'' Thus, DOE concludes that a 7 percent discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this analysis. In this analysis, to calculate the present and annualized values of climate benefits, DOE uses the same discount rate as the rate used to discount the value of damages from future GHG emissions, for internal consistency. That approach to discounting follows the same approach that the February 2021 TSD recommends ''to ensure internal consistency—*i.e.,* future damages from climate change using the SC–GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate.'' DOE has also consulted the National Academies' 2017 recommendations on how SC–GHG estimates can ''be combined in RIAs with other cost and benefits estimates that may use different discount rates.'' The National Academies reviewed ''several options,'' including ''presenting all discount rate combinations of other costs and benefits with [SC–GHG] estimates.''

As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with this assessment and will continue to follow developments in the literature pertaining to this issue.

While the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC–GHG estimates, it set the interim estimates to be the most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As explained in the February 2021 SC–GHG TSD, the IWG has recommended that agencies revert to the same set of four values drawn from the SC–GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values recommended for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change. As explained in the February 2021 SC–GHG TSD, and DOE agrees, this update reflects the immediate need to have an operational SC–GHG for use in regulatory benefit-cost analyses and other applications that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

There are a number of limitations and uncertainties associated with the SC–GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[252] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions''—*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages—lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

DOE's derivations of the SC–GHG (*i.e.,* SC–CO_2, SC–N_2O, and SC–CH_4) values used for this NOPR are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these pollutants are presented in section V.B.6.

a. Social Cost of Carbon

The SC–CO_2 values used for this NOPR were generated using the values presented in the 2021 update from the IWG's February 2021 TSD. Table IV.20 shows the updated sets of SC–CO_2 estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the NOPR TSD. For purposes of capturing the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CO_2 values, as recommended by the IWG.[253]

[252] Interagency Working Group on Social Cost of Greenhouse Gases (IWG). 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February. United States Government. (Available at: *www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/*) (Last accessed Jan. 18, 2022).

[253] For example, the February 2021 TSD discusses how the understanding of discounting approaches suggests that discount rates appropriate for intergenerational analysis in the context of climate change may be lower than 3 percent.

TABLE IV.20—ANNUAL SC–CO_2 VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050
[2020$ per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

In calculating the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2021 interagency report, adjusted to 2020$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. For each of the four sets of SC–CO_2 cases specified, the values for emissions in 2020 were $14, $51, $76, and $152 per metric ton avoided (values expressed in 2020$). DOE derived values from 2051 to 2070 based on estimates published by EPA.[254] These estimates are based on methods, assumptions, and parameters identical to the 2020–2050 estimates published by the IWG. DOE expects additional climate benefits to accrue for any longer-life furnaces post 2070, but a lack of available SC–CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis. If further analysis of monetized climate benefits beyond 2070 becomes available prior to the publication of the final rule, DOE will include that analysis in the final rule.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC–CO_2 value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC–CO_2 values in each case. See chapter 13 for the annual emissions reduction. See appendix 14A for the annual SC–CO_2 values.

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this NOPR were generated using the values presented in the 2021 update from the IWG.[255] Table IV.21 shows the updated sets of SC–CH_4 and SC–N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the NOPR TSD. To capture the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CH_4 and SC–N_2O values, as recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC–CO_2.

TABLE IV.21—ANNUAL SC–CH_4 AND SC–N_2O VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050
[2020$ per metric ton]

Year	SC–CH_4				SC–N_2O			
	Discount rate and statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC–CH_4 and SC–N_2O estimates for that year in each of the cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC–CH_4 and SC–N_2O estimates in each case. See chapter 13 for the annual emissions reduction. See appendix 14A for the annual SC–CH_4 and SC–N_2O values.

[254] See EPA, Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis, Washington, DC, December 2021 (Available at: *www.epa.gov/system/files/documents/2021-12/420r21028.pdf*) (Last accessed Jan. 13, 2022).

[255] See Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990,* Washington, DC (February 2021) (Available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*) (Last accessed Jan. 18, 2022).

2. Monetization of Other Air Pollutants

DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using the latest benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[256] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025, 2030, 2035 and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040 the values are held constant. DOE derived values specific to the sector for consumer furnaces using a method described in appendix 14B of the NOPR TSD.

DOE also estimated the monetized value of NO_X and SO_2 emissions reductions from site use of natural gas in NWGFs and MHGFs using benefit-per-ton estimates from the EPA's Benefits Mapping and Analysis Program. Although none of the sectors covered by EPA refers specifically to residential and commercial buildings, the sector called ''area sources'' would be a reasonable proxy for residential and commercial buildings.[257] The EPA document provides high and low estimates for 2025 and 2030 at 3- and 7-percent discount rates.[258] DOE used the same linear interpolation and extrapolation as it did with the values for electricity generation.

DOE multiplied the site emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate.

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 *AEO2021.* NEMS 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. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2021* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the NOPR 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 potential new or amended energy conservation standards.

Energy efficiency can reduce utility fixed and variable costs (*e.g.,* growth-related gas distribution infrastructure costs, fuel costs), the degree to which is highly variable and based on the particular utility's cost, operating, and regulatory characteristics. Energy efficiency can also reduce utility collected revenues through lower volumetric sales, the degree to which is dependent on rate design and proportion of customer bill that is volumetric. Utility financial impacts of energy efficiency, therefore, depend critically on the under-recovery of fixed costs when the decline in utility revenues is greater than the reduction in utility costs. To remedy the potential financial impacts of energy efficiency, regulators have approved regulatory and ratemaking mechanisms intended to make the utility financially harmless to the level of achieved energy savings. These mechanisms include revenue decoupling,[259] lost revenue adjustment mechanisms, and straight-fixed variable rate design.

As of February 2020, 26 states have approved revenue decoupling for one or more gas utilities. Several other states without revenue decoupling have approved lost revenue adjustment mechanisms (*e.g.,* Montana) or straight-fixed variable rate design (*e.g.,* Missouri) for at least one gas utility that function similar to revenue decoupling by addressing lost fixed cost recovery. Revenue decoupling mechanisms, in particular, are designed symmetrically with a ''true-up'' mechanism that either charge customers additional revenues in instances where collected revenues are less than authorized levels or refund customers when collected revenues are in excess of authorized levels. As a result, revenue decoupling does not result in higher costs to customers all the time.

The specific design of revenue decoupling mechanism varies across states and utilities, but the mechanisms share many common design elements, including adjustments to authorized revenue to account for growth in customers and ''attrition.'' These design elements ensure the utility fully recovers its fixed costs in years between rate cases and does not suffer loss of revenue. It is true that revenue decoupling does not insulate utilities from loss of customers. However, revenue decoupling does not alter underlying retail rate design that can be adjusted to limit fuel switching. Furthermore, loss of customers due to fuel switching is also dependent on the price of electricity as a substitute product and electric service rate design, factors that cannot be directly influenced by gas utilities.

The precise magnitude of impacts on utility revenues and customer retail rates, with or without revenue decoupling, lost revenue adjustment mechanisms, or straight-fixed variable rate design, depends on many factors. One of the most important drivers of financial impacts to utilities and ratepayers is the magnitude of energy savings, as the decline in retail sales drives both utility cost and revenue reductions. Similarly, the proportion of total utility costs that are fixed versus variable and the proportion of revenues that are based on volumetric sales also determine a significant portion of the magnitude of financial impacts. Given that many of these factors are utility-specific, it is difficult to ascertain the precise financial impacts on specific gas utilities, with or without revenue

[256] Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 21 Sectors. (Available at: *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors*) (Last accessed March 25, 2022).

[257] ''Area sources'' represents all emission sources for which states do not have exact (point) locations in their emissions inventories. Because exact locations would tend to be associated with larger sources, ''area sources'' would be fairly representative of small dispersed sources like homes and businesses.

[258] ''Area sources'' are a category in the 2018 document from EPA, but are not used in the 2021 document cited previously. See: *www.epa.gov/sites/default/files/2018-02/documents/source apportionmentbpttsd_2018.pdf.* (Last accessed March 25, 2022).

[259] Revenue decoupling is a regulatory approach ensuring natural gas utilities recover a defined amount of revenue sufficient to cover the utility's fixed and variable costs (including the authorized rate of return). Revenue decoupling mechanisms typically include a symmetrical ''true-up'' mechanism either charging customers additional revenues if actual utility collected revenues are below the fixed level due to a smaller volume of sales than expected. Conversely, if a utility's actual collected revenues are above the fixed level due to a larger volume of sales than expected, customers receive a credit from the utility 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 and utilities, therefore, are made indifferent to the level of energy efficiency (or other factors that may adversely affect their volumetric sales).

decoupling, lost revenue adjustment mechanisms, or straight-fixed variable rate design.

DOE identified the States (or groups of States) where it estimated that more than 5 percent of customers installing a non-weatherized gas furnace in the compliance year would switch to electric heating as a result of the potential amended standard. Of these 14 States, five have approved revenue decoupling or a similar mechanism for one or more gas utilities as of February 2020 (see chapter 13 of the NOPR TSD for details). Based on its current understanding of revenue decoupling arrangements, DOE tentatively concludes that negative impacts on gas utilities in these States would be minimal. The States without revenue decoupling include Florida and Texas, States for which DOE estimates switching would affect approximately 15 percent of customers installing a gas furnace in the compliance year. For these and several other States,[260] there would be a potential for negative financial impacts on gas utilities. The extent of impacts in a given State would depend on how much gas consumption would decline under the potential amended standards, relative to total utility gas sales. DOE evaluated the potential impacts for Texas, which has the largest estimated reduction in natural gas consumption due to both switching and installation of standard-compliant gas furnaces in the compliance year. For the proposed standards, the estimated reduction of 1.7 trillion Btu in 2029 is approximately 0.7 percent of residential natural gas consumption in Texas in 2019, and approximately 0.4 percent of residential and commercial natural gas consumption.[261] Although DOE has not been able to perform a financial analysis of potential impacts on specific gas utilities, based on the evaluation of Texas, it would appear that the impact of the standard would be minimal even where revenue decoupling is not in place.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a 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. 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''). 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.[262] 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 BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the 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'').[263] 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 proposed rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2029–2034), where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the NOPR 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 in this NOPR. Additional details regarding DOE's analyses are contained in the TSD supporting this notice.

A. Trial Standard Levels

In general, DOE typically evaluates potential amended standards for products and equipment at the product class level and by grouping select individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider industry-level manufacturer cost interactions between the product classes, to the extent that there are such interactions, and national-level market cross-elasticity from consumer purchasing decisions that may change when different

[260] Other States without revenue decoupling for which estimated switching is 5 percent or greater are Alabama, Kentucky, Mississippi, Louisiana, Oklahoma, California, and New Mexico.

[261] Natural gas consumption is from EIA data (Available at: *www.eia.gov/dnav/ng/ng_cons_sum_dcu_STX_a.htm*) (Last accessed Feb. 15, 2022).

[262] See U.S. Department of Commerce—Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)* (1997) U.S. Government Printing Office: Washington, DC (Available at: *apps.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf*) (Last accessed Feb. 15, 2022).

[263] Livingston, O.V., S.R. Bender, M.J. Scott, and R.W. Schultz. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide.* 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL–24563 (Available at: *www.pnnl.gov/main/publications/external/technical_reports/PNNL-24563.pdf*) (Last accessed Feb. 15, 2022).

standard levels are set. For consumer furnaces, it is particularly important to look at the aggregated impacts as characterized by TSLs due to the changes in consumer purchasing decisions as a result of the increased product and installation costs that impact the shipments model. The changes to the shipments model will drive differential national impacts both on the consumer and manufacturer side that are more realistic of how the market may change in response to amended DOE standards.

For this NOPR, DOE analyzed the consumer impacts of four efficiency levels for NWGFs, four efficiency levels for MHGFs, and the national impacts of nine TSLs for NWGFs and MHGFs. Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for NWGFs and MHGFs. It is noted that because the impact of a potential standard on different consumers can depend on the input capacity of the NWGF or MHGF, DOE considered certain TSLs (six cases) with an input capacity threshold, below which the proposed standard would remain at the current efficiency level of 80-percent AFUE. For other TSLs (three cases), DOE examined a national standard level for NWGFs and MHGFs not differentiated by input capacity. Also, because the impact of a potential standard on different consumers can depend on the region of the country, DOE considered a regional TSL such that the proposed standard would remain at an efficiency level of 80-percent AFUE outside the Northern region. Next, DOE presents the results for the TSLs and corresponding ELs in Table V.47 and Table V.48 of this document. Results for all efficiency levels that DOE analyzed are in the NOPR TSD.

The following provides a brief overview of the TSLs considered. Each TSL consists of similar efficiency levels for both NWGFs and MHGFs. TSL 9 represents the maximum technologically feasible (''max-tech'') energy efficiency for both NWGFs and MHGFs and represents the maximum energy savings possible among the specific efficiency levels analyzed by DOE (see section III.C.2 of this NOPR). TSL 8 consists of a national standard at an efficiency level of 95-percent AFUE for both NWGFs and MHGFs, which reflects a high degree of energy savings second only to the max-tech efficiency levels. TSL 7 consists of an efficiency level at 80-percent AFUE for small NWGFs and MHGFs at or below an input capacity of 55 kBtu/h and an efficiency level at 95-percent AFUE for large NWGFs and MHGFs. The threshold of 55 kBtu/h generally separates the market into larger capacity furnaces typically installed in larger single-family detached homes versus smaller capacity furnaces more likely to be installed in multi-family buildings and other households with higher potential installation costs. TSL 6 consists of the next highest efficiency levels, which would set a national standard at 92-percent AFUE for both NWGFs and MHGFs, regardless of input capacity. Similarly to TSL 7, TSL 5 is constructed with an input capacity threshold. TSL 5 consists of an efficiency level at 80-percent AFUE for small NWGFs and MHGFs at or below an input capacity of 55 kBtu/h and an efficiency level at 92-percent AFUE for large NWGFs and MHGFs. TSL 4 consists of the efficiency levels that represent 95-percent AFUE for the Northern region for both NWGFs and MHGFs, but retains the baseline efficiency level (80-percent AFUE) for the Rest of Country. TSLs 3, 2, and 1 are similar to TSL 5, except with an increasingly higher input capacity threshold (and a correspondingly smaller fraction of the market subject to more-stringent standards). TSL 3 consists of the efficiency level that represents 80-percent AFUE for small NWGFs and MHGFs at or below an input capacity of 60 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGFs and MHGFs. TSL 2 consists of the efficiency level that represents 80-percent AFUE for small NWGFs and MHGFs at or below an input capacity of 70 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGFs and MHGFs. TSL 1 consists of the efficiency level that represents 80-percent AFUE for small NWGFs and MHGFs at or below an input capacity of 80 kBtu/h and the efficiency level that represents 92-percent AFUE for large NWGFs and MHGFs.

TABLE V.1—TRIAL STANDARD LEVELS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

TSL	AFUE (percent)	
	Non-weatherized gas furnace	Mobile home gas furnace
1	92% (>80 kBtu/h)	92% (>80 kBtu/h).
	80% (≤80 kBtu/h)	80% (≤80 kBtu/h).
2	92% (>70 kBtu/h)	92% (>70 kBtu/h).
	80% (≤70 kBtu/h)	80% (≤70 kBtu/h).
3	92% (>60 kBtu/h)	92% (>60 kBtu/h).
	80% (≤60 kBtu/h)	80% (≤60 kBtu/h).
4	95% (North)	95% (North).
	80% (Rest of Country)	80% (Rest of Country).
5	92% (>55 kBtu/h)	92% (>55 kBtu/h).
	80% (≤55 kBtu/h)	80% (≤55 kBtu/h).
6	92%	92%.
7	95% (>55 kBtu/h)	95% (>55 kBtu/h).
	80% (≤55 kBtu/h)	80% (≤55 kBtu/h).
8	95%	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 NWGFs and MHGFs and represents the maximum energy savings possible among the specific efficiency levels analyzed by DOE (see section III.C.2 of this NOPR). TSL 2 represents efficiency levels below max-tech and represents the maximum energy savings excluding max-tech efficiency levels. TSL 1 represents efficiency level 1 for both NWGFs and MHGFs.

