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: Final rule.

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 U.S. Department of Energy (''DOE'' or ''the Department'') to determine periodically whether more stringent standards would be technologically feasible and economically justified, and would result in significant energy savings. In this final rule, DOE is adopting amended energy conservation standards for consumer furnaces, specifically non-weatherized gas furnaces and mobile home gas furnaces. The Department has determined that the amended energy conservation standards for the subject products would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES:

Effective date: The effective date of this rule is February 16, 2024.

Compliance date: Compliance with the amended standards established for the subject consumer furnaces in this final rule is required on and after December 18, 2028.

ADDRESSES: The docket for this rulemaking, which includes **Federal Register** notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at *www.regulations.gov.* All documents in the docket are listed in the *www.regulations.gov* index. However, 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/EERE-2014-BT-STD-0031.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

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For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Final Rule

The Energy Policy and Conservation Act, Public Law 94–163, (42 U.S.C. 6291–6317, as codified) as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B [2] of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291–6309) These products include non-weatherized gas furnaces (NWGFs) and mobile home gas furnaces (MHGFs), the subject of this rulemaking. (42 U.S.C. 6292(a)(5))

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that 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)) EPCA also provides that not later than six 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 (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)) This rulemaking is being undertaken pursuant to the statutorily-required second round of rulemaking for NWGFs and MHGFs, and it also satisfies the statutorily-required 6-year-lookback review.

In accordance with these and other relevant statutory provisions discussed in this document, DOE is adopting amended energy conservation standards for the subject consumer furnaces (*i.e.,* NWGFs and MHGFs). The adopted standards, which are expressed in terms of minimum annual fuel utilization efficiency (''AFUE''), are shown in Table I.1. These standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States starting on December 18, 2028. For the reasons discussed in section III.A of this document, DOE is not adopting standby mode or off mode power consumption standards for NWGFs and MHGFs in this final rule.

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

[Compliance Starting December 18, 2028]

Product class	AFUE (%)
Non-Weatherized Gas Furnaces	95.0
Mobile Home Gas Furnaces	95.0

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted standards 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 21.5 years (*see* section IV.F of this document).

[1] 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 reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

[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 of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (*see* section IV.F of this document).

TABLE I.2—IMPACTS OF ADOPTED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

Furnace class	Average LCC savings *(2022$)*	Simple pay-back period (*years*)
Non-Weatherized Gas Furnaces	350	7.6
Mobile Home Gas Furnaces	616	3.2

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

B. Impact on Manufacturers [4]

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2023–2058). The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, conversion costs, and manufacturer profit margins. Using a real discount rate of 6.4 percent, DOE estimates that the INPV for manufacturers of NWGFs and MHGFs in the case without amended standards is $1,371.8 million in 2022$. Under the adopted standards, DOE estimates the change in INPV to range from −26.8 percent to −2.5 percent, which is a reduction of approximately −$367.3 million to −$33.8 million. In order to bring products into compliance with amended standards, it is estimated that industry will incur total conversion costs of $162.0 million (which are incorporated into the calculation of INPV).

DOE's analysis of the impacts of the adopted energy conservation standards on manufacturers is described in sections IV.J and V.B.2 of this document.

C. National Benefits and Costs

DOE's analyses indicate that the adopted AFUE energy conservation standards for NWGFs and MHGFs would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for NWGFs and MHGFs purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2029–2058), are estimated to amount to 4.77 quadrillion British thermal units (''Btu''), or quads.[5] This represents a savings of 3.2 percent relative to the energy use of these products in the case without amended standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the amended standards for NWGFs and MHGFs ranges from $4.8 billion (at a 7-percent discount rate) to $16.3 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 years 2029 through 2058.

In addition, the adopted standards for NWGFs and MHGFs are projected to yield significant environmental benefits. DOE estimates that the amended standards will result in cumulative emission reductions (over the same period as for energy savings) of 332 million metric tons (Mt) [6] of carbon dioxide (CO_2), 4.3 million tons of methane (CH_4), 0.38 thousand tons of nitrous oxide (N_2O), and 0.9 million tons of nitrogen oxides (NO_X). The amended standards will result in cumulative emission increases of 10.0 thousand tons of sulfur dioxide (SO_2) and 0.08 tons of mercury (Hg).[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases (GHG) 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 GHG (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.1 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 $17.3 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 sets of SC–GHG estimates.

DOE estimated the monetized net health benefits of NO_X and SO_2 emissions changes, using benefit per ton estimates from the scientific literature, as discussed in section IV.L of this document.[9] DOE estimated the present value of the health benefits would be $8.7 billion using a 7-percent discount rate, and $26.6 billion using a 3-percent discount rate.[10] DOE is currently only monetizing (for SO_2 and NO_X) particulate matter ($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.3 summarizes the monetized benefits and costs expected to result from the amended 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.

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[4] All monetary values in this document are expressed in 2022 dollars (2022$).

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

[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 2023* (*AEO2023*). *AEO2023* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.K of this document for further discussion of *AEO2023* assumptions that effect air pollutant emissions. The increase in emissions of some pollutants is due to an increase in electricity consumption.

[8] To monetize the benefits of reducing GHG emissions this analysis uses the interim 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. (February 2021 SC–GHG TSD) (Available at: *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*) (Last accessed August 1, 2023).

[9] DOE did not monetize mercury emissions because the quantity is very small.

[10] DOE estimates the economic value of these emissions reductions resulting from the considered TSLs for the purpose of complying with the requirements of Executive Order 12866.

TABLE I.3—SUMMARY OF MONETIZED BENEFITS AND COSTS OF ADOPTED AFUE ENERGY CONSERVATION STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

[Trial Standard Level (TSL) 8]

	Billion 2022$
3% discount rate	
Consumer Operating Cost Savings	24.8
Climate Benefits *	17.3
Net Health Benefits **	26.6
Total Monetized Benefits †	68.7
Consumer Incremental Product Costs ‡	8.5
Net Monetized Benefits	60.2
Change in Producer Cashflow (INPV ‡‡)	(0.37)—(0.03)
7% discount rate	
Consumer Operating Cost Savings	9.3
Climate Benefits * (3% discount rate)	17.3
Net Health Benefits **	8.7
Total Monetized Benefits †	35.3
Consumer Incremental Product Costs ‡	4.5
Net Monetized Benefits	30.8
Change in Producer Cashflow (INPV ‡‡)	(0.37)—(0.03)

Note: This table presents the costs and benefits associated with the subject 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) (*see* section IV.L of this document). Together these represent the global 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** 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 quantified and 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.

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

‡‡ Operating Cost Savings are calculated based on the LCC analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 6.4 percent that is estimated in the MIA (*see* chapter 12 of the final rule technical support document ("TSD") for a complete description of the industry weighted average cost of capital). For NWGFs and MHGFs, those values are −$367 million to −$34 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Tiered scenario, which models a reduction of manufacturer markups due to reduced product differentiation as a result of amended standards. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with the Office of Management and Budget's (OMB) Circular A–4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this final rule, the net benefits would range from $59.83 billion to $60.17 billion at 3-percent discount rate and would range from $30.43 billion to $30.77 billion at 7-percent discount rate. Parentheses ( ) indicate negative values.

The benefits and costs of the adopted standards 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 increase in product purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.[11]

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 adopted 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.[12] Estimates of total benefits are presented for all four SC–GHG discount rates in section V.B of this document.

Table I.4 presents the total estimated monetized benefits and costs associated with the adopted 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 effects from changes in NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $511 million per year in increased equipment costs, while the estimated annual benefits are $1,054 million in reduced equipment operating costs, $1,021 million in climate benefits, and $987 million in net health benefits. In this case, the net benefit amounts to $2,551 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards is $500 million per year in increased equipment costs, while the estimated annual benefits are $1,467 million in reduced operating costs, $1,021 million in climate benefits, and $1,574 million in net health benefits. In this case, the net benefit amounts to $3,561 million per year.

TABLE I.4—ANNUALIZED MONETIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

[TSL 8]

	Million 2022$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	1,467	1,528	1,440
Climate Benefits *	1,021	1,003	1,028
Net Health Benefits **	1,574	1,546	1,585
Total Monetized Benefits †	4,061	4,077	4,053
Consumer Incremental Product Costs ‡	500	520	489
Net Monetized Benefits	3,561	3,557	3,564
Change in Producer Cashflow (INPV ‡‡)	(27)–(2)	(27)–(2)	(27)–(2)
7% discount rate			
Consumer Operating Cost Savings	1,054	1,094	1,051
Climate Benefits * (3% discount rate)	1,021	1,003	1,028
Health Benefits **	987	972	994
Total Monetized Benefits †	3,062	3,069	3,073
Consumer Incremental Product Costs ‡	511	528	501
Net Monetized Benefits	2,551	2,541	2,572
Change in Producer Cashflow (INPV ‡‡)	(27)–(2)	(27)–(2)	(27)–(2)

Note: This table presents the costs and benefits associated with the subject consumer furnaces shipped in 2029–2058. These results include consumer, health, and climate benefits 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** 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 disbenefits 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.

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

[11] 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. 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.

[12] As discussed in section IV.L.1 of this document, DOE agrees with the IWG that using consumption-based discount rates (*e.g.,* 3 percent) is appropriate when discounting the value of climate impacts. Combining climate effects discounted at an appropriate consumption-based discount rate with other costs and benefits discounted at a capital-based rate (*i.e.,* 7 percent) is reasonable because of the different nature of the types of benefits being measured.

‡‡ Operating Cost Savings are calculated based on the LCC analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 6.4 percent that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For NWGFs and MHGFs, those values are −$27 million to −$2 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Tiered scenario, where DOE assumed amended standards would result in a reduction of product differentiation and a compression of the markup tiers. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this final rule, the annualized net benefits would range from $3,534 million to $3,559 million at 3-percent discount rate and would range from $2,524 million to $2,549 million at 7-percent discount rate. Parentheses ( ) indicate negative values.

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

D. Conclusion

DOE concludes that the standards adopted in this final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. Specifically, with regards to technological feasibility, products achieving these standard levels are already commercially available for all product classes covered by this final rule. As for economic justification, DOE's analysis shows that the benefits of the standards exceed, to a great extent, the burdens of the standards.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 emissions reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the standards for NWGFs and MHGFs is $511 million per year in increased product costs, while the estimated annual benefits are $1,054 million in reduced product operating costs, $1,021 million in climate benefits, and $987 million in health benefits. The net benefit amounts to $2,551 million per year. DOE notes that the net benefits are substantial even in the absence of the climate benefits,[13] and DOE would adopt the same standards in the absence of such benefits.

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.[14] For example, 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. 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 4.77 quad (full-fuel-cycle (''FFC'')), the equivalent of the primary annual energy use of 51 million homes. Based on these findings, DOE has determined that the energy savings from the standard levels adopted in this final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying technical support document (''TSD'').

II. Introduction

The following section briefly discusses the statutory authority underlying this final rule, as well as some of the relevant historical background related to the amended standards for consumer NWGFs and MHGFs.

A. Authority

EPCA 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. (42 U.S.C. 6291–6309) 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 NOPR 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 the EPCA specifically include definitions (42 U.S.C. 6291), coverage (42 U.S.C. 6292), 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 that 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), 6295(o)(3)(A), and 6295(r)) Manufacturers of covered products must use the prescribed Federal test procedure as the basis for: (1) certifying to DOE that their products comply with

[13] The information on climate benefits is provided in compliance with Executive Order 12866.

[14] 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).

the applicable energy conservation standards adopted pursuant to EPCA and (2) making representations regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with the relevant energy conservation standards promulgated under EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for consumer 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, including consumer furnaces. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 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 NWGFs and MHGFs, 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 comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

(1) The economic impact of the standard on manufacturers and on 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 of, initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;

(3) The total projected amount of energy (or as applicable, water) savings likely to result directly from the imposition of the standard;

(4) Any lessening of the utility or the performance of the covered products likely to result from the imposition of 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 imposition of 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 at the time of the Secretary's finding. (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 different level of energy efficiency or energy use 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 a 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 a regional energy conservation standard 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 region must include only contiguous States (with the exception of Alaska and Hawaii, which may be included in a region 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).[15] (42 U.S.C. 6295(o)(6)(C)) Further, DOE can establish the additional regional standard for furnaces only: (1) where doing so would produce significant energy savings in comparison to a single national standard; (2) if the regional standard is economically justified; and (3) after considering the impact of such standard 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 if doing so would be consistent with section 6295(o). (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures for consumer furnaces address standby mode and off mode

[15] DOE notes that the regional standards provision at 42 U.S.C. 6295(o)(6) also applies to central air conditioners and heat pumps, products for which the statute permits either one or two regional standards. This is in contrast to furnaces, for which EPCA permits only one regional standard. As a result, the statute frequently employs plural language in these provisions.

energy use for all covered consumer 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 the NOPR published in the **Federal Register** on July 7, 2022 (''the July 2022 NOPR''), DOE proposed to specify new energy conservation standards to address the standby mode and off mode energy use of NWGFs and MHGFs. 87 FR 40590, 40706. However, for the reasons discussed in section III.A.8 of this document, DOE has concluded that it would not be consistent with section 6295(o) to adopt standby mode and off mode energy standards for NWGFs and MHGFs in this final rule. DOE will continue to investigate and analyze appropriate standby mode and off mode energy consumption standards for these products in a future rulemaking.

B. Background

1. Current Standards

The most recent energy conservation standards for NWGFs and MHGFs were adopted in a final rule published in the **Federal Register** on November 19, 2007 (''November 2007 Final Rule''), in which 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.[16] 72 FR 65136, 65169. Based on market assessment and the standard levels under consideration (and that were ultimately adopted), the November 2007 Final Rule established standards without regard to the certified input capacity of a furnace. *Id.*

Following a series of publications described in section II.B.2 of this document and discussed in further detail in the July 2022 NOPR (*see* 87 FR 40590, 40601–40602 (July 7, 2022)), required compliance with the standards established in the November 2007 Final Rule for these products began on November 19, 2015. The standards currently applicable to all consumer furnaces, including the two product classes for which DOE is amending standards in this final rule, are set forth in DOE's regulations at 10 CFR 430.32(e)(1)(ii). Table II.1 presents the currently applicable standards for NWGFs and MHGFs 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''), Public Law 100–12, established EPCA's original energy conservation standards for furnaces, consisting of the minimum AFUE levels for mobile home furnaces[17] and for all other furnaces except ''small'' gas furnaces. (42 U.S.C. 6295(f)(1)–(2)) The original standards established a minimum AFUE of 75 percent for mobile home furnaces and 78 percent for all other furnaces. Pursuant to 42 U.S.C. 6295(f)(1)(B), in a final rule published in the **Federal Register** on November 17, 1989 (''the November 1989 Final Rule''), DOE adopted a mandatory minimum AFUE level for ''small'' furnaces. 54 FR 47916. 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 previously, 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).[18] The standards amended in the November 2007 Final Rule were to apply to furnaces manufactured or imported on and after November 19, 2015; this compliance date was consistent with the 8-year statutory lead time provided under 42 U.S.C. 6295(f)(4)(B). 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

[16] 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 (Oct. 6, 2006). Thus, the proposed standards that were ultimately adopted in the November 2007 Final Rule only applied to non-weatherized oil-fired furnaces.

[17] DOE notes that prior to June 15, 1976, prefabricated homes that were built in a factory were commonly referred to as ''mobile homes,'' as reflected in the terminology used in EPCA. However, such dwellings built after that date came to be known as ''manufactured homes'' and have to meet specific construction standards required by the U.S. Department of Housing and Urban Development (HUD) Code. (24 CFR part 3280) DOE's mobile home furnace standards apply to furnaces designed for and intended to be used in both mobile and manufactured homes that meet DOE's ''mobile home furnace'' definition at 10 CFR 430.2.

[18] The November 2007 Final Rule adopted amended standards for ''oil-fired furnaces'' generally. However, on July 28, 2008, DOE published a final rule technical amendment in the **Federal Register** that clarified that the amended standards adopted in the November 2007 Final Rule for oil-fired furnaces did not apply to mobile home oil-fired furnaces and weatherized oil-fired furnaces; rather they were only applicable for non-weatherized oil-fired furnaces. 73 FR 43611, 43613.

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.*

On June 27, 2011, DOE published a direct final rule (''DFR'') in the **Federal Register** (''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. *Id. at* 76 FR 37445. The June 2011 DFR amended the existing AFUE energy conservation standards for NWGFs, MHGFs, and non-weathererized oil furnaces, and amended the compliance date (but left the existing standards in place) for weatherized gas furnaces.[19] *Id.* at 76 FR 37410. The existing AFUE 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). The June 2011 DFR also established electrical standby mode and off mode energy conservation standards for NWGFs (including mobile home furnaces), non-weatherized oil furnaces (including mobile home 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.

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.

Following DOE's adoption of the June 2011 DFR, the American Public Gas Association (''APGA'') filed a petition for review with the United States Court of Appeals for the District of Columbia Circuit (''D.C. Circuit'') to invalidate the DOE rule as it pertained to NWGFs. Petition for Review, *American Public Gas Ass'n, et al.* v. *U.S. Dep't of Energy, et al.,* No. 11–1485 (D.C. Cir. filed Dec. 23, 2011).[20] 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 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 90-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 in the **Federal Register** 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, under 42 U.S.C. 6295(p) and 5 U.S.C. 553(b) and (c), EPCA requires that DOE publish only a notice of proposed rulemaking and accept public comments before amending energy conservation standards in a final rule (*i.e.,* DOE is not required by statute 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 thousand British thermal units per hour (''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 that 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 55038, 55044.

Therefore, DOE published a supplemental notice of proposed rulemaking (''SNOPR'') in the **Federal**

[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).

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

[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.

Register on September 23, 2016 (''September 2016 SNOPR'') that proposed separate standards for small and large NWGFs.[23] 81 FR 65720. For NWGFs 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 NWGFs and for all MHGFs, 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 NWGFs 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 NWGFs and MHGFs, 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 (''W'') in both standby mode and off mode for NWGFs and MHGFs. 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 (''January 2021 Final Interpretive Rule'') [25] 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 2016 SNOPR for NWGFs and MHGFs, because DOE determined that those rulemaking documents were inconsistent with its revised interpretation. 86 FR 3873 (Jan. 15, 2021).

The interpretation adopted by the January 2021 Final Interpretive Rule reflected a significant departure from DOE's previous and long-standing interpretation (reflected in practice through decades of rulemaking and explicitly discussed in the December 2021 Final Interpretive Rule, with examples) that the type of technology (*e.g.,* non-condensing technology (and associated venting)) used to generate a furnace's heat did not provide a distinct consumer utility as would constitute a performance-related ''feature'' pursuant to 42 U.S.C. 6295(o)(4) that DOE may not eliminate by way of an energy conservation standard. The January 2021 Final Interpretive Rule justified this change by focusing on: (1) the potential space constraints arising from switching from non-condensing furnaces (and associated venting) to condensing furnaces (and associated venting) in replacement applications, including certain situations where such changes may not be possible; (2) the potential need for significant and unwelcome physical modifications to a home or business (*e.g.,* by adding new venting into the living/commercial space or decreasing closet or other storage/retail space), thereby impacting consumer utility, and (3) a policy decision to remain neutral regarding competing energy sources in the marketplace and maintaining a broader range of consumer choice for the relevant appliances across fuel types. 86 FR 4776, 4816 (Jan. 15, 2021). (See the January 2021 Final Interpretive Rule for a more complete discussion of DOE's rationale for its changed interpretation.) The anticipated result of DOE's change in interpretation was that the Department would set separate product classes and standards for condensing and non-condensing furnaces in its ongoing furnaces energy conservation standards rulemaking.

On January 20, 2021, the President 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 asks 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 the requirements under the EPCA, and in a manner consistent with 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 DOE 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''),[26] that returns to DOE's previous and long-standing interpretation (in effect prior to the January 2021 Final Interpretive Rule).[27] 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, DOE offered an extensive explanation for why it does not view non-condensing technology and associated venting to be a performance-related feature warranting

[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.

[25] DOE published a proposed interpretive rule (''July 2019 Proposed Interpretive Rule'') in the **Federal Register** for comment on July 11, 2019. 84 FR 22011. DOE also published a supplemental proposed interpretive rule (''September 2020 Supplemental Proposed Interpretive Rule'') in the **Federal Register** for comment on September 24, 2020. 85 FR 60090.

[26] DOE published a proposed interpretive rule (''August 2021 Proposed Interpretive Rule'') in the **Federal Register** for comment on August 27, 2021. 86 FR 48049.

[27] Prior to the January 2021 Final Interpretive Rule, DOE had not had a formal interpretation of EPCA's ''features'' provision at 42 U.S.C. 6295(o)(4), but instead, it had examined the consumer utility of potential appliance features in the context of individual energy conservation standards rulemakings. These rulemakings, which outline relevant DOE precedent prior to the January 2021 Final Interpretive Rule, are presented in some detail in the December 2021 Final Interpretive Rule (*see* 86 FR 73947, 73952–73958 (Dec. 29, 2021)).

a separate product class for such furnaces. As noted previously, in the December 2021 Final Interpretive Rule, DOE also included examples in other rules that are consistent with DOE's previous and long-standing interpretation. As DOE explained, non-condensing technology is not a performance-related feature because it does not affect the consumer utility of the product (*i.e.,* providing heat, irrespective of venting type). DOE noted the availability of technological alternatives for difficult installation situations and explained that it would properly account for the costs of such installations when considering a standard's economic justification. DOE has considered concerns regarding specific installation circumstances in the context of this product-specific rulemaking. *See* 86 FR 73947 (Dec. 29, 2021).

In conducting its review of the January 2021 Final Interpretive Rule under the requirements of EPCA and in a manner consistent with E.O. 13990, DOE ultimately arrived at a different determination in the December 2021 Final Interpretive Rule, based on a policy that emphasizes furtherance of the congressional purpose of improving the energy efficiency of covered products and equipment. DOE reasoned that maintaining less-efficient technologies which do not provide distinct consumer utility is contrary to the purposes of EPCA ''to conserve energy supplies through energy conservation programs, and, where necessary, the regulation of certain energy uses'' (42 U.S.C. 6201(4)) and ''to provide for improved energy efficiency of . . . major appliances, and certain other consumer products'' (42 U.S.C. 6201(5)). Such purposes are further reflected in the specific provisions of EPCA granting DOE authority to prescribe energy conservation standards designed to achieve the maximum improvement in energy efficiency, which are technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)). As discussed more fully in the December 2021 Final Interpretive Rule, DOE concluded that the concerns motivating its changed interpretation reflected in the January 2021 Final Interpretive Rule (*i.e.,* space constraints/difficult installation situations, the potential for unwanted physical modifications, and maintaining consumer choice of appliances across fuel types) could be addressed by other means. DOE found that these issues could be resolved through available technological solutions or by switching to an appliance using alternative technologies (*e.g.,* a heat pump). 86 FR 73947, 73960 (Dec. 29, 2021). DOE further concluded that the potential for fuel switching is likely to be limited and that there will continue to be a range of product availability across fuel types. *Id.* at 86 FR 73964.

Given the binary nature of the question at hand—whether non-condensing technology (and associated venting) is or is not a ''feature'' under 42 U.S.C. 6295(o)(4)—DOE did not identify any other policy alternatives on this matter. DOE further notes that it does not anticipate any strong reliance interests associated with the rescinded January 2021 Final Interpretive Rule, given that it was rescinded less than a year after its issuance and the fact that it was never applied in the context of any energy conservation standards rulemaking for a specific appliance.[28]

On July 7, 2022, DOE published the July 2022 NOPR in the **Federal Register**. 87 FR 40590. Consistent with the December 2021 Final Interpretive Rule, in conducting the analysis for the July 2022 NOPR, DOE did not consider identifying separate product classes based on condensing technologies and associated venting systems when analyzing potential energy conservation standards. Based on the results of the NOPR analysis, DOE proposed amended AFUE standards at 95-percent AFUE for both NWGFs and MHGFs, as well as an 8.5 W energy use standard for standby mode and off mode energy consumption. 87 FR 40590, 40706 (July 7, 2022). Additionally, on August 30, 2022, DOE published in the **Federal Register** a Notice of Data Availability (NODA) (August 2022 NODA) announcing an extension of the comment period, making available a revised version of the LCC spreadsheet supporting the July 2022 NOPR, and announcing a public meeting webinar on September 6, 2022, to assist stakeholders with operation of the LCC spreadsheet. 87 FR 52861.

DOE received 3,636 comments in response to the July 2022 NOPR and August 2022 NODA from the interested parties listed in Table II.2. (Note that of these total comments, 3,552 comments were ''form letter'' email submissions contained in docket entry EERE–2014–BT–STD–0031–0348. Additionally, several commenters submitted more than one comment to the docket.)

TABLE II.2—JULY 2022 NOPR COMMENTS

Commenter(s)	Abbreviation	Comment number in the Docket	Commenter type
Eduardo Veiga	Veiga	326	Individual.
Scott Willis	Willis	327	Individual.
Johanna E. Neumann	Neumann	328	Individual.
Anonymous 1	Anonymous 1	329	Individual.
American Public Gas Association; American Gas Association; Spire Inc.; Spire Missouri Inc.; Spire Alabama Inc.; National Propane Gas Association.	Joint Gas Commenters[29]	330	Utilities and Utility Trade Associations.
A. Kessler Consulting, LLC	A. Kessler Consulting	331	Industry Representative.
Natalie Guarin	Guarin	332	Individual.
Hayes Arnold	Arnold	333	Individual.
Christina Haag	Haag	334	Individual.
Adelita G. Cantu	Cantu	335	Individual.
Kim Marcellini	Marcellini	336	Individual.
Kaitlynn Liset	Liset	338	Individual.
Raelene Shippee-Rice	Shippee-Rice	339	Individual.

[28] A number of States and municipalities filed a legal challenge to the January 2021 Final Interpretive Rule in the U.S. Circuit Court of Appeals for the Second Circuit on March 16, 2021. *State of New York, et al.* v. *U.S. Dep't of Energy,* No. 21–602 (2d Cir. filed March 16, 2021).

[29] Although the stakeholders who authored the comments EERE–2014–BT–STD–0031–0330, EERE–2014–BT–STD–0031–0345, EERE–2014–BT–STD–0031–0356, and EERE–2014–BT–STD–0031–0362 refer to themselves as the ''Joint Requestors,'' Atmos Energy was not listed as a contributor to EERE–2014–BT–STD–0031–0330. Therefore, to distinguish the groups of authors, the authors of EERE–2014–BT–STD–0031–0330 are herein referred to as the ''Joint Gas Commenters.''

TABLE II.2—JULY 2022 NOPR COMMENTS—Continued

Commenter(s)	Abbreviation	Comment number in the Docket	Commenter type
Lee's Air, Plumbing, & Heating	Lee's Air, Plumbing, & Heating.	342	Industry Representative.
Natural Gas Supply Association	NGSA	343	Utility Trade Association.
Manufactured Housing Institute	MHI	344; 363; 365	Trade Association.
American Public Gas Association; American Gas Association; Spire Inc.; Spire Missouri Inc.; Spire Alabama Inc.; National Propane Gas Association; Atmos Energy.	Joint Requesters	345; 356; 362	Utilities and Utility Trade Associations.
Anonymous 2	Anonymous 2	346	Individual.
Ohio Partners for Affordable Energy	OPAE	347	Efficiency Advocate.
Individual Commenters	Individual Commenters	348	Individual.
Todd Snyder	Snyder	349	Individual.
Middle Tennessee Natural Gas Utility District	MTNGUD	350	Utility.
Watertown Municipal Utilities	WMU	351	Utility.
Southwest Gas Corporation	Southwest Gas Corporation	353	Utility.
Consumer Energy Alliance	Consumer Energy Alliance	354	Efficiency Advocate.
Lake Apopka Natural Gas District	LANGD	355	Utility.
Christopher Lish	Lish	358	Individual.
National Caucus of Environmental Legislators	National Caucus of Environmental Legislators.	359	State/Local Government Officials.
Theodore Trampe	Trampe	361	Individual.
Consumer Federation of America	CFA	363	Consumer Advocate.
Edison Electric Institute	Edison Electric Institute	363; 4099	Trade Association.
Environment America	Environment America	363	Efficiency/Environmental Advocate.
National Consumer Law Center	NCLC	363	Consumer Advocate.
Natural Resources Defense Council	NRDC	363	Efficiency/Environmental Advocate.
Philadelphia Solar Energy Association	PSEA	363	Efficiency/Environmental Advocate.
Physicians for Social Responsibility	Physicians for Social Responsibility.	363	Consumer Advocate.
Evergreen Action	Evergreen Action	364	Environmental Advocate.
Mark Strauch	Mark Strauch	366	Individual.
Municipal Gas Authority of Georgia	Georgia Gas Authority	367	Utility.
Northwest Energy Efficiency Alliance	NEEA	368	Efficiency/Environmental Advocates.
Competitive Enterprise Institute, Consumers' Research, Center for the American Experiment, *JunkScience.com,* Project 21, Caesar Rodney Institute, Rio Grande Foundation, Committee for a Constructive Tomorrow, FreedomWorks Foundation, Heartland Institute, Thomas Jefferson Institute, Independent Women's Forum, Independent Women's Voice, and Institute for Energy Research.	Joint Market and Consumer Organizations.	369, 373	Other Stakeholders.
National Comfort Products	NCP	370	Manufacturer.
Green & Healthy Homes Initiative	GHHI	363; 371	Efficiency/Environmental Advocates.
Distribution Contractors Association	DCA	372	Trade Association.
Napoleon (aka Wolf Steel Limited)	Napoleon	374	Manufacturer.
Pennsylvania Department of Environmental Protection; State of Nevada; New Jersey Board of Public Utilities; New York State Energy Research and Development Authority; Washington State Department of Commerce; Colorado Energy Office; New Mexico Energy, Minerals, and Natural Resources Department; California Energy Commission; Vermont Department of Public Service; Hawai'i State Energy Office.	State Agencies	375	State Agencies.
The Heartland Institute	The Heartland Institute	376	Other Stakeholder.
Carrier Global Corporation	Carrier	377	Manufacturer.
The Manufactured Housing Institute; National Apartment Association; National Association of Home Builders; National Leased Housing Association; National Multifamily Housing Council.	The Coalition	378	Trade Associations.
New York State Energy Research and Development Authority.	NYSERDA	379	State Agency.
The Natural Gas Association of Georgia	NGA of Georgia	380	Utility Trade Association.

TABLE II.2—JULY 2022 NOPR COMMENTS—Continued

Commenter(s)	Abbreviation	Comment number in the Docket	Commenter type
The Appliance Standards Awareness Project; American Council for Energy-Efficient Economy, CLASP, Consumer Federation of America, Government of the District of Columbia—Department of Energy & Environment, National Consumer Law Center; Natural Resources Defense Council; Northeast Energy Efficiency Partnerships; Southwest Energy Efficiency Project.	Joint Efficiency Commenters	381	Efficiency/Environmental Advocates.
California Energy Commission	CEC	382	State Agency.
The National Consumer Law Center on behalf of its low-income clients: Alliance for Affordable Energy; Pennsylvania Utility Law Project; Consumer Federation of America; Southface; Massachusetts Energy Directors' Association; Green Energy Consumers Alliance; Georgia Watch; North Carolina Justice Center; Texas Legal Services Center; Consumers Council of Missouri; Wildfire; Renew Missouri; Virginia Citizens Consumer Council.	NCLC *et al.*	383	Consumer Advocates.
Heating, Air-conditioning & Refrigeration Distributors International.	HARDI	384	Trade Association.
Gas Analytic & Advocacy Services	GAS	385	Other Stakeholder.
Weil-McLain; Williamson-Thermoflo; Marley Engineered Products, LLC; Patterson-Kelley, LLC.	The Marley Companies	386	Manufacturers.
American Public Gas Association	APGA	387	Utility Trade Association.
Center for Climate and Energy Solutions; Institute for Policy Integrity, New York University School of Law; Montana Environmental Information Center; Natural Resources Defense Council; Sierra Club; Union of Concerned Scientists.	Climate Commenters	388	Efficiency/Environmental Advocates.
Lennox International Inc.	Lennox	389	Manufacturer.
Jack Spencer and Kevin Dayaratna, Ph.D.	Spencer and Dayaratna	390	Other Stakeholder.
American Gas Association American; Pipeline Contractors Association; American Public Gas Association; American Society of Gas Engineers; American Supply Association; Arkansas Gas Association; Consumer Energy Alliance; Distribution Contractors Association; Hearth, Patio & Barbecue Association; Hispanics in Energy; Louisiana Gas Association; Manufactured Housing Institute; National Apartment Association; National Association of Home Builders; National Leased Housing Association; National Multifamily Housing Council; National Propane Gas Association; National Utility Contractors Association; Natural Gas Supply Association; Northeast Gas Association; Plastics Pipe Institute; Plumbing-Heating-Cooling Contractors Association; Rinnai America Corporation; Thermo Products LLC; U.S. Chamber of Commerce; Utility Workers Union of America, AFL–CIO; Williams Furnace Co. dba Williams Comfort Products or Williams.	AGA *et al.*	391	Manufacturers, Trade Associations, and Other Stakeholders.
American Coke and Coal Chemicals Institute; American Gas Association; American Public Gas Association; Independent Petroleum Association of America; National Mining Association; Plumbing-Heating-Cooling Contractors—National Association; U.S. Chamber of Commerce.	The Associations	392	Trade Associations.
Climate Smart Missoula; Environmental Defense Fund; Elevate Energy; Energy Efficiency Alliance of New Jersey; Campaign for 100% Renewable Energy; Evergreen Action; Green Energy Consumers Alliance; Green & Healthy Homes Initiative; Keystone Energy Efficiency Alliance; Montana Environmental Info Center; New Buildings Institute; New York Geothermal Energy Organization; Climate & Clean Energy Program; Rewiring America; RMI; Sealed; Sierra Club; Union of Concerned Scientists; Urban Green Council; Utah Clean Energy.	Climate Smart Missoula *et al.*	393	Efficiency/Environmental Advocates.
Rheem Manufacturing Company	Rheem	394	Manufacturer.
National Propane Gas Association	NPGA	395	Utility Trade Association.