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 energy use (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 that potential new and amended 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 in the following sections.

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, for NWGFs, 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.11.

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 NOPR TSD provides detailed information on the LCC and PBP analyses.

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. 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 2029) is shown in Table V.3 and Table V.4 for each TSL for NWGFs and MHGFs, respectively. The degree of switching increases at higher-efficiency TSLs where the installed cost of a NWGF is very high for some consumers, making the alternative option competitive. As discussed in section IV.F.12, DOE also conducted sensitivity analysis using no-switching, high, and low switching estimates. See appendix 8J of the NOPR TSD for more details. . For the proposed standards (TSL 8), the total switching and repair vs. replace is 11.1 percent for NWGFs and 10.3 percent for MHGFs.

TABLE V.3—RESULTS OF FUEL SWITCHING ANALYSIS FOR NON-WEATHERIZED GAS FURNACES IN 2029

Consumer option	Trial standard level								
	1	2	3	4	5	6	7	8	9
	% of consumers								
Purchase NWGF at Standard Level	98.4	97.7	96.3	98.5	95.4	88.8	95.5	88.9	86.4
Switch to Heat Pump *	0.8	1.1	2.2	0.6	2.9	7.3	2.8	7.3	8.9
Switch to Electric Furnace *	0.2	0.3	0.5	0.2	0.6	1.6	0.5	1.6	2.0
Repair vs. Replacing	0.6	0.9	1.0	0.8	1.2	2.4	1.2	2.3	2.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Includes switching from a gas water heater to an electric water heater.
Note: Components may not sum due to rounding.

TABLE V.4—RESULTS OF FUEL SWITCHING ANALYSIS FOR MOBILE HOME GAS FURNACES IN 2029

Consumer option	Trial standard level								
	1	2	3	4	5	6	7	8	9
	% of consumers								
Purchase MHGF at Standard Level	99.9	99.8	99.2	96.9	97.8	89.9	97.8	89.7	85.0
Switch to Heat Pump	0.0	0.0	0.58	1.5	0.6	4.8	0.6	4.9	4.7
Switch to Electric Furnace	0.0	0.0	0.0	0.6	1.0	3.0	1.1	3.1	3.2

TABLE V.4—RESULTS OF FUEL SWITCHING ANALYSIS FOR MOBILE HOME GAS FURNACES IN 2029—Continued

Consumer option	Trial standard level								
	1	2	3	4	5	6	7	8	9
	% of consumers								
Repair vs. Replacing	0.1	0.2	0.3	1.1	0.6	2.3	0.5	2.3	7.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Components may not sum due to rounding.

Table V.5 through Table V.8 show the LCC and PBP results for the TSLs considered for each product class. Table V.9 through Table V.12 show the LCC and PBP results for the TSLs considered for each product class for standby mode and off mode standards. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, the impacts are measured relative to the efficiency distribution in the in the no-new-standards case in the compliance year (see section IV.F.10 of this document). The LCC and PBP results for NWGFs include both residential and commercial users. The LCC and PBP results are shipment-weighted and averaged over all capacities and regions. Results for all efficiency levels are reported in chapter 8 of the NOPR TSD. LCC Results for the alternative product switching scenarios are reported in appendix 8J of the NOPR TSD.

Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline product and the average LCC at each TSL. 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 2020$				Simple payback years	Average life-time years
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	92/80 *	3,475	640	10,141	13,616	6.8	21.4
2	92/80 *	3,547	628	9,942	13,490	6.6	21.4
3	92/80 *	3,585	623	9,860	13,445	6.7	21.4
4	95/80 **	3,620	625	9,870	13,490	8.0	21.4
5	92/80 *	3,624	620	9,788	13,412	7.1	21.4
6	92 †	3,720	618	9,671	13,391	8.9	21.4
7	95/80 *	3,629	609	9,619	13,249	5.8	21.4
8	95 †	3,727	606	9,490	13,217	7.2	21.4
9	98 (Max-Tech) †	3,879	602	9,352	13,231	9.1	21.4

* 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 3: 60 kBtu/h
TSL 5: 55 kBtu/h
TSL 7: 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 2020$	Percentage of consumers that experience net cost, %
1	92/80 *	663	3.7
2	92/80 *	603	6.0
3	92/80 *	575	7.9
4	95/80 **	350	5.2
5	92/80*	625	9.1
6	92 †	470	17.7

TABLE V.6—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACE AFUE STANDARDS—Continued

TSL	AFUE %	Life-cycle cost savings	
		Average LCC savings 2020$	Percentage of consumers that experience net cost, %
7	95/80 *	563	8.3
8	95 †	464	16.6
9	98 (Max-Tech) †	254	52.4

* 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 3: 60 kBtu/h
TSL 5: 55 kBtu/h
TSL 7: 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 2020$				Simple payback years	Average lifetime years
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	92/80 *	2,114	517	8,372	10,486	6.5	21.4
2	92/80 *	2,183	504	8,181	10,364	5.6	21.4
3	92/80 *	2,208	500	8,123	10,331	5.7	21.4
4	95/80 **	2,264	498	8,011	10,275	7.7	21.4
5	92/80 *	2,256	491	7,967	10,223	5.7	21.4
6	92 †	2,389	485	7,702	10,091	8.5	21.4
7	95/80 *	2,262	486	7,888	10,150	5.1	21.4
8	95 †	2,399	479	7,601	10,000	7.5	21.4
9	96 (Max-Tech) †	2,406	496	7,601	10,007	12.6	21.4

* The first number refers to the standard for large MHGFs; the second refers to the standard for small MHGFs. The input capacity threshold definitions for small MHGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 3: 60 kBtu/h
TSL 5: 55 kBtu/h
TSL 7: 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.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 2020$	Percentage of consumers that experience net cost, %
1	92/80 *	406	1.9
2	92/80 *	516	3.2
3	92/80 *	501	3.9
4	95/80 **	446	10.4
5	92/80*	569	4.8
6	92 †	493	21.8
7	95/80 *	603	4.6
8	95 †	526	21.5
9	96 (Max-Tech) †	414	38.0

* 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 3: 60 kBtu/h
TSL 5: 55 kBtu/h

TSL 7: 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.9—AVERAGE LCC AND PBP RESULTS FOR NON-WEATHERIZED GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS

TSL	Watts	Average costs 2020$				Simple payback years	Average lifetime years
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	9.5	1	20	293	294	0.7	21.4
2	9.2	3	20	289	292	1.5	21.4
3	8.5 (Max-Tech)	5	19	279	284	2.0	21.4

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.10—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS

TSL	Watts	Life-cycle cost savings	
		Average LCC savings 2020$	Percentage of consumers that experience net cost
1	9.5	21	2.5
2	9.2	23	2.5
3	8.5 (Max-Tech)	26	3.5

* The savings represent the average LCC for affected consumers.

TABLE V.11—AVERAGE LCC AND PBP RESULTS FOR MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS

TSL	Watts	Average costs 2020$				Simple payback years	Average lifetime years
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	9.5	1	22	317	318	0.6	21.4
2	9.2	3	22	312	315	1.3	21.4
3	8.5 (Max-Tech)	5	21	301	306	1.7	21.4

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.12—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* 2020$	Percentage of consumers that experience net cost
1	9.5	22	1.2
2	9.2	24	1.2
3	8.5 (Max-Tech)	27	1.6

* 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.[264] Table V.13 and Table V.14 compare the average LCC savings

[264] 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.

and PBP at each efficiency level for the consumer subgroups, along with the average LCC savings for the entire consumer sample. Because the small NWGF and MHGF efficiency levels at TSLs 1, 2, 3, 5, and 7 and the Rest of Country efficiency level at TSL 4 are at the baseline (*i.e.,* the current standard), these tables only include results for large NWGFs and MHGFs or the Northern region for these TSLs. The percent of low-income NWGF and MHGF consumers experiencing a net cost is smaller than the full LCC sample in all cases, largely due to the high proportion of renter households. The percentage of senior-only NWGF and MHGF households experiencing a net cost is either very similar to or smaller than the full LCC sample. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.13—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS FOR NON-WEATHERIZED GAS FURNACE AFUE STANDARDS

TSL	Average LCC savings			Simple payback period			% of Consumers experiencing net cost			% of Consumers experiencing net benefit		
	2020$			Years			%			%		
	Low-income	Senior-only	All	Low-income	Senior-only	All	Low-income	Senior-only	All	Low-income	Senior-only	All
1*	384	190	663	3.1	6.6	6.8	2.0	3.9	3.7	4.3	6.4	6.8
2*	427	257	603	2.8	7.1	6.6	2.8	6.0	6.0	6.2	10.4	11.0
3*	307	293	575	2.4	6.9	6.7	4.2	7.5	7.9	11.0	13.2	13.8
4**	314	173	350	1.2	5.7	8.0	3.6	3.9	5.2	19.8	20.7	18.1
5*	359	430	625	2.5	7.2	7.1	5.0	9.1	9.1	14.2	16.0	15.9
6†	266	402	470	2.6	7.8	8.9	14.0	17.4	17.7	31.7	23.2	22.5
7*	376	328	563	2.0	5.8	5.8	5.0	7.4	8.3	24.7	31.7	31.1
8†	292	327	464	2.1	6.3	7.2	13.7	15.1	16.6	46.1	41.2	40.1
9†	160	329	254	2.8	8.2	9.1	34.8	43.4	52.4	58.2	52.0	45.6

* 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 3: 60 kBtu/h
TSL 5: 55 kBtu/h
TSL 7: 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.14—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS FOR MOBILE HOME GAS FURNACE AFUE STANDARDS

TSL	Average LCC savings (2020$)			Simple payback period (Years)			% of Consumers experiencing net cost			% of Consumers experiencing net benefit		
	Low-income	Senior-only	All	Low-income	Senior-only	All	Low-income	Senior-only	All	Low-income	Senior-only	All
1*	1,118	632	406	3.6	4.4	6.5	0.1	0.3	1.9	1.6	8.4	3.0
2*	965	480	516	3.1	5.0	5.6	0.5	3.5	3.2	16.0	24.0	16.2
3*	876	488	501	3.2	5.3	5.7	0.9	4.1	3.9	19.1	29.9	21.6
4**	779	401	298	2.3	3.6	12.1	5.3	7.2	22.6	31.7	17.8	28.0
5*	992	463	569	3.2	5.4	5.7	1.4	4.3	4.8	41.6	31.1	32.6
6†	745	796	493	4.7	4.5	8.5	11.8	17.0	21.8	61.5	49.5	48.7
7*	1024	411	603	2.8	4.6	5.1	1.5	3.7	4.6	47.4	40.6	39.0
8†	782	701	526	4.2	4.0	7.5	12.6	14.8	21.5	69.6	61.1	57.3
9†	663	1,648	414	7.0	5.3	12.6	23.3	32.0	38.0	75.4	65.4	60.5

* Refers to TSLs with separate standards for small and large MHGFs. The input capacity threshold definitions for small MHGFs are as follows:
* TSL 1: 80 kBtu/h
* TSL 2: 70 kBtu/h
* TSL 3: 60 kBtu/h
* TSL 5: 55 kBtu/h
* TSL 7: 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.

c. Rebuttable Presumption Payback

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. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for residential furnaces and boilers. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V.15 and Table V.16 present the rebuttable-presumption payback periods for the considered AFUE and standby mode/off mode TSLs, respectively, for NWGFs and MHGFs. The payback periods for most NWGF and MHGF AFUE TSLs do not meet the rebuttable-presumption criterion. The payback periods for all NWGF and MHGF standby mode and off mode TSLs meet the rebuttable-presumption criterion.

While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. 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.15—REBUTTABLE-PRESUMPTION PAYBACK PERIODS (YEARS) FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE STANDARDS

TSL	Non-weatherized gas furnaces	Mobile home gas furnaces
1 *	3.24	3.17
2 *	3.52	3.44
3 *	3.64	3.64
4 **	2.70	2.45
5 *	3.79	3.66
6 †	3.96	3.92
7 *	3.47	3.11
8 †	3.63	3.29
9 †	3.98	3.26

* Refers to TSLs with separate standards for small and large MHGFs. The input capacity threshold definitions for small MHGFs are as follows:
* TSL 1: 80 kBtu/h
* TSL 2: 70 kBtu/h
* TSL 3: 60 kBtu/h
* TSL 5: 55 kBtu/h
* TSL 7: 55 kBtu/h
** Regional standards.
† Refers to national standards.

TABLE V.16—REBUTTABLE-PRESUMPTION PAYBACK PERIODS (YEARS) FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS

TSL	Standby and off mMode energy use (watts)	Non-weatherized gas furnaces	Mobile home gas furnaces
1	9.5	0.62	0.64
2	9.2	1.43	1.48
3	8.5	1.89	1.96

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of NWGFs and MHGFs. The next section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the NOPR 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 could result from a standard. Table V.17 presents 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 would take 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 percentage markup scenario and a tiered markup scenario. For standby mode and off mode standards, DOE modeled a preservation of gross margin percentage 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 (2022) through the end of the analysis period (2058).

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 (2028). 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 percentage scenario. This scenario assumes industry would be able to maintain its average no-new-standards case gross margin percentage in the standard case, even as MPCs increase and companies make upfront investments to bring products into compliance with amended standards. DOE assumed gross margin percentages of 25.3% for NWGFs and 21.3% for MHGF.[265] Manufacturers noted in interviews that it is optimistic to assume that as their production costs increase in response to an amended energy conservation standard, they would be able to maintain the same gross margin percentage markup. DOE understands this scenario to be an upper bound to industry profitability under an 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 a tiered scenario. DOE implemented the tiered scenario because multiple manufacturers stated in interviews that they offer multiple tiers of product lines that are differentiated, in part, by efficiency level. Manufacturers further noted that pricing tiers encompass additional differentiators, such as the combustion system (*e.g.,* single-stage, two-stage, and modulating combustion systems). To account for this nuance, the tiered markup in the GRIM incorporates both efficiency and combustion system technology into the ''good, better, best'' manufacturer markup scenario.

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 efficiency levels in those tiers and the change in profitability at each level. DOE used this information to estimate manufacturer 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 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 scenario. In this scenario, manufacturer markups are set so that operating profit one year after the compliance date of amended energy conservation standards (2030) 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.

Cash-Flow Analysis Results for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces AFUE Standards

Table V.17 presents the financial impacts of the analyzed AFUE standards on NWGF and MHGF manufacturers. These impacts are represented by changes in INPV summed over the analysis period and free cash flow in the year before the standard (2028), as well as by the conversion costs that DOE estimates NWGF and MHGF manufacturers would incur at each TSL. The range of results reflect the two manufacturer markup scenarios that were modeled.