TABLE II.2—JULY 2022 NOPR COMMENTS—Continued

Commenter(s)	Abbreviation	Comment number in the Docket	Commenter type
ACTION-Housing Inc.; Audubon Mid-Atlantic; Clean Air Council; Community Action Association of Pennsylvania; Conservation Voters of Pennsylvania; Energy Coordinating Agency; Environmental Justice Center of Chestnut Hill United Church; Evangelical Environmental Network; Green Building United; Green & Healthy Homes Initiative; Housing Alliance of Pennsylvania; Keystone Energy Efficiency Alliance; National Housing Trust; PA Jewish Earth Alliance; PennEnvironment; Pennsylvania Council of Churches; Pennsylvania Interfaith Power and Light; Pennsylvania Utility Law Project; Performance Systems Development; Philadelphia Energy Authority; Philadelphia Solar Energy Association; Physicians for Social Responsibility Pennsylvania; Schuylkill Community Action; Vote Solar; Working for Justice Ministry.	ACTION-Housing Inc. *et al.*	396	Other Stakeholders.
Black Hills Energy	Black Hills Energy	397	Utility.
Air Condition Contractors of America	ACCA	398	Trade Association.
Allergy & Asthma Network; Alliance of Nurses for Healthy Environments; American Geophysical Union; American Lung Association; American Public Health Association; American Thoracic Society; Asthma and Allergy Foundation of America; Children's Environmental Health Network; Climate for Health/ecoAmerica; National Carbon Monoxide Awareness Association; Oregon Physicians for Social Responsibility; Physicians for Social Responsibility; Physicians for Social Responsibility Florida; Physicians for Social Responsibility Pennsylvania; Texas Physicians for Social Responsibility; Washington Physicians for Social Responsibility.	Climate and Health Coalition	399	Efficiency/Environmental Advocates.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively referred to as "the California Investor-Owned Utilities".	The CA IOUs	400	Utilities.
Sierra Club and Earthjustice	Sierra Club *et al.*	401	Efficiency/Environmental Advocates.
Avangrid; Consolidated Edison; Eversource; Exelon; Liberty Utilities; National Grid; Unitil; PG&E Corporation; Xcel.	The Joint Utilities	402	Utilities.
Plumbing-Heating-Cooling Contractors—National Association.	PHCC	403	Trade Association.
Plastics Pipe Institute	PPI	404	Trade Association.
American Gas Association	AGA	405	Utility Trade Association.
Nortek Global HVAC, LLC	Nortek	406	Manufacturer.
National Grid	National Grid	407	Utility.
Offices of the Attorney General for the States of Illinois, Maine, Maryland, Minnesota, Nevada, New Jersey, New Mexico, New York, Oregon, and Vermont, Washington, The Commonwealth of Massachusetts, the District of Columbia, and the City of New York.	Attorneys General	408	State/Local Government Agencies.
State of Washington, Department of Commerce	State of Washington	409	State Agency.
Mortex Products, Inc.	Mortex	410	Manufacturer.
Johnson Controls	JCI	411	Manufacturer.
Trane Technologies	Trane	412	Manufacturer.
Spire Inc.; Spire Alabama Inc.; Spire Missouri Inc.	Spire	413; 4099	Utilities.
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	414	Trade Association.
Atmos Energy Corporation	Atmos Energy	415	Utility.
Daikin Comfort Technologies Manufacturing, L.P.	Daikin	416	Manufacturer

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[30] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the public meetings held on August 3, 2022,[31] or September 6, 2022,[32] DOE cites the written comments throughout this final rule.

3. Current Standards in Canada

Although climate and fuel prices differ between the United States and Canada and will yield different results

[30] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for NWGFs and MHGFs. (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).

[31] The transcript for the August 3, 2022, public meeting can be found at Docket No. EERE–2014–BT–STD–0031–0363, which is maintained at *www.regulations.gov*.

[32] The transcript for the September 6, 2022, public meeting can be found at Docket No. EERE–2014–BT–STD–0031–4099, which is maintained at *www.regulations.gov*.

in terms of costs and benefits of the standard, there are similarities in the equipment and venting materials used in both the United States 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 United States, the Canadian experience in terms of installation of condensing furnaces has relevance to the United States. As such, multiple stakeholders discussed the Canadian standards in their comments on the July 2022 NOPR, and DOE references these standards several times later in this document. Further, as discussed in section V.C.1 of this document, the standard levels adopted for NWGFs by this final rule align with the Canadian regulations.

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.[33] The revised regulation, required on or after December 31, 2009, sets a minimum 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 kilowatts (''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.[34] In addition to the definition of ''gas furnaces,'' Natural Resources Canada added a separate definition for ''gas furnaces for relocatable buildings'' (*e.g.,* MHGFs). The revised regulation, which applies to covered gas furnaces (excluding gas furnaces for relocatable building, replacement gas furnaces, outdoor furnaces with an integrated cooling component, and through-the wall furnaces with an integrated cooling component) manufactured for sale or import into the Canadian market on or after July 3, 2019, sets a minimum efficiency of 95-percent AFUE. Furthermore, the revised regulation also sets a minimum efficiency of 80-percent AFUE for gas furnaces for relocatable buildings.[35]

III. General Discussion

DOE developed this final rule after considering comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters regarding rulemaking timing and process, product classes and scope of coverage, the test procedure, technological feasibility, significance of energy savings, economic justification, the compliance date, and impacts from other rulemakings.

A. General Comments

This section summarizes general comments received from interested parties regarding rulemaking timing and process.

1. Comments Regarding Authority

The Marley Companies commented that the regulation of multiple levels of components (*e.g.,* motors and furnace fans, which are themselves covered products under EPCA) internal to an appliance limits the utility of the appliance, because the specifications for such components (necessary for compliance with DOE energy conservation standards for those components as covered products) place constraints on the covered product's design and operation. (The Marley Companies, No. 386 at pp. 7–9) The Marley Companies argued that changes to the efficiency of a component, prescriptive requirements, and test procedures are all cumulatively subject to the 6-year window between standards provided to manufacturers per 42 U.S.C. 6295(m)(4)(B), so according to the commenter, any change to the standard for a covered product, to the standard for an internal component of that product, or to the test procedure should preclude further regulation of that product for six years pursuant to 42 U.S.C. 6295(m)(4)(B). (*Id.* at p. 7) Further, Marley asserted that the cumulative impact of multiple component efficiency regulations within a regulated appliance is that the operating range of the entire product is reduced. (*Id.*) The Marley Companies commented that the definition of ''energy conservation standard'' includes a reference to 42 U.S.C. 6295(r), which discusses the inclusion in standards of test procedures and other requirements, and, therefore, the term ''standard'' includes test procedures used to determine the efficiency of covered products. (*Id.* at p. 9) The Marley Companies commented that 42 U.S.C. 6293(e)(4) conveys that Congress realized and stated in EPCA that test procedures should not be altered at the same time as appliance level efficiencies, and, therefore, the Marley Companies asserted that Congress established that any change in an efficiency of any component, combination of components, or the entire covered product, as well as any required construction change through prescriptive requirements and any change in the test procedure used to determine efficiency, would reset the 6-year timeframe established by 42 U.S.C. 6295(m)(4)(B). (*Id.* at p. 9) In contrast, Sierra Club *et al.* commented that DOE correctly interprets furnaces and furnaces fan as two separate products for the purposes of the ''6-year lock-out'' provision at 42 U.S.C. 6295(m)(4)(B). (Sierra Club *et al.,* No. 401 at p. 3)

There are two products that can be found as a component of a consumer furnace and which are separately regulated by DOE: consumer furnace fans and certain types of electric motors. In response to comments from Marley Companies and the Sierra Club, DOE notes that consumer furnaces, consumer furnace fans, and electric motors are all separately covered products under EPCA. (42 U.S.C. 6292(a)(5); 42 U.S.C. 6295(f)(4)(D); 42 U.S.C. 6311(1)(A)) As such, DOE considers their timelines separately in the context of the requirement established by 42 U.S.C. 6295(m)(4)(B) that a manufacturer ''shall not be required to apply new standards to a product with respect to which other new standards have been required during the prior 6-year period.''[36] The 6-year period applies to covered products individually, and ECPA does not provide exceptions to the review requirements when related products or components have overlapping review timeframes. Furthermore, DOE notes that 42 U.S.C. 6295(m) applies to energy conservation standards, not test

[33] *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)

[34] *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)

[35] ''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.

[36] DOE notes that EPCA set a deadline of December 31, 2013, for the Department to prescribe an energy conservation standard or energy use standard for electricity used for purposes of circulating air through ductwork (colloquially referred to as ''furnace fans''). (42 U.S.C. 6295(f)(4)(D)) EPCA likewise set deadlines for the Department to set standards for certain motors, including a five-years lead time for compliance. (42 U.S.C. 6313(b)(4)(B)) These deadlines are independent of the standard-setting provisions for consumer furnaces at 42 U.S.C. 6295(f) and the six-year-lookback provisions at 42 U.S.C. 6295(m).

procedures. Under this provision, DOE is directed to amend energy conservation standards for a covered product if such standards would be technologically feasible, economically justified, and result in significant conservation of energy. (42 U.S.C. 6295(m)(1)(B); 42 U.S.C. 6295(o)) As such, DOE does not agree with the Marley Companies' contention that this statutory provision applies more broadly to test procedure changes, and the Department has concluded that the Marley Companies have advanced an incorrect reading of 42 U.S.C. 6295(r) to support their point. That provision of EPCA simply acknowledges that most energy conservation standards (*i.e.,* performance-based ones) will require an accompanying test procedure and may necessitate additional ancillary requirements to facilitate compliance. Further, 42 U.S.C. 6295(r) specifically refers to test procedures prescribed in accordance with 42 U.S.C. 6293. As such, there simply is no statutory basis for applying the 6-year timeframe, which applies to standards prescribed under 42 U.S.C. 6295(m), to test procedures prescribed under 42 U.S.C. 6293.[37]

NPGA stated that DOE has failed to provide a fair and transparent rulemaking process. (NPGA, No. 395 at p. 3) NPGA and AGA both commented that they believe the proposal to be unlawful because DOE is not authorized to create design standards for furnaces, but NPGA and AGA suggested that is what the proposed rule effectively does. (NPGA, No. 395 at p. 9; AGA, No. 405 at pp. 50–51) NPGA stated that the proposal sets a *de facto* standard for building design by requiring the alteration of building venting systems. (NPGA, No. 395 at p. 22) Additionally, NPGA and AGA stated that the necessity to include condensing technology, as well as other associated design elements, including new venting, electric fans, and a condensate drainage system, is effectively enforcing a design requirement. (NPGA, No. 395 at pp. 9–10; AGA, No. 405 at pp. 50–51) AGA further commented that Congress's decision to exclude furnaces from the list of products for which DOE can include design requirements, as outlined in 42 U.S.C. 6291(6)(B), demonstrates that DOE may not develop design requirements for furnaces. (AGA, No. 405 at pp. 50–52)

In response, DOE is not creating a prescriptive design requirement for consumer furnaces in this final rule. In its definition of ''energy conservation standard'' at 42 U.S.C. 6291(6), EPCA provides that a performance standard is one which prescribes a minimum level of energy efficiency or a maximum quantity of energy use for a covered product, determined in accordance with test procedures developed under 42 U.S.C. 6293. (42 U.S.C. 6291(6)(A)) In this case, the standards adopted in this final rule are set in terms of AFUE, which is a performance metric and is determined through testing consumer furnaces under the applicable DOE test procedure, as discussed in section III.C of this document. DOE does not mandate any specific design for achieving compliance with the amended standard, as would constitute a design requirement under 42 U.S.C. 6291(6)(B). Thus, the final rule complies with the statutory requirements for setting a performance standard under EPCA. The possibility that some technologies may not be sufficient to achieve compliance is true for any performance standard, and does not transform a performance standard into a *de facto* design requirement. DOE acknowledges that the NWGFs and MHGFs that currently achieve 95-percent AFUE do employ condensing technology. However, the performance-based standards adopted in this final rule do not preclude new or alternative heat exchanger designs, venting systems, or materials from being used in future furnace product designs, which may provide additional avenues (alone or in combination) for increasing furnace AFUE. In addition, this final rule provides a five-year lead time before compliance with the amended standards is required, so further innovation may be possible during that time. DOE's approach has been explained at length and in detail in both the July 2022 NOPR and this final rule, as well as the TSDs accompanying those documents.

2. Comments Opposing the July 2022 Proposal

This section summarizes comments opposing the July 2022 proposal.

Several commenters stated that DOE should withdraw the proposed rule. (Georgia Gas Authority, No. 367 at p. 1; MHI, No. 365 at p. 1; DCA, No. 372 at p. 2; The Heartland Institute, No. 376 at p. 1; HARDI, No. 384 at p. 2; Nortek, No. 406 at pp. 5–6) Plastics Pipe Institute commented that it opposes the proposed rule due to negative impacts on consumers (including senior and low-income households), small businesses, the overall gas furnace market, and the gas industry. (Plastics Pipe Institute, No. 404 at p. 1) Spire commented that the proposed standards place undue burden on consumers because many homes are not set up so as to be compatible with condensing gas furnaces. (Spire, No. 413 at pp. 20–21) The Heartland Institute commented that this rule is unnecessary. (The Heartland Institute, No. 376 at pp. 1–2) HARDI stated disagreement with the methodology and conclusions used to support the proposed standards. (HARDI, No. 384 at p. 2) A number of individuals urged DOE to reject the proposed rule on gas-burning residential furnaces because of considerations such as individual preferences, higher upfront costs, and higher maintenance costs. (Veiga, No. 326 at p. 1; Willis, No, 327 at p. 1; Anonymous 1, No. 329 at p. 1) PHCC commented that it does not support the proposed standards for NWGFs and MHGFs, as there are parts of the NOPR that are overly optimistic, do not reflect current market conditions, make inaccurate assumptions, minimize installation issues for condensing-type products, and would generally create negative impacts for manufacturers and consumers. (PHCC, No. 403 at p. 1) Strauch recommended that both condensing and non-condensing furnaces remain available on the market. (Strauch, No. 366 at p. 2) Spencer and Dayaratna stated that the standards proposed in the July 2022 NOPR are unnecessary because condensing furnaces are readily available in the marketplace and have already achieved significant market penetration. (Spencer and Dayaratna, No. 390 at p. 10)

The Heartland Institute expressed concern that the proposed standard would negatively impact energy consumption, emissions, and the economy. (The Heartland Institute, No. 376 at p. 1) The Heartland Institute further stated that there is a lack of economic justification. (*Id.* at p. 2) Additionally, the Heartland Institute argued that, while the highest-efficiency products may produce long-run savings for consumers under ideal laboratory settings, these gains from an increased efficiency are often not replicated in the real world. (*Id.* at p. 1) Atmos Energy similarly commented that the technical analyses do not reasonably consider economic impacts, particularly those on affordability and the potential disruption to highly-effective energy

[37] For example, DOE previously published in the **Federal Register** a direct final rule establishing new energy conservation standards for consumer furnaces on June 27, 2011 (76 FR 37408), and then published in the **Federal Register** a final rule amending the test procedure for consumer furnaces on January 15, 2016 (81 FR 2628). DOE previously published in the **Federal Register** a final rule amending the test procedure for furnace fans on January 3, 2014 (79 FR 500), and then published in the **Federal Register** a final rule establishing new energy conservation standards for furnace fans on July 3, 2014 (79 FR 38130).

conservation programs. (Atmos Energy, No. 415 at p. 2)

As discussed in section II.A of this document, EPCA provides DOE with the authority to regulate the energy efficiency of a number of consumer products, including NWGFs and MHGFs, which are a subset of consumer furnaces. (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) and 42 U.S.C. 6295(m)(1)). Any such new standards for NWGFs and MHGFs must, under 42 U.S.C. 6295(o)(2)(A), be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. DOE's analyses supporting its conclusion that it has met these criteria for the standards adopted in this final rule are presented in section IV and section V of this document, respectively.

Atmos Energy disagreed that the proposed standards would ''represent the maximum improvement in energy efficiency that is technologically feasible and economically justified,'' alleging that DOE's underlying technical analyses do not reasonably consider relevant economic impacts. (Atmos Energy, No. 415 at p. 2) Atmos Energy also disagreed with the July 2022 NOPR's tentative conclusion that the benefits of the proposed standards greatly exceed the burdens. (*Id.*) Atmos Energy commented that DOE should improve the accuracy of its analysis by tailoring its consideration of consumer behavior, life-cycle evaluations, and costs. (*Id.* at p. 5) Atmos Energy further commented that the proposed rule uses unsupported and broad assumptions that are not reflective of actual consumer behavior and information. (*Id.*) Similarly, the Coalition commented that DOE has failed to adequately consider the cost impacts of the proposed standards and has failed to properly assess the balancing of benefits and burdens. (The Coalition, No. 378 at p. 5) Spencer and Dayaratna stated that the standards proposed in the July 2022 NOPR do not meet the ''economically justified'' criteria for prescribing new or amended standards. (Spencer and Dayaratna, No. 390 at pp. 1–2) Specifically, Spencer and Dayaratna stated that the analysis in the July 2022 NOPR is questionable regarding all seven of the factors set by EPCA. (*Id.*) Spencer and Dayaratna suggested that DOE did not present sufficient rationale for factors 5 (*i.e.,* the effect of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard) and 6 (*i.e.,* the need for national energy and water conservation). (*Id.*) AGA commented that the NOPR suffers from many evidentiary shortcomings that fail to meet the statutory requirement that energy conservation standards must be ''supported by substantial evidence'' on the record. (AGA, No. 405 at pp. 29–30) AGA commented that the NOPR's conclusion that the proposed standards would be economically justified and technically feasible relies on unexplained assumptions and conclusions. (*Id.*) AGA asserted that the NOPR fundamentally fails to adhere to the Process Rule,[38] and specifically found fault with DOE's LCC model and the lack of sufficient time for public comment. (*Id.* at pp. 21–23) AGA commented that particularly in the LCC model, the qualitative and quantitative analytical methods are not fully documented for the public and do not produce results that can be explained and reproduced. (*Id.*) AGA commented that these issues prevent stakeholders from evaluating compliance with other aspects of EPCA's and the Process Rule's requirements, and the commenter encouraged DOE to correct these deficiencies. (*Id.*) Trampe commented that he does not support the proposed 95-percent AFUE standard, and that the standard should be maintained at 80-percent AFUE. (Trampe, No. 361 at p. 1)

Lennox suggested that DOE should reconsider whether a 92-percent AFUE standard is an appropriate minimum efficiency level for NWGFs. (Lennox, No. 389 at p. 2) Lennox also commented that, based on DOE's analysis, AFUE levels above 95 percent are not economically justified and have significant negative consumer impacts. (*Id.*)

In regard to the proposed MHGF standards, Nortek and JCI commented that they do not support the proposed 95-percent AFUE standard for MHGFs. (Nortek, No. 406 at p. 2; JCI, No. 411 at p. 1) Nortek commented that DOE should maintain the 80-percent AFUE requirement for MHGFs. (Nortek, No. 406 at pp. 5–6) JCI added that the 95-percent AFUE standard for MHGFs would impose costs on consumers with, on average, lower household incomes. (JCI, No. 411 at p. 1) JCI recommended that DOE should exclude MHGFs from this rulemaking and gather additional data on that product class, particularly in replacement applications. (*Id.*) AHRI also stated that DOE should reconsider active mode energy conservation standards for MHGFs. (AHRI, No. 414–2 at p. 2) Mortex commented that it too does not believe that DOE's proposed 95-percent AFUE standard is economically justified for MHGFs, and that DOE should retain the current standard for MHGFs. (Mortex, No. 410 at p. 1) In support of its recommendation, Mortex pointed to the two-tiered standards that Canada has developed for furnaces, with a 95-percent AFUE level for most residential gas furnaces and 80-percent AFUE level for gas furnaces in relocatable buildings and replacements in manufactured housing. (Mortex, No. 410 at p. 4) Mortex recommended this structure as a model for DOE to utilize. (*Id.*) MHI commented that the current MHGF AFUE standards strike a balance between energy savings and affordability, and the commenter urged DOE to withdraw the NOPR or replace the proposed 95-percent AFUE level for MHGF with a standard at 80-percent AFUE for gas furnaces used in manufactured homes. (MHI, No. 365 at pp. 2–3)

As discussed in section II.A of this document, EPCA provides specific statutory criteria for amending energy conservation standards. EPCA generally requires a public notice-and-comment process (*see* 42 U.S.C. 6295(p)), which affords members of the public the opportunity to comment on the rulemaking, and DOE makes all relevant documents publicly available at *www.regulations.gov.* As part of the process for this rulemaking, DOE convened two public meetings, including one aimed at helping stakeholders understand its analytical models, to ensure the transparency of its process. Additionally, DOE carefully considers the benefits and burdens of amended standards to determine whether the amended standards are the maximum standard levels that are technologically feasible and economically justified, and would conserve a significant amount of energy, as required by EPCA (see 42 U.S.C. 6295(o)(2)–(3)). Section IV of this document outlines DOE's approach to analyzing various potential amended standard levels, and section V of this document provides the results of those analyses, as well as a detailed explanation of DOE's weighing of the benefits and burdens and the rationale for the amended standards adopted by this final rule. As detailed in those sections, DOE has determined that its rulemaking process for the subject

[38] The ''Process Rule'' refers to 10 CFR part 430, subpart C, appendix A, ''Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Certain Commercial/Industrial Equipment''.

furnaces has satisfied the applicable requirements of EPCA and the Process Rule and that the adopted standards are supported by substantial evidence in the record. Further, DOE notes that the webinar held on September 6, 2022, provided further opportunity for clarification regarding the LCC model and extended the comment period to provide sufficient time to provide written comments.

Plastics Pipe Institute expressed concern with the precedent that would accompany this rule change, adding that it would open the door for future restrictions on natural gas. (Plastics Pipe Institute, No. 404 at p. 3) In response, DOE notes that the amended energy conservation standards for NWGFs and MHGFs do not prohibit the sale and use of gas-fired furnaces, nor do they restrict the use of natural gas, but instead, they improve the energy efficiency of those gas-burning products.

3. Comments Expressing Support for the July 2022 Proposal

This section summarizes comments expressing support for the July 2022 proposal.

DOE received comments from the OPAE, NCEL, State of Washington, NEEA, the Joint Utilities, the National Grid, Climate Smart Missoula *et al.,* Evergreen Action, the CA IOUs, the PSEA, the NCLC *et al.,* and the NRDC expressing support for the proposed energy conservation standards for NWGFs and MHGFs. (OPAE, No. 347 at p. 1; NCEL, No. 359 at p. 1; State of Washington, No. 409 at pp. 1–2; NEEA, No. 368 at pp. 1–2; the Joint Utilities, No. 402 at p. 1; National Grid, No. 407 at p. 1; Climate Smart Missoula *et al.,* No. 393 at pp. 1–2; Evergreen Action, No. 364 at p. 1; The CA IOUs, No. 400 at p. 1; PSEA, Public Meeting Webinar Transcript, No. 363 at p. 37; NCLC *et al.,* No. 383 at p. 9; NRDC, Public Meeting Webinar Transcript, No. 363 at p. 30;) GHHI, the Attorneys General, and Sierra Club *et al.* further encouraged DOE to adopt the proposed efficiency standards for consumer gas furnaces. (GHHI, No. 371 at p. 1; Attorneys General, No. 408 at pp. 1–2; Sierra Club *et al.,* No. 401 at p. 1) The Joint Efficiency Commenters added that they strongly support DOE's proposed standards for minimum efficiency of NWGFs and MHGFs and standby mode and off mode power consumption. (Joint Efficiency Commenters, No. 381 at p. 1) The CA IOUs further explained that the proposed rule would allow consumers to have greater access to energy-efficient products that are technologically feasible and economically justified. (The CA IOUs, No. 400 at p. 1) Daikin stated that despite some concerns regarding the accuracy of some portions of the TSD concerning costs due to the confidential nature of some manufacturer cost data, the company generally finds that DOE's analysis is reasonable in most areas based on the data that is publicly available. (Daikin, No. 416 at p. 3) The Joint Utilities stated that they support common-sense, cost-saving improvements to existing efficiency standards coupled with programs to provide the financial resources to enable customers to make the transition to higher-efficiency furnace products and minimize the impact of upfront costs. (The Joint Utilities, No. 402 at p. 1) National Grid stated that Federal energy conservation standards ensure that the benefits of efficiency gains can reach all customer segments, including renters who often do not make decisions about appliances. (National Grid, No. 407 at p. 1) The State of Washington added that it understands the cost savings and emissions benefits that more efficient standards can provide. (State of Washington, No. 409 at pp. 1–2)

DOE also received over 3,000 submissions of a form letter encouraging DOE to enact strong efficiency standards for furnaces that phase out the least-efficient furnace models. (Individual Commenters, No. 348 at pp. 1–3552) The commenters stated that heating homes should not produce pollution, and they stated that outdated and inefficient gas furnaces are emitting millions of tons of avoidable climate emissions and other harmful pollutants. (*Id.*) A number of other individual commenters expressed similar views. (Neumann, No. 328 at p. 1; Guarin, No. 332 at p. 1; Haag, No. 334 at p. 1; Cantu, No. 335 at p. 1; Marcellini, No. 336 at p. 1; Liset, No. 338 at p. 1; Snyder, No. 349 at p. 1; Lish, No. 358 at p. 1) In addition to expressing support for the standards via the form letter, Guarin, Haag, Cantu, Marcellini, NCEL, and Liset all commented that by requiring furnaces to use about 15-percent less energy, the proposed standard would cut 373 million metric tons of carbon emissions and 833 thousand tons of NO_X over 30 years of sales, as outlined in the July 2022 NOPR. (Guarin, No. 332 at p. 1; Haag, No. 334 at p. 1; Cantu, No. 335 at p. 1; Marcellini, No. 336 at p. 1; NCEL, No. 359 at p. 1; Liset, No. 338 at p. 1) These commenters added that the proposed standard would help with breathing since it would reduce needless greenhouse gas emissions. (Guarin, No. 332 at p. 1; Haag, No. 334 at p. 1; Cantu, No. 335 at p. 1; Marcellini, No. 336 at p. 1; Liset, No. 338 at p. 1) The CA IOUs similarly stated that this standard will significantly improve ambient and indoor air quality in the United States. (The CA IOUs, No. 400 at p. 2)

Other commenters similarly discussed the beneficial impacts that the proposed standards would have on health and the environment. Arnold asked DOE to help work toward a cleaner and more sustainable future by increasing the efficiency standards for furnaces. (Arnold, No. 333 at p. 1) Shippee-Rice urged DOE to enact these ''long overdue'' standards, stating that doing so will decrease pollutants that threaten human, animal, and plant health. Shippee-Rice also noted that this proposed standard will help to decrease the harmful effects of current climate change dangers. (Shippee-Rice, No. 339 at p. 1) Daikin agreed with DOE's initiatives to address emission reductions and set higher standards with climate change, decarbonization, and electrification in mind. (Daikin, No. 416 at pp. 2–3) Lee's Air, Plumbing & Heating commented that a higher standard would eliminate pollution and wasted energy. (Lee's Air, Plumbing & Heating, No. 342 at p. 1) The Physicians for Social Responsibility commented that pollutants from gas furnaces may be back-drafted into homes when indoor air pressure is reduced. Alternatively, they stated that pollutants can be vented out into the surrounding community. The commenter added that those pollutants from gas appliances can lead to the development of childhood asthma, increase susceptibility to other respiratory infections, decrease general cognitive and neurological functioning, and exacerbate cardiovascular disease. The commenter also stated that these pollutants can cause community-wide harm, particularly among low-income communities and communities of color. (The Physicians for Social Responsibility, Public Meeting Webinar Transcript, No. 363 at pp. 5–6) The commenter further argued that the proposed standards can help lower utility bills, which on its own can positively impact consumers' health. The commenter concluded that higher efficiency standards will reduce the health effects from air pollution and limit the impacts of climate change such as extreme heat, population displacement, and injuries and fatalities due to natural disasters. (*Id.* at p. 7) Evergreen Action noted that residential heating is the biggest utility in most U.S. households. Evergreen Action stated that gas heating appliances account for two-thirds of on-site household greenhouse gas emissions, and that gas furnaces are a significant source of NO_X. (Evergreen Action, No. 364 at p. 1) Climate Smart Missoula *et al.* also stated that furnaces have lifespans of 20 years or more and suggested that adopting updated standards will lead to benefits for consumers' pocketbooks, as well as the planet, through emission reduction. (Climate Smart Missoula *et al.,* No. 393 at p. 2) Environment America commented that the proposed standards would reduce pollution that causes climate change and negatively impacts health. (Environment America, Public Meeting Webinar Transcript, No. 363 at pp. 18–19) Environment America suggested that, based on the reduced energy use and emissions, along with reduced annual home heating bills, DOE should finalize the proposed standards. (*Id.*) The National Caucus of Environmental Legislators recommended that DOE not to give in to industry-delaying tactics because action has been delayed and stymied numerous times in the past 30 years. They further commented in support of the proposal to increase the efficiency level of gas furnaces to 95-percent AFUE. (National Caucus of Environmental Legislators, No. 359 at p. 1)

NEEA supported DOE's finding in the July 2022 NOPR that implementing a 95-percent AFUE standard for NWGFs and MHGFs would lead to significant, cost-effective energy savings. (NEEA, No. 368 at pp. 1–2) NEEA stated that the consumer furnace market is ready for a furnace standard set at a condensing level, as evidenced by the market maturity and the lack of insurmountable barriers. (*Id.* at pp. 2–3) NEEA noted that condensing furnaces make up the majority of sales in the Northwest and their market share is growing. (*Id.*) NEEA stated that a study commissioned by NEEA and other stakeholders demonstrated the lack of barriers as would prevent a condensing furnace installation. (*Id.*) Additionally, NEEA commented that a 5-year transition time would allow sufficient time for manufacturers to convert their production and close the remaining sales gap. (*Id.*)

Daikin commented that it believes the results of DOE's analysis would not substantially change even if DOE were provided additional data, and, therefore, it expressed support for the proposed 95-percent standard for NWGFs. (Daikin, No. 416 at p. 3) Carrier and Trane also expressed support for the 95-percent AFUE standard for NWGF, and Trane added that this level will provide significant CO_2 savings. (Carrier, No. 377 at p. 1; Trane, No. 412 at p. 1) AHRI stated that DOE has conducted sufficient analysis to amend active mode energy conservation standards for NWGFs and recommended that DOE finalize this rulemaking to bring resolution to the process and to bring certainty to the marketplace. (AHRI, No. 414–1 at p. 1) The CEC commented that it supports DOE's proposed standard for consumer furnaces at 95-percent AFUE and 8.5 W, and that DOE should finalize these standards. (CEC, No. 382 at pp. 1–2) AHRI and Rheem agreed with DOE's conclusion that a 98-percent AFUE standard would be unreasonable and not economically justified for NWGFs. (AHRI, No. 414–1 at pp. 1–2; Rheem, No. 394 at p. 2)

The State Agencies supported the proposed TSL 8 standard and methodology and encouraged DOE to adopt the rule. (State Agencies, No. 375 at pp. 1–2) The State Agencies further commented that the proposed TSL 8 standard is technologically achievable, beneficial to American consumers' physical and financial health, and is an important step in reducing emissions. (*Id.* at p. 1) NYSERDA supported DOE's proposal to adopt TSL 8 for MHGFs and NWGFs and recommended that DOE consider an even more stringent standard at 96-percent AFUE for NWGF. (NYSERDA, No. 379 at pp. 1–2) NYSERDA further commented that TSL 8 leads to significant energy and economic savings over the lifetime of the equipment. (*Id.*) The NCLC *et al.* and the Joint Efficiency Commenters also stated that the proposed TSL 8 efficiency levels promise substantial financial benefits to consumers and added that these financial benefits are especially promising for low-income consumers. (NCLC *et al.,* No. 383 at p. 4; Joint Efficiency Commenters, No. 381 at p. 2) The NCLC commented that low-income rental properties are more likely to have less-efficient furnaces and to pass the associated larger energy bills on to tenants. (NCLC, Public Meeting Webinar Transcript, No. 363 at pp. 8–10) NCLC noted that this could amount to $2,000 to $3,000 in incremental costs for tenants over the life of the furnace. (*Id.* at p. 9) The commenter also stated that low-income consumers have the fewest resources to address the harms of rising temperatures and would be further adversely impacted. The NCLC commented that this presents an equity issue and accordingly concluded that DOE should adopt a strong furnace efficiency standard. (*Id.* at p. 10)

The Philadelphia Solar Energy Association commented in support of the proposed standards, stating that high-efficiency furnaces help low-income consumers in Philadelphia reduce their energy costs, as well as indoor air pollution from atmospheric furnaces. (Philadelphia Solar Energy Association, Public Meeting Webinar Transcript, No. 363 at p. 37)

The Joint Efficiency Commenters stated that DOE should not adopt TSL 7 as an alternative to TSL 8, adding that the percentage of low-income consumers benefitting from the potential standards is significantly greater at TSL 8 compared to TSL 7. (Joint Efficiency Commenters, No. 381 at p. 2)

In response to the July 2022 NOPR, The NCLC *et al.* commented that if the standard is set too high, many consumers will be saddled with purchasing expensive products where energy savings do not outweigh initial costs. However, the NCLC *et al.* commented that, if the standard is set too low, then the percentage of customers who end up with higher LCC will increase. (NCLC *et al.,* No. 383 at p. 6) Therefore, the NCLC *et al.* commented that DOE should not reject a standard because some consumers will experience net costs over the life of the product. (*Id.*) NCLC *et al.* noted that, at TSL 8, the average net benefits are more significant than the average net costs for NWGFs. (*Id.*)

As discussed in section II.A of this document, DOE is directed by EPCA to conduct periodic rulemakings to determine whether to amend the standards for various products, including consumer furnaces. (42 U.S.C. 6295(f)(4) and 42 U.S.C. 6295(m)(1)) The standards adopted by this final rule, which include the same AFUE levels as those proposed in the July 2022 NOPR, adhere to the requirements of EPCA in that they are 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) and 42 U.S.C. 6295(o)(3)(B)) The analytical results showing both the benefits and burdens of the standards, along with DOE's rationale for adopting these amended standards, are discussed in section V of this document.

4. Regional Standards

Nortek, AHRI, and MHI encouraged DOE to consider regional standards that align with the U.S. Department of Housing and Urban Development (''HUD'') zones. (Nortek, No. 406 at p. 6; AHRI, No. 414–2 at pp. 3–4; MHI, No. 365 at pp. 1–2) MHI commented that the HUD code for manufactured homes prescribes energy efficiency features that are specific to the region where the home will be sited. (MHI, No. 365 at pp. 1–2) MHI suggested that consulting with

HUD will assist DOE in understanding how furnace standards impact consumer access to affordable housing, including manufactured housing. (*Id.*) PHCC commented that DOE's early efforts for this consumer furnace rulemaking considered creating regional standards to establish a pathway for higher-efficiency products that could not be justified on a national scale due to differences in usage and energy consumption of different climate zones. (PHCC, No. 403 at pp. 1–2) Trampe commented that the entire United States should not have to follow the same standard and added that what applies in Minnesota may not apply in Kansas, Tennessee, Texas, or other States. (Trampe, No. 361 at p. 1) Nortek pointed to NRCan's standards, which were set at 95-percent AFUE for NWGFs and 80-percent AFUE for MHGFs in 2019. Nortek noted that the climate in Canada has more severe winters than many parts of the United States. Nortek also stated that setting standards at a condensing level disproportionately impacts southern homeowners because most manufactured homes are in the South where mild winters allow furnaces to run for only 3 months a year. (Nortek, No. 406 at pp. 3–4) Like Nortek, the Heartland Institute also discussed regional differences, stating that in Northern States, such as Minnesota or Wisconsin, most residential natural gas furnaces already meet 95-percent AFUE. In Southern States, such as Texas, Georgia, and Florida, a smaller percentage of homeowners have adopted higher-efficiency furnace models. The Heartland Institute further offered that condensing models are already installed in regions where furnaces are heavily used, which mitigates the need for this mandate. (The Heartland Institute, No. 376 at p. 2) JCI commented that it believes a regional standard with a condensing level for the Northern region and a non-condensing level for the Southern region would be more economically justified and would align with the existing central air conditioning/heat pump standards. JCI commented that, in southern installations, the additional installation cost would result in a negative LCC using the amended values JCI supplied for manufacturer production costs (''MPCs''). (JCI, No. 411 at p. 2)

Conversely, Daikin commented that there are logistical and operational challenges associated with regional standards; therefore, Daikin supported a national energy conservation standard, stating that it does not support TSL 4. (Daikin, No. 416 at p. 2) Similarly, Rheem commented that DOE should maintain a single, nationwide and capacity-wide standard for NWGFs to avoid costly supply and inventory planning problems for manufacturers, distributors, and contractors. (Rheem, No. 394 at p. 3) The CFA commented that DOE should consider a uniform standard, arguing that certain furnaces no longer need to be exempted from the standard. (CFA, Public Meeting Webinar Transcript, No. 363 at p. 22)

In response, DOE's analyses of each considered efficiency level accounts for regional differences (*e.g.,* in terms of climate data, shipments) when appropriate, as discussed throughout this document. For the July 2022 NOPR and for this final rule, in addition to considering uniform national standard, DOE included consideration of a potential regional standard (*i.e.,* TSL 4; see section V.A of this document) consisting of efficiency levels at 95-percent AFUE for the Northern region and 80-percent AFUE for the rest of the country, for both NWGFs and MHGFs. However, as discussed in section V of this document, DOE conducts a walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified, as required under EPCA. In this final rule, DOE has found that a national standard for both NWGFs and MHGFs corresponding to 95-percent AFUE (*i.e.,* TSL 8) meets those statutory criteria, and, therefore, DOE is adopting a national standard rather than regional standards.