TABLE V.17—MANUFACTURER IMPACT ANALYSIS: AFUE STANDARDS RESULTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

	Units	No-new standards case	Trial standard level								
			TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
INPV	*2020$ millions*	1,411.8	1,316.7 to 1,394.6	1,280.4 to 1,395.0	1,260.0 to 1,387.8	1,126.6 to 1,395.7	1,250.7 to 1,394.2	1,237.4 to 1,377.4	1,067.5 to 1,396.8	1,031.5 to 1,381.4	728.0 to 1,420.8
Change in INPV	*2020$ millions*		(95.2) to (17.3)	(131.5) to (16.8)	(151.9) to (24.1)	(285.2) to (16.2)	(161.2) to (17.6)	(174.4) to (34.5)	(344.4) to (15.0)	(380.3) to (30.5)	(683.8) to 9.0
	%		(6.7) to (1.2)	(9.3) to (1.2)	(10.8) to (1.7)	(20.2) to (1.1)	(11.4) to (1.2)	(12.4) to (2.4)	(24.4) to (1.1)	(26.9) to (2.2)	(48.4) to 0.6
Free Cash Flow (2028)	*2020$ millions*	85.8	65.0	58.6	55.3	45.1	52.2	44.9	34.0	22.8	(42.1)
Change in Free Cash Flow (2028).	*%*		(24.2)	(31.7)	(35.6)	(47.5)	(39.2)	(47.7)	(60.4)	(73.4)	(149.0)
Product Conversion Costs.	*2020$ millions*		26.6	26.6	26.6	41.2	26.6	26.6	41.2	41.2	79.9
Capital Conversion Costs.	*2020$ millions*		25.4	39.6	47.1	58.3	53.9	70.2	82.9	107.8	221.6
Total Investment Required.	*2020$ millions*		51.9	66.1	73.6	99.6	80.5	96.8	124.1	149.0	301.6

Note: Parentheses indicate negative values.

The following cash flow results discussion refers to the AFUE efficiency levels and capacity threshold cutoffs detailed in section V.A of this document. Table V.18 and Table V.19 present the percentage of NWGF and MHGF shipments in 2028 that are considered to be large or small, based on the input capacity threshold for each TSL. See section IV.G of this document for additional details on the shipments analysis.

[265] The gross margin percentage values correspond to manufacturer markups of 1.34 for NWGFs and 1.27 for MHGFs.

TABLE V.18—SHIPMENTS BREAKDOWNS (2028) REPRESENTING LARGE AND SMALL NON-WEATHERIZED GAS FURNACES AT EACH TRIAL STANDARD LEVEL

Size	Trial standard level and capacity threshold								
	TSL 1 80 kBtu/h (%)	TSL 2 70 kBtu/h (%)	TSL 3 60 kBtu/h (%)	TSL 4 no cutoff (%)	TSL 5 55 kBtu/h (%)	TSL 6 no cutoff (%)	TSL 7 55 kBtu/h (%)	TSL 8 no cutoff (%)	TSL 9 no cutoff (%)
Large	41.2	65.0	76.7	100.0	88.8	100.0	88.8	100.0	100.0
Small	58.8	35.0	23.3	0.0	11.2	0.0	11.2	0.0	0.0

TABLE V.19—SHIPMENTS BREAKDOWNS (2028) REPRESENTING LARGE AND SMALL MOBILE HOME GAS FURNACES AT EACH TRIAL STANDARD LEVEL

Size	Trial standard level and capacity threshold								
	TSL 1 80 kBtu/h (%)	TSL 2 70 kBtu/h (%)	TSL 3 60 kBtu/h (%)	TSL 4 no cutoff (%)	TSL 5 55 kBtu/h (%)	TSL 6 no cutoff (%)	TSL 7 55 kBtu/h (%)	TSL 8 no cutoff (%)	TSL 9 no cutoff (%)
Large	11.6	40.2	53.3	100.0	78.2	100.0	78.2	100.0	100.0
Small	88.4	59.8	46.7	0.0	21.8	0.0	21.8	0.0	0.0

TSLs 1, 2, 3, and 5 all represent national standards set at 92-percent AFUE for large furnaces, while small furnaces remain at the current Federal minimum of 80-percent AFUE. However, the capacity threshold used to classify small furnaces is different at each TSL. Small NWGFs and MHGFs are defined as units having an input capacity of 80 kBtu/h or less at TSL 1, 70 kBtu/h or less at TSL 2, 60 kBtu/h or less at TSL 3, and 55 kBtu/h or less at TSL 5. As the capacity threshold decreases from 80 kBtu/h at TSL 1 down to 55 kBtu/h at TSL 5, the number of furnace shipments classified as large gas-fired consumer furnaces, 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. 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 $26.6 million in product conversion costs to develop such models at each of TSLs 1, 2, 3, and 5.

In addition to conversion costs, a national standard of 92-percent AFUE for large NWGFs and MHGFs could lead to a slight compression of manufacturer markups. In its manufacturer markup scenarios, DOE includes a scenario which models the industry maintaining 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,'' and they correspond to 92-percent AFUE, 95-percent AFUE, and max-tech levels (98-percent for NWGFs and 96-percent for MHGFs), respectively.

TSL 1 represents a national standard set at 92-percent AFUE for large NWGFs and MHGFs, while small NWGFs and MHGFs remain at the current Federal minimum of 80-percent AFUE. At TSL 1, small furnaces are defined as NWGFs and MHGFs with input capacities of 80 kBtu/h or less. DOE estimates the change in INPV to range from −$95.2 million to −$17.3 million, or a change of −6.7 percent to −1.2 percent. At this level, industry free cash flow in 2028 (the year before the compliance date) is estimated to decrease to $65.0 million, or a decrease of 24.2 percent compared to the no-new-standards case value of $85.8 million.

Small furnaces with input capacities of 80 kBtu/h or less account for approximately 58.8 percent of NWGF shipments and 88.4 percent of MHGF shipments in 2028, a year before the standard goes into effect. In the no-new-standards case, approximately 59.1 percent of NWGF shipments and 30.4 percent of MHGF shipments are expected to be sold at condensing levels in the year before the standard goes into effect. At TSL 1, once the standard goes into effect, DOE expects 70.5 percent of NWGF shipments and 36.5 percent of MHGF shipments to be sold at condensing levels, requiring the industry to expand its production of secondary heat exchangers. Manufacturers will incur an estimated $25.4 million in capital conversion costs 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 are expected to reach $51.9 million at TSL 1.

TSL 2 represents a national standard at 92-percent AFUE for large furnaces, while small furnaces remain at the current Federal minimum of 80-percent AFUE. Small furnaces are defined as NWGFs and MHGFS with input capacities of 70 kBtu/h or less. At TSL 2, DOE estimates the change in INPV to range from −$131.5 million to −$16.8 million, or a change in INPV of −9.3 percent to −1.2 percent. At this level, free cash flow in 2028 is estimated to decrease to $58.6 million, or a decrease of 31.7 percent compared to the no-new-standards-case value of $85.8 million in the year 2028.

Small furnaces with input capacities of 70 kBtu/h or less account for approximately 35.0 percent of NWGF shipments and 59.8 percent of MHGF shipments in the year before standards go into effect. At TSL 2, once the standard goes into effect, DOE expects 77.2 percent of NWGF shipments and 50.6 percent of MHGF shipments to be sold at condensing levels, requiring the industry to expand its production of secondary heat exchangers. Capital conversion costs increase from $25.4 million at TSL 1 to $39.6 million at TSL 2. Manufacturers would also incur product conversion costs driven by the development necessary to create compliant, cost-competitive products. Total industry conversion costs are expected to reach $66.1 million at TSL 2.

TSL 3 represents a national standard at 92-percent AFUE for large furnaces, while small furnaces remain at the current Federal minimum of 80-percent AFUE. Small furnaces are defined as NWGFs and MHGFs with input capacities of 60 kBtu/h or less. At TSL 3, DOE estimates the change in INPV to range from −$151.9 million to −$24.1 million, or a change in INPV of −10.8 percent to −1.7 percent. At this level, free cash flow is estimated to decrease to $55.3 million, or a decrease of 35.6 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

Small furnaces with input capacities of 60 kBtu/h or less account for approximately 23.3 percent of NWGF shipments and 46.7 percent of MHGF shipments in the year before standards take effect. At TSL 3, once standards go into effect, DOE expects 81.4 percent of NWGF shipments and 57.5 percent of MHGF shipments to be sold at condensing levels, requiring the industry to expand its production of secondary heat exchangers. Capital conversion costs would increase from $39.6 million at TSL 2 to $47.1 million at TSL 3 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 could reach $73.6 million at TSL 3.

TSL 4 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 Country. TSL 4 does not have a small furnace capacity threshold. At TSL 4, DOE estimates the change in INPV to range from −$285.2 million to −$16.2 million, or a change in INPV of −20.2 percent to –1.1 percent. At this level, free cash flow is estimated to decrease to $45.1 million, or a decrease of 47.5 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

In the year before the standard goes into effect, DOE expects that the North region will account for approximately 57.3 percent of consumer furnace shipments, with the remaining shipments attributable to the Rest of Country region. Once the standard goes into effect, consumer furnaces sold in the North must achieve 95-percent AFUE. At TSL 4, DOE expects 72.7 percent of NWGFs and 69.0 percent of MHGFs would be sold at condensing levels in 2029. Capital conversion costs are expected to reach $58.3 million as manufacturers increase secondary heat exchanger production line capacity. Product conversion costs reach $41.2 million, as manufacturers develop cost-optimized 95-percent AFUE furnaces that are competitive at reduced markups. Total industry conversion costs would be expected to reach $99.6 million at TSL 4.

For products sold in the North that must achieve 95-percent AFUE, the industry faces a noticeable compression of markups. In the no-new-standards case, 95-percent AFUE products garner a higher markup than baseline products. At TSL 4, 95-percent AFUE products become the minimum AFUE efficiency offering and would no longer command the same premium manufacturer markup in the North. However, at this level, manufacturers can still differentiate products and offer multiple markup tiers based on ''comfort'' features, such as two-stage or modulating combustion technology. DOE models the industry maintaining three manufacturer markup tiers (''good, better, best'') but at a compressed range of manufacturer markup values. This approach accounts for manufacturers' continued ability to differentiate products based on combustion system technology while recognizing that manufacturer markups (and profitability) for high-efficiency products in the North may be reduced due to the higher AFUE standard.

TSL 5 represents a standard set at 92-percent AFUE for large furnaces, while small furnaces remain at the current Federal minimum of 80-percent AFUE. Small furnaces are defined as NWGFs and MHGFs with input capacities of 55 kBtu/h or less. At TSL 5, DOE estimates the change in INPV to range from −$161.2 million to −$17.6 million, or a change in INPV of −11.4 percent to −1.2 percent. At this level, free cash flow is estimated to decrease to $52.2 million, or a decrease of 39.2 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

Small furnaces with input capacities of 55 kBtu/h or less account for approximately 11.2 percent of NWGFs and 21.8 percent of MHGFs in the year before the standard goes into effect. At TSL 5, 84.6 percent of NWGF shipments and 70.0 percent of MHGF shipments would be sold at condensing levels when the standard goes into effect, requiring the industry to expand its production of secondary heat exchangers. Capital conversion costs would increase from $47.1 million at TSL 3, the previous TSL with a separate standard level for small furnaces, to $53.9 million at TSL 5. 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 $80.5 million at TSL 5.

TSLs 6, 8, and 9 represent national standards for all covered NWGFs and MHGFs. At these TSLs, there is no separate standard level based on furnace input capacity. As the TSL increases from 6 to 8 to 9, the national standard increases and DOE models a compression of markups in the tiered markup scenario. Compressed markups are a significant driver of negative impacts to INPV in the tiered markup scenario, particularly at TSL 9 for NWGFs, when neither efficiency nor combustion system technology (*e.g.,* single-stage, two-stage, or modulating combustion) is a means for product differentiation.

TSL 6 represents a national 92-percent AFUE standard for all covered NWGFs and MHGFs. TSL 6 does not have a small furnace capacity threshold. At this level, DOE estimates the change in INPV to range from −$174.4 million to −$34.5 million, or a change in INPV of −12.4 percent to −2.4 percent. At this level, free cash flow is estimated to decrease to $44.9 million, or a decrease of 47.7 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

At TSL 6, all shipments of the covered product would be at a condensing level once the standard goes into effect. Manufacturer markups at TSL 6 are slightly reduced, but the industry is still able to maintain three tiers of markups. Manufacturers would incur product conversion costs of $26.6 million at TSL 6, as manufacturers develop 92-percent AFUE furnaces that are competitive at reduced markups. Capital conversion costs would total $70.2 million, as manufacturers add production capacity to have secondary heat exchangers for all NWGF and MHGF shipments sold into the domestic market. Total conversion costs could reach $96.8 million for the industry.

TSL 7 represents a 95-percent AFUE standard for large furnaces, while small furnaces remain at the current Federal minimum of 80-percent AFUE. At TSL 7, small furnaces are defined as NWGFs and MHGFs with input capacities of 55 kBtu/h or less. DOE estimates the change in INPV to range from −$344.4 million to −$15.0 million, or a change in INPV of −24.4 percent to −1.1 percent. At this level, free cash flow is estimated to decrease to $34.0 million, or a decrease of 60.4 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

Small furnaces with input capacities of 55 kBtu/h or less account for approximately 11.2 percent of NWGF shipments and 21.8 percent of MHGF shipments before the standard goes into effect. At this level, 84.6 percent of

NWGF shipments and 70.0 percent of MHGF shipments would be sold at condensing levels when the standard goes into effect, requiring the industry to expand its production of secondary heat exchangers. Capital conversion costs would total $82.9 million, as manufacturers add production capacity to have secondary heat exchangers for the majority of NWGF and MHGF shipments sold into the domestic market. Manufacturers would also incur product conversion costs of an estimated $41.2 million, driven by the development necessary to create compliant, cost-competitive products. Total conversion costs could reach $124.1 million.

For large NWGFs and MHGFs, industry faces a noticeable compression of markups due to their limited ability to differentiate products purely based on AFUE. However, as with TSL 4, manufacturers can still differentiate products subject to the 95-percent standard based on ''comfort'' features, such as two-stage or modulating combustion technology. DOE models the industry as maintaining three markup tiers (''good, better, best'') but at a compressed range of tiers where max-tech products do not command the same premium as they did in the no-new-standards case. This approach accounts for manufacturers' continued ability to differentiate large NWGFs and MHGFs based on combustion systems while recognizing that markups (and profitability) for high-efficiency products may be reduced for large furnaces due to the 95-percent AFUE standard. While manufacturers would not experience a compression of markups for small capacity products, most shipments qualify as large furnaces at this capacity cutoff. The reduction in premium product offerings and deterioration of markups for the majority of furnace shipments coupled with increased conversion costs are expected to result in a negative change in INPV at TSL 7.

TSL 8 represents a national 95-percent AFUE standard for all covered NWGFs and MHGFs. TSL 8 does not have a small capacity threshold. At TSL 8, DOE estimates the change in INPV to range from −$380.3 million to −$30.5 million, or a change in INPV of −26.9 percent to −2.2 percent. At this level, free cash flow is estimated to decrease to $22.8 million, or a decrease of 73.4 percent compared to the no-new-standards case value of $85.8 million in the year 2028.

DOE estimates that approximately 39.3 percent of the annual NWGF shipments and approximately 14.9 percent of the annual MHGF shipments currently meet or exceed the efficiencies required at TSL 8. At TSL 8, all covered furnaces would be condensing after the standard goes into effect. DOE estimates capital conversion costs would increase to $107.8 million at TSL 8, as manufacturers add production capacity to have secondary heat exchangers for all NWGF and MHGF shipments sold into the domestic market. Product conversion costs would total $41.2 million, as manufacturers develop cost-optimized 95-percent AFUE NWGF and MHGF models that are competitive at reduced markups. Total industry conversion costs could reach $149.0 million.

With a national standard of 95-percent AFUE, industry faces a noticeable compression of markups due to their limited ability to differentiate products purely based on AFUE. As with TSL 4 and TSL 7, manufacturers can still differentiate products based on ''comfort'' features such as the combustion systems. At TSL 8, DOE models the industry as maintaining three markup tiers (''good, better, best'') but at a compressed range of manufacturer markup values where max-tech products do not command the same premium as they did in the no-new-standards case. This approach accounts for manufacturers' continued ability to differentiate NWGFs and MHGFs based on combustion systems while recognizing that markups (and profitability) for high-efficiency products may be reduced due to the 95-percent AFUE standard. The compression of markups and a reduction in product offerings, coupled with increased conversion costs are expected to result in INPV losses at TSL 8.

TSL 9 represents a national max-tech standard, where NWGF products must achieve 98-percent AFUE and MHGF products must achieve 96-percent AFUE. At TSL 9, DOE estimates the change in INPV to range from −$683.8 million to $9.0 million, or a change in INPV of −48.4 percent to 0.6 percent. At this level, the large conversion costs result in a free cash flow dropping below zero in the years before the standard year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

At TSL 9, approximately 1.8 percent of NWGFs and 0.8 percent of MHGFs are sold at this level today. Manufacturers would incur $79.9 million in product conversion costs as they develop cost-optimized, high-efficiency NWGF models that can compete in a market where efficiency and combustion systems are no longer viable options for product differentiation and MHGF models that can compete in a market where efficiency is no longer a means for product differentiation. More than half of all NWGF and MHGF OEMs do not currently offer any models that meet the efficiency levels required by TSL 9. Manufacturers would also incur capital conversion costs of $221.6 million as manufacturers add the production capacity necessary to produce all NWGFs and MHGFs sold into the domestic market at 98-percent and 96-percent AFUE, respectively. Total conversion costs would be expected to reach $301.6 million for the industry.

Some manufacturers expressed great concern about the state of technology at max-tech. Specifically, those manufacturers' noted uncertainty about the ability to deliver cost-effective products for their customers. They also cited high conversion costs and large investments in R&D to produce all products at this level. Many OEMs do not currently manufacture any models that meet these efficiency levels. These OEMs would likely have more technical challenges in designing new models that meet max-tech levels. Furthermore, NWGF manufacturers would lose efficiency and combustion systems as differentiators between baseline and premium product offerings. The extent of conversion costs, the compression of markups, and the reduced ability to differentiate products would likely alter the consumer furnace competitive landscape.

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 presents 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 in the year before the standard (2028) 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 preservation of operating profit scenario. The preservation of gross margin percentage scenario represents the upper bound of impacts (less severe), while the preservation of 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 FURNACES AND MOBILE HOME GAS FURNACES

	Units	No-new-standards case	Trial standard level		
			TSL 1	TSL 2	TSL 3
INPV	*2020$ millions*	1,411.8	1,410.8 to 1,412.7	1,410.8 to 1,412.8	1,409.7 to 1,416.8
Change in INPV	*2020$ millions*		(1.0) to 0.9	(1.1) to 1.0	(2.1) to 5.0
	%		(0.1) to 0.1	(0.1) to 0.1	(0.1) to 0.4
Free Cash Flow (2028)	*2020$ millions*	85.8	85.4	85.4	85.3
Change in Free Cash Flow (2028)	*%*		(0.5)	(0.5)	(0.6)
Product Conversion Costs	*2020$ millions*		1.2	1.2	1.6
Capital Conversion Costs	*2020$ millions*				
Total Investment Required	*2020$ millions*		1.2	1.2	1.6

Note: Parentheses indicate negative values.

At TSL 1, DOE estimates the impacts on INPV for NWGF and MHGF manufacturers to change by less than 0.1 percent in both markup scenarios (preservation of gross margin percentage and preservation of operating profit). At this potential standard level, industry free cash flow is estimated to decrease by 0.5 percent compared to the no-new-standards case value of $85.8 million in 2028. DOE expects industry conversion costs for standby mode and off mode to be $1.2 million.

At TSL 2, DOE estimates the impacts on INPV for NWGF and MHGF manufacturers to change by less than 0.1 percent in both markup scenarios (preservation of gross margin percentage and preservation of operating profit). At this potential standard level, industry free cash flow is estimated to decrease by 0.5 percent compared to the no-new-standards case value of $85.8 million in 2028. DOE expects industry conversion costs for standby mode and off mode to be $1.2 million.

At TSL 3, DOE estimates the impacts on INPV for NWGF and MHGF manufacturers to range from a decrease of 0.1 percent to an increase of 0.4 percent. At this potential standard level, industry free cash flow is estimated to decrease by 0.6 percent compared to the no-new-standards case value of $85.8 million in 2028. DOE expects industry conversion costs for standby mode and off mode to be $1.6 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 AFUE standards cases during the analysis period. DOE calculated these values using statistical data from the U.S. Census Bureau's 2019 ASM,[266] the U.S. Bureau of Labor Statistics' (''BLS'') employee compensation data,[267] results of the engineering analysis, and manufacturer interviews.

Labor expenditures related to product manufacturing depend on the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the total 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 average fully burdened wage multiplied by the average number of hours worked per year per production worker. To do this, DOE relied on the ASM inputs Production Workers Annual Wages, Production Workers Annual Hours, Production Workers Average for Year, and Number of Employees. DOE also relied on the BLS employee compensation data to determine the fully burdened wage ratio. The fully burdened wage ratio factors in paid leave, supplemental pay, insurance, retirement and savings, and legally required benefits.

Total production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer interviews, product database analysis, and publicly available information. DOE estimates that 45 percent of gas-fired consumer furnaces are produced domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating, processing, or assembling products within the OEM facility. Workers performing services that are closely associated with production operations, such as handling materials using forklifts, are also included as production labor.[268] DOE's estimates only account for production workers who

[266] U.S. Census Bureau's Annual Survey of Manufactures: 2018–2019 (Available at *www.census.gov/programs-surveys/asm/data/tables.html*) (Last accessed Oct. 19, 2021).

[267] U.S. Bureau of Labor Statistics, *Employer Costs for Employee Compensation* (June 17, 2021) (Available at: *www.bls.gov/news.release/pdf/ecec.pdf*) (Last accessed May 20, 2022).

[268] The comprehensive description of production and non-production workers is available online at: *www.census.gov/programs-surveys/asm/information.html,* ''Definitions and Instructions for the Annual Survey of Manufacturers, MA–10000.'' (pp. 13–14).

manufacture the specific equipment covered by this rulemaking.

Non-production workers account for the remainder of the direct employment figure. The non-production employees covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, management, etc. Using the amount of domestic production workers calculated above, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-standards case and standards cases.

TABLE V.21—POTENTIAL CHANGES IN THE TOTAL NUMBER OF NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE PRODUCTION AND NON-PRODUCTION WORKERS IN 2029

	Trial standard level				
	No-new-standards case	TSL 1	TSL 2	TSL 3	TSL 4
Direct Employment in 2029 (Production workers + Non-Production Workers)	1,718	1,761	1,789	1,778	1,829
Potential Changes in Direct Employment Workers in 2029 *		(1,274) to 43	(1,274) to 71	(1,274) to 60	(1,274) to 111
	Trial standard level				
	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Direct employment estimate in 2029 (Production Workers + Non-Production Workers)	1,803	1,755	1,898	1,875	1,812
Potential Changes in Direct Employment Workers in 2029 *	(1,274) to 85	(1,274) to 37	(1,274) to 180	(1,274) to 157	(1,274) to 94

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative values.

The direct employment impacts shown in Table V.23 represent the potential domestic employment changes that could result following the compliance date for the NWGF and MHGF product classes in this proposal. The upper end of the range estimates an increase in the number of domestic workers producing NWGFs and MHGFs after implementation of an amended energy conservation standard at each TSL. This upper bound assumes manufacturers would continue to produce the same scope of covered products within the United States and would require additional labor to produce more-efficient products. The lower bound of the range represents the estimated maximum decrease in the total number of U.S. domestic workers if production moved to lower labor-cost countries or manufacturers left the market. 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 manufacturers to re-evaluate domestic production siting options.

The impacts in the direct employment analysis 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. While some product development effort would be required, the standby mode and off mode standard would not 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.

Additional detail on the analysis of direct employment can be found in chapter 12 of the NOPR TSD. Additionally, the employment impacts discussed in this section are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 15 of the NOPR TSD.

c. Impacts on Manufacturing Capacity

According to manufacturer feedback, production facilities are not currently equipped to supply the entire NWGF and MHGF market with condensing products. However, most manufacturers would be able to add capacity and adjust product designs in the 5-year period between the announcement year of the standard and the compliance year of the standard. DOE interviewed manufacturers representing over 65 percent of industry shipments. 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 max-tech efficiency 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 NOPR as part of the Regulatory Flexibility Analysis. In summary, the 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 classification, DOE identified four domestic OEMs that certify NWGFs and/or MHGFs in DOE's Compliance Certification Management System database (''CCMS'')[269] 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 NOPR and chapter 12 of the NOPR TSD.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves examining the cumulative impact of multiple DOE standards and the product-specific regulatory actions of other Federal agencies that affect the manufacturers of a covered product or equipment. 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. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. 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 Federal, product-specific regulations that could affect NWGF and MHGF manufacturers that take effect approximately three years before or after the 2029 compliance date. Table V.22 presents the DOE energy conservation standards that would impact manufacturers of NWGF and MHGF products in the 2026 to 2032 timeframe.

TABLE V.22—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING GAS-FIRED CONSUMER FURNACE ORIGINAL EQUIPMENT MANUFACTURERS

Federal energy conservation standard	Number of OEMs *	Number of OEMs affected from today's rule **	Approx. standards year	Industry conversion costs (millions $)	Industry conversion costs/product revenue *** (%)
Room Air Conditioners † 87 FR 20608 (April 7, 2022)	8	2	2026	$22.8	0. 5
Consumer Pool Heaters † 87 FR 22640 (April 15, 2022)	21	1	2028	38.8	1.9
Commercial Water Heating Equipment † 87 FR 30610 (May 19, 2022)	15	3	2026	34.6	4.7

* This column presents the total number of OEMs identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of OEMs producing consumer furnaces that are also listed as OEMs in the identified energy conservation standard contributing to cumulative regulatory burden.
*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the final rule. The conversion period typically ranges from 3 to 5 years, depending on the energy conservation standard.
† The Room Air Conditioners, Consumer Pool Heaters, and Commercial Water Heating Equipment rulemakings are in the NOPR stage and all values are subject to change until finalized.

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 and new standby mode and off mode standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended and new 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 standards (2029–2058). Table V.23 presents DOE's projections of the national energy savings for each AFUE TSL considered for NWGFs and MHGFs. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.23—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		quads								
Primary energy	NWGF	1.60	2.45	2.82	2.92	3.01	3.49	4.15	4.70	6.45
	MHGF	0.01	0.03	0.05	0.08	0.06	0.09	0.07	0.10	0.09
	Total	**1.61**	**2.49**	**2.86**	**3.00**	**3.07**	**3.58**	**4.22**	**4.81**	**6.54**
FFC energy	NWGF	1.77	2.72	3.14	3.26	3.37	4.03	4.63	5.37	7.38
	MHGF	0.01	0.04	0.05	0.09	0.06	0.10	0.08	0.12	0.11

[269] U.S. Department of Energy Compliance Certification Management System (''CCMS''). (Available at: *www.regulations.doe.gov/certification-data/*) (Last accessed July 7, 2021).

TABLE V.23—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)—Continued

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		quads								
	Total	**1.78**	**2.76**	**3.19**	**3.35**	**3.44**	**4.12**	**4.70**	**5.48**	**7.48**

For the proposed standards (TSL 8), the FFC energy savings of 5.48 quads are the FFC natural gas savings minus the increase in FFC energy use associated with higher electricity use due primarily to switching to electric heating.

The previously results reflect the use of the reference product switching scenario and repair vs. replace trend for NWGFs and MHGFs (as described in section IV.F.12 of this document). 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 appendix 10E of the NOPR TSD.

Table V.24 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.2 of this NOPR.

TABLE V.24—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)

Energy savings	Product class	Trial standard level		
		1	2	3
		quads		
Primary energy	NWGF	0.15	0.18	0.26
	MHGF	0.002	0.002	0.003
	Total	**0.15**	**0.18**	**0.27**
FFC energy	NWGF	0.15	0.18	0.27
	MHGF	0.002	0.002	0.003
	Total	**0.16**	**0.19**	**0.28**

OMB Circular A–4 [270] 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 9 years, rather than 30 years, of product shipments. The choice of a 9-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.[271] 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 are presented in Table V.25 for AFUE standards and Table V.26 for standby and off mode standards.[272] The impacts are counted over the lifetime of NWGFs and MHGFs purchased in 2029–2037.

TABLE V.25—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES AFUE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		quads								
Primary energy	NWGF	0.45	0.69	0.79	0.78	0.85	0.98	1.17	1.33	1.94
	MHGF	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
	Total	**0.45**	**0.70**	**0.80**	**0.81**	**0.86**	**1.01**	**1.19**	**1.36**	**1.96**
FFC energy	NWGF	0.50	0.76	0.88	0.88	0.95	1.15	1.30	1.53	2.23
	MHGF	0.00	0.01	0.02	0.03	0.02	0.03	0.02	0.03	0.03

[270] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (September 17, 2003) (Available at: *www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf*) (Last accessed Sept. 9, 2021).

[271] 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 products, the compliance period is 5 years rather than 3 years.

[272] DOE presents results based on a 9-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.25—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES AFUE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)—Continued

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		quads								
	Total	**0.50**	**0.77**	**0.90**	**0.90**	**0.97**	**1.17**	**1.33**	**1.56**	**2.26**

TABLE V.26—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)

Energy savings	Product class	Trial standard level		
		1	2	3
		quads		
Primary energy	NWGF	0.04	0.05	0.07
	MHGF	0.000	0.001	0.001
	Total	**0.04**	**0.05**	**0.07**
FFC energy	NWGF	0.04	0.05	0.08
	MHGF	0.000	0.001	0.001
	Total	**0.04**	**0.05**	**0.08**

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,[273] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.27 E;shows the consumer NPV results for AFUE standards with impacts counted over the lifetime of products purchased in 2029–2058.

TABLE V.27—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)

Discount rate	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		billion 2017$								
7 percent	NWGF	1.44	2.35	2.87	2.60	3.10	4.11	4.79	5.92	6.48
	MHGF	0.02	0.06	0.10	0.19	0.12	0.18	0.16	0.23	0.23
	Total	**1.45**	**2.41**	**2.97**	**2.79**	**3.22**	**4.28**	**4.95**	**6.15**	**6.71**
3 percent	NWGF	5.42	8.68	10.52	9.79	11.41	15.35	16.51	20.79	24.82
	MHGF	0.06	0.20	0.31	0.61	0.39	0.60	0.50	0.77	0.77
	Total	**5.48**	**8.88**	**10.83**	**10.40**	**11.79**	**15.94**	**17.01**	**21.56**	**25.59**

The above results reflect the use of the default product switching trend for NWGFs (as described in section IV.F.12 of this document). As previously discussed, DOE conducted a sensitivity analysis assuming higher and lower levels of product switching for NWGFs. The results of these alternative cases are presented in appendix 10 E of the NOPR TSD.