5. Recommendations for Analytical Changes

Atmos Energy commented that DOE should supplement its technical analysis in accordance with consumer welfare recommendations identified by the National Academy of Science peer review report before proceeding with a final rule, arguing that this would increase the accuracy of the technical analysis and have a material impact on the final standards. (Atmos Energy, No. 415 at p. 5) AGA commented that DOE should follow, or at a minimum respond to, the National Academies of Sciences, Engineering, and Medicine's (NAS) Recommendations (the NAS Report) on its process. (AGA, No. 405 at pp. 25–27) AGA stated that DOE should revisit the proposed rule to address NAS's recommendations and allow stakeholders an opportunity to comment on the revisions. (*Id.*) APGA stated that many months after the NAS Report, DOE does not reflect the NAS findings in the NOPR but merely states that DOE ''is in the process of evaluating the resulting report.'' (APGA, No. 387 at p. 56) APGA pointed out that the residential furnace rulemaking was one of the three rulemakings studied in depth by the NAS committee. (*Id.*) APGA noted that NAS came to conclusions about consumer behavior that are extremely critical to the NOPR. APGA cited the NAS Report's recommendation that ''[f]or some commercial goods in particular, there should be a presumption that the market actors behave rationally unless DOE can provide evidence or argument to the contrary.'' (*Id.*)

In response, DOE notes that the rulemaking process for energy conservation standards for covered products and equipment are outlined in appendix A to subpart C of 10 CFR part 430, and DOE periodically examines and revises these provisions in separate rulemaking proceedings. DOE notes that discussion of the recommendations of the NAS report, which pertain to the processes by which DOE analyzes energy conservation standards, will be addressed as part of a separate notice-and-comment process.

Rheem commented that DOE should consider a simplified analysis and reproducible model for future rulemakings. (Rheem, No. 394 at p. 2) Specifically, Rheem encouraged DOE to adopt a consistent and predictable approach to quantifying energy savings to ensure the recommendations will result in the estimated savings. (*Id.*) GAS argued that ''Uncertainties . . . include numerous variables contained within DOE's overly complex 'determination' apparatus,'' and that DOE has failed to ''use transparent and robust analytical methods.'' (GAS, No. 385 at pp. 4–5) AHRI suggested that, for future rulemakings, DOE should modify the way that it analyzes consumer economic impact to look at the probability that individual consumers will benefit from standards rather than whether the aggregate benefit is positive and stated that these changes would be best accomplished in an open review process. (AHRI, No. 414–1 at p. 2)

Although DOE understands the desire for simplicity, the Department notes that its analysis is informed by the Process Rule and includes a number of modifications in response to comments from interested parties on prior notices, which recommended that DOE consider a variety of additional factors when evaluating the impacts of potential standards. These additional considerations, while adding complexity to the analysis, are responsive to commenters and increase the granularity of results. A simplified analysis would run counter to those recommendations,[39] which have proven to have merit. In response to AHRI's comment that consumer impacts should be assessed individually, DOE notes that as discussed in section IV.F of this document, the LCC includes a Monte Carlo analysis that allows DOE to assess impacts on a wide range of installations. DOE uses this information to assess and consider how consumers would likely be impacted by potential standards. DOE also conducts a consumer subgroup analysis (described in section IV.I of this document) that evaluates the economic impacts of standards on specific groups. DOE further notes that its analysis is designed to be reproducible to interested parties, and DOE provides a range of statistics, including the percentage of consumers that will be negatively and positively impacted by an amended energy conservation standard. Therefore, for this final rule, DOE continued to conduct the energy savings and economic rulemakings using largely the same methodologies used in the July 2022 NOPR of this rulemaking, which are generally consistent with those used for prior rulemakings.

ACCA suggested that DOE should focus its attention on efficiency improvements, such as installing heating, ventilation, and air-conditioning (HVAC) systems according to the industry's recommended standards (including proper equipment sizing, duct re-design and sealing, and appropriate refrigerant charge levels), that would reduce peak electricity demand without requiring revised installation or design standards. (ACCA, No. 398 at p. 2)

As discussed in section IV.F.4 of this document, DOE's analysis accounts for the electricity consumption of NWGFs and MHGFs. Although reducing peak electricity demand can be a benefit of energy conservation standards, as discussed in section II.A of this document, EPCA provides specific factors that DOE must consider when establishing or amending energy conservation standards. One of these factors is the total projected energy savings that would result from the standard (*see* 42 U.S.C. 6295(o)(2)(B)(i)(III)), and DOE includes impacts on electricity consumption when evaluating the projected energy savings. DOE follows the statutory obligations laid out in EPCA when evaluating the potential for energy savings, technological feasibility, and economic justification.

[39] For example, sections 12 through 16 of the Process Rule outlines factors to be considered in the process for developing energy conservation standards, including delineating several factors relating to identification of candidate standard levels and other factors to be considered in the selection of proposed standards, as well as the subsequent selection of a final standard. These analyses, along with the accompanying sensitivity analyses, are necessary to ensure the robustness of the Energy Conservation Standards amendment process.

6. Opportunity for Public Input

MTNGUD, Watertown Municipal Utilities, and LANGD recommended that DOE hold a workshop to further discuss this rulemaking. (MTNGUD, No. 350 at pp. 1–2; WMU, No. 351 at p. 1; LANGD, No. 355 at p. 2) MTNGUD and LANGD specifically noted that at the workshop, DOE should further discuss its LCC analysis with stakeholders in order to achieve a common understanding, and these parties added that the LCC is a central part of the proposed standard. (MTNGUD, No. 350 at p. 1; WMU, No. 351 at p. 2; Consumer Energy Alliance, No. 354 at p. 1, LANGD, No. 355 at p. 2) MTNGUD, Watertown Municipal Utilities, and Joint Requesters stated that holding a workshop and extending the associated comment period would be in accordance with the objectives of the Process Rule. (MTNGUD, No. 350 at pp. 1–2; WMU, No. 351 at pp. 1–2; Joint Requesters, No. 356 at pp. 1–4) Joint Requesters requested another webinar to cover comments and questions related to DOE's LCC model that were not addressed during the webinar held on September 6, 2022. (Joint Requesters, No. 362 at p. 2) Additionally, the Consumer Energy Alliance urged that an extension of the comment period by DOE and hosting the requested workshop would allow for sufficient time for all stakeholders to analyze the NOPR so as to develop meaningful comments. (Consumer Energy Alliance, No. 354 at pp. 1–2)

MTNGUD, Watertown Municipal Utilities, Consumer Energy Alliance, and LANGD also encouraged DOE to extend the comment period at least 45 days after the workshop to give commenters additional time to effectively comment on the July 2022 NOPR. (MTNGUD, No. 350 at p. 2; WMU, No. 351 at p. 2; Consumer Energy Alliance, No. 354 at 2; LANGD, No. 355 at p. 2) LANGD and Watertown Municipal Utilities stated that more time is needed to evaluate the impacts on low-income households, seniors, and energy insecure consumers. (LANGD, No. 355 at p. 1; WMU, No. 351 at p. 1) Consumer Energy Alliance commented that the proposal and supporting documents are highly technical and voluminous, so it will take additional time to sufficiently analyze everything DOE has issued, adding that DOE's proposal will impact millions of consumers while also raising complex legal, regulatory, economic, and technical issues. (Consumer Energy Alliance, No. 354 at p. 1) Consumer Energy Alliance further commented that stakeholders should have a sufficient opportunity to evaluate the various issues raised in the NOPR, including how such issues may impact the stakeholders' members/customers. (*Id.*) Consumer Energy Alliance requested that an extension of the comment period be granted by DOE, and the commenter argued that hosting the requested workshop would allow for sufficient time for all stakeholders to analyze the NOPR and develop meaningful comments. (*Id.* at p. 2)

Several parties requested an extension of at least 60 days to sufficiently analyze the NOPR and the related documents. (Joint Commenters, No. 330 at p. 1; NGSA, No. 343, at p. 1; MHI, No. 344, at p. 1). They stated that DOE did not follow the Process Rule, and that the 60-day comment period made meaningful comment impossible. (Joint Commenters, No. 330 at p. 1; NPGA, No. 395 at pp. 26–27) Similarly, LANGD and the Consumer Energy Alliance commented that the 60-day comment period does not allow for a meaningful opportunity to verify DOE's analysis and provide substantive comments to aid in a productive rulemaking process. (LANGD, No. 355 at p. 1; Consumer Energy Alliance, No. 354 at p. 1) APGA and AGA noted that the Administrative Procedure Act (APA) requires that agencies provide a ''meaningful'' opportunity for comment. (APGA, No. 387 at p. 65; AGA, No. 405 at p. 24) APGA commented that DOE has violated the APA due to the deviation from past public comment periods and the complexities of the models in this rulemaking. (APGA, No. 387 at p. 65) APGA stated that DOE's justifications for fewer days to comment are unavailing, and that it appears DOE is rushing to judgment by denying APGA and other stakeholders a reasonable process to comment. (APGA, No. 387 at p. 67) AGA also commented that stakeholders have been denied a meaningful opportunity to evaluate the NOPR. (AGA, No. 405 at pp. 24–25)

Conversely, AHRI stated that by holding the webinar focused on the LCC model on September 6, 2022 and extending the comment period for the July 2022 NOPR, DOE provided all commenters with sufficient opportunity to review its models and make thoughtful comments. (AHRI, No. 414–1 at p. 1) Sierra Club *et al.* commented that the deviations from the Process Rule are justified in light of the long delay on these standards, which is in violation of the statutory deadline for this action and the schedule to which DOE agreed as part of a settlement agreement. (Sierra Club *et al.,* No. 401 at p. 1)

In response, DOE conducts all appliance standards rulemakings in accordance with its authority under EPCA, which involves making its analyses publicly available and providing the public an opportunity to comment on the rulemaking. (42 U.S.C. 6295(m)(2)) As explained in the July 2022 NOPR, DOE initially found it necessary and appropriate to provide a 60-day comment period given the overdue statutory deadline and because the analytical methods used for the NOPR were similar to those used in previous rulemaking notices regarding the subject furnaces. 87 FR 40590, 40607 (July 7, 2022). DOE held a public meeting webinar to discuss the July 2022 NOPR on August 3, 2022. Subsequently, as stakeholders requested, DOE held a second public meeting webinar on September 6, 2022 focused on helping stakeholders understand and operate the Department's analytical models. DOE also extended the comment period by 30 days, which totaled 90 days for stakeholders to provide input. 87 FR 52861 (August 30, 2022). As mentioned, interested parties such as AHRI and Sierra Club, *et al.* attested to the adequacy of the comment opportunity which DOE provided. (AHRI, No. 414–1, at p. 1; Sierra Club *et al.,* No. 401, at p. 1) As a result, DOE concludes that stakeholders have had ample time and opportunity to provide input on the rulemaking analyses and process related to the amended energy conservation standards for NWGFs and MHGFs.

7. Federal Financial Assistance

The Attorneys General commented that with new Federal funding available under the Infrastructure Investment and Jobs Act and the Inflation Reduction Act, the transition to more-efficient space heating will be cost-effective and affordable. (Attorneys General, No. 408 at p. 2) The Attorneys General added that the multibillion-dollar Congressional investment in weatherization, energy efficiency, and beneficial electrification programs will help alleviate equipment cost concerns for low- to moderate-income households and small businesses. (*Id.*) Similarly, Trane commented that aid should be provided through the Inflation Reduction Act to homeowners to offset any costs incurred from this standard due to increased purchase and installation costs. (Trane, No. 412 at pp. 1–2) Trane further stated that this assistance could help with the necessary advancements in venting technology that will accompany the standard. (*Id.*)

The Joint Utilities commented that they believe DOE can help Americans achieve meaningful cost savings while benefitting the environment by establishing rebates and incentive programs that could be used to support State-regulated efficiency and rebate programs. Furthermore, the Joint Utilities stated that this would assist electric and natural gas customers by reducing the upfront costs of achieving greater home heating efficiency. (The Joint Utilities, No. 402 at p. 1)

DOE agrees that Federal funding, specifically funding available through the Inflation Reduction Act, may be able to assist in the transition to more-efficient space heating. However, DOE also notes that such funding is separate from this rulemaking process and has yet to be fully implemented. Consequently, while DOE agrees that the costs of more-efficient furnaces could be reduced for certain consumers, DOE did not include impacts of any Federal funding in its reference case analysis. However, as discussed in section IV.F.10 of this document, DOE performed a sensitivity analysis in which tax credits significantly reduce the cost of a heat pump system as an alternative space-heating option, thereby incentivizing some consumers to switch from gas furnaces to heat pumps. The results of this sensitivity analysis are available in appendices 8J and 10E of the final rule TSD. Additionally, any potential incentives for more-efficient gas furnaces would only improve the consumer benefits as determined in the final rule analysis. Therefore, as discussed in section V of this document, DOE concludes that the amended standards are justified, and this decision is not dependent on whether additional Federal subsidies or investments are available.

8. Standby Mode and Off Mode Power Consumption Standards

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))

''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 Consumer Furnaces Other Than Boilers,'' 10 CFR part 430, subpart B, appendix N). In that test procedure, DOE defines ''standby mode'' as any mode in which the furnace 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, and/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. ''Off mode'' for consumer furnaces is defined as a mode in which the furnace 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. An ''off switch'' is defined as the switch on the furnace 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. As discussed previously, DOE does not currently prescribe standby mode or off mode standards for NWGFs and MHGFs.

In the July 2022 NOPR, DOE analyzed new standby mode and off mode power standards for NWGFs and MHGFs and proposed that the maximum allowable standby mode and off mode power consumption should be 8.5 W for NWGFs and MHGFs. 87 FR 40590, 40592 (July 7, 2022). Table IV.5 of the July 2022 NOPR shows the standby mode and off mode efficiency levels that DOE analyzed, along with a description of the design options anticipated to be used to achieve each efficiency level above baseline. The baseline efficiency level was determined to be 11 W, and it corresponds to the use of a linear power supply and a 40VA linear transformer (LTX). Other technology options that were analyzed to achieve efficiency levels above baseline include a low-loss LTX (''LL–LTX'') and two types of switching mode power supply (SMPS). 87 FR 40590, 40619 (July 7, 2022).

In response to DOE's proposed technology options and watt levels associated with each efficiency level for standby mode and off mode standards, Carrier commented that it agreed with DOE's statement that most furnaces use 40VA transformers, and further described that 40VA transformers provide power to sensors and components in the furnace, as well as a variety of external devices. (Carrier, No. 377 at p. 2) Carrier also commented that it does not believe the use of an SMPS will lower the transformer size without limiting the external devices and sensors that can be powered by the furnace, which would impact consumer experience and product performance. The commenter stated that DOE only considered thermostats, but noted that there are other devices that could be powered by the transformer. (Carrier, No. 377 at pp. 2–3) Carrier encouraged DOE to defer the standby mode and off mode power standards, asserting that the 8.5W level has the potential to reduce the utility of consumer furnaces, and therefore would not meet the requirements of 42 U.S.C. 6295(o)(2)(B)(iv). (Carrier, No. 377 at pp. 1–2) Carrier asserted that its analysis found that a maximum standby watt limit of 8.5 is achievable in only their furnaces with the lowest AFUE efficiency and least features. (Carriers, No. 377 at p. 2) Carrier argued that products that incorporate a 20VA transformer do not meet DOE's screening criteria of product utility or availability, nor will they have the ability to support the safety sensors that will or could be required in the future such as those that may be needed due to the Consumer Protection Safety Commission's stated intention to establish a requirement for carbon monoxide sensors on furnaces. (Carrier, No. 377 at p. 3) Carrier explained that efficiency level (EL) 1 is the only feasible technology option to support the safety sensors that will be required in the future. (Carrier, No. 377 at pp. 3–4) Carrier explained that potential requirements for new safety sensors would mean that a standard lower than 11 W could create an adverse impact on product utility. (Carrier, No. 377 at pp. 3–4) Carrier asserted that contractors would need to install larger transformers to maintain utility, which defeats the purpose of having a standby power limit and adds additional installation complexity. (Carrier, No. 377 at pp. 2–3) Therefore, Carrier commented that it opposed DOE's proposed 8.5W standby mode and off mode power standard for NWGFs. (Carrier, No. 377 at pp. 1–2) Carrier explained that it conducted an analysis of standby mode and off mode power on their furnaces and found that the limit of 8.5W is achievable for their lower-efficiency furnaces, but not for their mid-tier and deluxe furnaces without lessening the utility. (Carrier, No. 377 at p. 2) Overall, Carrier recommended that DOE defer standby mode and off mode power standards until further testing and analysis is conducted. (Carrier, No. 377 at pp. 3–4)

Trane also commented that DOE's assumption that furnaces would transition to a 20VA transformer at standby mode and off mode ELs 2 and 3 is inaccurate, because the transformer supplies power not only to the furnace but also to the attached air conditioner or heat pump, as well as the thermostat and other accessories. (Trane, No. 412 at p. 2) Trane commented that setting the standard at 8.5W would result in manufacturers adding transformers to supply power to the needed features; therefore, Trane recommended maintaining a standard of 11W. (*Id.*)

Lennox stated that 40VA transformers are utilized to provide adequate low voltage power for components and accessory items. (Lennox, No. 389 at pp. 4–5) Lennox commented that it offers transformers ranging up to 70VA to accommodate situations where several accessories are included in the HVAC system. (Lennox, No. 389 at p. 4) Lennox argued that DOE's assumption of a unit with SMPS having a transformer sized at 20VA is incorrect, since a 20VA transformer often does not provide sufficient power capability to drive the internal components necessary for all furnace/air conditioner/heat pump functions and a thermostat. (Lennox, No. 389 at p. 4) Lennox explained that SMPS are currently used in Lennox products controls, and the company is not aware of ways to further reduce standby mode and off mode power consumption. (*Id.*) Lennox also stated that the proposed standby mode and off mode standard level would inhibit implementation of additional safety features. (Lennox, No. 389 at pp. 3–4)

Lennox commented that the 8.5W limit for consumer furnaces will prevent advances in communicating controls, installation and diagnostic features, and zoning. (Lennox, No. 389 at p. 4) Lennox further stated that programs, including ENERGY STAR, are considering measures that would require these monitoring, diagnostic, and prognostic features that would require additional standby power, but would save more energy overall. (*Id.*) The commenter argued that future innovations and safety requirements (*e.g.,* thermostats, WiFi controls, extra power supplies) may force the power usage to rise above the 11W limit. (Lennox, No. 389 at p. 6) Lennox commented that DOE should not mandate standby mode and off mode power levels with *de minimis* energy savings that prevent the integration of controls and other features that enable significantly larger energy savings at the furnace and HVAC systems level. (Lennox, No. 389 at pp. 4–5) Lennox commented that DOE should not only reconsider the proposed standby mode and off mode standard of 8.5W but should also consider whether an 11W baseline would be sufficient. (Lennox, No. 389 at p. 6) Lennox further commented that the analysis for DOE's proposed standard for standby mode and off mode also does not consider system level impacts. (Lennox, No. 389 at p. 5)

Nortek commented that DOE should not implement a standby mode and off mode standard lower than 11W. (Nortek, No. 406 at pp. 1–2) Nortek commented that they do not support DOE's proposed standard of 8.5 W for standby mode and off mode, as it would limit necessary innovation in furnace controls, programming and usage displays, thermostats, and other devices. (Nortek, No. 406 at p. 1)

Rheem commented that DOE should adjust its proposed standby mode and off mode energy standards for NWGF. Rheem asserted that 8.5W may be overly limiting due to the previously mentioned shift toward smart products, and the shift to low global warming potential (GWP) refrigerants that require additional power for supporting communication and safety controls. The commenter warned that reductions in standby wattage limits potential diagnostic and installation functionality, advancements which could also result in energy savings. (Rheem, No. 394 at p. 1) Rheem commented that DOE should maintain a baseline standby mode and off mode power level of 11W, as would allow future improvements such as safety and communicating controls to be incorporated into future furnace designs. (Rheem, No. 394 at p. 2)

Daikin commented that it does not support DOE's proposed 8.5W standard for standby mode and off mode. (Daikin, No. 416 at p. 1) Daikin also stated that DOE has significantly underestimated the incremental MPCs for each of the standby mode and off mode efficiency levels, and that the cost increase for a Low-Loss Linear Transformer is more likely to be five to ten times higher than DOE's estimate. (*Id.* at p. 4) Daikin noted that many manufacturers offer a 70VA transformer as an accessory or service part to provide adequate low voltage power to all system components, and that manufacturers would likely need to limit accessory items to meet the proposed standby mode/off mode standards. (*Id.* at p. 5) Daikin recommended that DOE establish a standby mode and off mode criteria of 15W for condensing NWGFs with communicating features, multiple heating stages, ultra-low NO_X, an electrically commutated (ECM) motor, and controls associated with alternate refrigerants. (Daikin, No. 416 at p. 6)

AHRI explained that a maximum level of 8.5W of standby power would limit necessary innovation in furnaces and related connected devices powered through the furnace and could possibly prohibit significant energy-saving features. (AHRI, No. 414–1 at p. 2) AHRI stated that DOE should reconsider the standby mode and off mode energy standards proposed for NWGFs, as well as the max-tech level based upon the use of a 20VA low-loss linear transformer (''LL–LTX'') and SMPS. (AHRI, No. 414–1 at p. 3)

AHRI also noted that the NAS Peer Review Report[40] mentions the need to not stifle innovation, particularly regarding connected products. (AHRI, No. 414–1 at p. 2) AHRI stated that if the standby mode and off mode standards for furnaces are set too low, then connected products such as thermostats and Wi-Fi controls will use add-on power supplies, mentioning that such auxiliary power supplies are already available on the market. (AHRI, No. 414–1 at p. 3) AHRI expressed concern that the current baseline value of 11W may need to be adjusted in the future to remove the effects of safety and other control measures. (AHRI, No. 414–1 at p. 3)

AHRI likewise stated that DOE should reconsider the standby mode and off mode energy standards proposed for MHGFs, referencing the comments it submitted for NWGFs. Specifically, AHRI stated that the proposed maximum of 8.5 watts would stifle innovation and could reduce energy savings from connected products, and is inadequate to power safety and communication controls necessary for consumer utility. (AHRI, No. 414–2 at p. 3) Mortex commented that DOE's proposed 8.5W limit for standby mode and off mode would not be adequate to power safety and communicating controls necessary for consumer utility and that 11W should be retained. (Mortex, No. 410 at p. 4)

JCI commented that the 8.5W limit for standby mode and off mode power of NWGFs and MHGFs is too restrictive due to the additional requirements associated with the new A2L refrigerant requirement and other future communication and monitoring advancements. (JCI, No. 411 at p. 3)

Several commenters argued that furnaces will need to incorporate safety sensors for controlling components such as carbon monoxide, carbon dioxide, refrigerant leak detectors and/or low GWP along with other changes in the future, and they noted that such functionalities must be accounted for in meeting the currently proposed limit for standby mode and off mode power. (Lennox, No. 389 at pp. 4–5; Rheem, No. 394 at pp. 1–2; Carrier, No. 377 at pp. 3–4; Daikin, No. 416 at pp. 5–6; AHRI, No. 414–1 at pp. 2–3)

Daikin, Lennox, Trane and AHRI listed numerous components that are powered by transformers in consumer furnaces. The combined list of components includes: integrated furnace control board, indoor and outdoor air conditioning/heat pump (AC/HP) fan motors, gas valves, combustion air inducers, thermostats, ultraviolet (UV) germicidal lights, humidifiers, AC/HP outdoor control board, AC/HP defrost controls, AC/HP heat pump reversing valve, indoor air circulating blowers, indoor and outdoor electronic expansion valves, condensate pumps, communicating controls that aid in proper commissioning, AC/HP IoT devices, system performance monitoring and reporting, identification of faults, zoning systems consumer interface, temperature sensors, air pressure sensors, refrigerant pressure sensors, gas pressure sensors, proprietary diagnostic sensors, refrigerant leak detection systems for A2L refrigerants, carbon monoxide (CO) sensors, CO_2 sensors, and dual fuel HPs that require more power. (Daikin, No. 416 at p. 6; Lennox, No. 389 at pp. 4–5; Trane, No. 412 at p. 2; AHRI, No. 414–1 at pp. 2–3) AHRI stated that it is impossible at this time to determine the power draw from these components that may be added to furnaces in the future and suggested that DOE reevaluate these proposed standards for NWGFs in the next round of standards. (AHRI, No. 414–1 at p. 3) Trane argued that a 20VA transformer is inadequate to power all these items. (Trane, No. 412 at p. 2) Daikin recommended taking these future requirements into account, as these standards will not come into effect until after the new A2L refrigerant is required. (Daikin, No. 416 at pp. 5–6)

The CA IOUs commented that they analyzed the dataset of ten consumer furnaces shared by AHRI in which they found that 50 percent of the furnaces with AFUEs of 97 or higher would not meet the proposed standby mode and off mode requirement. They further stated that 70 percent would meet a standard of 9 W and that 100 percent would meet a standard of 10 W. (The CA IOUs, No. 400 at p. 3)

The CA IOUs requested that DOE confirm that the proposed standby mode and off mode energy conservation standard would not significantly reduce the market availability of the most efficient consumer furnaces and would preserve design flexibility for future products. The CA IOUs suggested that these design flexibilities could include diagnostic features to verify installation and monitor ongoing performance or additional safety features or reduce consumer costs through higher operational energy savings. The CA IOUs suggested that DOE should consider a separate standby mode and off mode adder for furnaces with higher energy efficiency than baseline furnaces. (The CA IOUs, No. 400 at p. 3)

The CA IOUs commented in support of a standby mode and off mode energy conservation standard; however, they stated that, in their experience, products with higher operational efficiencies sometimes have higher standby mode and off mode energy requirements. (The CA IOUs, No. 400 at pp. 2–3) They commented that, as an example, furnace fans with ECMs have higher standby mode energy consumption compared with furnaces fans outfitted with lower efficiency motors. (*Id.*)

CEC commented that consumer products in the marketplace already meet the proposed DOE standard of 8.5W in standby mode. The commenter conducted an analysis on AHRI's condensing data set, which showed 74 percent of condensing furnaces as using an ECM motor, and only 8 percent of those furnaces were shown to have a standby energy consumption greater than 8.5W. CEC stated that the average of this data was 6.1W and that the median was 5.7W for condensing furnaces with ECM motors. Therefore, CEC claimed that the 8.5W limit is both realistic and leaves room for additional functionality to be added. (CEC, No. 382 at p. 3)

NYSERDA expressed support for DOE's proposed standards for standby mode and off mode power consumption and agreed with DOE's findings that more-efficient transformers are realistic and attainable. (NYSERDA, No. 379 at pp. 7–8) NYSERDA also noted that the sample of condensing furnaces from the data set provided by AHRI to DOE in 2018[41] supports DOE's proposed standby mode and off mode power

[40] National Academies of Sciences, Engineering, and Medicine, Review of Methods Used by the U.S. Department of Energy in Setting Appliance and Equipment Standards. (2021) Washington, DC: The National Academies Press. pp. 2–3; 111–113. *doi.org/10.17226/25992.*

[41] The comment submitted by AHRI was in response to a separate proceeding, and can be found at: *www.regulations.gov/document/EERE-2018-BT-PET-0017-0002.*

standards. (NYSERDA, No. 379 at p. 8) According to NYSERDA, the majority of models tested at the time had standby mode and off mode power efficiencies at or below the proposed standard levels, thereby demonstrating the proposed standards to be technologically feasible and readily available. (*Id.*)

After considering this feedback, DOE understands that typical and baseline levels of power consumption of NWGFs and MHGFs in standby mode or off mode are likely to increase in the future as manufacturers continue to build increasingly complex controls into consumer furnaces, and that many of the likely changes are related to features such as safety sensors or to other improvements in functionality that would provide utility for the consumer. In addition, DOE understands that manufacturers may be introducing more sophisticated controls for furnaces that are intended to get paired with central heat pumps in the field, whose operation can be optimized for efficient performance. DOE takes Carrier's point that such innovations could contribute to the overall utility or performance of the covered product, an important consideration when assessing the economic justification of a potential standard (*see* 42 U.S.C. 6295(o)(2)(B)(i)(IV)). However, DOE further notes that this one EPCA factor in isolation is not dispositive of a potential standard's economic justification or lack thereof, but instead, the Department must weigh all seven factors under 42 U.S.C. 6295(o)(2)(B)(i) before setting any standby mode and off mode power standards.

Based on the totality of these comments, DOE has found that there is some degree of uncertainty that exists with respect to the appropriateness of the standby mode/off mode efficiency levels analyzed in the July 2022 NOPR—particularly for products that are in development but also possibly in some products already on the market. Consequently, DOE has determined that it lacks the necessary information to set appropriate standby mode and off mode standards pursuant to 42 U.S.C. 6295(gg)(3) at this time. Particularly since some of the functionalities at issue could have significant safety or energy-savings benefits, DOE does not wish to stymie such developments through well-intentioned but ultimately counterproductive standby mode/off mode standards. Instead, DOE needs to have a better understanding of the legitimate power consumption needs of the subject furnaces when operating in these modes. The Department has concluded that it does not currently have the requisite evidence to support standby mode and off mode standards under the applicable statutory criteria in 42 U.S.C. 6295(o)(2)(B)(i). Therefore, DOE is not adopting the standby mode/off mode power standards for NWGFs/MHGFs proposed in the July 2022 NOPR at this time, but instead, the Department will continue to investigate these issues and may consider such standards in a future rulemaking. In summary, based on the stakeholder feedback received, DOE concludes that more data is necessary to determine the appropriate baseline level for standby mode and off mode energy usage to allow for safety features, features that reduce active mode energy use, or other features that would provide additional functionality for consumers.

In response to the July 2022 NOPR, Daikin commented that it does not support DOE's proposed standby mode and off mode standard because the consumer life-cycle savings are negligible, the energy savings potential is extremely small, the burden on manufacturers is high, and there is a need to address low-voltage power supply for components in the future. (Daikin, No. 416 at p. 4) Similarly, PHCC commented that standby mode and off mode energy use cannot be considered in comparison to the overall energy consumption of the equipment because those potential savings are *de minimis.* (PHCC, No. 403 at p. 2)

Daikin disagreed with DOE's statement that current mounting brackets are sufficient to support the slight increase in size and weight of an LL–LTX. The commenter asserted that, according to ASTM D4728 (*Standard Test Method for Random Vibration Testing of Shipping Containers and Systems*), even small increases in mass can cause breaks, cracks, and deformation that mandate strengthening supports and brackets. Finally, Daikin stated that such modifications would lead to significant cost increases. (Daikin, No. 416 at p. 4)

As discussed previously in this section, DOE is not finalizing its previous proposal to set new standby mode and off mode power standards for NWGFs and MHGFs in this final rule. However, DOE will continue to monitor the standby mode and off mode power consumption of the subject consumer furnaces and may address such standards in a future rulemaking. The Department may consider these comments further at that time, as appropriate.

B. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards for a type (or class) of covered products, DOE divides covered products into product classes by the type of energy used, or by capacity or other performance-related features which other products within such type (or class) do not have and 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 rule, DOE is only analyzing a subset of consumer furnace classes. DOE agreed to the partial vacatur and remand of the June 2011 direct final rule (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 rule, DOE is only amending the energy conservation standards for NWGFs and for MHGFs. See section IV.A.1 of this document for a more detailed discussion of the product classes analyzed in this final rule.

C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test 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 (TP) for consumer furnaces (January 2016 TP Final Rule). 81 FR 2628. The revisions included:

1. Clarification of the electrical power term ''PE'';
2. Adoption of a smoke stick test for determining use of minimum default draft factors;
3. Allowance for the measurement of condensate under steady-state conditions;
4. Reference to manufacturer's installation and operation manual and clarifications for when that manual does not specify test set-up;
5. Specification of duct-work requirements for units that are installed without a return duct; and
6. 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.

Daikin commented that the test procedure should add clarity for the terms ''electrical auxiliaries'' and ''single auxiliary.'' (Daikin, No. 416 at p. 6) In response, DOE notes that amendments to the test procedure, including associated terminology, are not in scope for this analysis of amended energy conservation standards. However, DOE may consider this issue further in its next review of the consumer furnaces test procedure, which would occur in a separate test procedure rulemaking proceeding.

D. 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 NWGFs and MHGFs, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the final rule 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 of this final rule and in chapter 5 of the final rule TSD.

E. 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 amended standards (2029–2058).[42] 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 energy conservation standards.

DOE used its national impact analysis (NIA) spreadsheet models to estimate national energy savings (NES) from potential amended standards for NWGFs and MHGFs. The NIA spreadsheet model (described in section IV.H of this document) 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 *AEO2023*. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum), and, thus, presents a more complete picture of the impacts of energy conservation standards.[43] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

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. For example, 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

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

[43] 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).

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, 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.

The standard levels adopted in this final rule are projected to result in national energy savings of 4.77 quad (FFC) over 30 years of shipments, with GHG emissions savings equivalent to the energy use of 42 million homes in one year.[44] Based on the amount of FFC savings, the corresponding reduction in emissions, and need to confront the global climate crisis, DOE has determined (based on the methodology described in section IV.E of this document and the analytical results presented in section V.B.3.a of this document) that there is substantial evidence that the energy savings from the standard levels adopted in this final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B).

APGA commented that the purpose of EPCA is to reduce energy consumption. APGA stated that the energy savings for the proposed TSL 8 (of 5.48 quad) was significantly higher than all other TSLs except TSL 9. APGA stated that the analysis is extremely complex, but even with that complexity, the estimated savings represents just 3.5 percent relative to the energy use of these products in the no-new-standards case. APGA also added that DOE's estimates of energy savings are tainted based on flawed modeling in the LCC analysis. (APGA, No. 387 at p. 28)

DOE addresses APGA's comments with regard to the modeling assumptions in the LCC analysis in section IV.F of this document. With regard to the significance of savings, DOE is not required to consider the percentage of savings when considering significance. In particular, 42 U.S.C. 6295(o)(2)(B)(i)(III) refers to the total projected amount of energy savings, not the percentage savings. While those percentage savings have previously been considered as a test when overall energy savings are small, in this case, overall energy savings are quite large, particularly when aggregated over the 30-year analysis period. Therefore, DOE continues to maintain that the energy savings estimated for this final rule of 4.77 quads are significant.