Table V.28 shows the consumer NPV results for standby mode and off mode standards with impacts counted over the lifetime of products purchased in 2029–2058.

TABLE V.28—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)

Discount rate	Product class	Trial standard level		
		1	2	3
		billion 2020$		
7 percent	NWGF	0.67	0.77	1.13
	MHGF	0.01	0.01	0.01
	Total	**0.67**	**0.78**	**1.14**
3 percent	NWGF	1.94	2.27	3.34
	MHGF	0.02	0.03	0.04

[273] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (September 17, 2003) (Available at: *www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf*) (Last accessed September 9, 2021).

TABLE V.28—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS; 30 YEARS OF SHIPMENTS (2029–2058)—Continued

Discount rate	Product class	Trial standard level		
		1	2	3
		billion 2020$		
	Total	**1.96**	**2.30**	**3.38**

The NPV results for AFUE standards based on the aforementioned 9-year analytical period are presented in Table V.29 for AFUE standards and Table V.30 for standby and off mode standards.[274] The impacts are counted over the lifetime of products purchased in 2029–2037. 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.29—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)

Discount rate	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		billion 2020$								
7 percent	NWGF	0.7	1.1	1.4	1.3	1.5	2.1	2.5	3.2	3.6
	MHGF	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Total	**0.7**	**1.1**	**1.4**	**1.4**	**1.6**	**2.2**	**2.6**	**3.3**	**3.7**
3 percent	NWGF	1.8	3.0	3.7	3.6	4.1	5.5	6.3	8.0	9.9
	MHGF	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
	Total	**1.9**	**3.1**	**3.8**	**3.8**	**4.2**	**5.8**	**6.4**	**8.2**	**10.2**

TABLE V.30—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)

Discount rate	Product class	Trial standard level		
		1	2	3
		billion 2020$		
7 percent	NWGF	0.3	0.4	0.6
	MHGF	0.00	0.00	0.01
	Total	**0.3**	**0.4**	**0.6**
3 percent	NWGF	0.7	0.9	1.3
	MHGF	0.01	0.01	0.01
	Total	**0.8**	**0.9**	**1.3**

The previous results reflect the use of a default trend to estimate the change in price for NWGFs and MHGFs over the analysis period (see section IV.F.2 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the NOPR TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

It is estimated that amended energy conservation standards for NWGFs and MHGFs will reduce energy expenditures 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. 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 (2029–2034), where these uncertainties are reduced.

The results suggest that the proposed standards are 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 NOPR TSD presents detailed results regarding anticipated indirect employment impacts.

[274] DOE presents results based on a 9-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.

4. Impact on Utility or Performance of Products

As discussed in section III.E.1.d of this document, DOE has initially concluded that the standards proposed in this NOPR 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 of this document, EPCA directs the Attorney General of the United States (''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 in writing 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. DOE has also provided DOJ with copies of this NOPR 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. 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 NOPR 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 energy conservation 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.31 provides DOE's estimate of cumulative emissions reductions expected to result from the AFUE TSLs considered in this rulemaking. 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.32 provides DOE's estimate of cumulative emissions reductions expected to result from the standby mode and off mode TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

TABLE V.31—AFUE STANDARDS: CUMULATIVE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

	Trial standard level								
	1	2	3	4	5	6	7	8	9
Power Sector Emissions									
CO_2 (*million metric tons*)	89	140	166	176	182	251	245	318	440
SO_2 (*thousand tons*)	(3)	(6)	(11)	(13)	(15)	(50)	(16)	(52)	(77)
NO_X (*thousand tons*)	37	58	69	74	75	104	102	133	182
Hg (*tons*)	(0.02)	(0.04)	(0.07)	(0.09)	(0.10)	(0.31)	(0.11)	(0.33)	(0.48)
CH_4 (*thousand tons*)	1.5	2.0	1.9	1.9	1.8	(1.3)	2.9	(0.1)	(0.8)
N_2O (*thousand tons*)	0.12	0.16	0.11	0.09	0.07	(0.48)	0.17	(0.38)	(0.62)
Upstream Emissions									
CO_2 (*million metric tons*)	11	18	22	23	24	36	32	44	62
SO_2 (*thousand tons*)	0.02	0.01	(0.02)	(0.03)	(0.05)	(0.34)	(0.03)	(0.32)	(0.49)
NO_X (*thousand tons*)	172	275	332	353	367	555	489	686	957
Hg (*tons*)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CH_4 (*thousand tons*)	1,258	2,009	2,435	2,588	2,694	4,113	3,583	5,068	7,071
N_2O (*thousand tons*)	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.06
Total FFC Emissions									
CO_2 (*million metric tons*)	100	158	188	199	205	286	277	363	502
SO_2 (*thousand tons*)	(3)	(6)	(11)	(13)	(15)	(51)	(16)	(52)	(77)
NO_X (*thousand tons*)	209	333	401	427	443	660	591	819	1,139
Hg (*tons*)	(0.02)	(0.04)	(0.07)	(0.09)	(0.10)	(0.32)	(0.11)	(0.33)	(0.48)
CH_4 (*thousand tons*)	1,259	2,011	2,437	2,590	2,696	4,112	3,586	5,068	7,070
N_2O (*thousand tons*)	0.14	0.18	0.14	0.13	0.10	(0.45)	0.21	(0.33)	(0.56)

Negative values (shown in parentheses) refer to an increase in emissions.

TABLE V.32—STANDBY MODE AND OFF MODE STANDARDS: CUMULATIVE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

	Trial standard level		
	1	2	3
Power Sector Emissions			
CO_2 (*million metric tons*)	5.0	6.0	9.0
SO_2 (*thousand tons*)	2.5	3.0	4.4
NO_X (*thousand tons*)	2.1	2.5	3.7

TABLE V.32—STANDBY MODE AND OFF MODE STANDARDS: CUMULATIVE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058—Continued

	Trial standard level		
	1	2	3
Hg (*tons*)	0.01	0.02	0.03
CH_4 (*thousand tons*)	0.4	0.5	0.7
N_2O (*thousand tons*)	0.1	0.1	0.1
Upstream Emissions			
CO_2 (*million metric tons*)	0.4	0.4	0.7
SO_2 (*thousand tons*)	0.0	0.0	0.0
NO_X (*thousand tons*)	5.4	6.5	9.8
Hg (*tons*)	0.0	0.0	0.0
CH_4 (*thousand tons*)	36.3	43.6	65.1
N_2O (*thousand tons*)	0.0	0.0	0.0
Total FFC Emissions			
CO_2 (*million metric tons*)	5.4	6.4	9.6
SO_2 (*thousand tons*)	2.5	3.0	4.5
NO_X (*thousand tons*)	7.5	9.0	13.5
Hg (*tons*)	0.01	0.02	0.03
CH_4 (*thousand tons*)	36.7	44.1	65.9
N_2O (*thousand tons*)	0.1	0.1	0.1

As part of the analysis for this rulemaking, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for NWGFs and MHGFs. Section IV.L.1.a of this document discusses the SC–CO_2 values used.

Table V.33 presents the present value of the CO_2 emissions reduction at each AFUE TSL. Table V.34 presents the present value of CO_2 emissions reductions at each standby mode and off mode TSL.

TABLE V.33—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–CO_2 case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	648	3,038	4,868	9,191
2	1,021	4,788	7,673	14,486
3	1,217	5,701	9,134	17,249
4	1,250	5,886	9,445	17,800
5	1,332	6,240	9,998	18,882
6	1,867	8,733	13,984	26,427
7	1,789	8,389	13,442	25,380
8	2,360	11,047	17,695	33,429
9	3,307	15,441	24,714	46,740

TABLE V.34—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–CO_2 case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	35	165	264	499
2	42	198	317	599
3	63	296	473	895

As discussed in section IV.L.1.b of this document, DOE estimated monetary benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for furnaces. Table

V.35 and Table V.36 presents the value of the CH_4 emissions reduction at each TSL, and Table V.37 and Table V.38 presents the value of the N_2O emissions reduction at each TSL.

TABLE V.35—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–CH_4 case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	386	1,270	1,814	3,360
2	616	2,027	2,894	5,361
3	749	2,460	3,512	6,507
4	773	2,557	3,656	6,763
5	829	2,724	3,887	7,204
6	1,276	4,173	5,950	11,040
7	1,099	3,615	5,161	9,561
8	1,566	5,133	7,322	13,578
9	2,210	7,218	10,289	19,096

TABLE V.36—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–CH_4 case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	11	37	53	98
2	14	45	64	118
3	20	67	95	176

TABLE V.37—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–N_2O case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	0.3	1.5	2.4	4.1
2	0.4	2.0	3.1	5.2
3	0.3	1.5	2.4	3.9
4	0.3	1.4	2.2	3.7
5	0.2	1.1	1.7	2.8
6	(1.2)	(5.2)	(8.1)	(13.8)
7	0.5	2.3	3.6	6.1
8	(0.9)	(3.9)	(6.0)	(10.3)
9	(1.5)	(6.4)	(10.0)	(17.0)

TABLE V.38—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	SC–N_2O case discount rate and statistics			
	5%, Average	3%, Average	2.5%, Average	3%, 95th percentile
	million 2020$			
1	0.2	0.7	1.0	1.8
2	0.2	0.8	1.3	2.1
3	0.3	1.2	1.9	3.2

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 GHG emissions in this rulemaking is subject to change. That said, because of omitted damages, DOE agrees with the IWG that these estimates most likely underestimate the climate benefits of greenhouse gas reductions. 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. DOE notes that the proposed standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic impacts associated with changes in SO_2 emissions 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.2 of this document. Table V.39 presents the present value SO_2 emission changes for each AFUE TSL calculated using 7-percent and 3-percent discount rates. Table V.40 presents the cumulative present values for SO_2 emissions for each standby mode and off mode TSL calculated using 7-percent and 3-percent discount rates. These tables present results that use the low benefit-per-ton values, which reflect DOE's primary estimate.

TABLE V.39—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF SO_2 EMISSION CHANGES FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	7% discount rate	3% discount rate
	million 2020$	
1	(39)	(125)
2	(91)	(288)
3	(165)	(517)
4	(173)	(570)
5	(218)	(680)
6	(745)	(2,296)
7	(229)	(737)
8	(756)	(2,357)
9	(1,122)	(3,490)

Parentheses indicate negative (−) values.

TABLE V.40—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: PRESENT VALUE OF SO_2 EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	7% discount rate	3% discount rate
	million 2020$	
1	33.3	108.3
2	40.0	129.9
3	59.7	194.1

DOE also estimated the 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.41 presents the present value for NO_X emissions reduction for each AFUE TSL calculated using 7-percent and 3-percent discount rates. Table V.42 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 results that use the low benefit-per-ton values, which reflect DOE's primary estimate.

TABLE V.41—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	7% discount rate	3% discount rate
	million 2020$	
1	1,720	5,682
2	2,726	9,008
3	3,284	10,820
4	3,327	11,233
5	3,620	11,907
6	5,344	17,393
7	4,815	15,903

TABLE V.41—POTENTIAL AFUE STANDARDS: PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058—Continued

TSL	7% discount rate	3% discount rate
	million 2020$	
8	6,631	21,695
9	9,390	30,407

Note: Results are based on the low benefit-per-ton values.

TABLE V.42—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES SHIPPED IN 2029–2058

TSL	7% discount rate	3% discount rate
	million 2020$	
1	75.7	247.8
2	90.8	297.4
3	135.7	444.3

Note: Results are based on the low benefit-per-ton values.

The benefits of reduced CO_2, CH_4, and N_2O emissions are collectively referred to as climate benefits. The net benefits of SO_2 and NO_X emission changes are collectively referred to as health benefits. For the time series of estimated monetary values of reduced emissions, see chapter 14 of the NOPR TSD.

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

Table V.43 and Table V.44 present the NPV values that result from adding the monetized estimates of the potential economic, climate, and health net benefits resulting from GHG, SO_2, and NO_X emission changes to the NPV of consumer savings calculated for each TSL considered in this rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered NWGFs and MHGFs, and are measured for the lifetime of products shipped in 2029–2058. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits and are also calculated based on the lifetime of consumer furnaces shipped in 2029–2058. The climate benefits associated with four SC–GHG estimates are shown. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

TABLE V.43—POTENTIAL AFUE STANDARDS: NPV OF CONSUMER BENEFITS COMBINED WITH MONETIZED CLIMATE AND HEALTH BENEFITS FROM EMISSIONS REDUCTIONS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
3% discount rate for NPV of Consumer and Health Benefits (billion 2020$)									
5% d.r., Average SC–GHG case	12.1	19.2	23.1	23.1	25.2	34.2	35.1	44.8	58.0
3% d.r., Average SC–GHG case	15.3	24.4	29.3	29.5	32.0	43.9	44.2	57.1	75.2
2.5% d.r., Average SC–GHG case	17.7	28.2	33.8	34.2	36.9	51.0	50.8	65.9	87.5
3% d.r., 95th percentile SC–GHG case	23.6	37.4	44.9	45.6	49.1	68.5	67.1	87.9	118.3
7% discount rate for NPV of Consumer and Health Benefits (billion 2020$)									
5% d.r., Average SC–GHG case	4.2	6.7	8.1	8.0	8.8	12.0	12.4	16.0	20.5
3% d.r., Average SC–GHG case	7.4	11.9	14.2	14.4	15.6	21.8	21.5	28.2	37.6
2.5% d.r., Average SC–GHG case	9.8	15.6	18.7	19.0	20.5	28.8	28.1	37.0	50.0
3% d.r., 95th percentile SC–GHG case	15.7	24.9	29.8	30.5	32.7	46.3	44.5	59.0	80.8

TABLE V.44—POTENTIAL STANDBY MODE AND OFF MODE STANDARDS: NPV OF CONSUMER BENEFITS COMBINED WITH MONETIZED CLIMATE AND HEALTH BENEFITS FROM EMISSIONS REDUCTIONS

Category	TSL 1	TSL 2	TSL 3
3% discount rate for NPV of Consumer and Health Benefits (billion 2020$)			
5% d.r., Average SC–GHG case	2.4	2.8	4.1
3% d.r., Average SC–GHG case	2.5	3.0	4.4
2.5% d.r., Average SC–GHG case	2.6	3.1	4.6
3% d.r., 95th percentile SC–GHG case	2.9	3.4	5.1
7% discount rate for NPV of Consumer and Health Benefits (billion 2020$)			
5% d.r., Average SC–GHG case	0.8	1.0	1.4
3% d.r., Average SC–GHG case	1.0	1.2	1.7
2.5% d.r., Average SC–GHG case	1.1	1.3	1.9
3% d.r., 95th percentile SC–GHG case	1.4	1.6	2.4

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))

In this NOPR, DOE considered the impacts of amended and new 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 forego 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.[275]

1. Benefits and Burdens of TSLs Considered for Non-Weatherized Gas Furnace and Mobile Home Gas Furnace AFUE Standards

Table V.45 and Table V.46 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 (2029–2058). The energy savings and emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described further in section V.A of this document.

[275] P.C. Reiss and M.W. White (2005), Household Electricity Demand, Revisited. *The Review of Economic Studies,* 72 (3), 853–883 (Available at: *academic.oup.com/restud/article/72/3/853/1557538*) (Last accessed Feb. 15, 2022).