The DCA commented that the unpredictable nature of renewable energy sources, such as solar and wind, demonstrate that these energy sources alone will not meet current and future demand. (DCA, No. 372 at pp. 1–2) The DCA commented that the United States will not be able to achieve its clean energy ambitions without substantial growth of natural gas production and a large expansion of natural gas distribution pipelines. (*Id.*) The DCA commented that natural gas enables the use of renewable energy sources. (*Id.* at p. 2)

With respect to DCA's comment regarding the mix of fuels needed to meet future energy demand, DOE notes that the EIA's *AEO2023* projects natural gas to account for 35 percent of all domestic energy production in 2050.[45] *AEO's* projections of future energy systems in the U.S. are based on a robust and comprehensive macroeconomic model, taking into account a wealth of factors and data, and those projections are the best available to DOE.

F. 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 a manufacturer impact analysis (''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 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 standard.

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

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

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

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

The LCC and PBP analyses focus on consumers who will purchase the covered products in the first year of

[44] Equivalencies based on: *www.epa.gov/energy/greenhouse-gas-equivalencies-calculator* (last accessed Sept. 15, 2023).

[45] Energy Information Administration, *Annual Energy Outlook 2023,* Table 1 (available at: *www.eia.gov/outlooks/aeo/tables_ref.php*).

compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F 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.

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 adopted 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 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 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)) To assist the Department of Justice (DOJ) in making such a determination, DOE transmitted copies of its proposed rule and the NOPR TSD to the Attorney General for review, with a request that the DOJ provide its determination on this issue. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for NWGFs and MHGFs are unlikely to substantially lessen competition in any particular product or geographic market. DOJ added that in the course of its review, it was told that the MHGF market may be more highly concentrated than DOE's analysis suggests. DOJ stated that given the necessarily short time-frame for its review, it is not in a position to confirm the level of concentration increase that may be caused by the rule, but it encouraged DOE to closely examine and consider potential competitive issues that commenters may raise with respect to this rulemaking. The Department is publishing the Attorney General's assessment at the end of this final rule. DOE notes that it has carefully considered the issues mentioned by DOJ in arriving at the standards adopted in this final rule.

NGA of Georgia stated that the NOPR analysis indicated that nearly 32 percent of current furnaces in Georgia would be converted to an alternate fuel source under the proposed standard, which would have implications for the competitive balance of natural gas utilities, contractors that specialize in gas piping and appliances, and manufacturers that only make gas equipment or venting. (NGA of Georgia, No. 380 at p. 3) GAS asserted that DOE has ignored anti-competitive effects of its energy conservation standards rulemakings. (GAS, No. 385 at p. 6) APGA commented that the rulemaking record created by DOE does not do a good job of quantifying the impact on competition, and noted that APGA addressed the competition issue in comments to the Department of Justice dated August 19, 2022. (APGA, No. 387 at pp. 64–65) APGA asserted that establishing a 95-percent AFUE standard could have a profound impact on competition, as consumers may shift to alternative methods of home heating equipment due to the higher up-front cost of a 95-percent AFUE furnace (compared to a 90-percent AFUE furnace). (APGA, No. 387 at p. 65) Spencer and Dayaratna asserted that the proposed standard ''would effectively remove a technology from the marketplace and reduce competition.'' (Spencer and Dayaratna, No. 390 at p. 2) They claim that the proposed standard will remove an entire technology from the market, limiting the incentive for condensing furnace manufacturers to lower prices or to increase efficiency further. (*Id.* at 3) Mortex submitted written comments specific to competition in the MHGF marketplace, asserting that one MHGF manufacturer is dominant and sells both to mobile home manufacturers and into the replacement market. Additionally, Mortex raised concerns about the availability of 20″ wide and 24″ deep MHGFs if DOE adopts a condensing standard and the financial impacts that lessened competition in the MHGF market could have on low-income consumers. (Mortex, No. 410 at pp. 3–4) In addition to dimensional differences between MHGFs and NWGFs, JCI stated that there are product configuration differences (*i.e.,* MHGFs typically utilize a downflow configuration and NWGFs typically utilize an upflow configuration). JCI raised concerns about the availability of downflow condensing MHGFs. JCI questioned the feasibility of retrofitting an upflow MHGF into a manufactured home constructed to make use of a downflow furnace. Specifically, JCI asserted that the costs of reconfiguring ductwork, filling voids, and making other necessary structural changes would prevent such a change. (JCI, No. 411 at pp. 2–3)

In response to stakeholders' comments and DOJ's comment regarding the MHGF industry, DOE reviewed the manufacturer landscape of NWGFs and the manufacturer landscape of MHGFs separately. In the NWGF market, DOE notes that the 10 original equipment manufacturers (OEMs) of non-condensing NWGFs also manufacture condensing NWGFs that meet or exceed the adopted level (95-percent AFUE). Additionally, DOE identified three OEMs that only manufacture condensing NWGFs. These three NWGF OEMs also all offer models that meet or exceed the adopted level. Thus, a variety of companies already participate in the condensing NWGF market. Given that the number of competitors is not decreased at the adopted levels, DOE does not anticipate lessening of competition in the NWGF market. Compared to the NWGF market, the MHGF market is smaller (*i.e.,* lower annual shipments) and is served by fewer OEMs. DOE estimates that NWGFs account for approximately 97 percent of shipments covered by this rulemaking (around 3.1 million units in 2029) and that MHGFs account for the remaining 3 percent of shipments (around 0.1 million units in 2029). In the July 2022 NOPR, DOE identified seven OEMs of MHGFs. For this final rule, DOE further researched the furnace market and refreshed its database of model listings to include the most up-to-date information on NWGF and MHGF models currently available on the market. Through its review of the updated product database and other public sources, DOE determined that one MHGF OEM no longer offers products covered by this rulemaking. At the time of the July 2022 NOPR, this

OEM offered one condensing MHGF model, which has since been discontinued. Therefore, through its careful review of the MHGF market, DOE has determined that six OEMs manufacture MHGFs for the U.S. market. Of these six OEMs, one OEM only manufactures non-condensing MHGFs, two OEMs only manufacture condensing MHGFs, and the remaining three OEMs manufacture both non-condensing and condensing MHGFs. All five OEMs of condensing MHGFs offer models that meet or exceed the adopted level (95-percent AFUE). Furthermore, all OEMs of condensing MHGFs offer downflow condensing models. Given the existing availability of downflow condensing models, DOE finds that a market shift to condensing furnaces would not eliminate downflow configurations from the market. Similarly, DOE found a range of condensing MHGF models that fit into compact footprints. The availability of such models from Burnham Holdings (Thermo Pride) and Madison Industries (Nortek) suggest there is no technical constraint to offering condensing MHGFs that fit a compact footprint. DOE recognizes that one manufacturer dominates the MHGF space in sales volume, and the remaining competitors have small market shares. As a result, the MHGF market is concentrated. However, DOE does not expect the adopted standard would significantly alter the level of concentration. DOE notes that consumers have access to a range of alternate heating solutions and that those alternatives limit price increases in a market where one manufacturer already dominates the space. As discussed earlier in this section, in a September 6, 2022, letter written in response to the NOPR, DOJ stated that ''[b]ased on our review of the information currently available, we do not believe that the proposed energy conservation standards for consumer furnaces are likely to substantially lessen competition in any particular product or geographic market.''

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))

Spencer and Dayaratna asserted that DOE's NOPR fails to establish the need for national energy conservation as would justify the proposed standard under 42 U.S.C. 6295(o)(2)(B)(i)(VI). These commenters argued that there is not a current and pressing problem concerning conservation, as the United States is in a time of energy abundance (citing EIA estimates of U.S. oil and gas reserves equating to nearly 100 years of supply, uranium reserves, as well as the potential for new energy discoveries such as oil shale). Spencer and Dayaratna also challenged the proposed standards' anticipated reductions in toxic air emissions as a weak reason for showing the need for national energy conservation; the commenters argued that air pollutant concentration levels have declined significantly since 1990, so with the air clean and getting cleaner, they asserted that the costs and benefits of the regulation are outweighed by its impacts on consumer choice, family finances, and broad inconvenience. (Spencer and Dayaratna, No. 390 at pp. 4–6)

DOE disagrees with this comment from Spencer and Dayaratna. DOE finds this comment to start from the flawed premise that further improvements in energy efficiency and reduced emissions are unnecessary or would not provide substantial benefits to consumers and the Nation. As discussed in section I.C of this final rule, the amended standards for the subject consumer furnaces are expected to save 4.77 quad of energy over 30 years and the cumulative NPV of total consumer benefits of the amended standards for NWGFs and MHGFs ranges from $4.8 billion (at a 7-percent discount rate) to $16.3 billion (at a 3-percent discount rate) over the same time period. In DOE's view, the presence of an abundant energy supply neither precludes DOE's approach nor justifies the approach suggested by the commenters, which would result in waste of significant amounts of energy when more-efficient options are technologically feasible and economically justified.

Likewise, DOE does not agree that the Nation and its citizens (particularly children) would not benefit from the reduction in toxic air emissions associated with the amended energy conservation standards for the subject consumer furnaces. Despite the Nation's substantial progress in reducing emissions in recent years, DOE does not believe that further efforts in terms of environmental and human health protection are unnecessary. 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 adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (GHGs) associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document. These positive economic and health benefits are set forth in detail in section V.B.6 of this document.

Furthermore, DOE notes that the energy savings from the adopted standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M 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 previously, DOE could consider such information under ''other factors.''

Spencer and Dayaratna stated that one other factor to consider is how the proposed standard meaningfully advances EPCA's intent, given the abundant energy sources that the United States enjoys today that were not contemplated in 1975. (Spencer and Dayaratna, No. 390 at p. 11) They add that given the change in the value proposition for energy efficiency since 1975, setting efficiency standards no longer has the same impact on energy availability as it did during times of perceived energy scarcity, concluding that the proposed standards do not meaningfully advance the intent of EPCA and do not justify the restrictions that they state the proposed rule will impose on consumer choice. (*Id.* at p. 11–12)

DOE's response here is similar to that made in the preceding section in response to Spencer and Dayaratna's argument regarding establishing the need for national energy conservation. Again, DOE disagrees with the commenters' assertion that an abundant energy supply somehow ends DOE's statutory mandate to pursue further improvements in energy efficiency and reduced emissions, despite the fact that such actions would provide substantial benefits to consumers and the Nation. Additionally, the consideration of total projected energy savings is only one of the seven factors enumerated in EPCA. (42 U.S.C. 6295(o)(2)(B)(i)). Energy savings have value both in times of scarcity and abundance, and particularly in light of the EPCA amendments in recent years mandating review of existing conservation standards on a six-year cycle,[46] it is apparent that Congress intends for DOE to continue to pursue energy efficiency gains that meet the applicable statutory criteria—even in times of energy abundance. As discussed in section I.C of this final rule, the amended standards for the subject consumer furnaces are expected to save 4.77 quad of energy over 30 years and the cumulative NPV of total consumer benefits of the amended standards for NWGFs and MHGFs ranges from $4.8 billion (at a 7-percent discount rate) to $16.3 billion (at a 3-percent discount rate) over the same period. DOE has determined that the full measure of anticipated energy and cost savings from amended energy conservation standards for the subject furnaces are unlikely to be realized in the absence of amended standards. Furthermore, as discussed in section III.F.1.f 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. Again, in DOE's view, the presence of an abundant energy supply neither precludes DOE's approach nor justifies the approach suggested by the commenters, which would result in waste of significant amounts of energy when more-efficient options are technologically feasible and economically justified.

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 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 three-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 final rule.

G. Compliance Date

In the July 2022 NOPR, DOE discussed in some detail the relevant provisions of EPCA related to calculation of the requisite lead time between publication of a final rule and compliance with amended standards, and the Department ultimately proposed a five-year lead time for compliance with any amended energy conservation standards for NWGFs and MHGFs. 87 FR 40590, 40611 (July 7, 2022). Additionally, as explained in the July 2022 NOPR, furnaces and furnace fans are separate products under EPCA, and, therefore, the required six-year period under 42 U.S.C. 6295(m)(4)(B) is not relevant because it applies only in the context of standards directly pertinent to the product in question. As such, the energy conservation standards for furnace fans are not a consideration when applying the six-year spacing period to new or amended standards for furnaces. *Id.* at 87 FR 40611–40612. DOE did not receive any comments related to the proposed five-year lead time for compliance presented in the July 2022 NOPR and is adopting a five-year lead time in this final rule.

H. Impact From Other Rulemakings

Veiga commented that home appliances have energy-efficiency standards that collectively make homes more expensive. (Veiga, No. 326 at p. 1) Lennox commented that DOE needs to consider the total cumulative regulatory burden for consumer furnaces, as there are multiple concurrent DOE, Environmental Protection Agency (EPA), and other regulatory actions undergoing updates. (Lennox, No. 389 at p. 8) Lennox stated that the NOPR's cumulative regulatory burden analysis was inadequate and did not include all relevant regulations. The commenter provided the following list of relevant regulations: ''2023 DOE Energy Conservation Standards (''ECS'') change for central air conditioners; 2023 DOE Energy Conservation Standard change for commercial air conditioners; 2023 DOE ECS change for commercial warm air furnaces (''CWAFs''); EPA phase-down to lower GWP refrigerants to meet the American Innovation and Manufacturing (''AIM'') Act objectives; National and Regional Cold Climate Heat Pump Specifications; 2025 DOE ECS change for Three-Phase, Below 65,000 Btu/h; DOE Test procedure for VRF [Variable Refrigerant Flow] Systems; EPA Energy Star 6.0+ for Residential HVAC; EPA Energy Star 4.0 for Light Commercial HVAC, and DOE ECS changes for electric motors, commercial fans and blowers, furnace fans, oil and weatherized gas furnaces, and walk-in coolers and freezers''. (*Id.*) Lennox stated that the significant cumulative regulatory burdens are stressing technical and laboratory resources within the industry. (*Id.* at p. 9)

Many of the rules listed by Lennox are not finalized. Regulations that are not yet finalized are not considered in cumulative regulatory burden, as the timing, cost, and impacts of unfinalized rules are speculative. However, to aid stakeholders in identifying potential cumulative regulatory burden, DOE does list rulemakings that have proposed rules, which have tentative compliance dates, compliance levels, and compliance cost estimates. In addition, the commercial fans and blowers, furnace fans, and oil and weatherized gas furnaces, and air-cooled unitary air conditioners rulemakings identified by Lennox have not yet been proposed. The walk-in coolers and freezer (''WICF'') rulemaking was not proposed at the time of the July 2022 NOPR. A proposed rule for WICFs has since been published, and DOE added the WICF ECS NOPR rulemaking to its list of appliance standards that could contribute to cumulative regulatory burden in section V.B.2.e of this document. 88 FR 60746 (Sept. 5, 2023). The expanded scope electric motors (ESEMs) rulemaking was also still in development at the time of the July 2022 NOPR.[47] In the ESEM rulemaking, DOE is considering including expanded scope electric motors including certain permanent split capacitor (PSC) motors that exceed 0.25 horsepower and are single-speed. DOE understands that the

[46] See amendments to EPCA contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140 (enacted Dec. 19, 2007), and in the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (enacted Dec. 18, 2012).

[47] *See* Docket EERE–2020–BT–STD–0007. DOE initially used the term small, non-small electric motors (SNEMs) to designate ESEMs.

vast majority of furnace fans used in MHGFs use either electrically commutated motors (*i.e.,* ''ECMs'' which are also referred to as BPM motors in this rulemaking) or are multiple-speed PSC motors, both of which are out of the preliminary scope of the ESEM rulemaking. Thus, furnace fans used in MHGFs are not likely to be impacted by the ESEM rulemaking. In addition, DOE does not expect that any potential efficiency standard for ESEMs would impact NWGFs because the furnace fans used in those products use BPM motors, for which standards were not analyzed in the ESEMs rulemaking.

As discussed in section IV.C.2.c. of this document, the MHGF MPCs that were developed for this analysis were normalized to represent the cost of the furnace units with furnace fans that include improved PSC motors [48] at all ELs. Using the same furnace fan motor at all ELs ensures that the incremental costs between ELs are proportional only to the addition of the specific technologies associated with achieving each next-higher EL. Thus, should a baseline technology for SNEMs be finalized that is higher than the assumed improved PSC motors, this new technology would be implemented at each efficiency level. Any changes in furnace fan motor costs would impact the cost of each efficiency level for MHGFs equally. Therefore, while DOE acknowledges the potential for a small increase in MPCs for MHGFs as a result of the SNEMs rulemaking (if finalized), DOE expects that the incremental costs of MHGFs between ELs would not be impacted. Similarly, installed costs for consumers would likely increase slightly due to the increased motor cost, but an equivalent impact would be expected across all efficiency levels. Additionally, an increase in furnace fan motor efficiency would decrease the total electrical energy consumption of each MHGF in the field, but it is not expected to impact the performance of the overall furnace as measured by AFUE, and, therefore, the efficiency levels included in this analysis would not be impacted. Therefore, the conclusion of economic justification for the amended standards adopted in this final rule would be unchanged by a potential new standard for SNEMs.

In the analysis of cumulative regulatory burden, DOE considers Federal, product-specific regulations that have compliance dates within three years of one another. The compliance date for this final rule is in 2029. The compliance dates for the central air conditioners in 2023, commercial unitary air conditioners standards in 2023, commercial warm air furnace standards in 2023, VRF system test procedures in 2024, and the ''air-cooled, three-phase equipment with cooling capacity less than 65,000 Btu/h'' in 2025 occur outside the cumulative regulatory burden timeframe and are not explicitly considered in the selection of the adopted standard. The EPA ENERGY STAR programs for residential HVAC and light commercial HVAC, as well as the ENERGY STAR Cold Climate Heat Pump Controls Verification Procedure, are voluntary programs and are not considered in DOE's analysis of cumulative regulatory burden. See section V.B.2.e of this document or chapter 12 of the final rule TSD for additional information on cumulative regulatory burden.

HARDI commented that the proposed standards also do not meet the requirements under the Regulatory Flexibility Act, as DOE only assessed the impact on four small manufacturers, but not on distributors, contractors, or manufacturers of furnace supplies. HARDI stated that there are a number of small businesses that serve as furnace suppliers. (HARDI, No. 384 at pp. 3–4) NGA of Georgia similarly stated that the proposal fails to capture the negative effects on small businesses that manufacture venting and accessories for non-condensing furnaces. (NGA of Georgia, No. 380 at p. 2)

In response, DOE conducted an initial regulatory flexibility analysis in support of the July 2022 NOPR. *See* 87 FR 40590, 40698–40701 (July 7, 2022). However, NGA of Georgia and HARDI have misinterpreted the requirements of the Regulatory Flexibility Act, which requires an agency to perform a regulatory flexibility analysis of small entity impacts when a rule directly regulates the small entities, rather than a broader array of entities which may be indirectly impacted. This final rule regulates manufacturers of consumer furnaces, not the other types of businesses to which NGA of Georgia and HARDI refer. The impacts on small manufacturers of the subject consumer furnaces are presented in the final regulatory flexibility analysis, found in section VI.B of this document.

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 on consumers and manufacturers. 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 the latest version of the EIA's *Annual Energy Outlook* 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 in the following sections. *See* chapter 3 of the final rule 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:

[48] In this analysis, DOE uses ''improved PSC motors'' to refer to PSC motors with at least three airflow-control settings.

(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.2 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). For a more complete discussion of the history of this litigation and its impacts on this rulemaking, see 80 FR 13120, 13130–13132 (March 12, 2015). Therefore, in this rulemaking, DOE is only amending the energy conservation standards for these two product classes of residential furnaces (*i.e.,* NWGFs and MHGFs).

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used. DOE will also establish separate product classes if a group of products has a capacity or other performance-related feature that other products within such type do not have and such feature justifies a different standard. (42 U.S.C. 6295(q)) In determining whether a performance-related feature justifies a different standard, DOE considers such factors as the utility to the consumers of the feature and other factors DOE determines are appropriate.

At various rulemaking stages, interested parties have raised concerns pertaining to potential impacts of a nation-wide standard corresponding to condensing efficiency levels for NWGFs and MHGFs 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 NWGFs for buildings with lower heating loads, thereby helping to alleviate the negative impacts of the proposed standards. DOE responded to these comments in the since withdrawn September 2016 SNOPR, in which DOE tentatively concluded that the establishment of a small furnace class would have merit. Accordingly, after considering the energy savings and economic benefits of several potential input capacity thresholds, DOE proposed to establish a separate product class for small NWGFs, defined as those furnaces with a certified input capacity of less than or equal to 55 kBtu/h, and DOE proposed to retain a minimum standard of 80-percent AFUE for this class. 81 FR 65720, 65752 and 65837 (Sept. 23, 2016).

For the July 2022 NOPR analysis, DOE again considered whether a ''small furnace'' product class would be justified for NWGFs and MHGFs and evaluated several input capacity thresholds, including the 55 kBtu/h threshold that was proposed in the withdrawn September 2016 SNOPR, along with several others. However, DOE did not propose to divide furnace product classes by capacity. 87 FR 40590, 40665 and 40706 (July 7, 2022).

NCP commented that 95-percent AFUE standards for large NWGFs and 80-percent AFUE for small NWGFs will lead to significant energy savings while reducing the number of consumers that would experience net costs. NCP pointed to the withdrawn September 2016 SNOPR as rationale for splitting NWGFs into these two groups, where large NWGFs with input capacities greater than 55 kBtu/h have a 95-percent AFUE standard and small NWGFs with input capacities less than 55 kBtu/h have a standard of 80 percent. (NCP, No. 370 at pp. 2–3) PHCC commented that after the litigation against these regional standards, several stakeholders came to the consensus that there should be a category of small capacity non-condensing furnaces, as well as a category of larger-capacity condensing furnaces. PHCC commented that the industry submitted a proposal regarding this issue, but that the NOPR does not place much value on this proposal. (*Id.*)

For the current final rule analysis, DOE again considered whether a ''small furnace'' product class is justified for NWGFs and MHGFs and evaluated several input capacity thresholds, including at 55 kBtu/h. DOE analyzed a range of potential input capacity cut-offs and considered the benefits and burdens of each. As discussed in section V.C.1 of this document, after considering the benefits and burdens of the various approaches, DOE is finalizing its proposal to adopt a single standard level for NWGFs and a single standard level MHGFs that cover all capacities within the scope of each class.

b. Through-the-Wall Units

In response to the July 2022 NOPR, NCP commented that if DOE concludes that the separate levels for large and small NWGFs are not justified, there should be a separate class for space-constrained through-the-wall units to accommodate unique conditions for multi-family buildings. (NCP, No. 370 at p. 3) NCP noted that space-constrained through-the-wall systems are often 55 kBtu/h or less, and are installed in unique, often more expensive ways. NCP asserted that multi-family buildings with space-constrained through-the-wall HVAC systems have their condensate stacks plumbed to grade for drainage of the air conditioning portion of the unit in cooling mode and are not set up for condensate removal during heating in cold ambient conditions. NCP commented that the modifications necessary for condensing furnaces would not be feasible in new or existing multi-family constructions. (*Id.* at pp. 2–3) Additionally, NCP stated that while it makes space-constrained through-the-wall HVAC systems at 95-percent

AFUE, such systems are relatively early in their commercialization phase and cannot be used in all applications. Also, NCP commented that these systems are a relatively new technology that originated in 2015–2016. Since 2016, NCP noted that it has encountered several challenges with this technology, including freezing in low temperatures and high wind conditions. (*Id.* at p. 3)

Napoleon commented that DOE should align its standards for new installations with NRCAN's standards and create a separate category for ''through the wall'' furnaces. Napoleon suggested that DOE should require a minimum efficiency of 90-percent AFUE for these products because of their cabinet size limitations. (Napoleon, No. 374 at p. 2) Napoleon stated that it is not reasonable to require the same efficiency from ''through the wall furnaces with integrated cooling module'' products as other products that have larger cabinets because these products would likely not have the ability to produce the higher airflows that are necessary for higher efficiencies. (*Id.*)

In response, DOE notes that through-the-wall furnaces are currently included within the broader consumer furnace product classes to the extent that they meet the definitions for consumer furnaces discussed in section IV.A.1.a of this document. As discussed in section III.B of this document, when evaluating and establishing energy conservation standards, DOE may establish separate standards for a group of covered products (*i.e.,* establish a separate product class) if DOE determines that separate standards are justified based on the type of energy used, or if DOE determines that a product has a capacity or other performance-related feature that other products within such type (or class) do not have and such feature justifies a different standard. In making a determination of whether a performance-related feature justifies a different standard, DOE must consider factors such as the utility to the consumer of the feature and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)(1)) Historically, DOE has viewed utility as an aspect of the product that is accessible to the layperson and is based on user operation and interaction with the product.

DOE has identified through-the-wall furnaces rated above 96 percent AFUE that have the same dimensions as comparable non-condensing (*i.e.,* 80 percent AFUE) through-the-wall furnaces and that are marketed for the same applications.[49] Therefore, DOE concludes that 80-percent AFUE units could be readily replaced with 95-percent AFUE units (*i.e.,* the minimum efficiency level adopted in this final rule) because substitutes are available on the market having the same cabinet size. Regarding NCP's concerns about the technical challenges associated with condensate drainage and freezing, DOE notes that while certain multi-family applications may be difficult, there are installation methods to avoid freezing such as using heat tape. As discussed in section IV.F.2.b of this document, DOE accounted for additional costs for condensate drainage in these difficult installations. Consequently, DOE is not creating a separate product class for through-the-wall furnaces.

c. Condensing and Non-Condensing Furnaces

In response to the July 2022 NOPR, APGA, AGA, and NPGA all stated that DOE's failure to establish a separate product class for non-condensing residential natural gas furnaces is a violation of EPCA. (APGA, No. 387 at pp. 42–45; AGA, No. 405 at pp. 46–49; NPGA, No. 395 at p. 19) APGA expressed that it disagreed with the NOPR's conclusion to set standards at condensing levels because the legal interpretation upon which the NOPR relies to avoid EPCA's Unavailability Provisions is unreasonable and contrary to law. APGA instead argued that, if standards specific to condensing products are justified, DOE should recognize that the compatibility of a NWGF with existing atmospheric venting systems is a ''performance-related feature'' that requires separate standards for condensing and non-condensing furnaces. (APGA, No. 387 at pp. 42–45) APGA further cited EPCA provisions requiring that the standards not deprive purchasers of ''product choices and characteristics, features, sizes, etc.,'' and that energy savings are achieved ''without sacrificing the utility or convenience of appliances to consumers.'' (APGA, No. 387 at p. 42–45) AGA commented that the new proposed rule wrongfully asserts that the differing constraints and functionality between condensing and non-condensing appliances do not constitute performance-related features. AGA further urged DOE to correct its ''flawed interpretation'' of EPCA to treat condensing and non-condensing products as being in the same class. (AGA, No. 405 at pp. 32–38) AGA encouraged DOE to follow its past practices by continuing to recognize non-condensing furnaces that function in homes constrained by existing exhaust and plumbing systems as a separate class from condensing products. (AGA, No. 405 at pp. 46–49) NPGA stated that there have been other instances of DOE creating separate product classes where standards would otherwise deprive purchasers of products that could not be installed without the need to change the space provided for an appliance and cited these as precedent for separate non-condensing and condensing product classes (*e.g.,* ''space-constrained'' central air conditioners, package terminal air conditioners (PTACs), and ventless clothes dryers). (NPGA, No. 395 at pp. 21–22) NPGA stated that the NOPR sets a *de facto* standard for building design by requiring the alteration of building venting systems, which is beyond the scope of DOE's statutory authority. (NPGA, No. 395 at p. 22) NPGA suggested that the proposed standard will make furnaces incompatible with millions of homes without substantial renovations. (NPGA, No. 395 at pp. 9–10)

Spire commented that DOE should recognize that the compatibility of a product with existing atmospheric venting systems is a ''performance-related feature,'' which would require separate standards for condensing and non-condensing products if standards specific to condensing products are justified. (Spire, No. 413 at p. 21) Spire and AGA formally requested that any final rule in this proceeding include a written finding that interested persons have established that the proposed standards are likely to result in the unavailability in the United States of residential furnaces with ''performance characteristics (including reliability, features, sizes, capacities, and volumes) that are substantially the same as those generally available in the United States.'' (Spire, No. 413 at p. 20; AGA, No. 405 at pp. 49–50)

HARDI commented that the proposed standards will have an adverse impact on consumers in terms of utility. (HARDI, No. 384 at p. 4) HARDI stated its opposition to DOE's decision to revert to its prior interpretation related to non-condensing technology (and associated venting), as expressed in the December 2021 Final Interpretive Rule. (*Id.*) HARDI commented that, for many existing homes and some new construction applications, condensing furnaces provide negative utility for consumers because the venting system will need to be changed, which, in turn,

[49] See *app.salsify.com/catalogs/73d44623-0667-454c-a453-3b3faaf8d4d1/products/P-S26A-F12A-A* and *app.salsify.com/catalogs/73d44623-0667-454c-a453-3b3faaf8d4d1/products/P-C50A-F18A-A* (last accessed May 31, 2023).

changes the living spaces; HARDI stated that this could negatively impact consumers. HARDI also commented that non-condensing furnaces prevent the consumer from needing heat tape and other freeze-mitigation equipment, and added that the need to constantly heat the venting system would be impractical for consumers who only use heating equipment part-time. (HARDI, No. 384 at pp. 4–5)

The Joint Market and Consumer Organizations also commented that they oppose the elimination of non-condensing products and stated that EPCA prohibits any new or amended standard if the Secretary finds, by a preponderance of evidence, that it is ''likely to result in the unavailability in the United States. . . of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States at the time of the Secretary Finding.'' [50] (Joint Market and Consumer Organizations, No. 373 at p. 3) The Joint Market and Consumer Organizations stated that this provision can be interpreted to disallow natural gas furnace standards so stringent that they effectively force non-condensing versions off the market in favor of condensing furnaces with very different characteristics that make them incompatible with some homes. (*Id.* at p. 3) AGA, Spire, and the Marley Companies also stated a belief that EPCA 42 U.S.C. 6295(o)(4) prohibits the elimination of non-condensing fuel-fired appliances. (AGA No. 405 at pp. 49–50; Spire, No. 413 at pp. 2–5; The Marley Companies, No. 386 at p. 5) Spire commented that the proposed standards would ultimately require efficiencies that only condensing furnaces can achieve and claimed that the proposed rulemaking would also violate EPCA 42 U.S.C. 6295(o)(2). (Spire, No. 413 at pp. 2–5) Spire also noted that the Unavailability Provision of EPCA cannot be avoided by simply adjusting installation costs within the economic analysis. (Spire, No. 413 at pp. 20–21) The Marley Companies commented that non-condensing products utilizing natural draft venting provide advantages and must remain available for several reasons related to product continuity, utility, and availability. (The Marley Companies, No. 386 at p. 5)

With respect to product availability, the Marley Companies commented that many residential applications cannot support upgrading the existing venting system as would be required for non-natural draft venting or higher-efficiency products. (The Marley Companies, No. 386 at p. 5) PHCC commented that it opposes the elimination of non-condensing products due to venting issues, difficult installations, and some questions PHCC has regarding the accuracy of DOE's analysis. (PHCC, No. 403 at p. 6) The Coalition commented that the need to use condensing furnaces will require physical design changes of some housing types that can become more problematic in multifamily and entry-level homes. (The Coalition, No. 378 at p. 4) The Coalition added that condensing furnaces typically require larger cabinets, different and larger venting/combustion air intake systems, and condensate drain systems. (*Id.*) APGA and Spire commented they have demonstrated that condensing products are incompatible with many existing buildings in which non-condensing natural gas furnaces are installed. (APGA, No. 387 at p. 43–45; Spire, No. 413 at p. 3)

In response, when evaluating and establishing energy conservation standards, DOE is required to establish product classes based on: (1) the type of energy used; and (2) capacity or other performance-related feature which other products within such type (or class) do not have and that DOE determines justify a different standard. In making a determination of whether a performance-related feature justifies a different standard, the Department must consider factors such as the utility to the consumer of the feature and other factors DOE determines are appropriate. (42 U.S.C. 6295(q))

With respect to commenters' statements that category I venting itself is a performance-related feature that justifies a separate product class, DOE first notes that venting, like a gas burner or heat exchanger, is one of the basic components found in every gas-fired furnace (condensing or noncondensing). As such, assuming venting is a performance-related feature, it's a feature that all gas-fired furnaces possess. As a result, it cannot be the basis for a product class. *See* 42 U.S.C. 6295(q)(1)(B). Thus, in order to meet the product class requirements in 42 U.S.C. 6295(q)(1)(B), APGA and other commenters are requesting DOE determine that a specific type of venting is a performance-related feature.

In response, DOE first notes that almost every component of a covered product could be broken down further by any of a number of factors. For example, heat exchangers, which are used in a variety of covered products, could be divided further by geometry or material; refrigerator compressors could be further divided by single-speed or variable-speed, and air-conditioning refrigerants could be further divided by global warming potential. As a general matter, energy conservation standards save energy by removing the least-efficient technologies and designs from the market. For example, DOE set energy conservation standards for furnace fans at a level that effectively eliminated permanent split capacitor (PSC) motors from several product classes, but which could be met by brushless permanent magnet (BPM) motors, which are more efficient. 79 FR 38130 (July 3, 2014). As another example, DOE set energy conservation standards for microwave oven standby mode and off mode at a level that effectively eliminated the use of linear power supplies, but which could be met by switch-mode power supplies, which exhibit significantly lower standby mode and off mode power consumption. 78 FR 36316 (June 17, 2013). The energy-saving purposes of EPCA would be completely frustrated if DOE were required to set standards that maintain less-efficient covered products and equipment in the market based simply on the fact that they use a specific type of (less efficient) heat exchanger, motor, power supply, *etc.*

As discussed in the December 2021 final interpretive rule, DOE believes that a consumer would be aware of performance-related features of a covered product or equipment and would recognize such features as providing additional benefits during operation of the covered product or equipment. 86 FR 73955. Using the previous example of furnace fan motors, if an interested person had wanted to preserve furnace fans with PSC motors in the market, they would have had to show that furnace fans with PSC motors offered some additional benefit during operation as compared to furnace fans with BPM motors. Refrigerator-freezers, on the other hand, are an example of where DOE determined that a specific type of performance-related feature offered additional benefit during operation. Some refrigerator-freezers have automatic icemakers. Additionally, some automatic icemakers offer through-the-door ice service, which provides consumers with an additional benefit during operation. As such, DOE further divided refrigerator-freezers into product classes based on the specific type of automatic icemaker (*i.e.,* whether the automatic icemaker offers through-the-door ice service). *See* 10 CFR 430.32(a).

[50] The commenter included a citation to 42 U.S.C. 6295(o)(4) for the referenced provision.

Commenters have not pointed to any additional benefits during operation offered by furnaces that use category I venting as compared to furnaces that use other types of venting. Instead, these commenters generally cite compatibility with existing venting and other economic considerations as reasons why category I venting should be considered a performance-related feature for the purposes of EPCA's product class provision. unavailability provision.

As stated previously, DOE's performance-related feature analysis is not based on considerations (including design parameters) that do not provide the consumer additional benefit during operation. Nor does it account for costs that anyone, including the consumer, manufacturer, installer, or utility companies, may bear. DOE has reasoned that this approach is consistent with EPCA's requirement for a separate and extensive analysis of economic justification for the adoption of any new or amended energy conservation standard (*see* 42 U.S.C. 6295(o)(2)(A)–(B) and (3)). Specifically with regard to venting, DOE has determined that differences in cost or complexity of installation between different methods of venting (*e.g.,* a condensing furnace versus a non-condensing furnace) do not make specific methods of venting a performance-related feature under 42 U.S.C. 6295(o)(4), as would justify separating the products/equipment into different product/equipment classes under 42 U.S.C. 6295(q)(1). 86 FR 73947, 73951 (Dec. 29, 2021). Accordingly, because DOE views the issues related to condensing vs. noncondensing technology (and associated methods of venting) to be matters of cost, the Department finds it appropriate under the statute to address these issues through the rulemaking's economic analysis. 86 FR 73947, 73951 (Dec. 29, 2021). This interpretation is consistent with EPCA's requirement for a separate and extensive analysis of economic justification for the adoption of any new or amended energy conservation standard (*see* 42 U.S.C. 6295(o)(2)–(3); 42 U.S.C. 6313(a)(6)(A)–(C); 42 U.S.C. 6316(a)). Comments on the July 2022 Furnaces NOPR have provided no new arguments or other information that were not already considered as part of the December 2021 Final Interpretive Rule. As such, DOE continues to find that there is no basis for altering the Department's approach regarding the establishment of product classes for this rulemaking.

DOE has found in its analysis of installation costs (as discussed in further detail in section IV.F.2 of this document) that thanks to various technological solutions, virtually all homes can accommodate a condensing furnace, although some small percentage may face significant installation costs. DOE accounts for these costs in its economic analysis. In all cases, consumers have a variety of choices to meet their space-heating needs, and the standards promulgated in this final rule do not eliminate any ''performance-related features.''

Thus, for the reasons previously explained, DOE declines the requests of AGA and Spire that in this final rule the agency include a written finding that interested persons have established by a preponderance of the evidence that the proposed standards are likely to result in the unavailability in the U.S. of residential furnaces with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States on the date any such rule issues, because that burden of proof has not been met in the present case. *See* 42 U.S.C. 6295(o)(4). For similar reasons, DOE declines Spire's request that DOE recognize that the compatibility of a product with existing atmospheric venting systems is a ''performance-related feature'' that would require separate standards for condensing and non-condensing products. Because DOE has determined that non-condensing technology (and associated venting) does not constitute a performance-related feature for consumer furnaces, such actions would not be appropriate pursuant to EPCA.

As DOE has stated previously, EPCA directs DOE to regulate the energy efficiency of a multitude of disparate covered products and equipment that are not always directly comparable. Consequently, consideration of class-setting and performance-related features tends to be product-specific. NPGA's assertion that DOE's proposed furnace standards would amount to a *de facto* building design standard is incorrect and a mischaracterization of DOE's rulemaking, as is its contention that furnace installation costs are different in nature from those of other appliances. Installation costs are always unique to location, and DOE has a well-developed methodology for estimation of installation costs that has been used for many years (*see* chapter 8 and appendix 8D of the final rule TSD). DOE has concluded that in most cases, a condensing furnace may be installed with reasonable installation costs, and there would almost always be a technological solution to accomplish that (*e.g.,* such as through use of DuraVent FasNSeal or a draft inducer paired with a chimney liner). In cases where the consumer perceives such costs to be too high, the consumer may opt to convert to another type of space-heating appliance (*e.g.,* a heat pump or electric resistance heating).

As mentioned, NPGA has pointed to other DOE rulemakings involving space-constrained products and equipment (*e.g.,* central air conditioners, package terminal air conditioners (PTACs), and ventless clothes dryers) as analogous to consumer furnaces. AGA similarly mentioned DOE's prior furnace fans rulemaking as analogous. However, the present case of non-condensing gas-fired residential furnaces is distinguishable from these other products cited by these commenters for the reasons that follow.

Regarding ventless clothes dryers, DOE established separate product classes because some clothes dryers had a performance-related feature (ventless operation) that other clothes dryers (vented) did not, and such feature justified a different standard. As stated previously, condensing and non-condensing gas furnaces both require venting. As such, establishing separate product classes for vented and ventless clothes dryers is simply not analogous to establishing separate product classes for gas furnaces based on specific types of venting.

With regard to compact clothes dryers, the ''compact'' delineation relates directly to the size and capacity of the product—two attributes explicitly listed in the ''features'' provision. (*See* 42 U.S.C. 6295(o)(4)) This difference in size and capacity is recognized by the consumer in operation of the product (*i.e.,* by limiting the amount of wet clothes which can be processed per cycle). Moreover, DOE determined that compact-size clothes dryers have inherently different energy consumption than standard-size clothes dryers. 76 FR 22454, 22485 (April 21, 2011). Consistent with the specific recognition that size and capacity are relevant features, DOE has routinely set product classes based on size or capacity, including standards for consumer water heaters, 10 CFR 430.32(d), which separate standards by storage volume and input capacity; standards for room air conditioners, 10 CFR 430.32(b), which distinguish several product classes by cooling capacity; and standards for dishwashers and clothes washers, 10 CFR 430.32(f) and (g), respectively, which both distinguish between standard and compact products.

In establishing a separate product class for space-constrained central air conditioners, DOE recognized the space constraints faced by these products and that the efficiency of such products is limited by physical dimensions that are rigidly constrained by the intended application. 76 FR 37408, 37446 (June 27, 2011). Space-constrained central air conditioners have an indoor or outdoor unit that is limited in size due to the location in which the unit operates. As a result, space-constrained central air conditioners lack the flexibility of other central air conditioners to increase the physical size of the unit, thereby limiting the ability of space-constrained units to achieve improved efficiency through use of a larger coil. *Id.* In establishing standards for space-constrained central air conditioners, DOE discussed the expense of modifying an exterior opening to accommodate a larger unit, but such discussion did not abrogate DOE's determination that space-constrained central air conditioners provide centralized air conditioning in locations with space constraints that would preclude the use of other types of central air conditioners. *Id.* In contrast, the subject non-condensing residential furnaces are not significantly different in overall footprint, size, or heating capacity from their condensing counterparts [51] (although the composition of the venting used may be different), and the energy efficiency differences are a result of the technology used, a design parameter that is dictated by considerations other than size.

With regard to the equipment classes for PTACs, in its prior rulemaking, DOE found that the size of the heat exchanger directly affects the energy efficiency of the equipment. 73 FR 58772, 58782 (Oct. 7, 2008). Like space-constrained central air conditioners, the location of operation of a PTAC directly influences the size of the equipment, which impacts the size of the heat exchanger and has a corresponding direct effect on the energy efficiency of the equipment. *Id.* DOE acknowledged the potentially high costs that would be associated with installing a non-standard sized PTAC in an existing building due to the need to increase the wall opening (*i.e.,* the wall sleeve) in which a replacement PTAC is installed. *Id.* As explained in a subsequent rulemaking for PTACs, DOE further clarified that it accounts for installation costs in the life-cycle cost (LCC) and payback period (PBP) analyses used to evaluate increased standard levels, which is a separate and distinct consideration from whether separate product classes are justified. 80 FR 43162, 43167 (July 21, 2015). Consideration of installation costs in the LCC and PBP analysis used for evaluating an increased energy conservation standard level is consistent with the application of 42 U.S.C. 6295(o)(4) and 6295(q)(1) adopted in the December 2021 Final Interpretive Rule.

The furnace fan product classes also are not analogous to residential furnaces that rely on non-condensing technology. Furnace fans are electrically powered devices used in consumer products for the purpose of circulating air through ductwork. 10 CFR 430.2. A furnace fan operates to allow the furnace in which it is installed to function. The references to condensing and non-condensing in the furnace fan product classes do not reflect a difference in utility between condensing and non-condensing furnaces, but rather reflect the differences between the operation of a furnace fan installed in a condensing furnace as compared to a furnace fan installed in a non-condensing furnace. In establishing the energy conservation standards for furnace fans, DOE differentiated between furnace fan product classes based on internal structure and application-specific design differences that impact furnace fan energy consumption. 79 FR 38130, 38142 (July 3, 2014). The internal structures differ for a furnace fan installed in a condensing furnace, as compared to a furnace fan installed in a non-condensing furnace. The presence of an evaporator coil or secondary heat exchanger, as in a condensing furnace, significantly impacts the internal structure of an HVAC product, and in turn, the energy performance of the furnace fan integrated in that HVAC product. *Id.* These differences result in different energy use profiles for furnace fans suitable for installation in condensing furnaces, as compared to furnace fans suitable for installation in non-condensing furnace, which justifies the separate product classes.

Overall, the examples of ventless dryers, space-constrained air conditioners, PTACs, and furnace fans involved subsets of the product or equipment type in question that had different physical and energy-consumption characteristics and that were designed to address specific applications. DOE determined that these situations met the applicable statutory requirements and, accordingly, warranted separate product/equipment classes. In contrast, the consumer furnaces rulemaking involves products of essentially the same size that could operate in any space-heating application. Maintaining a separate product class for non-condensing furnaces would allow the less-efficient furnaces to remain available not only to consumers facing difficult installation situations, but to all consumers. Establishment of a separate product class for non-condensing furnaces would run counter to EPCA's purposes to ''conserve energy supplies'' and for ''improved energy efficiency of . . . major appliances.'' (42 U.S.C. 6201(4) and (5))

NPGA, PHCC, the Coalition, Marley Companies, Spire, HARDI, and AGA have not provided estimates as to the number of installation situations they would consider to be problematic, instead choosing to focus on the qualitative impact of what DOE assesses to be a relatively small number of cases. DOE disagrees with AGA's assertion that the Department has not properly accounted for the necessary changes related to venting of consumer furnaces or common venting of multiples appliances, including consumer water heaters. Further details regarding DOE's estimates of total installation costs are provided in section IV.F.2 of this document and in chapter 8 and appendix 8D of the final rule TSD.

d. Mobile Home Gas Furnaces

In response to the July 2022 NOPR, AHRI commented that several design differences between MHGFs and NWGFs make it possible for DOE to establish different AFUE standards for MHGFs and NWGFs without meaningful risk that MHGFs would be used outside of mobile homes or create a ''loophole'' for NWGFs. (AHRI, No. 414–2 at pp. 2–3) AHRI stated that MHGFs are specialized products meant to be operated only in mobile home applications under the U.S. Department of Housing and Urban Development (''HUD'') code, adding that no interior air is used for the combustion process and that non-condensing MHGFs are mostly all downflow. (AHRI, No. 414–2 at p. 2)

Nortek encouraged DOE to withdraw the NOPR and consult with HUD, MHI, and the Manufactured Housing Consensus Committee (MHCC) in setting standards for MHGFs. (Nortek, No. 406 at p. 6) Nortek commented that it does not find a problem with different standard levels for manufactured housing and NWGFs because physical size differences prevent MHGFs from being installed in NWGF applications. Additionally, Nortek mentioned that the new M1 [52] labeling requirements state that equipment designed for

[51] DOE surveyed the dimensions of consumer furnaces and found the height and diameter dimensions comparable. See chapter 5 of the TSD.

[52] The commenter was referring to DOE's test method for measuring the energy consumption of central air conditioners and heat pumps, located at 10 CFR part 430, subpart B, appendix M1.

manufactured housings must be labelled ''for installation only in HUD manufactured home[s]. . . .'' Nortek also stated that there are application differences between MHGFs and NWGFs (*e.g.,* downflow versus upflow); therefore, Nortek is not concerned that manufactured home gas furnaces will be utilized in other residential applications if the minimum efficiency levels differ. (Nortek, No. 406 at pp. 4–5) JCI similarly commented that there are dimensional and configuration differences between MHGFs and NWGFs (upflow airflow versus downflow airflow). JCI provided an example, where the MHGF is 23 inches (in.) deep by 76 in. high by 19.5 in. wide and has a downflow configuration, but the NWGF is 29 in. deep by 33 in. high and between 14.5 in. and 24.5 in. wide for various configurations. JCI asserted that NWGFs could not reasonably be applied in mobile home applications without overcoming significant structural barriers and voiding the warranty. (JCI, No. 411 at pp. 2–3) Mortex added that the typical downflow furnace footprint for MHGFs is 24 in. deep by 20 in. wide, which is very different from standard residential furnaces that tend to be 29 in. deep by 17, 21, or 24 in. wide. (Mortex, No. 410 at p. 2)

The CA IOUs commented that a review of manufacturer literature on MHGFs suggests that the proposed standard level will not increase product size or adversely affect the range of available input capacities. (The CA IOUs, No. 400 at p. 2) Additionally, Sierra Club *et al.* commented that nothing in EPCA obligates DOE to seek input or approval from the Department of Housing and Urban Development or the Manufactured Housing Consensus Committee. Sierra Club *et al.* commented that any assertions to the contrary ignore DOE's obligation under EPCA to review and update its existing standards for mobile home gas furnaces. (Sierra Club *et al.,* No. 401 at p. 3)

DOE is aware of the different applications served by MHGFs and NWGFs and agrees with stakeholders that there are specific requirements that must be met for classification as an MHGF and that some MHGFs have a different footprint than is typical of NWGFs.[53] Because NWGFs and MHGFs are separate product classes, they have been analyzed separately for this final rule. However, as discussed in section V.A DOE groups products into TSLs because use of TSLs allows DOE to identify and consider 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 standard levels are set. In the present case, DOE evaluated similar levels in each TSL for NWGFs and MHGFs and considered the TSL as a whole, but also weighed the merits of the adopted 95-percent AFUE levels for each class separately. Therefore, while DOE is cognizant of interactions between the classes, the primary motivation for adopting 95-percent AFUE for MHGFs was not to avoid a ''loophole'' whereby NWGF consumers would choose to install MHGFs if they were available at lower efficiencies and costs. Rather, it was because the 95-percent AFUE level is technologically feasible and economically justified for both NWGFs and MHGFs. See section V of this document for further discussion on the selection of the final standard levels for this final rule.

In response to comments regarding consultation with HUD, MHI, and MHCC, DOE notes that all stakeholders, including trade associations, have the opportunity to provide DOE with comments, data, and other input through both the public webinars and written comment periods throughout the duration of the rulemaking. DOE takes all input received into consideration in the analysis for amending standards, and therefore does not consult with individual groups in its rulemaking process.

2. Technology Options

In the market analysis and technology assessment for the July 2022 NOPR, DOE 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 the July 2022 NOPR, DOE also considered three technology options that could potentially reduce the standby mode and off mode energy consumption of NWGFs and MHGFs. However, for the reasons explained in section III.A.8 of this document, DOE has determined that it cannot establish standby mode and off mode standards that meet the criteria of EPCA at this time, so such technologies and standards are not considered further in this final rule.) 87 FR 40590, 40615 (July 7, 2022). DOE did not identify any additional technology options between the publication of the July 2022 NOPR and this final rule. A detailed discussion of each technology option identified is contained in chapter 3 of the final rule TSD.

DOE considered each technology further in the screening analysis (*see* section IV.B of this document or chapter 4 of the final rule 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 commercially viable, existing prototypes will not be considered further.

(2) *Practicability to manufacture, install, and service.* If it is determined that mass production of a technology in commercial products and reliable installation and servicing of the technology 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.* If a technology is determined to have a significant adverse impact on the utility of the product to subgroups of consumers, or result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

(4) *Safety of technologies.* 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 technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it 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).

[53] However, DOE has also identified MHGFs that are essentially identical to a corresponding NWGF model and require only a conversion kit to be installed as an MHGF.

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed 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 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. DOE did not receive any comments pertaining to the screening analysis in response to the July 2022 NOPR.

1. Screened-Out Technologies

For this analysis of amended AFUE standards, DOE has screened out the following technologies: pulse combustion and burner de-rating. Each of these will be discussed in turn.

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 have resulted in manufacturers generally not considering pulse combustion as 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.

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 the July 2022 NOPR, DOE identified NWGF furnaces with premix burners on the market and, therefore, did not screen 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 [54] 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 level are discussed further in section IV.C.1 of this finale rule. Chapter 4 of the TSD includes additional information on the screening analysis.

2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the other identified technologies listed in section IV.A.2 met all five screening criteria to be examined further as design options in DOE's final rule 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 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 finds that all of the remaining technology options meet the other screening criteria (*i.e.,* practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety, 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 final rule TSD.

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

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 products, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each product class, DOE estimates the baseline cost,[55] as well as the incremental cost for the product at efficiency levels above the baseline efficiency. 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 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 an 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 efficiency, the price to 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 both condensing furnaces without ''premium'' features

[55] The baseline cost reflects the expenses associated with a baseline model. DOE defines a ''baseline model'' as a model in each product class that represents the characteristics of products typical of that class (*e.g.,* capacity, physical size) and that has an efficiency equal to the current Federal energy conservation standard.

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 additional designs or features 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 so to provide consumers with a lowest-cost option with only essential functionality. This approach aligns with feedback received during manufacturer interviews that manufacturers would continue to differentiate between premium and value units to best serve all segments of the market, and would invest in optimizing the cost of certain product offerings for consumers that are highly sensitive to the upfront cost. Therefore, DOE concluded that increasing AFUE energy conservation standards would not necessarily increase the presence of ''premium'' features on furnaces in the market.

DOE's analysis and decision 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 final rule 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 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)) Accordingly, bills of materials (BOMs) are generated by a DOE contractor using the manufacturer-specific and product-specific data to estimate the industry-aggregate MPCs. DOE's contractor conducts interviews with manufacturers under non-disclosure agreements (''NDAs'') to determine whether the MPCs developed by the analysis reflect the industry average manufacturing costs. 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 and are not released outside the aggregated form to DOE or its National Labs. This approach allows manufacturers to provide candid and detailed feedback under NDA, thereby improving the quality of the analysis. 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 were published in the July 2022 NOPR and available to the public for review and comment. 87 FR 40590, 40621 (July 7, 2022).

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 interpolate to define ''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).

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.

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 model. 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 final rule TSD.

Table IV.1 presents the baseline AFUE levels identified for each product class of furnaces addressed by this rulemaking. The baseline AFUE levels 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

b. Higher Efficiency Levels

As part of DOE's analysis, the maximum available efficiency level is the highest efficiency unit currently available on the market. DOE also defines a ''max-tech'' efficiency level to represent the maximum possible efficiency for a given product. Tables IV.2 and IV.3 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. Since the July 2022 NOPR, DOE has identified new models of NWGFs certified in DOE's Compliance Certification Database (CCD)[56] with efficiencies up to 99-percent AFUE and of MHGFs certified with efficiencies up to 97-percent AFUE. However, there is only one model of NWGF at 99-percent AFUE, at only one input size. Several other models from the same model family do not achieve 99-percent AFUE. Therefore, at the time of this final rule analysis, it is unclear whether 99 percent would be an appropriate max-tech level for all NWGFs that is achievable across a range of input capacities, and, as a result, DOE maintained the same maximum efficiency level for NWGFs as in the July 2022 NOPR (*i.e.,* 98-percent AFUE). Similarly, there are only two input capacities of MHGFs that would exceed a 97-percent efficiency level, and these models are from the same model line, but several other models at other input capacities within that same model line do not achieve 97-percent AFUE. Therefore, it is at present uncertain as to whether 97-percent AFUE would be an appropriate max-tech level for all MHGFs, so DOE maintained the same maximum efficiency level for MHGFs as in the July 2022 NOPR (*i.e.,* 96-percent AFUE). Therefore, the maximum efficiency level analyzed for both NWGFs and MHGFs has been maintained at a level representing the highest-efficiency models available on the market when DOE began this analysis as outlined in chapter 3 of the final rule TSD.

TABLE IV.2—AFUE EFFICIENCY LEVELS FOR NON-WEATHERIZED GAS FURNACES

Efficiency level (EL)	AFUE (%)	Technology options
0—Baseline	80	Baseline.
1	90	EL 0 + Secondary condensing heat exchanger.
2	92	EL 1 + Increased heat exchanger area.
3	95	EL 2 + Increased heat exchanger area.
4—Max-Tech	98	EL 3 + Increased heat exchanger area + Step-modulating combustion + Constant-airflow BPM blower motor.

TABLE IV.3—AFUE EFFICIENCY LEVELS FOR MOBILE HOME GAS FURNACES

Efficiency level (EL)	AFUE (%)	Technology options
0—Baseline	80	Baseline.
1	90	EL 0 + Secondary condensing heat exchanger.
2	92	EL 1 + Increased heat exchanger area.
3	95	EL 2 + Increased heat exchanger area.
4—Max-Tech	96	EL 3 + Increased heat exchanger area.

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 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 neither a physical nor catalog teardown is feasible (*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 MPCs for products at various efficiency levels spanning the full range of

[56] U.S. Department of Energy Compliance Certification Management System (''CCMS'') (available at *www.regulations.doe.gov/certification-data/*) (last accessed March 22, 2023).

efficiencies from the baseline to the maximum technology achievable 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. In advance of the July 2022 NOPR, a second round of interviews was held in 2021, in part to gain additional insight for updating the cost analysis to reflect current conditions. DOE used the information gathered from these interviews, along with the information obtained through the teardown analysis, to develop its updated MPC estimates. For this final rule, DOE updated its analysis to incorporate the most recent input data (*e.g.,* raw materials, purchased components, labor) in its BOMs (and, correspondingly, in the MPC estimates derived from those BOMs). DOE performed an additional 23 physical teardowns for the July 2022 NOPR. DOE also incorporated additional physical teardowns from previous analyses into the analysis for this rulemaking when the designs and components of those units reflect those observed in products currently available on the market. For additional detail about the models used for teardowns, see chapter 5 of the final rule TSD.

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer mark-up) to the MPC. The resulting manufacturer selling price (''MSP'') is the price at which the manufacturer distributes a unit into commerce. DOE initially developed an average manufacturer mark-up by examining the annual Securities and Exchange Commission (''SEC'') 10–K [57] 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. The manufacturer mark-ups were used to convert the MPCs into MSPs. Further information on this analytical methodology is presented in the following subsections.

a. Teardown Analysis

To assemble BOMs and to calculate 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 to manufacture 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 final rule, data from 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 that incorporates all materials, components, and fasteners (classified as either raw materials or purchased parts and assemblies), and characterizes 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.c 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 final rule TSD.

b. Cost Estimation Method

The costs of individual models are estimated using the content of the BOMs (*i.e.,* relating to materials, fabrication, labor, and all other aspects that make up a production facility) to generate MPCs. The resulting MPCs include costs such as overhead and depreciation, in addition to materials and labor costs. DOE collected information on labor rates, tooling costs, raw material prices, and other factors to use 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 five-year averages to smooth out spikes in demand. Other raw materials, such as plastic resins and insulation materials, are estimated on a current-market basis. The costs of raw materials are determined 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.,[58] PolymerUpdate,[59] the U.S. geologic survey (''USGS''),[60] and the Bureau of Labor Statistics (''BLS'').[61] 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 the MIA (*see* section IV.J of this document).

Tables IV.4 and IV.5 present DOE's estimates of the MPCs by AFUE efficiency level at the representative input capacity (80 kBtu/h) for both NWGFs and MHGFs. The MPCs at each efficiency level incorporate the design characteristics of NWGFs and MHGFs shown in Tables IV.2 and IV.3. DOE

[57] 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).

[58] For more information on MEPS Intl, please visit *www.mepsinternational.com/gb/en* (last accessed March 21, 2023).

[59] For more information on PolymerUpdate, please visit *www.polymerupdate.com* (last accessed March 21, 2023).

[60] For more information on USGS metal price statistics, please visit *www.usgs.gov/centers/national-minerals-information-center/commodity-statistics-and-information* (last accessed March 21, 2023).

[61] For more information on the BLS producer price indices, please visit *www.bls.gov/ppi/* (last accessed March 21, 2023).

observed in its market analysis that products are available on the market with a mix of blower motor technologies, including constant torque brushless permanent magnet (''BPM'') motors, constant airflow BPM motors, and (for MHGFs), PSC 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 between the individual units torn down and across efficiency levels and allow for estimation of the cost differences between models with different blower technologies. DOE normalized the costs of the blower assemblies in its teardown models, and then used these adders in its LCC analysis to account for the distribution of blower motor technologies expected to be sold on the market (*see* section IV.F of this document). For NWGFs, DOE used constant-torque BPM motors as the baseline design option for all efficiency levels except the max-tech level, which was always assumed to use a constant airflow BPM motor. All MHGFs were modeled with improved PSC motors as the normalized design option. These adders are discussed in more detail in chapter 5 of the TSD accompanying this rule.

Similarly, in its market analysis and teardown analysis, DOE observed models with single-stage, two-stage, and modulating operation. Therefore, DOE normalized its engineering analysis costs to reflect single-stage designs (with the exception of max-tech NWGFs, which were all assumed to use modulating designs) but also developed a cost adder for two-stage and modulating combustion systems (as compared to single-stage models) that was used in the LCC analysis to account for the distribution of models with two-stage and modulating combustion. 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 similarly normalized the costs, when necessary, to account for the presence any premium controls or features that would increase cost but are not needed for improving efficiency.

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 final rule TSD.) Using this information, DOE then developed cost adders to reflect the cost difference between NWGF and MHGF models, and applied this cost adder to the NWGF MPCs in order to estimate the MPCs of MHGFs at each of the MHGF efficiency levels.

Table IV.4 presents the MPCs for NWGFs 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). Table IV.5 presents the MPCs for MHGFs with an improved PSC and single-stage combustion. DOE has determined that these designs are likely the most representative of furnaces on the current market, although DOE recognizes there are some exceptions. As discussed in this section, DOE has observed that a variety of blower motor technologies and burner system stages exist on the market, so DOE developed adders to translate MPCs across various technologies.

TABLE IV.4—MANUFACTURER PRODUCTION COST FOR NON-WEATHERIZED GAS FURNACES AT THE REPRESENTATIVE INPUT CAPACITY OF 80 kBtu/h

Efficiency level	Efficiency level (AFUE) (%)	MPC (2022$)	Incremental cost above baseline (2022$)
Baseline	80	335	
EL1	90	420	85
EL2	92	428	93
EL3	95	444	109
EL4	98	572	216

TABLE IV.5—MANUFACTURER PRODUCTION COST FOR MOBILE HOME GAS FURNACES AT THE REPRESENTATIVE INPUT CAPACITY OF 80 kBtu/h

Efficiency level	Efficiency level (AFUE) (%)	MPC (2022$)	Incremental cost above baseline (2022$)
Baseline	80	360	
EL1	90	441	81
EL2	92	450	90
EL3	95	466	106
EL4	96	471	111

JCI commented that DOE should work with MHI and HUD to get cost and buyer data for MHGF replacements and reevaluate whether a 95-percent AFUE standard is appropriate based on those findings. (JCI, No. 411 at p. 2)

In response, DOE notes that it conducted the engineering analysis for this final rule using a combination of physical and catalog teardowns. As discussed in section IV.C.2 of this document, DOE only relies on price surveys as the basis for the engineering analysis if neither physical nor catalog teardowns are feasible, or if these options are cost-prohibitive and otherwise impractical. The resulting MPCs do not include manufacturer mark-ups and will not reflect prices seen by consumers. DOE estimates and applies additional markups to its MPCs, as discussed in sections IV.C.2.e and IV.D of this document. Additionally, 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 concluded that using prices of furnaces as currently seen in the marketplace, as JCI suggested, would not be an accurate method of estimating future furnace prices following an amended standard and, in turn, validating DOE's approach of conducting an engineering analysis and mark-ups analysis for this final rule.

Daikin commented that there is a higher burden on manufacturers than DOE estimated because DOE does not consider that NWGFs with higher AFUE take more time to assemble due to: (1) more components, (2) higher complexity, (3) tighter assembly requirements, and (4) more end-of-line testing. (Daikin, No. 416 at p. 3)

JCI commented that the DOE fan energy rating (FER) rule and recent supply chain issues have increased MHGF MPCs by more than 42 percent between 2018 and 2021, and by 36 percent for NWGFs. (JCI, No. 411 at p. 2)

Lennox commented that it found that DOE's MPCs generally reflect the correct costs in 2020, except for the difference between EL 2 at 92-percent AFUE and EL 3 at 95-percent AFUE, which it believes to be too low. (Lennox, No. 389 at p. 7) Lennox stated that this cost difference should be increased by 50 to 70 percent. (*Id.*) Lennox further commented that inflation has increased these costs more than 15 percent since 2020. (*Id.*)

In response to Daikin, DOE notes that its estimates for labor costs associated with higher-efficiency NWGFs are based on available industry data, as well as manufacturer feedback received during confidential interviews. Increased assembly and fabrication time, different components and processes, and all other change associated with higher efficiency levels for NWGFs are accounted for and reflected in the cost estimates for labor and, in turn, the overall MPC estimates. In addition, DOE agrees with JCI and Lennox that furnace MPCs have increased in recent years, and notes that the MPCs developed for this NOPR are higher than those in the NOPR, primarily due to changes in component and raw material prices.

In the July 2022 NOPR, DOE requested comment on the designs of the secondary heat exchanger (including any recent design changes), as well as the cost of AL29–4C stainless steel. 87 FR 40590, 40705 (July 7, 2022). In response, Lennox stated that it regards AL29–4C stainless steel, which is used in Lennox condensing furnaces, as the standard for secondary heat exchangers due to its corrosive-resistant properties. (Lennox, No. 389 at p. 7) As discussed in chapter 5 of the TSD accompanying this final rule, DOE did assume AL29–4C is used in the construction of secondary heat exchangers for condensing furnaces. Because no additional comments were received, DOE did not make any changes to its cost models for condensing furnace heat exchangers compared to what was used for the July 2022 NOPR analysis, other than updating prices to reflect the most recent five-year average materials prices available.

Chapter 5 of the final rule TSD presents more information regarding the development of DOE's estimates of the MPCs.

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 that are representative of the various input capacities available on the market. 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 final rule TSD. As discussed in section IV.C.2.c of this document, DOE used information from teardowns of MHGF and NWGF to developed cost adders for MHGF as compared to NWGF, which were applied to the NWGF MPCs 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 final rule TSD.

As displayed in Tables IV.4 and IV.5 of this document, the results show that the cost-efficiency relationships for NWGFs and MHGFs are nonlinear. For both product classes, 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 Markup

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 material, labor, depreciation and overhead costs 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 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 and chapter 12 of the final rule TSD.

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 first 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. Subsequently, in

2021, DOE conducted a second series of interviews to obtain feedback on the updates to the cost analyses from the additional teardowns performed for the July 2022 NOPR. 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 analyses as averages. Additional information on manufacturer interviews can be found in chapter 12 of the final rule TSD.

g. 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.10 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.[62]

The MPCs of electric furnaces were developed by calculating a market share-weighted MPC of the three modular blower units that were torn down, and then adding the MPC of the electric heat kit to the market share-weighted modular blower MPC. The MPC of the electric heat kit was scaled appropriately in order to approximate the MPCs of different input capacity electric furnaces. Similar to the engineering analysis performed for NWGFs, DOE estimated the MPCs of electric furnaces at input capacities of 40, 60, 80, 100, and 120 kBtu/h. All material prices have been updated since the July 2022 NOPR to reflect recent changes in the market. These MPCs are presented in Table IV.6.

TABLE IV.6—ELECTRIC FURNACE MPCS

Input capacity (kBtu/h)	MPC (2022$)
40	324
60	358
80	391
100	405
120	439

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

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.,* manufacturer markups, retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MPC/MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. The markups are multiplicative factors applied to MPCs and MSPs. At each step in the distribution channel, companies mark up the price of the product to cover business costs and generate a profit margin. Before developing markups, DOE defines key market participants and identifies distribution channels.

For consumer furnaces, the main parties in the distribution chain are: (1) manufacturers; (2) wholesalers or distributors; (3) retailers; (4) mechanical contractors; (5) builders; (6) manufactured home manufacturers, and (7) manufactured home dealers/retailers. See chapter 6 and appendix 6A of the final rule TSD for a more detailed discussion about parties in the distribution chain.

For the final rule, DOE maintained the same approach as in the NOPR. DOE characterized two distribution channel market segments to describe how NWGF and MHGF products pass from the manufacturer to residential and commercial consumers:[63] (1) replacements and new owners[64] 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 2023 BRG report,[65] 2019 Clear Seas Research HVAC contractor survey,[66] and Decision Analyst's 2022 American Home Comfort Study,[67] 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 for NWGF and 20 percent for MHGF (including mobile home specialty retailer/dealer) will be going through this market channel as follows (including some consumers that purchase directly and then have contractors install it):[68]

Manufacturer → Retailer → Mechanical Contractor → Consumer

Manufacturer → Mobile Home Specialty Retailer/Dealer → Consumer

The NWGF new construction distribution channel is characterized as follows, where DOE assumes that for 50 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, through a wholesaler, sells directly to a consumer.[69]

Manufacturer → Wholesaler (National Account) → Consumer

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

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

[64] 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.

[65] BRG Building Solutions, The North American Heating & Cooling Product Markets (2023 Edition). (Available at *www.brgbuildingsolutions.com/reports-insights*) (Last accessed August 1, 2023).

[66] Clear Seas Research, 2019 Unitary Trends. (Available at *clearseasresearch.com/?attachment_id=2311*) (Last accessed August 1, 2023).

[67] Decision Analyst, 2022 American Home Comfort Studies. (Available at *www.decisionanalyst.com/syndicated/homecomfort/*) (Last accessed August 1, 2023).

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

[69] 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 7 percent of NWGFs installed in the residential and commercial sector use national accounts, based on the fraction of small to mid-sized commercial buildings with NWGFs relative to residential buildings with NWGFs in the 2023 BRG report.

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.[70]

To estimate average baseline and incremental mark-ups, DOE relied on several sources, including: (1) the 2017 Annual Wholesale Trade Survey [71] (for wholesalers and distributors); (2) U.S. Census Bureau 2017 Economic Census data [72] on the residential and commercial building construction industry (for builders, mechanical contractors, and mobile home manufacturers); (3) SEC 10–K reports [73] from Home Depot and Lowe's and 2017 Annual Retail Trade Survey [74] (for retailers); (4) 2017 Economic Census and other sources (for mobile home dealers and retailers). 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 [75] to disaggregate the mechanical contractor mark-ups into replacement and new construction markets and the HARDI 2013 Profit Report [76] to derive regional-to-national wholesaler markup ratio. DOE also used various sources for the derivation of the mobile home dealer mark-ups (see chapter 6 of the final rule 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 the job. After reviewing the available 2017 economic census data,[77] 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 [78] and other cost books [79] 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 1.39 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 2.85 for NWGFs and 2.49 for MHGFs, while the incremental mark-up is 2.09 for NWGFs and 1.91 for MHGFs. See chapter 6 and appendix 6A of the final rule TSD for more details.

In addition to the mark-ups, DOE obtained State and local taxes from data provided by the Sales Tax Clearinghouse.[80] 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 8N of the final rule 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.

Lennox commented that the assumption that the incremental markup would be lower for condensing than for non-condensing furnace standard levels is incorrect, as the installed cost difference between EL 2 and EL 3 is less than the difference between the MPC and MSP for these two levels. (Lennox, No. 389 at p. 2) Lennox further asserted that the incremental markup should be consistent for condensing and non-condensing levels. (*Id.*)

DOE clarifies that the incremental mark-up is used for efficiency levels above the baseline, applied to those costs above the baseline cost. In the case of consumer furnaces, all condensing furnaces have an efficiency above the baseline, and, therefore, they all share the same incremental mark-up factor (absolute mark-up will vary based on the incremental cost). Baseline, non-condensing furnaces are characterized with a baseline mark-up only. Chapter 6 of the final rule TSD provides details on DOE's development of markups for NWGFs and MHGFs.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of NWGFs and MHGFs at different efficiencies in representative U.S. single-family homes, multi-family residences, 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,

[70] 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.