TABLE V.45—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Cumulative FFC National Energy Savings (quads)									
Quads	1.78	2.76	3.19	3.35	3.44	4.12	4.70	5.48	7.48
Cumulative FFC Emissions Reduction (total FFC emission)									
CO_2 (*million metric tons*)	100	158	188	199	205	286	277	363	502
SO_2 (*thousand tons*)	(2.6)	(6.2)	(11.3)	(13.1)	(14.9)	(50.6)	(16.4)	(52.3)	(77.1)
NO_X (*thousand tons*)	209	333	401	427	443	660	591	819	1,139
Hg (*tons*)	(0.02)	(0.04)	(0.07)	(0.09)	(0.10)	(0.32)	(0.11)	(0.33)	(0.48)
CH_4 (*thousand tons*)	1,259	2,011	2,437	2,590	2,696	4,112	3,586	5,068	7,070
N_2O (*thousand tons*)	0.14	0.18	0.14	0.13	0.10	(0.45)	0.21	(0.33)	(0.56)
Present Value of Benefits and Costs (3% discount rate, billion 2020$)									
Consumer Operating Cost Savings	7.8	12.4	15.1	15.0	16.6	22.8	22.8	29.7	40.0
Climate Benefits *	4.3	6.8	8.2	8.4	9.0	12.9	12.0	16.2	22.7
Net Health Benefits **	5.6	8.7	10.3	10.7	11.2	15.1	15.2	19.3	26.9
Total Benefits †	17.6	27.9	33.6	34.1	36.8	50.8	50.0	65.2	89.6
Consumer Incremental Product Costs ‡	2.3	3.6	4.3	4.6	4.9	6.9	5.9	8.2	14.4
Consumer Net Benefits	5.5	8.9	10.8	10.4	11.8	15.9	17.0	21.6	25.6
Total Net Benefits	15.3	24.4	29.3	29.5	32.0	43.9	44.2	57.1	75.2
Present Value of Benefits and Costs (7% discount rate, billions 2020$)									
Consumer Operating Cost Savings	2.6	4.2	5.2	5.0	5.7	7.8	7.8	10.2	13.9
Climate Benefits *	4.3	6.8	8.2	8.4	9.0	12.9	12.0	16.2	22.7
Health Benefits **	1.7	2.6	3.1	3.2	3.4	4.6	4.6	5.9	8.3
Total Benefits †	8.6	13.7	16.4	16.6	18.1	25.3	24.4	32.2	44.8
Consumer Incremental Product Costs ‡	1.2	1.8	2.2	2.2	2.5	3.5	2.9	4.0	7.2
Consumer Net Benefits	1.5	2.4	3.0	2.8	3.2	4.3	4.9	6.2	6.7
Total Net Benefits	7.4	11.9	14.2	14.4	15.6	21.8	21.5	28.2	37.6

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058. Parentheses indicate negative (−) values.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21-cv-1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Net health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

TABLE V.46—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Manufacturer Impacts									
Industry NPV (*million 2020$*) (No-new-standards case INPV = 1,411.8)	1,316.7 to 1,394.6	1,280.4 to 1,395.0	1,260.0 to 1,387.8	1,126.6 to 1,395.7	1,250.7 to 1,394.2	1,237.4 to 1,377.4	1,067.5 to 1,396.8	1,031.5 to 1,381.4	728.0 to 1,420.8
Industry NPV (*% change*)	(6.7) to (1.2)	(9.3) to (1.2)	(10.8) to (1.7)	(20.2) to (1.1)	(11.4) to (1.2)	(12.4) to (2.4)	(24.4) to (1.1)	(26.9) to (2.2)	(48.4) to 0.6
Consumer Average LCC Savings (2020$)									
NWGF	663	603	575	350	625	470	563	464	254
MHGF	406	516	501	298	569	493	603	526	414
Shipment-Weighted Average *	661	601	573	348	624	471	564	466	258

TABLE V.46—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE AFUE TSLS: MANUFACTURER AND CONSUMER IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Consumer Simple PBP (*years*)									
NWGF	6.8	6.6	6.7	8.0	7.1	8.9	5.8	7.2	9.1
MHGF	6.5	5.6	5.7	12.1	5.7	8.5	5.1	7.5	12.6
Shipment-Weighted Average *	6.8	6.6	6.7	8.0	7.1	8.8	5.8	7.2	9.2
Percentage of Consumers That Experience a Net Cost									
NWGF	3.7	6.0	7.9	5.2	9.1	17.7	8.3	16.6	52.4
MHGF	1.9	3.2	3.9	10.4	4.8	21.8	4.6	21.5	38.0
Shipment-Weighted Average *	3.7	6.0	7.8	5.3	9.0	17.8	8.3	16.7	52.1

Parentheses indicate negative (−) values.
* Weighted by shares of each product class in total projected shipments in 2029.

DOE first considered the AFUE standards at TSL 9, which represents the max-tech efficiency levels and which includes the highest efficiency commercially available for both non-weatherized gas furnaces and mobile furnaces (*i.e.,* 98-percent AFUE for NWGFs and 96-percent AFUE for MHGFs). TSL 9 would save 7.48 quads of energy, an amount DOE considers significant. Under TSL 9, the NPV of consumer benefit would be $6.7 billion using a discount rate of 7 percent, and $25.6 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 9 are 502 Mt of CO_2, 1.1 million tons of NO_X, and 7.1 million tons of CH_4. Projected emissions show an increase of 77 thousand tons of SO_2, 0.6 thousand tons of N_2O, and 0.5 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 climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 9 is $22.7 billion. The estimated monetary value of the health benefits from changes to SO_2 and NO_X emissions at TSL 9 is $8.3 billion using a 7-percent discount rate and $26.9 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 9 is $37.6 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 9 is $75.2 billion.

At TSL 9, the average LCC impact on affected consumers is a savings of $254 for NWGFs and $414 for MHGFs. The simple payback period is 9.1 years for NWGFs and 12.6 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 52.4 percent for NWGFs and 38.0 percent for MHGFs. The fraction of low-income consumers experiencing a net LCC cost is 34.8 percent for NWGFs and 23.3 percent for MHGFs.

At TSL 9, the projected changes in INPV range from a decrease of $683.8 million to an increase of 9.0 million. If the more severe end of this range is realized, TSL 9 could result in a net loss of 48.4 percent in INPV. Industry conversion costs could reach $301.6 million at this TSL.

At TSL 9, manufacturers would need to significantly restructure their product offerings. Currently, less than half of consumer furnace manufacturers offer a product that meets the max-tech efficiencies. The models available at these efficiencies are not produced in high volumes. DOE estimates that approximately 1.8 percent of NWGF shipments and 0.8 percent of MHGF shipments are currently sold at the max-tech levels, 98-percent AFUE and 96-percent AFUE, respectively. The NWGF industry would incur significant product conversion costs to develop cost-optimized NWGF models for a marketplace where efficiency and combustion system technology are no longer viable options for product differentiation. Similarly, the MHGF industry would incur significant product conversion costs to develop cost-optimized models for a marketplace where efficiency is no longer a means for product differentiation. As noted in section IV.J.2.d of this document, manufacturers currently maintain multiple tiers of product lines, which have varying levels of profitability. DOE models the industry operating with three manufacturer markup tiers (''good, better, best'') that are primarily differentiated on AFUE and combustion system technology (*e.g.,* single-stage, two-stage, and modulating combustion systems). Generally, higher efficiency models and those with more advanced combustion system technology command a higher manufacturer markup than lower efficiency models. At max-tech, NWGF and MHGF manufacturers would lose the ability to charge a premium markup based on AFUE, which would lead to an overall reduction in profitability. At the NWGF max-tech level, manufacturers would also lose the ability to differentiate products based on combustion system technology as all models would need to integrate modulating combustion. Without these differentiators, manufacturers would have a more difficult time maintaining premium product lines that command higher manufacturer markups. The reduction in product differentiation leads to a reduction in profitability, which is a key driver of loss in INPV. Even as profitability of products are expected to decline, NWGF and MHGF manufacturers would need to invest in significant capital conversion costs to update manufacturing lines to produce max-tech designs at high volume. The reduced profitability due to limited product differentiation, large upfront investments to remain in the market, and negative impacts on INPV could alter the consumer furnaces competitive landscape. Manufacturers that have lower cash reserves, more difficulty raising capital, a greater portion of products that require redesign, or fewer technical resources would experience more business risk than their competitors in the industry.

Based upon the above considerations, the Secretary tentatively concludes that at TSL 9 for NWGFs and MHGFs AFUE standards, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the health benefits of emissions reductions would be outweighed by the economic burden on many consumers, especially low-income consumers, as well as the impacts on manufacturers, including the large potential reduction in INPV. In reaching this initial decision, DOE notes that a large fraction of both NWGF and MHGF consumers (52.4 percent and 38.0 percent, respectively), including low-income consumers, experience a net cost at TSL 9. This is due to the high incremental cost of NWGFs and MHGFs at the max-tech efficiency levels. This is particularly pronounced for NWGFs, where the incremental production cost above baseline is more than twice as large as the next highest efficiency level (see section IV.C.2 of this document). Consumers with existing furnaces above 90-percent AFUE but below 98-percent AFUE are more likely to experience a net cost at TSL 9, given the relatively modest decrease in operating costs compared to the high incremental installed costs. At max-tech, most manufacturers would need to make significant upfront investments to update product lines and manufacturing facilities. Additionally, the companies must make those investments to remain in a less-profitable market where there is less product differentiation to maintain premium pricing tiers and where consumers are more likely to repair their existing furnaces or switch to alternative heating technologies. As result, there is risk that some manufacturers would choose to leave the market and risk that the standard would drive industry consolidation that would not otherwise have occurred. Consequently, the Secretary has tentatively concluded that TSL 9 is not economically justified.

DOE then considered the AFUE standards at TSL 8, which consists of intermediate condensing efficiency levels at 95-percent AFUE for both NWGFs and MHGFs across the Nation. TSL 8 would save 5.48 quads of energy, an amount DOE considers significant. Under TSL 8, the NPV of consumer benefit would be $6.2 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 8 would be expected to be 363 Mt of CO_2, 0.8 million tons of NO_X, and 5.1 million tons of CH_4. Projected emissions show an increase of 52 thousand tons of SO_2, 0.3 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 climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 8 is $16.2 billion. The estimated monetary value of the health benefits from changes to SO_2 and NO_X emissions at TSL 8 is $5.9 billion using a 7-percent discount rate and $19.3 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 8 is $28.2 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 8 is $57.1 billion.

At TSL 8, the average LCC impact on affected consumers is a savings of $464 for NWGFs and $526 for MHGFs. The simple payback period is 7.2 years for NWGFs and 7.5 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 16.6 percent for NWGFs and 21.5 percent for MHGFs. The fraction of low-income consumers experiencing a net LCC cost is 13.7 percent for NWGFs and 12.6 percent for MHGFs.

At TSL 8, the projected changes in INPV range from a decrease of $380.3 million to a decrease of $30.5 million. If the more severe end of this range is realized, TSL 8 could result in a net loss of 26.9 percent in INPV. Industry conversion costs would reach $149.0 million as manufacturers expand secondary heat exchanger capacity and redesign products to meet the standard.

At TSL 8, manufacturers would incur conversion costs to develop cost-optimized model offerings at the new minimum 95-percent AFUE and to expand secondary heat exchanger production capacity. However, the conversion costs at TSL 8 are substantially lower than those at TSL 9. Ninety percent of manufacturers currently have a range of compliant offerings at TSL 8. DOE estimates that approximately 39.3 percent of the annual NWGF shipments and approximately 14.9 percent of the annual MHGF shipments are already at this level. Furthermore, manufacturers would not be making the upfront investments with same level of profitability risk noted at TSL 9. With a national standard of 95-percent AFUE, both NWGF and MHGF manufacturers would maintain the ability to differentiate products based on efficiency and combustion system technology. With these options available, industry can continue to operate with three markup tiers (''good, better, best'') that enable greater industry profitability. However, the range of manufacturer markups are compressed, as max-tech products would not be expected to command the same premium as they did in the no-new-standards case.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that an AFUE standard set at TSL 8 for NWGFs and MHGFs would be economically justified. At this TSL, the average LCC savings for both NWGF and MHGF consumers are positive. An estimated 16.6 percent of NWGF consumers and 21.5 percent of MHGF consumers experience a net cost. The reduction in the percentage of consumers experiencing a net cost at TSL 8 compared to TSL 9 is largely due to the market share of consumers already with a furnace at 95-percent AFUE (see section IV.F.9 of this document). These consumers are not impacted by a standard set at TSL 8. For the remaining consumers that are impacted, the lower incremental cost above baseline for a 95-percent AFUE furnace compared to a max-tech furnace (see section IV.C.2 of this document), particularly for NWGFs, results in fewer consumers experiencing a net cost as compared to TSL 9. The FFC national energy savings at TSL 8 are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 8, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 15 times higher than the maximum estimated manufacturers' loss in INPV. The shipment-weighted average LCC savings are more than 80 percent larger than at TSL 9. The standard levels at TSL 8 are economically justified even without weighing the estimated monetary value of the health benefits of emissions reductions. When those emissions reductions are included—representing $16.2 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $19.3 billion (using a 3-percent discount rate) or $5.9 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

DOE further notes that there have been regulations in Canada requiring condensing furnaces with at least 90-percent AFUE for over ten years and requiring at least 95-precent AFUE since July 2019 (see section II.B.3 of this NOPR). The proposed standard levels for NWGFs at TSL 8 align with the Canadian regulations. As discussed in the 2016 SNOPR (since withdrawn), some stakeholders noted that Canada has required condensing furnaces for years and stated that neither Natural Resources Canada nor its mortgage agency found any significant implementation issues. 81 FR 65720, 65779 (Sept. 23, 2016). While DOE realizes that climate and fuel prices differ between the U.S. and Canada and will yield different results on costs and benefits of the standard, there are similarities in the equipment and venting materials used in both the U.S. and Canada with respect to NWGFs. Because the stock of buildings using NWGFs in Canada has many similarities to the stock using NWGFs in northern parts of the U.S., the Canadian experience in terms of installation of condensing furnaces may have relevance to the U.S.

DOE acknowledges that an estimated 13.7 percent of low-income NWGF and 12.6 percent of low-income MHGF consumers experience a net cost at TSL 8, whereas an estimated 5.0 percent of low-income NWGF and 1.5 percent of low-income MHGF consumers experience a net cost at TSL 7. (TSL 7 is an AFUE standard at the same level as TSL 8 but for NWGFs and MHGFs greater than 55 kBtu/h only.) The majority of negatively impacted low-income consumers at TSL 8 have smaller capacity NWGFs or MHGFs below 55 kBtu/h and, therefore, would not be impacted by a standard set at TSL 7, since the standards for NWGFs and MHGFs below 55 kBtu/h would remain at 80-percent AFUE. However, compared to TSL 7, it is estimated that TSL 8 would result in additional FFC national energy savings of 0.78 quads and additional health benefits of $4.1 billion (using a 3-percent discount rate) or $1.3 billion (using a 7-percent discount rate). The national consumer NPV similarly increases at TSL 8, compared to TSL 7, by $1.3 billion using a 7-percent discount rate and $4.6 billion using a 3-percent discount rate. These additional savings and benefits at TSL 8 are significant. DOE considers these impacts to be, as a whole, economically justified at TSL 8, but will continue to evaluate the impacts on low-income consumers relative to all consumers. If DOE were to conclude that the costs of TSL 8 outweighed the benefits of TSL 8, then DOE could consider factors in TSL 7 such as the national energy savings of 4.70 quads, the NPV of consumer benefit of $4.9 billion using a discount rate of 7 percent and $17.0 billion using a discount rate of 3 percent, and CO_2 emission reductions of 277 million metric tons over the analysis period. Accordingly, DOE seeks comment on the merits of adopting TSL 7 as an alternative consideration to mitigating the impacts on low-income consumers. DOE could consider TSL 7, among others, in the final rule based on comments received.