[71] U.S. Census Bureau, 2017 Annual Wholesale Trade Survey. (Available at *www.census.gov/data/tables/2017/econ/awts/*) (Last accessed August 1, 2023).

[72] U.S. Census Bureau, *2017 Economic Census Data.* (Available at *www.census.gov/econ/*) (Last accessed August 1, 2023).

[73] U.S. Securities and Exchange Commission, *SEC 10–K Reports* (available at *www.sec.gov/*) (last accessed August 1, 2023).

[74] U.S. Census Bureau, 2017 Annual Retail Trade Survey Data (available at *www.census.gov/programs-surveys/arts.html*) (last accessed August 1, 2023).

[75] Air Conditioning Contractors of America (ACCA), *Financial Analysis for the HVACR Contracting Industry (2005).* (Available at *www.acca.org/store*) (Last accessed August 1, 2023).

[76] Heating, Air Conditioning & Refrigeration Distributors International (HARDI), *2013 HARDI Profit Report.* (Available at *www.hardinet.org/*) (Last accessed August 1, 2023).

[77] U.S. Census Bureau, *2017 Economic Census Data.* (Available at *www.census.gov/econ/*) (Last accessed August 1, 2023).

[78] RS Means Company Inc., *2023 RS Means Mechanical Cost Data. Kingston,* MA (2023). (Available at *www.rsmeans.com/products/books/*) (Last accessed August 1, 2022).

[79] Craftsman Book Company, 2023 National Construction Estimator, CA (2023). (Available at *craftsman-book.com/books-and-software/shop-by-type/shop-estimating-books*) (Last accessed August 1, 2023).

[80] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates (June 14, 2023). (Available at *www.thestc.com/STrates.stm*) (Last accessed August 1, 2023).

liquid petroleum gas (LPG), and electricity used by the furnace.

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

1. Building Sample

To determine the field energy use of NWGFs and MHGFs used in residential housing units and commercial buildings, DOE established a sample of households using EIA's 2020 Residential Energy Consumption Survey (RECS 2020)[81] and sample of commercial buildings using EIA's 2018 Commercial Building Energy Consumption Survey (CBECS 2018), which were the most recent such surveys that were available at that time.[82] The RECS and CBECS data provide information on the vintage of the home or building, as well as heating energy use in each housing unit or building. DOE used the housing and building samples not only to determine existing furnace's annual energy consumption, but also as the basis for conducting the LCC and PBP analyses. RECS and CBECS includes weights for each housing unit or commercial building in order to produce housing and commercial building population estimates to represent all housing units and commercial buildings, including those not in the survey sample. DOE used these RECS and CBECS weights along with furnace shipments data and furnace sample criteria to develop the projected furnace sample shipment weights in 2029, the first year of compliance with any amended or new energy conservation standards for NWGFs and MHGFs, used in the analysis. To characterize future new homes and buildings, DOE used a subset of housing units and commercial buildings in RECS and CBECS that were built after 2000.

APGA argued that with DOE's usage of EIA's RECS 2015, DOE is imputing to over 120 million households characteristics based upon a survey of a few hundred. APGA further argued that RECS surveys are suspect because they rely on respondents knowing precisely the appliance that heats their house and for how long that has been. (APGA, No. 387 at p.11) DOE notes that this characterization is incorrect. RECS 2015 is based on a nationally representative sample of 5,686 households, not a few hundred. RECS 2020 had 18,496 respondents complete the survey. Furthermore, EIA employs a number of different data collection modes, including in-person interviews with detailed measurements of the housing unit, as well as collecting fuel billing and delivery data from energy suppliers. There are a number of cross-checks and quality control steps to ensure the robustness of the survey, as detailed in the RECS technical documentation.

APGA claimed that DOE relied on stale data from EIA's RECS 2015 in the NOPR. APGA argued that DOE should incorporate RECS 2020 data and run its analysis again, allowing public comment in a supplemental NOPR. (APGA, No. 387 at p. 61)

In response, DOE notes that the energy use analysis relies on the energy consumption and expenditures microdata from RECS, which at the time of the NOPR analysis were not yet published for RECS 2020. Only the preliminary housing characteristics statistics tables from RECS 2020 were available at the time of the NOPR analysis. However, it is common practice for DOE to include updated data in its analyses when they become available. The RECS 2020 final version of the microdata (including energy consumption and expenditures data) have since been published, and DOE has updated its analysis for the final rule to include the latest RECS 2020 data. DOE has also updated its analysis for the final rule to include the latest CBECS 2018 data. See appendix 7A of the final rule TSD for details regarding the sample.

JCI commented that manufactured home applications are not specifically addressed in RECS data after 1974. The commenter asserted that manufactured home applications are instead categorized in single-family homes. JCI argued that replacements in manufactured homes are, therefore, not accurately represented in DOE's analysis, and that manufactured homes would be disproportionately negatively impacted by a 95-percent AFUE standard. (JCI, No. 411 at p. 2)

In response, DOE clarifies that RECS does include survey responses from households in manufactured homes. They are labeled as ''mobile homes'' and are included in DOE's analysis. These are the households that would be representative of MHGF installations and energy consumption.

The CA IOUs cited the U.S. Energy Information Administration's 2015 Residential Energy Consumption Survey to report that only 26 percent of mobile homes use natural gas and propane MHGFs for space heating, while 55 percent of mobile homes use electricity for space heating. (The CA IOUs, No. 400 at p. 2) In response, DOE notes that in the NOPR, it used 2015 RECS data directly, and, therefore, this breakdown of energy usage was reflected in DOE's NOPR analysis, and the current breakdown of energy use from 2020 RECS data is reflected in DOE's final rule analysis.

2. Furnace Sizing

DOE assigned an input capacity for the existing NWGF or MHGF of each housing unit or building based on an algorithm that correlates the calculated design heating load served by the furnace with furnace shipments data by input capacity. DOE used ACCA's Manual J[83] and Manual N[84] calculation methods to more accurately determine the design heating load requirements for each sampled housing unit or building based primarily on RECS 2020 and CBECS 2018 building characteristics (including heated square footage, the outdoor design temperature for heating,[85] wall type, insulation type, year built, roof type, number of floors, availability of an attic, basement, or crawlspace, *etc.*). The ACCA Manual J and Manual N process is the most widely accepted method to calculate heating and cooling requirements for a house by using well-documented values and building codes, based on experimental data and extreme conditions (worst-case assumptions). DOE distributed the input capacities based on shipments data by input capacity bins provided by AHRI from 1995–2014,[86] HARDI shipments data by capacity and region from 2013–2022,[87] BRG report shipments data by capacity from 2014–2022,[88] and manufacturer

[81] Energy Information Administration (EIA), 2020 Residential Energy Consumption Survey (RECS). (Available at: *www.eia.gov/consumption/residential/*) (Last accessed August 1, 2023).

[82] U.S. Department of Energy: Energy Information Administration, Commercial Buildings Energy Consumption Survey (2018). (Available at: *www.eia.gov/consumption/commercial/*) (Last accessed August 1, 2023).

[83] Air Conditioning Contractors of America Association (ACCA). Manual J—Residential Load Calculation (available at: *www.acca.org/standards/technical-manuals/manual-j*) (last accessed August 1, 2023).

[84] Air Conditioning Contractors of America Association (ACCA). Manual N—Commercial Load Calculation (available at: *www.acca.org/standards/technical-manuals/manual-n*) (last accessed August 1, 2023).

[85] This is the dry-bulb design temperature that is expected to be exceeded ninety-nine percent of the time.

[86] 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 August 1, 2023).

[87] Heating, Air-conditioning and Refrigeration Distributors International (HARDI), DRIVE portal (HARDI Visualization Tool managed by D+R International until 2022), proprietary Gas Furnace Shipments Data from 2013–2022 provided to Lawrence Berkeley National Laboratory (LBNL).

[88] BRG Building Solutions, The North American Heating & Cooling Product Markets (2023 Edition)

Continued

input from manufacturer interviews. The shipments data by input capacity were further disaggregated into 5-kBtu/h bins based on a set of non-repetitive or unique models from DOE's 2023 Compliance Certification Management System database for furnaces [89] and from AHRI's 2023 residential furnace certification directory.[90] The households' calculated design heating load values are then rank ordered to match actual shipments distributions to determine the assigned furnace input capacity. DOE assumed that for the new furnace installation, the output capacity would remain similar to the output capacity for the existing furnace.

This sizing 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. For example, this methodology, applied to both NWGFs and MHGFs, allows for older, less-insulated homes to be assigned larger furnaces compared to similar newly-built homes. 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 design heating load are also captured in the sizing methodology by using the outdoor design temperature that best matches the household location and climate characteristics.

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 design 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 by input capacity [91] and the HARDI furnace shipments by input capacity and region.[92] DOE notes that this will primarily affect furnaces located in warmer areas of the country (with higher cooling loads), which potentially leads to a higher amount of oversizing than is assumed in the analysis for these households. 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 final rule, DOE made a conservative assumption that larger furnace input capacities will be necessary to satisfy these cooling requirements because smaller capacity furnaces with larger fans are not commonly available in the market. If smaller capacity furnaces with larger fans become more common, the costs to replace these furnaces would be lower, increasing the net consumer benefits. *See* chapter 7 and appendix 7B of the final rule 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 housing unit or building heating load using the RECS 2020 and CBECS 2018 estimates of housing unit or building furnace annual energy consumption,[93] 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. DOE also took into account any secondary heating that might be present, utilizing the same fuel as the NWGF or MHGF, by reducing the heating load covered by the NWGF or MHGF. 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 or CBECS and historical data on the market share of furnaces by AFUE by region (*see* appendix 7B of the final rule TSD). DOE then used the housing unit or 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 consumer furnace test procedure.

a. Adjustments to Energy Use Estimates

DOE adjusted the energy use estimates in RECS 2020 (for the year 2020) and in CBECS 2018 (for the year 2018) to ''normal'' weather using long-term heating degree-day (HDD) data for each geographical region.[94] For this final rule, DOE then applied an HDD correction factor from *AEO2023* [95] that accounts for projected population migrations across the Nation and continues any realized historical changes in HDD at the State level.

DOE also accounted for changes in building shell efficiency between 2020 (for RECS 2020) or 2018 (for CBECS 2018) and the compliance year by applying the shell integrity indexes associated with *AEO2023*. 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 0.91 for residential replacements and 0.77 for residential new construction relative to the 2022 building shell efficiency. The factor applied for commercial building replacements depend on building type and Census Division, ranging from 0.82 to 0.97 relative to the 2018 building shell efficiency. For new construction commercial buildings, the factor used ranged from 0.31 to 0.86, depending on building type and Census Division relative to the 2020 building shell

(available at: *www.brgbuildingsolutions.com/reports-insights*) (last accessed August 3, 2023).

[89] U.S. Department of Energy, Compliance Certification Management System (available at: *www.regulations.doe.gov/certification-data/*) (last accessed August 1, 2023).

[90] AHRI, Directory of Certified Product Performance: Residential Furnaces (available at: *www.ahridirectory.org/Search/QuickSearch?category=8&searchTypeId=3&producttype*=32) (last accessed August 1, 2023).

[91] 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 August 1, 2023).

[92] Heating, Air-conditioning and Refrigeration Distributors International (HARDI), DRIVE portal (HARDI Visualization Tool managed by D+R International until 2022), proprietary Gas Furnace Shipments Data from 2013–2022 provided to Lawrence Berkeley National Laboratory (LBNL).

[93] EIA estimated the equipment's annual energy consumption from the household's or buildings utility bills using conditional demand analysis. To learn more, see *www.eia.gov/consumption/residential/data/2020/pdf/2020%20RECS%20CE%20Methodology_Final.pdf.* (Last accessed August 1, 2023).

[94] National Oceanic and Atmospheric Administration (NOAA), NNDC Climate Data Online (available at: *www.ncdc.noaa.gov/cdo-web/search*) (last accessed August 1, 2023).

[95] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2023* (available at: *www.eia.gov/outlooks/aeo/*) (last accessed August 1, 2023).

efficiency. *See* chapter 7 of the final rule TSD for more details.

Building codes and building practices vary widely across the U.S. For example, as of August 2023, more than half of the States were still under the 2009 International Energy Conservation Code (''IECC'') or older codes instead of the 2015 IECC, 2018 IECC, or 2021 IECC.[96] 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. The building shell index also accounts for the impact of incentive programs in improving building shell efficiency. 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.

AHRI stated that DOE did not consider changes to Manufactured Housing Efficiency Standards in its analysis of proposed efficiency standards for MHGFs, adding that the new standards were promulgated by DOE in May 2022 and will take effect on May 31, 2023. AHRI commented that the new requirements will enhance the thermal efficiency of the building envelope of new manufactured homes, which will in turn reduce the heating demand for furnaces. AHRI added that the reduced heating demand for furnaces will then reduce the cost justification (in particular, LCC savings) for the proposed standards. Additionally, AHRI stated that DOE cannot double-count energy savings produced by a more-efficient building envelope and from improved furnace efficiency. (AHRI, No. 414–2 at pp. 1–3) Along these same lines, MHI commented that it does not think DOE considered the increased energy efficiency caused by the May 2022 ECS Final Rule for manufactured housing in its technical models. (MHI, No. 365 at p. 3)

Mortex similarly commented that the standards for manufactured homes will lead to less usage and average input of furnaces, which weakens the cost justification for amending the furnaces standard. The commenter stated that these standards will reduce heating season gas demand and energy usage by approximately 15 percent, which means that there will be fewer energy savings to offset the increased up-front costs if a 95-percent AFUE furnace. (Mortex, No. 410 at p. 3)

Mortex further commented that this rulemaking double-counts energy savings between this rulemaking and the manufactured housing rulemaking. The company also pointed to the manufactured housing rulemaking and the tiered approach such that requirements for single-section manufactured homes imposed less of a cost than requirements for multi-section manufactured homes in consideration of affordability of housing for mobile home residents. Mortex commented that such considerations should also be taken into account by DOE in the rulemaking for MHGFs. (Mortex, No. 410 at p. 3)

In response, DOE notes that the NOPR analysis was performed using *AEO2022,* which was developed before promulgation of the May 2022 final rule for manufactured housing (87 FR 32728). *AEO* projections only include the impacts of finalized regulations and, thus, do not include DOE's May 2022 manufactured housing rule. However, it is common practice for DOE to include updated data in its analyses when they become available. For the final rule, DOE used the latest *AEO2023* building shell efficiency projections, which take into account all finalized rules in 2022, including the May 2022 final rule for manufactured housing, as well as other incentives to improve building shell efficiency. These projections result in a decrease in the estimated space heating energy use in the final rule. The updated analysis eliminates any potential double-counting. DOE's conclusion of economic justification for MHGFs from the NOPR remains unchanged. With respect to affordability, DOE notes that smaller-capacity furnaces, which would be used in smaller mobile homes, have lower incremental costs.

Sierra Club *et al.* mentioned that the rule for energy efficiency standards for new manufactured homes was based in part on the requirements of the 2021 IECC, though DOE declined to consider IECC requirements in setting minimum efficiency levels for heating appliances installed in such homes due to the coverage of these products under EPCA's appliance efficiency standards program. 87 FR 32728, 32774 (May 31, 2022). Sierra Club *et al.* stated that another stakeholder's comments on the NOPR—claiming that DOE is extending the IECC's requirements to mobile home gas furnaces—have an unclear basis. (Sierra Club *et al.,* No. 401 at pp. 2–3)

In response, DOE acknowledges that coverage under EPCA for MHGFs is under consumer furnaces provisions of EPCA and not under the manufactured housing rulemaking. DOE agrees with Sierra Club *et al.* that it is not extending IECC requirements. Instead, DOE is independently evaluating the technological feasibility and economic justification of amended energy conservation standards for MHGFs by conducting its own analysis.

4. Furnace Electricity Use

DOE's analysis of furnace electricity consumption takes into account the electricity used by the furnace's electrical components (*e.g.,* blower, draft inducer, and 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.[97] 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,[98] as well as in DOE's 2023 unique furnace model dataset and manufacturer product literature. The electricity consumption of condensing furnaces also reflects the use of condensate pumps and heat tape.

[96] DOE Building Energy Codes Program, Status of State Energy Code Adoption (available at: *www.energycodes.gov/status*) (last accessed August 1, 2023).

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

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

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[99]) can be met using constant-torque 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 final rule 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 analysis in the October 2022 Preliminary Analysis for consumer furnace fans.[100] DOE also accounted for additional electricity use by the furnace fan during continuous fan operation.

F. Life-Cycle Cost and Payback Period Analysis

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 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 markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.
- *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.

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, also commercial buildings. As stated previously, DOE developed household samples from 2020 RECS and CBECS 2018. 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 efficiencies.

In regard to DOE's cost calculations, GAS commented that DOE is defying its own intent to use ''transparent and robust analytical methods.'' Instead, GAS commented, DOE games its analytical methods through undue complexity to declare some level of (usually minimal) positive LCC savings necessary to clear the low hurdle rate established by EPCA. GAS commented that DOE ''grossly inflates'' its LCC savings estimates by opaque methodologies that defy independent validation. (GAS, No. 385 at pp. 4–5)

Trampe commented that a long-term study is needed where total costs (initial and maintenance) of furnaces with different efficiencies are compared. The commenter added that this study should cover different States and temperatures. Trampe stated that HVAC installers, repairers, distributors, and manufacturers can provide their input on what these total costs would be. (Trampe, No. 361 at p. 1)

In response, DOE conducts all appliance standards rulemakings through the public notice-and-comment process, in which all members of the public are given the opportunity to comment on the rulemaking, and all documents are made publicly available at *www.regulations.gov.* Additionally, all benefits and burdens of the rulemaking are carefully considered by DOE. Section IV.F of this document explains DOE's rationale regarding cost impacts and LCC models. As part of this rulemaking, DOE also hosted a number of public meetings, including one focused on its analytical models, in order to increase the transparency of its process. DOE currently works with manufacturers to determine appropriate costs, as Trampe suggested. Although predicted future and long-term costs are calculated and considered, a long-term study regarding total costs of furnaces at various efficiencies will not be conducted as part of this rulemaking because DOE has determined that its current methodology captures the elements which the commenter suggests. However, because DOE consistently strives to improve its analytical processes, the Department may consider Trampe's comment as a topic for possible continued future research.

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and NGWF and

[99] 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.

[100] 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: Consumer Furnace Fans (October 2022) (available at: *www.regulations.gov/document/EERE-2021-BT-STD-0029-0014*) (last accessed August 1, 2023).

MHGF user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[101] Details regarding the various inputs to the model are discussed in the subsections below. 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 calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who are projected to purchase more-efficient furnaces than the baseline furnace in the no-new-standards case, DOE avoids overstating the potential benefits from increasing product efficiency. DOE calculated the LCC and PBP for 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 apply to NWGFs and MHGFs manufactured five years after the date on which any new or amended standard is published in the **Federal Register**. (42 U.S.C. 6295(f)(4)(C)) Therefore, DOE used 2029 as the first year of compliance with any amended 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 final rule 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.8 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.10 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 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) (*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, DOE has found it unnecessary to decide whether EPCA allows DOE to consider the benefits from this standard rule on consumers of other covered products (*e.g.,* electric heat pumps). However, in this analysis, DOE has accounted for the expected effect that these standards will have on consumers' decisions to switch from home heating via a gas-fired furnace to home heating via electric alternatives. As explained in detail below, 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 with and without product switching for the LCC analysis (presented in section V.B.1.a of this document and in appendix 8J of the final rule TSD) and for the NIA as well (presented in sections V.B.3.a and V.B.3.b of this document and in appendix 10E of the final rule TSD). The economic justifications for the considered 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 in section III.F.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.7 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The

[101] 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: *https://www.oracle.com/middleware/technologies/crystalball.html*) (last accessed Aug. 3, 2023).

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 final rule TSD and its appendices.

TABLE IV.7—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost	Derived by multiplying MPCs by manufacturer, wholesaler, and contractor 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 2022 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 2020 and CBECS 2018.
Energy Prices	*Natural Gas:* Based on EIA's Natural Gas Navigator data for 2022 and RECS 2020 and CBECS 2018 billing data. *Propane:* Based on EIA's State Energy Data System (''SEDS'') for 2021. *Electricity:* Based on EIA's Form 861 data for 2022 and RECS 2020 and CBECS 2018 billing data. *Variability:* State energy prices determined for residential and commercial applications. Marginal prices used for natural gas, propane, and electricity prices.
Energy Price Trends	Based on *AEO2023* price projections.
Repair and Maintenance Costs.	Based on 2023 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 21.5 years.
Discount Rates	*Residential:* approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. *Commercial:* Calculated as the weighted average cost of capital for businesses purchasing NWGFs. Primary data source was Damodaran Online.
Compliance Date	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 final rule TSD.

A number of commenters expressed opposition to the proposed rule based on the LCC and PBP results. AGA *et al.* stated that under DOE's proposal in the July 2022 NOPR, approximately 40 percent of NWGFs would be eliminated from the market, and consumers would have to either upgrade existing venting systems or switch to an electric furnace, which the commenters say will have higher operating costs and require upgrades to home or business electrical systems. (AGA *et al.,* No. 391 at p. 1) AGA *et al.* also stated that consumers, where it is economically appropriate for new homes or renovations, are already installing condensing furnaces and other high-efficiency units throughout the United States, and these commenters suggested that this high level of voluntary adoption demonstrates that DOE's proposal is ''redundant.'' (AGA *et al.,* No. 391 at p. 2)

LANGD and Georgia Gas Authority commented that in its current form, the proposed standard will negatively impact nearly 1 in 6 customers of non-weatherized gas furnaces, including 1 in 5 senior-only households, 1 in 7 low-income households, and 1 in 5 small business consumers. (LANGD, No. 355 at p. 1; Georgia Gas Authority, No. 367 at p. 2) LANGD further stated that there are other ways to achieve lower emissions, improved energy efficiency, and reduced bills than those proposed in the NOPR. (LANGD, No. 355 at pp. 1–2)

The Coalition commented that the added costs associated with a 95-percent AFUE unit would be more than three times the value of their first-year energy savings, adding that some homeowners may never recoup the added upfront costs. The Coalition further commented that these calculations can be even more complicated in the rental housing environment where there can be a disconnect between who pays the upfront equipment cost and who pays the expenses for utilities. (The Coalition, No. 378 at pp. 5–6)

Atmos Energy commented that DOE should improve the accuracy of its analysis by tailoring its consideration of consumer behavior, life-cycle evaluations, and costs. Atmos Energy further commented that the proposed rule uses unsupported and broad assumptions that are not reflective of actual consumer behavior and information. (Atmos Energy, No. 415 at p. 5) Atmos Energy also commented that the consequences of this proposed rule would hit especially hard in their service territory. The commenter stated that in Louisiana, Mississippi, and Texas alone, more than 1.5 million households live below 150 percent of the Federal poverty line. In addition, Atmos Energy stated that Texas households that fall between 100 and 150 percent of the Federal poverty level experience an average energy burden (*i.e.,* cost of energy as a percentage of income) of 8 percent, while Texans living below the Federal poverty level experience an average energy burden of 16 percent. In Louisiana and Mississippi, Atmos Energy stated that it serves 361,000 households that fall below the Federal poverty line, commenting that these households spend approximately $350 more on energy each year than the national average with an estimated average energy burden of 22 percent. (Atmos Energy, No. 415 at p. 4)

Black Hills Energy stated that approximately 40 percent of non-weatherized natural gas furnaces shipped to customers annually are non-condensing furnaces. The commenter stated that the proposed rule would eliminate non-condensing furnaces and that neither updates to venting for a condensing furnaces nor updates to electrical systems for an electric furnaces are pro-consumer. Additionally, Black Hills Energy stated, that electric furnaces may have a higher operating cost. (Black Hills Energy, No. 397 at pp. 1–2) Black Hills Energy stated that the proposed rule is unnecessary because those for whom a condensing furnace is beneficial are choosing those furnaces, but the option for a non-condensing furnace should not be taken away from those for whom a conversion is difficult due to issues of affordability. (Black Hills Energy, No. 397 at p. 2) Plastics Pipe Institute similarly commented that consumers are already installing higher-efficiency condensing furnaces throughout the country, and, therefore, the proposed rule is unnecessary. (Plastics Pipe Institute, No. 404 at p. 2) A. Kessler opposed the proposed rule, arguing that a condensing furnace is not economically justified for some households, such as a townhome with a commonly vented water heater or a two-story home with a poured concrete foundation with brick exterior walls. (A. Kessler, No. 331 at pp. 2–4)

In response, DOE acknowledges that for certain installations, there are significant costs. This is accounted for in the full distribution of LCC results, including consumers that experience net costs, and is part of the evaluation of economic justification as discussed in section V.C of this document. DOE also considered the impacts to low-income consumers, as described in sections IV.I.1 and V.B.1.b of this document. Additionally, DOE acknowledges that some consumers are already purchasing higher-efficiency condensing furnaces, and this market share is accounted for in the analysis, resulting in a percentage of consumers who are not impacted by the amended standard. The development of the distribution of efficiency in the no-new-standards case is discussed in further detail in section IV.F.8 of this document.

AGA stated that DOE should revise its analysis to ensure that impacts are not inappropriately affected by the inclusion of buildings that are designed for condensing equipment and for which consumers already have condensing furnaces. (AGA, No. 405, pp. 86–87)

In response, DOE clarifies that consumers who are not impacted by a standard in the LCC analysis, because they are already purchasing a higher-efficiency furnace, do not factor into the average LCC savings. The average LCC savings only reflect impacted consumers. The percentage of consumers not impacted by a standard is shown separately from the percentages of consumers negatively impacted and positively impacted under the new-standards case in the LCC spreadsheet.

AGA stated that even with some sensitivity analysis, establishing averages in terms of furnace costs, installation costs, annual maintenance costs, energy consumption, *etc.,* is not appropriate for this type of DOE consumer covered product. (AGA, No. 405 at p. 88) In response, DOE notes the commenter is mischaracterizing the analysis. DOE uses a distribution of installation costs, equipment capacity, maintenance cost, and energy consumption as part of the LCC analysis and does not really on average values for these inputs.

AGA commented that DOE's modeling approach is fundamentally flawed, being shaped by random numbers producing inconsistent results and, in some cases, profoundly different economic analyses. (AGA, No. 405 at pp. 73–74) In response, DOE notes that it has conducted a number of sensitivity scenario analyses, all of which vary key input parameters, and the results of the analyses do not alter DOE's conclusion of economic justification.

In contrast, other commenters agreed with DOE's analysis that the proposed standard level for NWGFs and MHGFs is economically justified, based on the LCC and PBP results.

NYSERDA offered that based on their analysis of the active models of the six major furnace manufacturers identified in chapter 3 of the NOPR TSD, a wide variety of models would continue to be available across a range of input capacities if the AFUE level were to be set at 96 percent. NYSERDA added that at this AFUE level, a broad range of residential applications would continue to be served, and consumers would not suffer from a deficit of market options. (NYSERDA, No. 379 at p. 2) NYSERDA stated that 30 percent of NWGF models would not be compliant if an AFUE level were to be set at 96 percent instead of 95 percent, but the commenter opined that manufacturers would have enough time over the five years following the initial rule to redesign and preserve many of those models. (*Id.*) NYSERDA commented that DOE's update to the standards for the subject consumer furnaces would result in significant consumer benefits. NYSERDA further commented that the current LLC analysis, while robust, may overstate costs and underestimate benefits. (NYSERDA, No. 379 at p. 3) More specifically, NYSERDA commented that the composite effect of low heating energy use, low burner operating hours, and short equipment lifetime could affect LCC savings significantly. (NYSERDA, No. 379 at p. 5)

NYSERDA commented that there are real-world mitigating factors that are not factored into LCC analysis but are nonetheless likely to arise. As examples of some of these potential factors, the commenters pointed to limited warranties that do not completely cover an early failure, renters being responsible for equipment operation and building owners being responsible for the upfront purchase, future natural gas costs that may differ from EIA gas forecasts, and consumers opting for an alternative heating source to avoid high-cost gas furnaces. (NYSERDA, No. 379 at p. 5)

Daikin commented that DOE's proposed 95-percent AFUE standard has the shortest rebuttable payback period of the ELs considered, regardless of the standard type considered. (Daikin, No. 416 at p. 2) On this point, DOE clarifies that the 95-percent AFUE level has the shortest simple payback period, relative to the baseline model and assuming a national standard, of the condensing ELs considered.

NPGA commented that no deliberate attempts appear to have been made by DOE to address consumer choice and tradeoffs as recommended in the NAS report. (NPGA, No. 395 at p. 13)

DOE notes that discussion of the recommendations of the NAS report will be addressed as part of a separate notice-and-comment process, and not on an individual rulemaking-by-rulemaking basis.

NPGA commented that the Monte Carlo analysis as implemented in the LCC and PBP analyses do not meet the requirements of the Office of Management and Budget Circular A–4 for Regulatory Analysis. (NPGA, No. 395 at p. 14) The commenter argued that DOE does not evaluate variables in the simulation for independence and fails to use the functionality of the Crystal Ball Microsoft Excel add-in to quantify relationships among correlated variables. (NPGA, No. 395 at p. 15) NPGA commented that DOE does not implement correlation of any distributional inputs, therefore presuming that all such inputs are independent random variables. NPGA asserted that DOE's approach is not reasonable to represent actual consumers. NPGA further stated that the TSD does not suggest that DOE conducted a systematic analysis of correlated variables, as would be implied by the Circular A–4 guidance. (NPGA, No. 395 at p. 15) NPGA listed the following input variable pairs as likely correlated distributional input variables affecting LCC savings: furnace maintenance failure year and repair cost, furnace lifetime and EL design complexity, and EL design complexity and repair cost. (NPGA, No. 395 at pp. 15–16)

In response, DOE notes that multiple variables are correlated in the analysis. For example, installation costs depend on installation location and other housing characteristics. There is also a relationship between design options, lifetime, and maintenance and repair costs. As discussed in chapter 8 and appendix 8F of the final rule TSD, repair costs do vary by failure year, and this is captured in the analysis. Annualized maintenance and repair costs also differ between non-condensing and condensing furnace. For other variables, DOE does not have enough information regarding any correlation. See appendix 8B for a description of the correlated variables. Thus, NPGA's assertion that DOE does not implement correlation of variables is incorrect.

NPGA commented that the NOPR does not provide evidence to suggest the use of the techniques in Circular A–4 for developing expert judgment estimates. (NPGA, No. 395 at p. 16)

NPGA commented that DOE frequently mixes the objectives of modeling input diversity and uncertainty within a single distribution. (NPGA, No. 395 at p. 16) In response, DOE notes that this mischaracterizes the analysis. DOE uses probability distributions for a number of input variables that are reasonably expected to exhibit natural variation and diversity in practice (*e.g.,* lifetime, repair cost, installation costs). These probability distributions are modeling diversity. In contrast, DOE addresses input uncertainty primarily with the use of sensitivity scenarios. To determine whether the conclusions of the analysis are robust, DOE performed several sensitivity scenarios with more extreme versions of these input variables (including high/low economic growth and energy price scenarios, alternative price trend scenarios, alternative mean lifetime scenarios, alternative product switching scenarios, an alternative venting technology scenario, and scenarios with different Monte Carlo sampling). The relative comparison of potential standard levels in the analysis remains the same throughout these sensitivity scenarios, confirming that the conclusion of economic justification is robust despite some input uncertainty.

NPGA stated that DOE does not employ Oracle guidance in implementing the Crystal Ball software in the analysis. (NPGA, No. 395 at p. 16) According to NPGA, DOE only provides rudimentary flow diagrams of its Crystal Ball LCC savings and payback spreadsheet. (NPGA, No. 395 at p. 17) NPGA stated that DOE also does not provide a record on how it arrived at model design or how alternative model designs were considered. (NPGA, No. 395 at p. 17) In response, DOE clarifies that the use of Crystal Ball is to generate the sequence of random numbers necessary to build the 10,000 samples utilized in the LCC analysis. All other calculations are contained in the LCC spreadsheet, which has been extensively documented and discussed at length with interested parties through various iterations of notice-and-comment, as well as informal workshops. Every calculation dependent on a random value is outlined in the LCC spreadsheet, including all the probability distributions relevant to the calculation. The LCC spreadsheet includes flow diagrams of all worksheets and outlines the dependencies of all calculations.

NPGA stated that DOE does not assess validity in terms of reasonableness or validity of ''outlier'' consumer cases. (NPGA, No. 395 at p. 18) NPGA further commented that DOE does not apply manufacturer and consumer outcome data or implement methods or proxy calculations for validating its LCC and PBP calculations. (NPGA, No. 395 at p. 18) NPGA stated that DOE failed to analyze key options for modeling and data inputs. (NPGA, No. 395 at p. 18) NPGA stated that DOE's current process for supporting its LCC savings and payback analysis discounts the potential value of subject matter experts participating in the design, implementation, testing, and validation of its LCC savings and payback calculations. (NPGA, No. 395 at p. 18)

DOE has requested, repeatedly, data and input from interested parties and has incorporated many such pieces of information and data into its analysis. When such data are provided, they are incorporated into the analysis to the maximum extent possible. DOE does not discount the value of commenters' expert judgement, but DOE also relies on concrete data whenever possible to inform the analysis. With respect to outlier results, DOE notes that the full distribution of results, including median results, are available in the LCC spreadsheet.

NPGA recommended that DOE should test extreme conditions and compare the model to any similar models. (NPGA, No. 395 at pp. 18–19) NPGA added that stakeholders have offered to provide calculations based on simpler approaches. (NPGA, No. 395 at p. 19) In response, DOE's development of the LCC model is based on many prior comments over the years recommending the inclusion of various effects and other considerations. The increasing complexity of the model is due, in part, to DOE's responsiveness to these prior comments from previous notices. Additionally, DOE considers the distribution of potential impacts across a range of conditions, which is why many input variables are characterized by probability distributions (whenever possible) and the LCC analyzes a sample of 10,000 households.

AGPA asserted that DOE fails to deal with outlier data points in a reasonable manner. According to the commenter, extreme values should be eliminated from an analysis, but DOE has failed to make such an adjustment. (APGA, No. 387 at p. 17)

AHRI stated that DOE should utilize median values (as opposed to mean values) for future LCC analyses, stating that this method will remove the impacts of outlier buildings. However, AHRI acknowledged that switching from mean to median leaves DOE's conclusions for this rulemaking essentially unchanged. (AHRI, No. 414–2 at pp. 3–4)

In response, DOE provides a full range of statistics in the LCC spreadsheet, including median values and results at various percentiles. DOE also provides a distribution of impacts, including consumers with a net benefit, net cost, and not impacted by the rule. DOE further notes that the evaluation of economic justification would be the same using either average or median LCC savings. Therefore, individual LCC results at the ends of the distribution are not distorting DOE's evaluation.