Accordingly, the Secretary has tentatively concluded that TSL 8 would offer the maximum improvement in efficiency that is technologically feasible and economically justified and would result in the significant conservation of energy. Although results are presented here in terms of TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. For both NWGFs and MHGFs, TSL 8 is comprised of the highest efficiency level below max-tech. For NWGFs and MHGFs, the max-tech efficiency level results in a large percentage of consumers that experience a net LCC cost, in addition to significant manufacturer impacts. The ELs one level below max-tech, representing the proposed standard levels, result in positive LCC savings for both classes, significantly reduce the number of consumers experiencing a net cost, and reduce the decrease in INPV and conversion costs to the point where DOE has tentatively concluded they are economically justified, as discussed for TSL 8 in the preceding paragraphs. However, DOE acknowledges the potential impacts to low-income consumers and seeks additional information for further consideration.

Therefore, based on the above considerations, DOE proposes the AFUE energy conservation standards for NWGFs and MHGFs at TSL 8. The proposed energy conservation standards for NWGFs and MHGFs, which are expressed as AFUE, are shown in Table V.47.

TABLE V.47—PROPOSED AFUE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

[Compliance starting 2029]

Product class	AFUE (percent)
Non-Weatherized Gas Furnaces	95
Mobile Home Gas Furnaces	95

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.48 and Table V.49 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 amended standards (2029–2058). The energy savings and 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.48—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings (*quads*)			
Quads	0.16	0.19	0.28
Cumulative FFC Emissions Reduction (Total FFC Emission)			
CO_2 (*million metric tons*)	5.4	6.4	9.6
SO_2 (*thousand tons*)	2.5	3.0	4.5
NO_X (*thousand tons*)	7.5	9.0	13.5

TABLE V.48—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE TSLs: NATIONAL IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3
Hg (*tons*)	0.015	0.018	0.027
CH_4 (*thousand tons*)	36.7	44.1	65.9
N_2O (*thousand tons*)	0.06	0.07	0.11
Present Value of Benefits and Costs (*3% discount rate, billion 2020$*)			
Consumer Operating Cost Savings	2.0	2.4	3.6
Climate Benefits *	0.2	0.2	0.4
Health Benefits **	0.4	0.4	0.6
Total Benefits †	2.6	3.1	4.6
Consumer Incremental Product Costs‡	0.0	0.1	0.2
Consumer Net Benefits	2.0	2.3	3.4
Total Net Benefits	2.5	3.0	4.4
Present Value of Benefits and Costs (*7% discount rate, billions 2020$*)			
Consumer Operating Cost Savings	0.7	0.8	1.2
Climate Benefits *	0.2	0.2	0.4
Health Benefits **	0.1	0.1	0.2
Total Benefits †	1.0	1.2	1.8
Consumer Incremental Product Costs ‡	0.0	0.0	0.1
Consumer Net Benefits	0.7	0.8	1.1
Total Net Benefits	1.0	1.2	1.7

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058. Parentheses indicate negative (−) values.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

* Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

TABLE V.49—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	TSL 1	TSL 2	TSL 3
Manufacturer Impacts			
Industry NPV (*million 2020$*) (No-new-standards case INPV = 1,411.8)	1,410.8 to 1,412.7	1,410.8 to 1,412.8	1,409.7 to 1,416.8
Industry NPV (*% change*)	(0.1) to 0.1	(0.1) to 0.1	(0.1) to 0.4
Consumer Average LCC Savings (*2020$*)			
NWGF	21	23	26
MHGF	22	24	27
Shipment-Weighted Average *	21	23	26
Consumer Simple PBP (*years*)			
NWGF	0.7	1.5	2.0
MHGF	0.6	1.3	1.7
Shipment-Weighted Average *	0.7	1.5	2.0
Percent of Consumers that Experience a Net Cost			
NWGF	2.5	2.5	3.5
MHGF	1.2	1.2	1.6

TABLE V.49—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDBY MODE AND OFF MODE TSLS: MANUFACTURER AND CONSUMER IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3
Shipment-Weighted Average *	2.5	2.5	3.4

Parentheses indicate negative (−) values.
* Weighted by shares of each product class in total projected shipments in 2029.

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 $1.1 billion using a discount rate of 7 percent, and $3.4 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 9.6 Mt of CO_2, 4.5 thousand tons of SO_2, 13.5 thousand tons of NO_X, 0.03 tons of Hg, 65.9 thousand tons of CH_4, and 0.1 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 3 is $0.4 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.2 million using a 7-percent discount rate and $0.6 million using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $1.7 billion. Using a 3-percent discount rate for all benefits and costs, the at TSL 3 is $4.4 billion.

At TSL 3, the average LCC impact is a savings of $26 for NWGFs and $27 for MHGFs. The simple payback period is 2.0 years for NWGFs and 1.7 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 3.5 percent for NWGFs and 1.6 percent for MHGFs.

At TSL 3, the change in INPV is projected to range from a decrease of $2.1 million to an increase of $5.0 million, which corresponds to a 0.1 percent decrease and 0.4 percent increase, respectively. The more negative INPV results are driven by the conversion costs, which could reach $1.6 million, and the model's lower bound assumption that manufacturers would not be able to pass these costs onto consumers. These changes have less than a one percent impact on free cash flow in 2028.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that standby and off mode standards set at TSL 3 for NWGFs and MHGFs would be economically justified. At this TSL, the average LCC savings for both NWGF and MHGF consumers are expected to be positive. Only an estimated 3.5 percent of NWGF consumers and 1.6 percent of MHGF consumers are expected to experience a net cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the national benefits vastly outweigh the costs. The positive LCC savings—a different way of quantifying consumer benefits—reinforces this conclusion. The shipment-weighted average LCC savings are largest at TSL 3. The standard levels at TSL 3 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $0.4 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $0.6 billion (using a 3-percent discount rate) or $0.2 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

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. Although results are presented here in terms of TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. For both NWGFs and MHGFs, TSL 3 is comprised of the max-tech efficiency level. The ELs representing the proposed standard levels result in positive LCC savings for both classes, a small percentage of consumers experiencing a net cost, and a small decrease in INPV to the point where DOE has tentatively concluded they are economically justified, as discussed for TSL 3 in the preceding paragraphs.

Therefore, based on the above considerations, DOE proposes the standby mode and off mode energy conservation standards for NWGFs and MHGFs at TSL 3. The proposed energy conservation standards for NWGFs and MHGFs, which are expressed as watts, are shown in Table V.50.

TABLE V.50—PROPOSED STANDBY MODE AND OFF MODE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (COMPLIANCE STARTING 2029)

Product class	Standby mode standard: $P_{W,SB}$ (watts)	Off mode standard: $P_{W,OFF}$ (watts)
Non-Weatherized Gas Furnaces	8.5	8.5
Mobile Home Gas Furnaces	8.5	8.5

3. 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 (1) the annualized national economic value (expressed in 2020$) 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), and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Table V.51 shows the annualized values for NWGFs and MHGFs AFUE standards under TSL 8, expressed in

2020$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed AFUE standards for NWGFs and MHGFs is $524 million per year in increased equipment costs, while the estimated annual benefits would be $1,320 million in reduced equipment operating costs, $1,015 million in climate benefits, and $760 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $2,571 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed AFUE standards for NWGFs and MHGFs is $511 million per year in increased equipment costs, while the estimated annual benefits would be $1,865 million in reduced operating costs, $1,015 million in climate benefits, and $1,213 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $3,581 million per year.

TABLE V.51—ANNUALIZED MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (TSL 8)

	Million 2020$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	1,865	1,891	1,937
Climate Benefits *	1,015	1,000	1,042
Net Health Benefits **	1,213	1,197	1,251
Total Benefits †	4,093	4,088	4,230
Consumer Incremental Product Costs ‡	511	508	461
Net Benefits	3,581	3,580	3,769
7% discount rate			
Consumer Operating Cost Savings	1,320	1,338	1,352
Climate Benefits *	1,015	1,000	1,042
Health Benefits **	760	751	780
Total Benefits †	3,095	3,089	3,173
Consumer Incremental Product Costs ‡	524	516	471
Net Benefits	2,571	2,573	2,702

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

Table V.52 shows the annualized values for NWGFs and MHGFs standby mode and off mode standards under TSL 3, expressed in 2020$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $12.2 million per year in increased equipment costs, while the estimated annual benefits would be $160 million in reduced equipment operating costs, $23 million in climate benefits, and $25 million in health benefits. In this case, the net benefit would amount to $196 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standby mode and off mode standards for NWGFs and MHGFs is $12.4 million per year in increased equipment costs, while the estimated annual benefits would be $224 million in reduced operating costs, $23 million in climate benefits, and $40 million in health benefits. In this case, the net benefit would amount to $275 million per year.

TABLE V.52—ANNUALIZED MONETIZED BENEFITS AND COSTS OF PROPOSED STANDBY MODE AND OFF MODE STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES (TSL 3)

	Million 2020$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	224	214	251
Climate Benefits *	23	23	24
Health Benefits **	40	40	43
Total Benefits †	287	276	318
Consumer Incremental Product Costs ‡	12	12	13
Net Benefits	275	264	305
7% discount rate			
Consumer Operating Cost Savings	160	155	176
Climate Benefits *	23	23	24
Health Benefits **	25	25	27
Total Benefits †	208	203	227
Consumer Incremental Product Costs ‡	12	12	13
Net Benefits	196	190	214

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

DOE considers and evaluates these standards independently under EPCA and the analytical process outlined in DOE's Process Rule (as amended). However, DOE is also presenting the combined effects of these standards for the benefit of the public and in compliance with E.O. 12866. To provide a complete picture of the overall impacts of this NOPR, the following combines and summarizes the benefits and costs for both the amended AFUE standards and the proposed standby mode and off mode standards for NWGFs and MHGFs. Table V.53 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.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from SO_2 and NO_X emission changes, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the proposed standards in this rule is $536 million per year in increased equipment costs, while the estimated annual benefits would be $1,480 million in reduced equipment operating costs, $1,038 million in climate benefits, and $785 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $2,767 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards in this rule is $524 million per year in increased equipment costs, while the estimated annual benefits would be $2,089 million in reduced operating costs, $1,038 million in climate benefits, and $1,253 million in health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit would amount to $3,856 million per year.

TABLE V.53—MONETIZED BENEFITS AND COSTS OF PROPOSED AFUE (TSL 8) AND STANDBY MODE AND OFF MODE (TSL 3) STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

	Annualized (million 2020$/yr)	Total present value (billion 2020$)
3%		
Consumer Operating Cost Savings	2,089	33.3
Climate Benefits *	1,038	16.5
Health Benefits **	1,253	20.0
Total Benefits †	4,380	69.8
Consumer Incremental Product Costs ‡	524	8.3
Net Benefits	3,856	61.5
7%		
Consumer Operating Cost Savings	1,480	11.4
Climate Benefits *	1,038	16.5
Health Benefits **	785	6.1
Total Benefits †	3,303	34.0
Consumer Incremental Product Costs ‡	536	4.1
Net Benefits	2,767	29.9

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review, 76 FR 3821 (Jan. 21, 2011), requires agencies, to the extent permitted by law, 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 E.O. 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, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') 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, this proposed regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this proposed regulatory action constitutes an economically significant regulatory action under section 3(f) of E.O. 12866. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the proposed 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. A summary of the potential costs and benefits of the combined regulatory actions are presented in Table VI.1.

TABLE VI.1—MONETIZED BENEFITS, COSTS, AND NET BENEFITS OF PROPOSED AFUE AND STANDBY AND MODE AND OFF MODE STANDARDS

	Annualized (million 2020$/yr)	Total present value (billion 2020$)
3%		
Consumer Operating Cost Savings	2,089	33.3
Climate Benefits *	1,038	16.5
Health Benefits **	1,253	20.0
Total Benefits †	4,380	69.8
Consumer Incremental Product Costs‡	524	8.3
Net Benefits	3,856	61.5
7%		
Consumer Operating Cost Savings	1,480	11.4
Climate Benefits *	1,038	16.5
Health Benefits **	785	6.1
Total Benefits †	3,303	34.0
Consumer Incremental Product Costs ‡	536	4.1
Net Benefits	2,767	29.9

Note: This table presents the costs and benefits associated with consumer furnaces shipped in 2029–2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029–2058.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). Together these represent the global social cost of greenhouse gases (SC–GHG). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate. See section. IV.L of this document for more details. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21-cv-1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four SC–GHG estimates.

‡ Costs include incremental equipment costs as well as installation costs.

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 E.O. 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 DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*www.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 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. (*See* 13 CFR part 121.) The size standards are listed by North American Industry Classification System (''NAICS'') code and industry description and are available at *www.sba.gov/document/support--table-size-standards.* 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 fewer for an entity to be considered as a small business for this category.

1. Description of Reasons Why Action Is Being Considered

DOE is proposing amended energy conservation standards and new standby mode and off mode energy standards for NWGFs and MHGFs. EPCA specifically provides that DOE must conduct two rounds of energy conservation standard rulemakings for

NWGFs and MHGFs. (42 U.S.C. 6295(f)(4)(B) and (C)) The statute 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 determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards. (42 U.S.C. 6295(m)(1)) This rulemaking is pursuant to the statutorily required second round of rulemaking for NWGFs and MHGFs, and the statutorily required 6-year review.

2. Objectives of, and Legal Basis for, Rule

Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (NAECA; Pub. L. 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.

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 previously, 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 (Nov. 19, 2007). 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 72 FR 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 in the **Federal Register** 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 energy conservation 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 in the **Federal Register** 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 allowed for the settlement agreement reached between DOE and APGA, in which DOE agreed to a 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. As noted earlier in section II.B.2 of this document, in accordance with the settlement agreement, DOE issued a NOPR in March of 2015 and an SNOPR in September of 2016 to address NWGFs and MHGFs; however, in January of 2021, DOE published notification of withdrawal of the March 2015 NOPR and September 2016 SNOPR. 86 FR 3873 (Jan. 15, 2021).

3. Description of Estimated Number of Small Entities Regulated

DOE reviewed this proposed rule 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 to identify potential small manufacturers of the covered products. DOE began its assessment by reviewing DOE's CCMS database,[276] California Energy Commission's Modernized Appliance Efficiency Database System (''MAEDbS''),[277] Air Conditioning, Heating, and Refrigeration Institute's (''AHRI'') Directory of Certified Product Performance database,[278] individual retailer websites, and the withdrawn September 2016 SNOPR to identify manufacturers of the covered products. 81 FR 65720. DOE then consulted publicly available data, such as manufacturer websites, manufacturer specifications and product literature, import/export logs, and basic

[276] DOE's CCMS (Available at: *www.regulations.doe.gov/certification-data/*) (Last accessed July 7, 2021).

[277] California Energy Commission's MAEDbS (Available at: *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx*) (Last accessed July 15, 2021).

[278] AHRI's Directory of Certified Product Performance (Available at: *www.ahridirectory.org/Search/SearchHome*) (last accessed July 15, 2021).

model numbers, to identify original equipment manufacturers (''OEMs'') of the products covered by this rulemaking. DOE further relied on public data and subscription-based market research tools (*e.g.,* Dun & Bradstreet reports[279]) to determine company location, headcount, and annual revenue. DOE also asked industry representatives if they were aware of any other small manufacturers during manufacturer interviews. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the SBA's definition of a ''small business,'' or are foreign-owned and operated.

DOE initially identified 15 OEMs that sell NWGFs and/or MHGFs in the United States. Of the 15 OEMs identified, DOE tentatively determined that four companies qualify as small businesses and are not foreign-owned or operated.

4. Description and Estimate of Compliance Requirements Including Differences in Cost, if Any, for Different Groups of Small Entities

In response to the withdrawn September 2016 SNOPR IRFA, AHRI and Mortex Products, Inc. (''Mortex'') raised concerns that DOE's methodology of using model counts to scale industry-level conversion costs down to a company level do not fully characterize the impacts on small manufacturers. (AHRI, No. 303 at p. 12; Mortex, No. 305 at p. 4) They were concerned that this methodology understates the cost impact to small manufacturers, with particular concern about ''the small manufacturer whose primary product is marketed for manufactured homes does not make a single product that meets the lofty 92% AFUE.'' (AHRI, No. 303 at p. 12) As noted by Mortex, ''we do not manufacture condensing mobile home gas furnaces.'' (Mortex, No. 305 at p. 1)

In response to these stakeholder comments, DOE updated its conversion cost methodology. Specifically, DOE updated its analysis to give special consideration to Mortex. In the withdrawn September 2016 SNOPR IRFA, DOE's small business compliance costs were based on data collected during the 2014 manufacturer interviews. However, unlike the MHGF manufacturers that DOE interviewed, Mortex does not currently offer condensing products. As a result, Mortex's conversion cost were not well reflected in the withdrawn September 2016 SNOPR IRFA since Mortex would need to make a different set of investments than the rest of the MHGF industry. In this Notice's IRFA, DOE estimates the cost for Mortex to set up a production line capable of manufacturing condensing furnaces. Mortex's conversion costs are analyzed separately from the rest of the MHGF industry.

a. AFUE Standards

Of the four small domestic OEMs identified, two manufacture NWGFs, one manufactures MHGFs, and one manufactures both NWGFs and MHGFs. DOE considered the impact of today's rule on the four manufacturers.

One of the small NWGF manufacturers sells a niche product in the NWGF market. The company offers three basic models of a through-the-wall furnace marketed for multi-family construction. The three models have identical dimensions and share many components. One model is rated at 80-percent AFUE, one model is rated at 93-percent AFUE, and the other model is rated at 95-percent AFUE. Given the product similarities and low volume of sales, DOE expects the manufacturer would likely discontinue the non-compliant models. DOE does not expect the small manufacturer would incur conversion costs due to the proposed standard, as the company currently offers their niche product at 95-percent AFUE.

The other small NWGF manufacturer does not currently certify any models of the covered product in DOE's CCMS. DOE identified this small business through its review of the California Energy Commission's MAEDbS and the withdrawn September 2016 SNOPR. DOE reviewed the company's website and available product literature to determine the range of products offered by this small manufacturer. According to the company's website, they offer condensing and non-condensing NWGFs, including models that meet the 95-percent AFUE required by the proposed standard. However, detailed product information is scarce, and the company's 2021 Product Catalog does not include gas-fired consumer furnaces. The limited product information and lack of legally compliant products indicate that the company may no longer produce covered NWGFs. If the company still manufactures NWGFs, DOE expects the manufacturer would likely discontinue the non-compliant models given the low volume of sales. As with the other small NWGF manufacturer, DOE does not expect this company would incur conversion costs as they currently offer a product at 95-percent AFUE.

The small MHGF manufacturer, Mortex, sells non-condensing furnaces into the manufactured housing replacement market. DOE identified this small business through its review of the withdrawn September 2016 SNOPR. Of the seven MHGF OEMs identified, Mortex is the only company that does not offer a condensing product. DOE analyzed the conversion costs for Mortex separately from other MHGF manufacturers since Mortex would need to make a different set of investments than the rest of the MHGF industry.

To offer condensing MHGFs, Mortex would need to either source secondary heat exchangers from a vendor or setup its own manufacturing line to produce secondary heat exchangers. Setting up in-house production is the significantly more capital-intensive option. For this IRFA, DOE estimated the investments required for the company to setup in-house production. Based on DOE's engineering analysis, the main driver of additional capital conversion costs would be the production of secondary heat exchangers. Including equipment, tooling, and conveyer, DOE estimates upfront capital investments of $4.1 million to setup manufacturing of condensing MHGFs. Additionally, the design and product development of condensing products could run as high as $1.4 million. If the company has less than 15 percent market share in the MHGF market, as suggested by the percentage of industry model offerings, the cost recovery period for this investment would be in excess of 10 years. Unlike other MHGF manufacturers, which can leverage their investments in secondary heat exchanger production across other heating products, DOE is not aware of any other heating product from Mortex that could make use of the secondary heat exchanger production capacity. The total conversion costs of $5.5 million are approximately 2 percent of company revenues over the 5-year conversion period and are considered significant.

Given the high upfront investment and long cost recovery period, the small manufacturer would likely seek options other than investing in secondary heat exchanger production capabilities. The company could source the secondary heat exchanger, which would reduce the need for capital conversion costs but would also increase the per-unit cost of the final product. DOE estimates that the secondary heat exchanger accounts for approximately 14 percent of the total manufacturer production cost. Sourcing the heat exchanger could put the company at a pricing disadvantage relative to manufacturers that produce

[279] D&B Hoovers | Company Information | Industry Information | Lists, *app.dnbhoovers.com/*) (Last accessed Sept. 22, 2021).

their heat exchangers in-house. Depending on the business' ability to compete on factors other than price, its willingness to invest technical resources toward designing a condensing product, and the role of MHGFs in the company's business strategy, the small manufacturer could also choose to leave the MHGF business.

The small domestic manufacturer of NWGFs and MHGFs is one of the six MHGF companies that offer condensing products. Of these six companies with condensing MHGFs, one manufacturer only offers products at or above the proposed AFUE standard and would, therefore, likely incur no conversion costs. The remaining five manufacturers, which includes the small manufacturer of NWGFs and MHGFs, have some products that do not meet the standard. All MHGF conversion costs that are not directly attributed to Mortex would be borne by these five manufacturers. The small domestic business has two MHGF models that would require redesign or retirement, which is an estimated 2.6 percent of the 76 MHGF models in CCMS with an AFUE below 95-percent.

DOE estimated industry conversion costs of $2.8 million for the MHGF AFUE standard when excluding the conversion costs attributable to Mortex. For the purposes of this IRFA analysis, DOE assumes the $2.8 million in conversion costs are evenly allocated across the five companies that may incur MHGF conversion costs. The MHGF-related conversion costs are approximately $0.6 million per company. DOE believes this even allocation of capital and product conversion costs avoids under-estimating the investment requirements on the small, domestic manufacturer, given that this manufacturer has a small market share. For the small manufacturer, total conversion costs are approximately 0.1 percent of company revenue over the 5-year conversion period.

As noted earlier, this small domestic manufacturer also produces NWGFs. The company offers four NWGF models, out of over 2,200 NWGFs in CCMS. All four of their NWGF offerings are at or above the proposed AFUE standard and would not likely incur conversion costs due to the AFUE standard. Therefore, the small manufacturer that produces both MHGFs and NWGFs is expected to only incur conversion costs relating to their MHGF products at TSL 8, the proposed standard level.

b. 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 the potential impacts of the proposed AFUE standards and standby mode and off mode standards on small manufacturers.

5. 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.

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's proposed rule, represented by TSL 8. In reviewing alternatives to the proposed rule, DOE examined a range of different efficiency levels and their respective impacts to both manufacturers and consumers. Representative of lower efficiency levels, TSL 1, 2, 3, 4, 5, 6, and 7 would reduce the impact on small business manufacturers but at the expense of a reduction in energy savings. TSL 9 was also analyzed, but it was determined those levels would lead to greater costs to manufacturers.

Based on the presented discussion, DOE believes that TSL 8 would deliver the highest energy savings while mitigating the potential burdens placed on NWGF and MHGF manufacturers, including small business manufacturers. Accordingly, DOE does not propose one of the other TSLs considered in the analysis, or the other policy alternatives as part of the regulatory impact analysis and included in chapter 17 of the NOPR TSD.

In reviewing alternatives to the proposed standards, DOE examined energy conservation standards set at both lower and higher efficiency levels than the proposed levels. At TSL 9, the conversion costs were higher for small businesses and for industry overall. At TSLs 1, 2, 3, 4, 5, 6, and 7, the impacts on small manufacturers would have been potentially lower. Those changes would have would come at the expense of reduced consumer benefits and a reduction in energy savings. In general, the consumer benefits were an order of magnitude greater than the cost to industry, and multiple orders of magnitude greater than the conversion costs to small manufacturers. DOE believes that establishing standards at the proposed level, TSL 8, balances the benefits of energy savings with the potential burdens placed on manufacturers of covered products, including small business manufacturers.

Additional compliance flexibilities may be available through other means. 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 standard. (42 U.S.C. 6295(t)) Additionally, manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR 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 terms of AFUE.

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. *See generally* 10 CFR part 429. The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (''PRA''), and has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 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.

Under EPCA, DOE's energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. For covered equipment, relevant provisions of the Act include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

DOE's certification and compliance activities ensure accurate and comprehensive information about the energy and water use characteristics of covered products and covered equipment sold in the United States. Manufacturers of all covered products and covered equipment must submit a certification report before a basic model is distributed in commerce, annually thereafter, and if the basic model is redesigned in such a manner to increase the consumption or decrease the efficiency of the basic model such that the certified rating is no longer supported by the test data. Additionally, manufacturers must report when production of a basic model has ceased and is no longer offered for sale as part of the next annual certification report following such cessation. DOE requires the manufacturer of any covered product or covered equipment to establish, maintain, and retain the records of certification reports, of the underlying test data for all certification testing, and of any other testing conducted to satisfy the requirements of part 429, part and part 431. Certification reports provide DOE and consumers with comprehensive, up-to date efficiency information and support effective enforcement.

DOE requires manufacturers or their party representatives to prepare and submit certification reports and compliance statements using DOE's electronic Web-based tool, the CCMS, which is the primary mechanism for submitting certification reports to DOE. CCMS currently has product and equipment specific templates which manufacturers are required to use when submitting certification data to DOE. DOE believes the availability of electronic filing through the CCMS system reduces reporting burdens, streamlines the process, and provides DOE with needed information in a standardized, more accessible form. This electronic filing system also ensures that records are recorded in a permanent, systematic way.

DOE is not proposing to amend the existing reporting requirements or establish new DOE reporting requirements. Were DOE to establish amended and new energy conservation standards as proposed in this NOPR, DOE would consider associated reporting and certification requirements in a future rulemaking. Therefore, DOE has tentatively concluded that amended energy conservation standards for NWGFs and MHGFs would not impose additional costs for manufacturers related to reporting and certification.

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

DOE is analyzing this proposed regulation in accordance with the National Environmental Policy Act of 1969 (''NEPA'') and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for rulemakings that establish energy conservation standards for consumer products or industrial equipment. 10 CFR part 1021, subpart D, appendix B5.1. DOE anticipates that this rulemaking qualifies for categorical exclusion B5.1 because it is a rulemaking that establishes amended energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in categorical exclusion B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it otherwise meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final rule.

E. Review Under Executive Order 13132

E.O. 13132, ''Federalism,'' 64 FR 43255 (August 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 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(d)) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' 61 FR 4729 (Feb. 7, 1996), 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. 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 sections 3(a) and 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 E.O. 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. Public Law 104–4, section 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 ''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 *https://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

This proposed rule does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by the private sector. As a result, the analytical requirements of UMRA do not apply.

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 proposed 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 18, 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). Pursuant to OMB Memorandum M–19–15, ''Improving Implementation of the Information Quality Act'' (April 24, 2019), DOE published updated guidelines which are available at: *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this NOPR 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 new and amended 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. Review Under the Information Quality Bulletin for Peer Review

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 energy conservation standards rulemaking analyses 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.'' 70 FR 2664, 2667 (Jan. 14, 2005).

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 report describing that peer review.[280] 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. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. DOE is in the process of evaluating the resulting report.[281]

[280] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *www.energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.*

[281] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-*

Continued

VII. Public Participation

A. Participation in the Public Meeting Webinar

The time and date of the webinar meeting are listed in the **DATES** section at the beginning of this document. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=59&action=viewlive.* 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 an interest in the topics addressed in this proposed rule, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the public meeting webinar. Such persons may submit requests to speak via email to the Appliance and Equipment Standards Program at: *ApplianceStandardsQuestions@ee.doe.gov.* Persons who wish to speak should include with their request a computer file in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least two weeks before the public meeting webinar. At its discretion, DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Office. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

C. Conduct of the Public Meeting Webinar

DOE will designate a DOE official to preside at the webinar/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 webinar/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 webinar/public meeting and until the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the rulemaking.

The public meeting webinar will be conducted in an informal, conference style. DOE will present summaries of comments received before the webinar, 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 webinar 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 webinar.

A transcript of the public meeting webinar will be included in the docket, which can be viewed as described in the Docket section at the beginning of this NOPR. 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 webinar, 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* web page 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. If this instruction is followed, 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.

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. Comments and documents submitted via email also will be posted to *www.regulations.gov.* If you do not want your personal contact information to be

performance-standards (Last accessed Feb. 16, 2022).

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. 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 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. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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 requests data and information on the price trend for condensing NWGFs as compared to the trend for non-condensing NWGFs.

(2) 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 the potential impacts of the proposed AFUE standards and standby mode and off mode standards on small manufacturers.

(3) DOE seeks comment on the feasibility of integrating LL–LTX designs and whether significant changes would need to be made to integrate them.

(4) DOE seeks further comment on its estimates for the MPC of consumer furnaces under each standards scenario.

(5) DOE seeks further comment on the designs of the secondary heat exchanger, including on any recent design changes. DOE also seeks additional feedback on the cost of AL29–4C stainless steel.

(6) DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each AFUE standard TSL.

(7) DOE seeks comments, information, and data on the capital conversion costs and product conversion costs estimated for each standby mode and off mode TSL.

(8) 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 the potential impacts of the proposed AFUE standards and standby mode and off mode standards on small manufacturers.

(9) DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and affordability and how to quantify this impact in its regulatory analysis in this and future rulemakings.

(10) DOE requests data and information on the price trend for condensing NWGFs as compared to the trend for non-condensing NWGFs.

(11) DOE requests comment on its approach to monetizing the impact of the rebound effect in standards cases.

(12) DOE welcomes any additional comments on the approach for conducting the emissions analysis for furnaces.

Additionally, DOE welcomes comments on other issues relevant to the conduct of this rulemaking that may not specifically be identified in this document.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and request for comment.

List of Subjects

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Small businesses.

Signing Authority

This document of the Department of Energy was signed on June 10, 2022, by Kelly J. Speakes-Backman, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on June 14, 2022.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons set forth in the preamble, DOE proposes to amend part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 1. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 2. 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 September 1, 1990; weatherized gas-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 (percent) [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 (percent) [1]
(A) Non-weatherized gas furnaces (not including mobile home gas furnaces)	95.0
(B) Mobile home gas furnaces	95.0

[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*]

* * * * *

[FR Doc. 2022–13108 Filed 7–6–22; 8:45 am]

BILLING CODE 6450–01–P