The Marley Companies claimed that DOE recognizes there is uncertainty in the model, but only accounts for uncertainty in some parts of the model, thereby discrediting the variation in the information used to perform calculations. The commenter further claimed that DOE fails to use documented variation in both the RECS and CBECS data sets and uses ''representative capacities'' in product categories instead of the well-documented range of input capacities in each product category. (The Marley Companies, No. 386 at p. 2)

The Marley Companies further asserted that any life-cycle cost modeling must, at a minimum, include the variation in the CBECS and RECS data sets, consistently relate all references to the specific geographic information of the home or building modeled, and utilize both the variation and average of the energy usage identified in the national energy surveys noted in the 2015 RECS comparison with other studies. The commenter asserted that DOE must provide the impact to the results using different sources of information than RECS and CBECS, as well as provide realistic modeling by accounting for documented uncertainties and variation in the inputs to the analysis. (The Marley Companies, No. 386 at pp. 3–5)

APGA claimed that DOE's analysis does not merely fail to address uncertainty in many cases in which uncertainty is known to exist; there are key cases in which DOE's model uses a single parameter input (as opposed to a distribution of inputs) and, thus, fails to address both the known variability of that input and any uncertainty as to what the range and distribution of that input should be. (APGA. No. 387 at p. 12)

In response, DOE acknowledges that the summary statistics published by RECS and CBECS include documented statistical uncertainties; however, DOE's analysis uses the individual household microdata directly. These are survey responses from individual households. Accordingly, the standard errors published for RECS and CBECS do not directly apply. The average LCC savings, based on these microdata, include a full distribution of results, as presented in chapter 8 of the final rule TSD and the LCC spreadsheet. These results are based on a similar averaging and sampling weights as in the RECS and CBECS summary statistics. The LCC results at several different percentiles are available.

DOE further notes that there will always be natural variation in RECS and CBECS editions because they are snapshots in time, and many aspects of energy consumption change with time. It is normal and expected for RECS and CBECS results to change with each edition, and DOE utilizes the most recent data set whenever possible so as to be as representative as possible. RECS and CBECS remain, by far, the most comprehensive and statistically representative surveys of energy consumption in residential and commercial buildings available for the U.S., and the commenters have failed to provide any alternative data sources that are of comparable quality. RECS and CBECS are the highest quality data sources available to DOE. DOE does correlate a number of inputs to individual building characteristics from RECS and CBECS as part of its energy use analysis, including heating load, building shell indices, installation costs, and no-new-standards case efficiency probability.

DOE develops probabilities for as many inputs to the LCC analysis as possible, to reflect the distribution of impacts as comprehensively as possible. For example, DOE develops probabilities for building sampling, installation costs, lifetime, discount rate, and efficiency distribution, among other inputs. If there are insufficient data with respect to a specific input parameter to create a robust probability distribution, DOE will utilize a single input parameter. Such approach is neither arbitrary nor capricious; it is informed by the available data.

Finally, DOE developed a number of sensitivity scenarios for the NOPR and this final rule to specifically address the potential uncertainty in some key input parameters, as raised in prior comments. DOE has been responsive to these comments and has provided a wealth of additional sensitivity scenarios to demonstrate that its conclusions of economic justification are robust.

NPGA commented that representation in variability and uncertainty is not fully considered by DOE around installation costs of propane furnaces in replacement applications that require venting changes. (NPGA, No. 395 at p. 14)

Atmos Energy commented that DOE should more accurately and justifiably consider the variability and uncertainty around installation costs of natural gas furnaces, adding that this is particularly important in furnace replacement applications requiring a shift in venting systems from atmospheric to power venting. The commenter added that the consequences of required venting changes to other appliances should also be more accurately and justifiably considered. Atmos Energy also stated that this suggestion would be consistent with National Academy of Science peer review report's recommendation. (Atmos Energy, No. 415 at p. 6)

In response, DOE notes that its installation cost estimates do include a number of input parameters characterized by probability distributions, including for propane furnaces. DOE further emphasizes that a significant number of factors are considered in replacement applications, as discussed in section IV.F.2 of this document. DOE has been responsive to prior comments and has enhanced the installation cost estimates, including the installation of new venting, a number of times based on these comments.

Southwest Gas Corporation commented that for the vast majority of Southwest customers who reside in a hot/dry climate, where the forced air system is used primarily for cooling, the payback period is estimated to range 20 to 23 years, beyond the useful life of the furnace of 18 years. (Southwest, No. 353 at p. 1)

MHI commented that consumers in southern climates will be disproportionately impacted by the proposed standards for MHGFs. MHI argued that, in places where heating requirements are minimal, high-efficiency furnaces make little economic sense, with longer payback periods. The commenter further asserted that southern consumers would likely move away from the gas furnace market, thereby shrinking the market and creating more challenges for manufactured homeowners who often rely on gas heating. (MHI, No. 365 at p. 4)

Georgia Gas Authority argued that consumers in Southern States, like Georgia, Florida, Alabama, and Texas, require much less home heating, making higher efficiency gas furnaces uneconomical. (Georgia Gas Authority, No. 367 at p. 3)

NGA argued that DOE's model understates the number of customers negatively impacted by the standard. (NGA of Georgia, No. 380 at p. 2) NGA stated that with the majority of Georgians receiving negative or neutral payback from this standard, it believes that DOE has violated factor (ii) of 42 U.S.C. 6295(o)(2)(B). (*Id.*)

HARDI commented that the payback period determined by DOE does not hold true for Southern States, such that the standards should not be updated nationwide. However, HARDI also commented that it opposes the development of regional standards for consumer furnaces, as Northern States are already trending towards high-efficiency products. (HARDI, No. 384 at p. 3)

The Coalition commented that in some areas (particularly the South), it will take years if not decades for owners to recoup the added costs of 95-percent AFUE furnaces through long-term energy savings, adding that furnaces run a maximum of three months a year in many southern climates. (The Coalition, No. 378 at p. 5)

ACCA stated that DOE's analysis overlooked regional burdens, especially in the Southern U.S. (ACCA, No. 398 at p. 3)

Daikin commented that DOE's payback analysis does not specify the impacts on particular regions, specifically the South, which has a lower heating load and longer payback periods. Daikin noted that the analysis still shows a national average benefit, but that southern areas are likely better suited for heat pump applications. (Daikin, No. 416 at p. 3)

AGA commented that the NOPR fails to address significant regional differences in costs and benefits that will disproportionately impact millions of Americans. Fuel switching has a disproportionate impact on projected LCC savings for consumers in the South. (AGA, No. 405 at pp. 81–82)

In response, DOE notes that the analysis considers all households, including households in the Southern

U.S. This analysis allows DOE to meet its statutory obligation under EPCA when determining the economic justification of a potential standard to assess 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 which are likely to result from a new or amended standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE acknowledges that the impact of amended energy conservation standards for the subject furnaces on consumers, including the payback period, can vary from household to household and in different regions of the country. Some consumers may experience a net benefit and some may experience a net cost. This distribution of impacts is accounted for in the analysis and is part of the LCC results. DOE further acknowledges that some percentage of consumers will experience a net cost in the new-amended-standards case when weighing costs and benefits as part of its evaluation of economic justification, as discussed in further detail in section V.C of this document. The full range of statistics, including simple payback period, is available in the LCC spreadsheet (specifically in the ''Statistics'' and ''Forecast Cells'' worksheets). The LCC results are also presented by region in chapter 8 of the final rule TSD.

DOE finds without merit NGA's argument that because some percentage of consumers at either a national or regional level would experience a net LCC cost or an extended payback period, the Department has violated its obligations under 42 U.S.C. 6295(o)(2)(B)(i)(II).[102] The statute directs DOE to consider economic justification of a potential standard by determining whether its benefits exceed its burdens, by, to the greatest extent practicable, considering seven enumerated factors (*see* 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)). Consumer impacts are just one of the factors DOE must weigh when considering a potential standard. Furthermore, DOE assesses impacts of potential standards at a national level, so impacts at a State or regional level will not automatically trigger a determination that a potential standard lacks economic justification in the manner NGA suggests.

Under EPCA, DOE may consider adopting an additional, regional standard for consumer furnaces that is more stringent than the national standard. (42 U.S.C. 6295(o)(6)(B)(ii)) In order to establish a regional standard, DOE would have to, among other things, determine that a regional standard would save significant additional energy as compared to a single, base national standard and be economically justified. (42 U.S.C. 6295(o)(6)(D)). DOE did consider a regional standard in one of its TSLs (TSL 4), but as explained in section V.C of this document, DOE has found that a national standard for both NWGFs and MHGFs corresponding to 95-percent AFUE (*i.e.,* TSL 8) represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)). DOE did not consider adopting a more stringent, regional standard in addition to the base national standard of 95-percent AFUE.

NPGA stated that DOE's LCC analysis and proposed minimum efficiency rule failed to include a separate breakout of category I non-weatherized residential propane furnaces from the currently grouped analysis of efficiency levels (EL) for categories I, III, and IV. (NPGA, No. 395 at p. 21) NPGA stated that the proposal would deprive consumers of the utility of simple, lower-cost furnace replacements. NPGA added that replacement may not always be easily accomplished due to housing structural design and may compromise consumer safety. (*Id.*)

As discussed in sections II.B.2 and IV.A.1.c of this document, DOE published a final interpretive rule in the **Federal Register** on December 29, 2021, returning to DOE's long-standing interpretation (from which the January 2021 Final Interpretive Rule departed). 86 FR 73947. Accordingly, for purposes of the analyses conducted for this final rule, DOE did not analyze separate equipment classes for non-condensing and condensing furnaces nor for separate categories of venting. However, the costs and requirements associated with different venting categories are included in DOE's analysis, and any changes in venting in the new-amended-standards case are included in the LCC impacts.

PHCC commented that Tables V.5 and V.6 of the NOPR should consider consumers who have existing high-efficiency products and replace them with new high-efficiency products. (PHCC, No. 403 at p. 6)

In response, DOE clarifies that the average LCC savings and percentage of consumers with a net cost, as presented in Table V.6 of the NOPR, does include consumers who replace an existing high-efficiency product with a new high-efficiency product. Those consumers are not impacted by the standard. Table V.5 presents results for each TSL assuming that all consumers use products at that efficiency level. The approach in Table V.5 is done for the purposes of presenting typical average costs at each efficiency level for an average household, whereas Table V.6 incorporates distributional impacts and the existing market share of consumers already utilizing higher-efficiency equipment.

AGA argued that the LCC model's cost savings relies on unreasonable and unsupported assumptions about what share of the market non-condensing furnaces would hold without the proposed rule's requirements. (AGA, No. 405 at p. 91)

In response, DOE's estimated market share of condensing and non-condensing furnaces in the LCC is based on historical shipment data provided by industry stakeholders or market research firms. DOE includes an increasing penetration of condensing furnaces in the no-new-standards case, based on recent trends. DOE disagrees with AGA's assertion that utilizing such industry data in the LCC analysis is unreasonable or unsupported.

NPGA stated that DOE's economic analysis fails to take into account additional costs and circumstances specifically related to propane. (NPGA, No. 395 at p. 2) More specifically, NPGA argued that DOE did not directly calculate the specific costs and benefits to propane consumers from its proposed minimum efficiency standards. (NPGA, No. 395 at p. 23) NPGA commented that by aggregating consumer costs and benefits of all gas furnaces, the analysis is biased by the natural gas consumer market share. NPGA stated that the analysis does not account for the large presence of consumer propane market households in rural areas. (*Id.*) NPGA added that DOE did not account for the unique costs related to fuel switching from propane to electric space heating. (*Id.*) NPGA stated that the lack of representation of propane customers in the simulation results is a fundamental problem, noting that eleven States and the District of Columbia had no propane customers in the LCC. (*Id.* at p. 24)

[102] DOE notes that NGA's comment specifically referenced 42 U.S.C. 6295(o)(2)(B)(ii), which pertains to the U.S. Attorney General's obligation to determine, in writing, whether a proposed energy conservation standard would result in a lessening of competition in the relevant market. Because NGA's comment focuses on consumer impacts, DOE has concluded that the statutory provision in the comment was cited in error, but instead, DOE presumes that NGA intended to cite 42 U.S.C. 6295(o)(2)(B)(i)(II), the provision related to consumer impacts. DOE has responded to that comment accordingly. DOE further notes that the U.S. Department of Justice did conduct the requisite anti-competitive review for this rulemaking pursuant to 42 U.S.C. 6295(o)(2)(B)(ii), as discussed in section III.F.1.e of this document.

In response, DOE notes that the analysis takes into account the energy price for propane and uses a representative building sample of homes using a NWGF with propane based on RECS 2020 for the residential sample and CBECS 2018 for the commercial sample. RECS and CBECS, while representative, have an upper limit on the number of households and buildings that were surveyed. The eleven States identified by the commenter and DC comprise a very small fraction of the national population, and natural survey sampling can produce the results seen in the LCC. DOE notes that the national fraction of propane customers for NWGFs and MHGFs is appropriately accounted for in the analysis, even if some low-population States are under-sampled by RECS and CBECS. This does not invalidate the conclusions of the analysis. For installation costs, DOE used the latest information available in terms of piping and propane tank requirements. For this final rule, updated the energy prices using the latest EIA data and *AEO2023* energy price trends. In addition, DOE used the latest RECS 2020 and CBECS 2018 samples. In terms of installation costs, DOE updated its propane-related installation costs as highlighted in chapter 8 and appendices 8D and 8J of the final rule TSD.

Lennox commented that they found that DOE has taken the necessary steps to improve the analysis of amended AFUE standards for consumer furnaces under EPCA but recommended that DOE should further assess the economic justification of these standards while minimizing negative consumer impacts. (Lennox, No. 389 at p. 2) In response, DOE has continued to refine its analysis and updated using the latest data, as described in this document and in the final rule TSD.

Atmos Energy commented that DOE should account for the savings among the choices of a baseline natural gas furnace against the proposed TSLs or the savings that could accrue from continuing to own a baseline product versus purchasing TSL efficiency products. Atmos Energy added that these savings are crucial for estimating the benefits of appliance replacement programs, adding that such savings analyses will better illuminate potential consumer impacts. (Atmos Energy, No. 415 at p. 6) In response, DOE notes that it does estimate the impacts of purchasing higher-efficiency furnaces against the impacts of replacing existing furnace efficiencies that would have been purchased in the absence of a new energy conservation standard. This is already captured in the LCC analysis, and indeed, some percentage of consumers would accrue economic savings from continuing to own, or from buying as a replacement, a lower-efficiency furnace, as compared to a furnace at the adopted standard level. This is reflected in the percentage of consumers experiencing a net cost, as presented in section V.B of this document, and it is considered as part of DOE's evaluation of economic justification.

Atmos Energy commented that DOE should separately assess natural gas and propane when calculating LCC, adding that the LCC of the proposed rule would be more accurate if natural gas and propane products were evaluated separately. (Atmos Energy, No. 415 at p. 7) Atmos Energy further commented that propane is more costly than natural gas, stating that aggregating these two products introduces an unsupported bias against natural gas into the consumer LCC savings and payback analysis and skews the outcome of the comparative cost of fuel-switching. (Atmos Energy, No. 415 at p. 7) In response, DOE accounts for both propane and natural gas consumers of furnaces in its analysis. However, since a potential standard is established at the product class level, the LCC results are aggregated up to this level.

PHCC commented that that the calculations regarding the annual benefit for DOE's proposed standby mode and off mode standards for NWGFs and MHGFs are unclear, as estimates show a $26 annual benefit (with a two-year payback period) in some places and a $2.60 annual benefit (with a two-year payback period) in others. PHCC claimed that their calculations related to the annual benefit of the proposed standby mode and off mode standards yielded $3.29 (assuming 2.5 kw, 24 hours a day, 365 days a year, and 15 cents per kWh). (PHCC, No. 403 at p. 3)

Similarly, Daikin commented that the anticipated energy savings associated with standby mode and off mode are very small, adding that the incremental annual savings between TSL 1 ($1.44/yr.) and TSL 3 ($2.40/yr.) would equate to only $0.96. Daikin further stated that DOE's analysis overstates the annual electricity consumption of auxiliary components by using 6680 hours for standby mode operation and 73.48 kWh of energy per year, which does not include weighting for two-stage products with fewer operating hours. (Daikin, No. 416 at p. 5)

As discussed previously in section III.A.8 of this document, DOE is not finalizing its previous proposal to set new standby mode and off mode power standards for NWGFs and MHGFs in this final rule. However, DOE will continue to monitor the standby mode and off mode power consumption of consumer furnaces and may address such standards in a future rulemaking. The Department may consider these comments at that time, as appropriate.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described previously (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products because DOE applies an incremental markup 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 2022.[103] An inflation-adjusted PPI was calculated using the implicit price deflators for gross domestic product (GDP) for the same years. To calculate an experience rate, DOE performed a least-squares power-law fit on the inflation-adjusted PPI versus cumulative shipments of residential furnaces, based on a corresponding series for total shipments of residential furnaces (*see* section IV.G of this 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 2018. 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 2022 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

[103] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices Series ID PCU333415333415C (available at: *www.bls.gov/ppi/*) (last accessed August 1, 2023).

literature on accounting for technological change and empirical studies of energy technology learning rates.[104] 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 from 2011–2020, 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 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 acknowledges that the prices of non-condensing and condensing furnaces may not change at the same rate and that using a trend for all NWGFs and MHGFs to represent the price trend of condensing furnaces may underestimate the future changes in the cost of condensing furnaces. DOE 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 final rule, DOE used the same price trend projection for condensing and non-condensing NWGFs and MHGFs.

NYSERDA recommended that DOE also should consider furnace shipments to Canada when estimating learning rates for condensing furnaces, since the vast majority of condensing furnaces sold in Canada are the same models sold in the U.S. NYSERDA further urged DOE to consider how the recent Canadian furnace standard may impact the North American furnace market so as to result in additional price learning and less costly condensing equipment for consumers in U.S. and Canada. (NYSERDA, No. 379 at p. 9) However, NYSERDA expect that DOE's 4.3 percent and 7.1 percent price learning rates are more conservative than what would take place in the real world once an amended standard were to take effect. (*Id.*)

NYSERDA also commented that the Heating, Refrigeration and Air Conditioning Institute (HRAI) of Canada reported that over 845,000 residential furnaces were shipped to Canada between 2020 and the first quarter of 2022. The commenter added that nearly 400,000 condensing furnaces are now being shipped into Canada annually, stating that the value is approximately 12 percent of annual U.S. furnace shipments. NYSERDA further commented that the Canadian condensing furnace market is increasing, with approximately 8.5 million Canadian homes currently relying on furnaces for heating. Furthermore, the commenter stated that it has found that the vast majority of furnaces sold in Canada are the same models sold in the U.S., and, as such, NYSERDA concluded that a higher learning rate factor should be considered in appendix 8C of the TSD. (NYSERDA, No. 379 at pp. 9–10)

In response, DOE notes that if DOE included historical furnace shipments to Canada when developing learning rates, it would also need to include projected furnace shipments to Canada during the analysis period to project future prices, resulting in approximately the same price trend as a function of time. Furthermore, DOE analyzes sensitivity scenarios using alternative price trends, including a higher learning rate and a constant price trend, in appendix 8C of the final rule TSD. Consequently, in light of these considerations, DOE has decided to retain the same evaluation of economic justification for all sensitivity scenarios, as was done in the July 2022 NOPR.

Joint Efficiency Commenters stated that DOE may be overestimating the future cost of condensing furnaces by not applying a learning rate associated with condensing technology. These commenters further stated that price trends associated with condensing technology will likely be different than the overall furnace price trends. (Joint Efficiency Commenters, No. 381 at p. 4)

In contrast, Lennox commented that price trends are indeed similar for both condensing and non-condensing consumer furnaces, as Lennox offers both technologies with premium features. Lennox commented that the trends increase the most for premium products, and the trends are similar for base and mid-level products. (Lennox, No. 389 at p. 6)

As noted previously, DOE was not able to disaggregate non-condensing and condensing furnaces in developing future price trends based on the available data. DOE acknowledges the input from Lennox supporting the use of the same trend for all furnaces.

Lennox further stated that costs and prices for all furnaces have increased significantly as a result of the pandemic, supply chain issues, and inflationary pressures. (Lennox, No. 389 at p. 6) Similarly, HARDI commented that supply chain and workforce issues since the beginning of the pandemic have dramatically changed the pricing of products, as would change the results of DOE's analysis, which the commenter faulted as based on pre-pandemic data. (HARDI, No. 384 at p. 3) PHCC commented that DOE's estimated equipment costs for gas furnaces are too low due to material cost and supply chain issues. (PHCC, No. 403 at p. 5) In response, DOE notes that its analysis adjusts costs and prices using updated price indices to reflect the changing dollar value, including the broader impact of inflation. DOE assumes that current supply chain issues will not persist out to 2029 and beyond, given that such issues are already in the process of resolving and current supply chains are not as constrained as they were during the pandemic.

JCI pointed to several regulatory and market-related cost increases that impact mobile homes and mobile home HVAC products. As examples, the commenter noted the July 2014 furnace fan ECS rulemaking that eliminated PSC motors, recent inflation as a result of the COVID–19 pandemic that disproportionately impacted the MHGF industry, the January 2017 ECS rulemaking for CACs and heat pumps, and the IECC Construction Code

[104] 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 August 1, 2023).

mandate for manufactured homes. (JCI, No. 411 at pp. 1–2) JCI commented that the 2021 IECC Construction Code and the CAC/HP ECS rulemaking mandate will contribute additional cost increases, which JCI asserted will have the further effect of reducing mobile home ownership. (JCI, No. 411 at p. 2)

MHI also commented that, in May 2022, DOE finalized an energy rule that required manufactured homes to comply with the 2021 IECC but not the product standards within the 2021 IECC. (MHI, Public Meeting Webinar Transcript, No. 363 at pp. 25–26) MHI commented that DOE's proposed furnace standards align with the 2021 IECC, which the commenter argued did not consider homes that are built in a factory and transported to the site. (*Id.*) MHI stated that enforcing the IECC would require manufacturers to have to redesign current manufactured housing floor plans. (*Id.*)

In response, DOE notes that the purported mobile home cost increases, unrelated to the furnaces rulemaking, will not impact the LCC results. Because these costs are already present in the no-new-standards case, there is no incremental cost to include in the amended standards case. The impact of cost increases for rules on manufactured homes or other equipment are captured as part of the analyses for those separate rulemakings. DOE further notes that the July 2014 final rule for furnace fans did not eliminate PSC motors for furnace fans in MHGFs. Finally, DOE reiterates that it adjusts costs and prices using price indices to reflect the changing dollar value, including the broader impact of inflation. DOE has also evaluated the cost of installing furnaces in new manufactured housing construction as part of the LCC analysis, which in many cases is less expensive (as summarized in section IV.F.2.e of this document) due to the materials required. Given this context, DOE's expectation is that redesign costs are likely to be minimal.

Lennox commented that condensing furnace products are mature products that constitute the majority of the current market. Therefore, Lennox recommended that DOE should reassess the ''learning curve'' for these products, as the commenter opined that the Department is overstating the degree to which a ''learning curve'' could lead to significant reduction in MPCs. (Lennox, No. 389 at p. 3) NYSERDA commented that it expects that the final furnaces standard will provide market certainty to streamline the manufacturing process to only condensing equipment and added that this is expected to decrease the marginal production costs in the medium- to long-run due to economies of scale and technological improvements. (NYSERDA, No. 379 at p. 11)

Regarding the points involving learning curve-related prices declines raised by Lennox and NYSERDA, DOE notes that it has evaluated several price trend scenarios, including a constant price scenario, as part of its analysis (see appendix 8C of the final rule TSD for further details). The conclusions of the analysis remain the same regardless of the price trend scenario.

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

2. Installation Cost

The installation cost is the cost to the consumer of installing the furnace, in addition to the cost of the furnace itself. Installation cost includes all labor, overhead, and any materials 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 a consumer 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 2020 (updated from RECS 2015 in the NOPR). For this final rule, DOE used 2023 RS Means data for the installation cost estimates, including labor costs.[105] [106] [107] [108] DOE's analysis of installation costs accounted for regional differences in labor costs by aggregating city-level labor rates from RS Means into the 50 distinct States plus Washington, DC to match RECS 2020 and CBECS 2018 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.

HARDI commented that increased installation costs should be considered in this analysis despite DOE's statement that installation and retrofit requirements are not to be used in determining product utility for a class. (HARDI, No. 384 at p. 5)

In response, DOE notes that a variety of installation factors are included in the analysis, as described extensively in the paragraphs that follow, which generally increase the installation cost of higher-efficiency furnaces. Even though installation costs do not form a basis for the development of product classes, DOE does include all relevant installation costs to estimate the total economic impacts on consumers.

ACCA stated that data from a 2016 survey of over 700 of ACCA's members showed that installing a condensing furnace costs $569 more than installing a non-condensing furnace, so the commenter concluded that DOE's cost assumptions inadequately reflect the true cost to consumers. (ACCA, No. 398 at p. 2)

DOE clarifies that in the final rule analysis, on average for replacement installations, the incremental installation cost is $490 for condensing NWGFs relative to non-condensing NWGFs, while the total installed costs for ranges between $654 and $914, which is consistent with ACCA's survey results.

APGA commented that DOE understates the cost difference between condensing and non-condensing furnaces because DOE is not reporting real consumer prices. (APGA, No. 387 at pp. 50–53) APGA explained that a website sponsored by a team of industry experts in the HVAC industry report that the installed cost of a condensing NWGF is three times more than a non-condensing NWGF at the current standard: an ''80AFUE, Variable Speed Furnace'' is $1,320 less than a ''95AFUE 2-Stage, Variable Speed Furnace.'' (*Id.*) APGA noted that DOE's LCC model, however, provides that the difference in the average installed cost of a condensing furnace and a non-condensing furnace is only $417. (*Id.*)

[105] RS Means Company Inc., RS Means Mechanical Cost Data. Kingston, MA (2023) (available at: *www.rsmeans.com/products/books/2023-cost-data-books*) (last accessed August 1, 2023).

[106] RS Means Company Inc., RS Means Residential Repair & Remodeling Cost Data. Kingston, MA (2023) (available at: *www.rsmeans.com/products/books/2023-cost-data-books*) (last accessed August 1, 2023).

[107] RS Means Company Inc., RS Means Plumbing Cost Data. Kingston, MA (2023) (available at: *www.rsmeans.com/products/books/2023-cost-data-books*) (last accessed August 1, 2023).

[108] RS Means Company Inc., RS Means Electrical Cost Data. Kingston, MA (2023) (available at: *www.rsmeans.com/products/books/2023-cost-data-books*) (last accessed August 1, 2023).

Thus, APGA stated that DOE's view of the additional cost of an installed furnace complying with the proposed standard is inconsistent with reality. (*Id.*)

In response, DOE emphasizes that it has conducted an extensive engineering tear-down cost analysis, as well as a manufacturer and distribution channel mark-up analysis, to estimate final consumer prices. These prices reflect an amended-standards scenario in which a given efficiency level is the new minimally compliant, baseline level. These products may not fully correspond to products in the market today sold and marketed as a ''premium'' product, and therefore the prices are not necessarily comparable. DOE further notes that the vast majority of consumer furnaces are sold through a distribution channel involving a contractor, not via a retail outlet. Therefore prices seen on a website are unlikely to be representative of typical prices ultimately paid for by consumers.

NPGA commented that merging product installed costs with changes in building structural elements required for a change in venting systems goes beyond the scope of minimum efficiency standards for a covered product as outlined in EPCA. (NPGA, No.395 at p. 21) In response, DOE notes that the installation cost analysis considers all relevant costs associated with the installation of furnaces, as required by EPCA, in order to estimate representative impacts to consumers.

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 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),[109] 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) for NWGFs, which have similar performance curves as PSC motors.[110]

DOE notes that asbestos presents a safety hazard that must be properly abated for all retrofit installations where it is present. As explained previously, 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 final rule 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 eight percent of non-condensing to non-condensing furnace replacement installations in 2029, with an average cost of $990. In addition, DOE estimated that 23 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 $328.

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 final rule describes the methodology used to determine the installation costs for all of the issues described in the paragraphs that follow.

NGA of Georgia stated that because furnace replacements will have to undergo structural modifications and contractors will have to devise custom installation plans and procure materials after surveying the home, installations will take a few days rather than simply changing out the unit. Furthermore, the commenter stated that the longer installations will force homeowners to endure cold conditions longer, and to risk home damage in the form of freezing pipes, and they may be forced to endure the expense of a hotel room during the installation. NGA of Georgia stated that DOE's analysis did not adequately consider these additional costs or the environmental impact of attempting to heat homes with electric room heaters during construction. (NGA of Georgia, No. 380 at p. 2) In response, DOE notes that its analysis thoroughly accounts for any potential vent or duct-work redesign. However, for most homes, installation is unlikely to take several days, even in the case of replacing a non-condensing furnace with a condensing furnace. DOE acknowledges that some fraction of replacements are emergency replacements, as described previously, with increased labor costs due to the emergency nature of the work during possibly challenging winter conditions. Accordingly, DOE also accounts for the cost of temporary space heating during the replacement of the furnace.

[109] 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.

[110] For further details, *see* the TSD for the July 2014 final rule for furnace fans. (Available at: *www.regulations.gov/document/EERE-2010-BT-STD-0011-0111*) (Last accessed August 1, 2023).

ACCA stated that DOE's analysis overlooked the increased costs and extent of venting modifications and electrical upgrades necessary for condensing furnaces. (ACCA, No. 398 at p. 3)

In response, DOE emphasizes that its analysis includes an extensive list of factors impacting the installation cost of venting, as discussed in this section and in chapter 8 of the final rule TSD. Several of these factors were previously suggested by commenters and incorporated into the analysis. ACCA did not provide any further details on additional venting modifications that should have been considered. With respect to electrical upgrades, those are accounted for in the analysis, including the potential requirement to upgrade the electrical panel.

AGA asserted that the imposition of standards that non-condensing products cannot achieve would raise significant practical, economic, and legal issues. Furthermore, AGA claimed that the economic analysis in the NOPR fails to properly account for the necessary engineering relative to venting consumer furnaces or common venting of multiple appliances, including consumer water heaters. According to the commenter, the modifications required to alter existing buildings to accommodate the use of condensing products are far more complicated, extensive, and burdensome than the NOPR assumes. (AGA, No. 405 at p. 39)

In response, DOE has already included a variety of factors in its installation cost estimates, including costs related to updating flue venting, accommodating the venting of multiple appliances such as water heaters, and any necessary building modifications to accommodate new venting outlets. The commenter has not provided any additional, specific factors for DOE to consider, other than to assert that DOE's estimates are incorrect. Furthermore, the experience of replacing non-condensing furnaces with condensing furnaces in several jurisdictions (*e.g.,* Canada) has shown that such installations can be achieved without excessively burdensome or costly modifications.

AGA argued that DOE has potentially overestimated the cost of venting for non-condensing furnaces. The commenter claimed that DOE's method for calculating labor overestimates time spent on tasks because it includes an average unit of type for each individual part instead of acknowledging that tasks can be completed concurrently. (AGA, No. 405 at pp. 88–89)

On this topic, DOE clarifies that for non-condensing furnaces, there are several potential scenarios. In a replacement scenario, if the existing venting is in good condition, no additional installation costs are required, and the venting system can be used as-is. Costs for installing venting for non-condensing furnaces are only applicable if the existing venting has reached the end of its lifetime (in older homes), based on the estimated equipment age derived from RECS data and historical shipments, or in new construction. Therefore, DOE's estimated costs for installing venting for non-condensing furnaces are not necessarily applicable in all situations. Regarding labor cost estimates, these are based on data from industry reference manuals and input from HVAC consultants and apply to both non-condensing and condensing installations. DOE estimates the time spent for typical tasks and multiplies this time by a labor rate. The overall labor time for a given installation will vary based on the specifics of the installation, as described in further detail in chapter 8 and appendix 8D of the final rule TSD.

AGA recommended that DOE undertake additional evaluation of installation costs and annual maintenance costs of non-weatherized residential and manufactured home gas furnaces to ensure a complete LCC and payback period analysis. Specifically, AGA recommended a comprehensive analysis of the average installed replacement cost of an 80 kBtu/hour, 80-percent AFUE non-condensing residential non-weatherized natural gas furnace. (AGA, No. 405 at p. 87)

In response, DOE notes that it already conducts such an analysis. There are a range of input capacities considered as part of the LCC analysis, including 80 kBtu/hour furnaces.

AGA commented that DOE may have overestimated the length of pipe, which makes up half the cost of a new 4'' vent. AGA stated that for buildings where the furnace was installed in the basement, the DOE calculations appear to fit a typical 2-story home where the average vent length is 26 feet. However, for buildings where the furnace is in the attic, the average length is 10 feet, so DOE's analysis would result in venting extending up to 15 feet beyond the roof surface. (AGA, No. 405 at p. 89)

In response, DOE clarifies that its installation cost methodology does not assume a fixed vent length for each home or building in the LCC. The length of the vent varies and is dependent on the characteristics of that specific building. For example, the vent length depends on the furnace location in the house, the ceiling height, and the number of floors above the furnace, among other factors. The analysis accounts for attic installations and does not assume excessively long vent lengths beyond the roof.

In contrast, the Joint Efficiency Commenters stated that DOE may be overestimating the installation costs of condensing NWGFs in certain scenarios. (Joint Efficiency Commenters, No. 381 at p. 4)

In response, DOE has included a number of factors that may impact the installation costs of condensing NWGFs, partly based on prior comments. There is no indication that these costs are systematically overestimated, and the commenter has not provided any data with which to update the analysis.

Joint Efficiency Commenters stated that they are not aware of any issues regarding the size or installation of condensing MHGFs in new or replacement applications. These commenters further stated that these issues have been thoroughly evaluated and adequately addressed. (Joint Efficiency Commenters, No. 381 at p. 5) Similarly, NCLC stated that installing condensing MHGFs in manufactured homes will not present unique, significant, or insurmountable challenges. (NCLC, No. 383 at p. 7) DOE agrees.

Joint Efficiency Commenters stated that DOE extensively evaluated installation scenarios and costs for consumer furnaces in the NOPR analysis and expressed their belief that these thorough evaluations are comprehensive and reasonable for condensing furnace installations. (Joint Efficiency Commenters, No. 381 at pp. 5–6) DOE agrees.

OPAE commented that a Cleveland-based heating and weatherization contractor for one of their member agencies who has been working in the low-income weatherization program for over 30 years, stated that he has not found a home where he could not install a condensing furnace. Additionally, OPAE stated that for most cases where venting changes may be difficult, manufacturers are developing solutions to use an existing chimney as a chase-way for the condensing furnace's intake and exhaust pipes and other category I appliance ventilation. Furthermore, OPAE stated that these methods usually remove any impediment to installing a condensing furnace in situations that currently provide challenges. (OPAE, No. 347 at p. 1) DOE agrees that solutions exist for such situations, as described by the commentator and as evidenced in other jurisdictions (*e.g.,* Canada). Moreover, DOE accounts for increased installation costs in these situations.

NYSERDA recommended that DOE should investigate the economics of newer venting technologies. The commenter added that newer venting technologies enable reuse of existing vents or masonry chimneys, thereby allowing condensing furnaces and water heaters with atmospheric combustion to share the same vent. NYSERDA further remarked that this technology could reduce total installation costs for consumers and improve LCC savings. (NYSERDA, No. 379 at p. 6)

NCLC *et al.* commented that DOE has not fully considered venting technologies that could bring down the assumed installation costs in settings where installing a condensing furnace may present challenges and added costs. (NCLC *et al.,* No. 383 at p. 7)

In response, DOE notes that it did investigate new venting technologies in a sensitivity scenario for the July 2022 NOPR, and does so again for the final rule (*see* appendix 8L of the final rule TSD). The LCC impacts are very similar to the reference case, and DOE's evaluation of economic justification remains the same.

NGA of Georgia stated that the proposed rule would eliminate the ability to common vent multiple gas appliances. The commenter also stated that this would prevent the use of gas appliances in older homes, multi-family developments, row homes, and townhomes. Furthermore, NGA of Georgia stated that because of this, water heaters may need to be changed out when the furnace is replaced, even if the water heater is still working. (NGA of Georgia, No. 380 at p. 2)

APGA claimed that DOE does not account correctly for ''orphaned'' non-condensing gas water heaters. In those situations, APGA asserted that additional costs should be considered for updating flue vent connectors, vent resizing, or chimney relining. Where costs are relatively higher to address an orphaned water heater, the costs of venting should be higher there as well. APGA argued that DOE understates additional venting installation costs in multi-family buildings, townhomes, and row houses. AGA also argued that other homeowner obstacles are unaccounted for entirely, including: zoning variances required when venting is too close to a property line; building code restrictions; historic building limitations; and concerns about venting near places of congregation such as decks. (APGA, No. 387 at pp. 54–55)

In response, DOE acknowledges that common vents may need to be replaced and includes those costs in its analysis where applicable, including updating flue connectors, vent resizing, or chimney relining. However, DOE finds that these obstacles can be overcome, given that these buildings already have an existing furnace exhaust vent. Full details of the installation cost methodology are provided in appendix 8D of the final rule TSD. DOE additionally includes situations in which the water heater is replaced as well, instead of updating the venting to permit continued use of the existing gas appliance. These costs are all included as part of the LCC analysis.

ACCA stated that DOE's analysis overlooked potential building code restrictions for apartments, condominiums, and/or row houses/townhomes. (ACCA, No. 398 at p. 3)

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. Condensing NWGFs have been successfully installed in multi-family buildings, townhomes and row houses in jurisdictions requiring condensing furnaces (*e.g.,* Canada, which has very similar building codes as the U.S.) and in regions with active efficiency and weatherization programs. The analysis includes additional costs, where necessary, to capture the increased complexity of such installations.

PHCC commented that installation labor costs in DOE's NOPR are not near today's contractor rates, and that DOE's residential and commercial rates are low, which will impact the economic model calculations. (PHCC, No. 403 at p. 5) In response, DOE notes that its analysis uses the latest RSMeans data to estimate labor rates, which are the best data available to the Department. No other sources of contractor rate data were submitted to DOE.

Similarly, Daikin commented that there are existing applications (such as placement of furnaces in cold spaces such as attics and crawl spaces) that will incur additional burden as a result of a condensing standard. (Daikin, No. 416 at p. 2) In response, DOE accounts for such applications as described subsequently in this document and in chapter 8 of the final rule TSD.

Plastics Pipe Institute commented that if DOE eliminates non-condensing furnaces as a viable option, consumers will have to update their existing venting systems to accommodate a new natural gas furnace. (Plastics Pipe Institute, No. 404 at p. 2) Plastics Pipe Institute added that this conversion will lead to higher operating costs and will require electrical upgrades, inevitably increasing the cost of heating. (*Id.*)

In response, DOE acknowledges that the installation of a condensing furnace may require an update to the venting system and includes these additional costs in the analysis. DOE also accounts for households that may require a new electrical connection.

(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 other 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 ft., 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,[111] 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, 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 has determined 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 [112] 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 final rule, DOE assigned additional venting installation costs (on average $241) for a quarter of replacement installations [113] 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).[114] [115] 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.[116] 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.[117] 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.[118] 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).

(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

[111] 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 August 1, 2023).

[112] Data from the consumer water heater NOPR were used in this analysis. 88 FR 49058 (July 28, 2023).

[113] This fraction accounts for buildings without common venting; buildings where all/most furnaces are replaced at the same time (many rentals/homeowners association (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 2020 RECS data regarding the number of apartments/units and the number of stories per multi-family building.

[114] 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 August 1, 2023).

[115] 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 August 1, 2023).

[116] 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 August 1, 2023).

[117] 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 August 1, 2023).

[118] 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 August 1, 2023).

offers significant energy savings [119] and safety [120] advantages.[121 122]

DOE's analysis assumes that two-thirds of condensing furnaces will be installed with the direct vent feature, based on a consultant report (*see* appendix 8D of the final rule TSD for further details). 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 NWGF installations, including, when applicable, a condensate drain, condensate pump, freeze protection (heat tape),[123] 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 [124 125] 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.[126] 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 final rule, 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.

Napoleon stated that the proposals in the July 2022 NOPR will have negative economic and safety impacts on consumers in replacement scenarios. The commenter stated that increasing the minimum efficiency will require the furnaces to be condensing, and it is not practical to use the condensate removal system for an air conditioner (typically located in unconditioned space outside the building structure) to remove condensate from a condensing furnace when it could be subject to freezing temperatures. Napoleon also stated that installing a plumbed drain will be a significant cost for the consumer and may not even be feasible, and the commenter further added that installing such plumbing could be cost-prohibitive and force property owners to attempt to perpetually repair their existing products, thereby leading to a safety hazard. Therefore, Napoleon recommended that 80-percent AFUE furnaces must remain available for the replacement market because, according to the commenter, they are the only cost-effective and safe option for consumers. (Napoleon, No. 374 at p. 1–2)

In response, DOE notes that the analysis does consider appropriate additional costs to remove condensate for condensing furnaces, as described above, in accordance with all manufacturer instructions and local requirements. The analysis accounts for situations in which additional freeze protection is required, imposing additional costs on the installation. DOE acknowledges that in some cases the costs to address condensate withdrawal may be significant, but these are already captured by the analysis and included in the distribution of impacts.

(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 39 percent of replacements in residential applications could be labeled as ''difficult'' installations,[127] with an average incremental installation cost of $867 relative to the baseline 80-percent AFUE NWGF (compared to an incremental cost of $247 for all other replacement installations).

DOE sought any information or data regarding potential physical limitations when installing a new condensing furnace. In consumer [128] and contractor [129] surveys, relocation was not mentioned as an issue for furnace installation.[130] 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

[119] 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.

[120] 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.

[121] DOE, Technology Fact Sheet. 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 August 1, 2023).

[122] DOE, Furnace and Boilers (available at: *www.energy.gov/energysaver/home-heating-systems/furnaces-and-boilers*) (last accessed August 1, 2023).

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

[124] 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 August 1, 2023).

[125] Bryant, Installation Instructions: Condensate Drain Protection (2008) (available at: *www.questargas.com/ForEmployees/qgcOperationsTraining/Furnaces/Bryant_355AAV.pdf*) (last accessed August 1, 2023).

[126] 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 August 1, 2023).

[127] 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).

[128] Decision Analyst, Homeowner ''Spotlight'' Report: Equipment Switching, Repair Profile and Energy Efficiency (August 2011) (available at: *www.decisionanalyst.com/*) (last accessed August 1, 2023).

[129] Decision Analyst, Contractor ''Spotlight'' Report: Energy Efficiency and Installation Profile (August 2011) (available at: *www.decisionanalyst.com/*) (last accessed August 1, 2023).

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

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.

GAS commented that by not drawing a regulatory distinction between condensing and non-condensing appliances, DOE ignores the well-documented ''problematic designs'' faced by consumers forced into replacing non-condensing appliances into structures that were not designed for condensing appliances. (GAS, No. 385 at p. 3)

The Coalition also commented as to the construction and configuration challenges that come with converting to a condensing furnace. The Coalition stated that insufficient exterior wall clearance for venting would be an obstacle, and that altering the venting might also necessitate replacement of the gas hot water heater. (The Coalition, No. 378 at p. 5) Also, the Coalition argued that plumbing issues would lead to considerable expense, and the cost impact of changing out flues and adding combustion air ducts would impact fire-rated floor assemblies. Finally, the Coalition commented that these issues of converting to a condensing furnace would potentially result in the displacement of residents, interruption of resident quality of life, disruption to property operation, and significant costs. (*Id.*)

As DOE has discussed here and in further detail in chapter 8 and appendix 8D of the final rule TSD, the analysis accounts for some situations in which there are high costs associated with the replacement of a non-condensing furnace with a condensing furnace, including interior wall displacement, vent or equipment relocation, and condensate withdrawal management. Those impacts are included in the distribution of LCC results. Furthermore, DOE has concluded that any disruptions associated with installation of a more-efficient furnace are likely to be temporary and of limited duration. Because such disruptions are temporary, they would not have a significant effect on the results of the analyses or DOE's conclusions.

(g) Emergency Replacements

DOE acknowledges that installation costs could increase for condensing furnaces in an unplanned emergency situation for the reasons that follow. Decision Analyst's 2022 American Home Comfort Study (AHCS)[131] reported that unplanned replacements accounted for one-third of gas furnace installations. For this final rule, 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 $539. For new construction and new owners, the incremental installation cost was estimated to be, on average, −$708.[132] Since 26 percent of shipments were estimated to be in the new construction and new owners market, based on the projected growth in new housing units and historical shipments (see chapter 9 of the final rule TSD), the resulting average incremental installation cost was $218. The incremental installation cost estimates reflect labor cost and installation material cost data from 2023 RS Means.

In response to the July 2022 NOPR, the DCA commented that DOE does not need to force the installation of condensing furnaces by terminating the types of furnaces that can be easily installed without retrofitting. The DCA further commented that this proposed rulemaking would eliminate the 40 percent of non-weatherized natural gas furnaces that are non-condensing. (DCA, No. 372 at p. 2) Daikin commented that in 2019, the standard in Canada was set to condensing standard of 95-percent AFUE, so presumably, that country must have found ways to overcome these installation challenges. (Daikin, No. 416 at p. 2) Similarly, the Watertown Municipal Utilities stated that close to 75 percent of the homes and businesses in its service area currently use non-condensing furnaces, and the commenter argued that retrofitting existing homes will increase monthly expenses for the average consumer. (WMU, No. 351 at p. 1)

The Coalition commented that replacing non-condensing units with condensing units might require substantial retrofitting and/or property modifications. (The Coalition, No. 378 at p. 4) The Coalition commented that the cost of retrofitting could be prohibitive or even impossible. (*Id.*) The Coalition added that this would result in some owners switching to less-efficient forms of heating that defeat the purpose of the proposed standards. (*Id.*)

In response, DOE has conducted an extensive analysis of potential retrofit costs as detailed in this section, including replacement situations involving significant additional installation costs. These ''difficult'' installations are accounted for in the distribution of results (see section IV.F.2.b.f of this document). DOE has further evaluated the potential for some consumers to switch to alternative forms of space-heating as described in more detail in section IV.F.10 of this document.

(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).[133] 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 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

[131] Decision Analysts, 2022 American Home Comfort Studies (available at: *www.decisionanalyst.com/syndicated/homecomfort/*) (last accessed August 1, 2023).

[132] DOE calculated that, on average, condensing NWGF installation costs are lower in the new construction market compared to non-condensing NWGFs, since high-efficiency NWGFs 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 final rule for more details regarding new construction installation costs.

[133] Lekov A., V. Franco, G. Wong-Parodi, J. McMahon, P. Chan, Economics of residential gas furnaces and water heaters in U.S. 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 August 1, 2023).

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 adopted 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 manufactured-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. Manufactured home designs must be approved by an accepted third-party inspection agency, 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 sealed combustion system appliances. MHGFs cannot be commonly vented with other gas-fired equipment (such as a gas-fired water heater) (24 CFR 328.709). Further, manufacturers are required to have an inspection agent, and each home must be inspected by the inspection agent in at least one phase of production, and the manufacturer must self-certify each section of the home as in compliance with the HUD code (24 CFR 3282.204 and 3282.205). DOE also adjusted the condensate withdrawal installation costs to account for a fraction of installations that encounter difficulty installing the condensate drain.

In regard to space constraints and installation, DOE received several comments in response to the July 2022 NOPR. HARDI commented that EPCA prevents DOE from finalizing a rule that would outlaw equipment with certain size requirements. HARDI commented that size is not limited to the equipment itself, but any encroachment on the consumer's living space. (HARDI, No. 384 at p. 5) PHCC commented that venting poses a major challenge to installation, which will affect the installation costs. PHCC further stated that potential venting issues include excessive vent lengths, significant building modifications, drainage issues, or nuisance condensing vent plumes. (PHCC, No. 403 at p. 3) CEC commented that although some owners of manufactured homes may be concerned about potential space and cost constraints related to the proposed standards for MHGFs, updating their heating system with an efficient furnaces or electric heat pumps is feasible, both technically and economically. (CEC, No. 382 at p. 2)

In response, DOE notes that the LCC includes costs related to additional venting requirements, condensate removal, and any modifications to address any space constraints for replacement installations of MHGFs. There is no technical limitation preventing the installation of a condensing MHGF, and all relevant costs are included in the analysis. Alternatively, consumers could switch to an appliance which utilizes a different technology (*e.g.,* a heat pump). For these reasons, DOE has concluded that the approach adopted in this final rule is consistent with the requirements of EPCA.

MHI commented that condensing furnaces require different venting and combustion air intake designs as compared to non-condensing furnaces, as well as the addition of condensate drain systems. (MHI, No. 365 at p. 2) Also, MHI noted that condensing furnaces would require manufactured home designers to change the typical floor plans of their designs, adding costs to this process that will be passed down to the consumer. (*Id.*) MHI commented that the impacts of changing the typical floor plan of a manufactured home in order to accommodate a condensing furnace are not fully captured in the July 2022 NOPR, and these impacts are particularly harmful for manufactured housing consumers, especially in southern climates. (*Id.*)

MHI commented that the proposed standards for MHGF would increase construction costs for new manufactured homes by approximately $1300. (*Id.*) Nortek commented that condensing furnaces cost approximately $1300 more than non-condensing furnaces, and that they require significantly different venting/combustion air in-take/condensate drainage systems. According to the commenter, these changes would lead to additional cost and floorplan design changes for manufactured homes. (Nortek, No. 406 at p. 4) In response, DOE's analysis includes all costs necessary to install a condensing MHGF in new construction, including venting costs and condensate removal. However, DOE's analysis, based on the best available evidence, does not indicate that incremental costs for installation of a condensing MHGF are as high as $1300.[134]

MHI commented that owners of manufactured homes typically have more budgetary restrictions than other consumers, as their median annual household income is well below the national average. MHI argued that manufactured homeowners, who would be unlikely to see cost savings from condensing furnaces for many years, would face significant budgetary burdens. (MHI, No. 365 at p. 3) In response, DOE notes that its analysis captures the discount rate that is applicable to owners of manufactured homes, based on their household income, and which reflects their access to capital and budgetary constraints.

MHI estimated that certain floorplans of manufactured housing would incur up to $7000 to comply with the requirements of the May 2022 final rule for manufactured housing. (MHI, No. 365 at p. 3) Similarly, Nortek commented that DOE's final rule to establish energy conservation standards for manufactured housing will also impose costs on manufactured homeowners, and that DOE's analytical models do for the furnaces rule not consider these costs.(Nortek, No. 406 at pp. 2–3)

In response, DOE notes that the impacts of the May 2022 final rule for manufactured housing were considered as part of that rule and are not relevant in this rulemaking.

MHI commented that the proposed standards for MHGFs will negatively impact the manufactured home resale and replacement market. The commenter argued that about one-third of manufactured homes use natural gas for heating, and that the cost to replace a non-condensing gas furnace with a condensing one could be burdensome to the consumer due to increased cost, the need to increase the cabinet size, and changes to venting. (MHI, No. 365 at pp. 3–4) MHI also noted that there are a limited number of furnace manufacturers that manufacture condensing furnaces for use in manufactured homes. (*Id.* at 3) MHI commented that furnace replacements that would typically cost around $3,000 now would cost $10,000 or more under DOE's proposal, which the commenters asserted that many manufactured

[134] On average, DOE's analysis indicates that the incremental totaled installed cost of an AFUE 95 percent MHGF, compared to an AFUE 80 percent MHGF, is only $188 (averaged over replacement installations and new construction and including both equipment and installation costs). Further details can be found in chapter 8 and appendix 8D of the final rule TSD.

homeowners would not be able to afford. (MHI, Public Meeting Webinar Transcript, No. 363 at p. 28) MHI also stated that these impacts would be disproportionately felt by homeowners in Southern States. (*Id.*) MHI also asserted that this rulemaking would require redesigns of manufactured homes subject to the National Home Construction and Safety Standards Act, as any changes to a home's design, manufacture, or installation must be reviewed and approved by HUD. (MHI, No. 365 at p. 2)

Mortex commented that DOE's incremental cost from non-condensing to condensing furnaces is much lower than MHI's estimate, which is conservative. (Mortex, No. 410 at p. 2) Mortex estimated that the incremental cost to consumers to move from a non-condensing to a condensing MHGF is between $1700 and $2100. (*Id.*) Mortex further commented that the average savings estimated by DOE would be eliminated if the incremental cost was adjusted, meaning that there would be no payback for manufactured homeowners. Mortex further commented that southern consumers would be even less likely to experience life cycle cost savings. (Mortex, No. 410 at pp. 2–3)

AHRI expressed its concern regarding DOE's results for TSL 8. AHRI stated that MHI has estimated that the incremental cost of a condensing furnace is $1,300, as opposed to the $315 estimated by DOE, adding that the LCC savings from a condensing furnace disappear when any cost approaching MHI's estimated value is used. (AHRI, No. 414–2 at p. 3)

JCI commented that it disagrees with the costs and benefits assumed for MHGFs in DOE's analysis, arguing in particular that the replacement market is not accurately reflected. (JCI, No. 411 at p. 3)

In response to these comments, DOE disagrees with these cost estimates and notes that no persuasive evidence was submitted to substantiate these estimates. DOE has performed a detailed cost analysis and has determined that the potential benefits outweigh the costs, including the costs to replace a non-condensing MHGF with a condensing MHGF (including adjusting cabinet size and venting). DOE disagrees that a more-efficient MHGF will negatively impact the resale value of a manufactured home, as a more efficient MHGF will have lower operating costs, which is more attractive to potential buyers. Furthermore, DOE notes that potential investments made by manufactured housing OEMs are outside the scope of this rulemaking. DOE must follow specific statutory criteria for prescribing new or amended energy conservation standards for covered products, such as the subject consumer furnaces. Pursuant to EPCA, DOE's analysis considers the economic impact of the standard on consumers and manufacturers of the products subject to the standard (*i.e.,* manufacturers of NWGFs and MHGFs). (42 U.S.C. 6295(o)(2)(B)(i)(I)) The LCC analysis is focused on consumers of MHGFs and the costs to purchase the covered product (*see* 42 U.S.C. 6295(o)(2)(B)(i)(II)), not the costs to purchase a manufactured home. With respect to manufacturers, since manufactured housing OEMs are not manufacturers of the products subject to the standard, DOE does not explicitly analyze those investments in its MIA. Furthermore, DOE did not include the manufactured housing rulemaking in its cumulative regulatory burden analysis for this rulemaking as none of the MHGF OEMs identified produce manufactured homes subject to the May 2022 final rule for manufactured housing.

JCI also commented that manufactured homeowners often have electrical limitations due to remote locations and limited electrical capacity, meaning that it would be more challenging for these consumers to switch to other methods of heating such as electric furnaces and heat pumps. (JCI, No. 411 at p. 2) JCI stated this means that manufactured homeowners would be more likely to incur the higher costs for condensing furnaces. (*Id.*) JCI stated that this is because electric mobile home furnaces and heat pumps require electric resistance backup heating which have additional power/kW requirements which can greatly exceed those of a gas furnace especially in colder, northern climates (*i.e.,* approximately 15 amps for the gas furnace vs 90 amps for the electric furnace). (*Id.*) JCI further noted that electric furnaces require 240 V, while gas furnaces require 120 V, which is more common. (*Id.*) Finally, JCI stated that southern areas are better suited for heat pump loads, with backup heat required for anomaly events. JCI commented that these requirements add cost for manufactured homeowners, increasing with colder temperatures. (*Id.*)

In response, DOE acknowledges that there may be additional electrical connection costs when replacing a non-condensing furnace with a condensing furnace and has included such costs in the analysis.

In contrast, NCLC *et al.* stated that installing condensing furnaces in manufactured homes will not present unique, significant, or insurmountable challenges, adding that the Low-income Energy Affordability Network has always been able to find condensing furnaces that fit into the available space when upgrading from non-condensing furnaces. (NCLC *et al.,* No. 383 at p. 7) DOE agrees with this comment.

The CA IOUs agreed with DOE that the average cost of a condensing MHGF in a new mobile home is comparable to a non-condensing MHGF because the price increase of the product is offset by lower installation costs for a condensing MHGF for most installations. (The CA IOUs, No. 400 at p. 2) Additionally, the CA IOUs noted that the National Consumer Law Center contacted two programs that retrofit mobile homes to improve efficiency (Action for Boston Community Development and Action Inc., Gloucester, Massachusetts) which indicated that the proposal would not be burdensome for MHGF replacements. (*Id.*)

d. Contractor Survey and DOE's Sources

DOE notes that its focus for installation costs is to estimate the incremental cost between different efficiency levels. DOE used the results of a contractor survey previously submitted to DOE in order 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 final rule, 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 final rule, DOE also compared its average estimates to the AHRI/ACCA/PHCC contractor survey report and other sources such as Home Advisor,[135] ImproveNet,[136] Angie's List,[137] HomeWyse,[138] Cost Helper,[139] Fixr,[140] CostOwl,[141] and Gas Furnace Guide,[142] 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 final rule, the average incremental installation cost for a condensing NWGF in a retrofit installation was $539 (in 2022$), which is consistent with the AHRI/ACCA/PHCC contractor survey and data provided by SoCalGas, as well as the other sources previously listed. Therefore, DOE concludes that the industry-supplied data support its installation cost methodology.

e. Summary of Installation Costs

Table IV.8 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 2020) and a number of other sources that are described in chapter 8 of the final rule TSD.

TABLE IV.8—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 (2022$)	Replacement installations impacted (percent)	Average cost (2022$)
Non-Condensing Furnaces				
Updating Vent Connector	23	$328		
Updating Flue Vent *	8	990	100	$233
Condensing Furnaces				
New Flue Venting (PVC)	100	308	100	58
Combustion Air Venting (PVC)	62	324	100	58
Concealing Vent Pipes	5	603		
Orphaned Water Heater	7	806		
Condensate Removal	100	92	100	163
Multi-Family Adder	2	241		
Mobile Home Adder			25	127

* 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.9 shows the estimated fraction of new home installations impacted and the average cost for each of the adders.

TABLE IV.9—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 (2022$)	New installations impacted (percent)	Average cost (2022$)
Non-Condensing Furnaces				
New Flue Vent (Metal) *	100	$1,835	100	$263
Condensing Furnaces				
New Flue Venting (PVC)	100	190	100	52
Combustion Air Venting (PVC)	66	358	100	52
Concealing Vent Pipes *	1	206		
Orphaned Water Heater	46	1,380		

[135] Home Advisor, How Much Does a New Gas Furnace Cost? (available at: *www.homeadvisor.com/cost/heating-and-cooling/gas-furnace-prices/*) (last accessed August 1, 2023).

[136] *See www.improvenet.com/* (last accessed August 1, 2023).

[137] 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 August 1, 2023).

[138] HomeWyse, Cost to Install a Furnace (available at: *www.homewyse.com/services/cost_to_install_furnace.html*) (last accessed August 1, 2023).

[139] Cost Helper, How Much Does a Furnace Cost? (available at: *home.costhelper.com/furnace.html*) (last accessed August 1, 2023).

[140] FIXr, Gas Central Heating Installation Cost (available at: *www.fixr.com/costs/gas-central-heating-installation*) (last accessed August 1, 2023).

[141] *CostOwl.com,* How much Does a New Furnace Cost? (available at: *www.costowl.com/home-improvement/hvac-furnace-replacement-cost.html*) (last accessed August 1, 2023).

[142] Gas Furnace Guide, Gas Furnace Prices and Installation Cost Comparison (available at: *www.gasfurnaceguide.com/compare/*) (last accessed August 1, 2023).

TABLE IV.9—ADDITIONAL INSTALLATION COSTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES IN NEW CONSTRUCTION AND NEW OWNER APPLICATIONS—Continued

Installation cost adder	NWGFs		MHGFs	
	New installations impacted (percent)	Average cost (2022$)	New installations impacted (percent)	Average cost (2022$)
Condensate Removal	100	56	100	53

* Applied to new owner installations only.

3. 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 previously 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.[143] 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[144] and a 2013 paper by Thomas and Azevedo.[145] Both of these publications examined the same studies that were reviewed by Sorrell, as well as Greening *et al.*,[146] 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.[147] However, for commercial applications DOE applied no rebound effect, consistent with other recent energy conservation standards rulemakings.[148 149 150]

The LCC analysis considers increases in product and installation costs as well as decreases in operating costs, as directed by EPCA. In this analysis, DOE did not include the rebound effect in the LCC for the reasons that follow. 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. At the same time, those consumers will also experience a welfare gain from the increased utilization of the equipment, which has economic value. DOE includes 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 for further details.

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 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 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

[143] 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 August 1, 2023).

[144] 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 August 1, 2023).

[145] 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 August 1, 2023).

[146] 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 August 1, 2023).

[147] See: *www.eia.gov/outlooks/aeo/nems/documentation/residential/pdf/m067(2020).pdf* (last accessed August 1, 2023).

[148] 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 August 1, 2023).

[149] 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 August 1, 2023).

[150] 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 August 1, 2023).

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 to 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 final rule TSD for more details.

4. Energy Prices

A marginal energy price reflects the cost or benefit of adding or subtracting one additional unit of energy consumption. Because marginal electricity price more accurately captures the incremental savings associated with a change in energy use from higher efficiency, it provides 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.

DOE derived average monthly marginal residential and commercial electricity, natural gas, and LPG prices for each State using data from EIA.[151] [152] [153] 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 2022 for residential and commercial natural gas and electricity prices and historical data up to 2021 for LPG prices. Further details may be found in chapter 8 of the final rule 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.[154] 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 into account, DOE developed price factors for each individual household and building using the annual RECS 2020 and CBECS 2018 energy cost and energy use data. These data are then normalized to match the average State price factors, which are equivalent to a consumption-weighted average price across all households in the State. For more details on the comparative analysis and energy price analysis, *see* appendix 8E of the final rule TSD.

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each of the nine Census Divisions from the Reference case in *AEO2023,* which has an end year of 2050.[155] 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 final rule TSD.

NCLC and Joint Efficiency Commenters stated that DOE may be underestimating future costs of natural gas and, therefore, the energy savings from installing a more efficient furnace. (NCLC, No. 383 at pp. 6–7; Joint Efficiency Commenters, No. 381 at p. 3) In contrast, AGA claimed that DOE continues to utilize energy price projections with an upward bias, consistently overestimates future natural gas costs, and should utilize price distributions instead of a mean. (AGA, No. 405 at pp. 90–91) In response, DOE notes that projected energy price trends from *AEO* are the best available to DOE at the time of the analysis, and DOE does not have any persuasive evidence to suggest these projected energy prices are underestimated. There is no other data set on energy prices of which DOE is aware that is as comprehensive or nationally representative as that from EIA. Furthermore, *AEO* provides a projection of future energy prices based on comprehensive macroeconomic modeling. Near-term projections of energy prices (as used in the LCC) tend to be similar to today's prices. The analysis does not use a single mean value, but rather the energy prices vary by State according to the input data. Finally, DOE conducts sensitivity analyses using high/low economic growth scenarios from *AEO,* which have higher/lower energy price trends.

NYSERDA agreed that actual prices deviating from forecasted prices in a given year would not significantly change the analysis, especially over a 30-year time frame, but recommended that DOE develop and publish forecast accuracy estimates for energy price projections. (NYSERDA, No. 379 at p. 10) In response, DOE acknowledges the uncertainty in energy price projections, but calculating formal uncertainty parameters based on historical editions of *AEO* is not necessarily informative, due to the constantly evolving models and input data sets. Prior forecast accuracy is not necessarily reflective of current models. Instead, DOE addresses energy price projection uncertainty with

[151] U.S. Department of Energy-Energy Information Administration, Form EIA–861M (formerly EIA–826) detailed data (2022) (available at: *www.eia.gov/electricity/data/eia861m/*) (last accessed August 1, 2023).

[152] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2022) (available at: *www.eia.gov/naturalgas/data.php*) (last accessed August 1, 2023).

[153] U.S. Department of Energy-Energy Information Administration, 2021 State Energy Data System (SEDS) (2021) (available at: *www.eia.gov/state/seds/*) (last accessed August 1, 2023).

[154] Gas Technology Institute (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 August 1, 2023).

[155] U.S. Department of Energy-Energy Information Administration, *Annual Energy Outlook 2023* (available at: *www.eia.gov/outlooks/aeo/*) (last accessed August 1, 2023).

the use of sensitivity scenarios, in particular the high- and low-economic-growth sensitivity scenarios. These utilize alternative economic growth cases in *AEO,* as well as alternative energy price projections. The conclusions of the analysis remain the same regardless of the scenario.

APGA commented that, given the need to greatly expand electricity infrastructure to meet electrification and clean electricity goals, it is dubious that *AEO2021* relied on in the NOPR predicts residential electricity prices declining over the next 30 years. (APGA, No. 387 at p. 60) In response, DOE notes that the analysis has been updated with *AEO2023,* which projects increasing electricity prices in years beyond 2030.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product.

DOE estimated maintenance costs for residential furnaces at each considered efficiency level using a variety of sources, including 2023 RS Means,[156] manufacturer literature, and information from expert consultants. DOE estimated the frequency of annual maintenance using data from RECS 2020 and the 2022 American Home Comfort Study.[157] 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 fill material). 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, inducer fan, and furnace fan blower, as well as replacing or repairing the condensate pump, if applicable. To determine the service lifetime of various components, DOE used a Gas Research Institute (''GRI'') study.[158] 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 maintenance and repair costs, including all online resources reviewed, *see* appendix 8F of the TSD for this final rule.

6. 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.[159] For this analysis, DOE relied on RECS 1990, 1993, 2001, 2005, 2009, 2015, and 2020.[160] DOE also used the U.S. Census's biennial American Housing Survey (''AHS''), from 1974–2021, which surveys all housing, noting the presence of a range of appliances.[161] 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 21.5 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,[162] 2020 RECS data,[163] and 2015–2021 AHS data survey data.[164] DOE also incorporated lifetime data from Decision Analysts AHCS from 2006, 2008, 2010, 2013, 2016, 2019, and 2022.[165] The average lifetime used in this final rule is 22.5 years in the North and 20.2 years in the rest of country for both NWGFs and MHGFs (national average is 21.5 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 final rule).

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).

[156] RS Means Company Inc., *RS Means Facilities Maintenance & Repair Cost Data* (2023) (available at: *www.rsmeans.com/*) (last accessed August 1, 2023).

[157] Decision Analysts, 2022 American Home Comfort Study (available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (last accessed August 1, 2023).

[158] 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 August 1, 2023).

[159] 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): p. 28. (Available at *www.tandfonline.com/doi/abs/10.1080/10789669.2011.558166*) (last accessed August 1, 2023).

[160] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey (''RECS''),* Multiple Years (1990, 1993, 1997, 2001, 2005, 2009, 2015, and 2020). (Available at *www.eia.gov/consumption/residential/*) (last accessed August 1, 2023).

[161] 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, 2019, and 2021). (Available at *www.census.gov/programs-surveys/ahs/*) (last accessed August 1, 2023).

[162] 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).

[163] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey (''RECS'')* (2020). (Available at *www.eia.gov/consumption/residential/*) (last accessed August 1, 2023).

[164] U.S. Census Bureau: Housing and Household Economic Statistics Division, *American Housing Survey,* Multiple Years (2015–2021). (Available at *www.census.gov/programs-surveys/ahs/*) (last accessed August 1, 2023).

[165] Decision Analysts, 2006, 2008, 2010, 2013, 2016, 2019, and 2022 American Home Comfort Studies. (Available at *www.decisionanalyst.com/Syndicated/HomeComfort/*) (last accessed August 1, 2023).

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

AGPA claimed that a more complex condensing furnace with more parts that could break down will have a shorter life. APGA asserted that appliance manufacturers have explained to DOE that condensing natural gas appliances are more complex than their baseline counterparts, so the likelihood that the condensing appliance will fail is greater than with a non-condensing appliance. (APGA, No. 387 at pp. 49–50)

As described in more detail in appendix 8G of the final rule TSD, the historical lifetime data do not show any indication that condensing furnace lifetimes are significantly different from non-condensing furnaces. The historical data cover a time period during which condensing furnaces gained more significant market share. As described in section IV.F.5 of this document, DOE included additional repair and maintenance costs for condensing furnaces to account for the increased complexity of these products, which would cover minor component failures that do not necessitate replacing the furnace.

APGA asserted that DOE made an absurd conclusion that 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. APGA claims that where furnaces run longer and harder in the North, product lifetime should be shorter rather than longer. (APGA, No. 387 at p. 50)

In response, DOE notes that although the heating load is higher in the North compared to the rest of country, furnace sizing is also typically much higher. As a result, burner operating hours are not necessarily higher in the North than the rest of country, due to the increased capacity, and, thus, the furnace is not necessarily ''working harder'' in the North as the commenter claims. Furthermore, furnaces in the rest of country are more likely to be paired with an air conditioner, and, thus, the air handler can have significantly higher operating hours than in the North. Therefore, the fact that the lifetime is slightly lower in the rest of country is a reasonable result. DOE also notes that, with a slightly shorter lifetime in the rest of country, which typically has lower furnace operating costs compared to the North, DOE's estimates of LCC savings are, therefore, more conservative than if DOE had assumed a higher lifetime for the rest of country.

AGA argued that DOE's economic analysis is highly sensitive to equipment lifetime assumptions, but the assumed consumer furnace lifetime used in that analysis is neither reasonable nor justified. More specifically, AGA asserted that the LCC spreadsheet incorrectly assumes that all consumer gas furnaces have the same lifetime regardless of energy efficiency. According to the commenter, since condensing furnaces are subject to condensing, acidic water vapor, contain more parts, and are generally more complex, it is unreasonable to assume condensing furnaces would not have a shorter lifetime than non-condensing furnaces. Indeed, AGA argued that the shorter lifespan of condensing products is well documented by actual data and studies that the NOPR fails to confront. AGA presented an analysis using DOE's LCC model spreadsheet that seeks to demonstrate that even modest changes in assumed equipment lifetime produce significant changes in the life-cycle cost savings. (AGA, No. 405 at pp. 67–70)

In response, DOE conducted an analysis of the available data on furnace lifetime, including both condensing and non-condensing furnaces. As discussed in further detail in appendix 8G of the final rule TSD, DOE found no data to support a shorter lifetime for condensing furnaces, despite their generally more complex nature. DOE further notes that it presented sensitivity scenarios with alternative lifetime estimates in the NOPR TSD and does so again for the final rule TSD (*see* appendix 8G). With a shorter lifetime assumption, the average LCC savings are obviously not as large as DOE's reference case. However, LCC savings at the adopted standard level remain positive, with a similar percentage of consumers experiencing net cost, and the relative comparison between the potential standard levels remain the same. Therefore, DOE's conclusions regarding the economic justification for the rule remain unchanged, even under these scenarios with alternative lifetimes.

APGA argued that including distant benefits beyond 2058 is contrary to the statute and that DOE should limit its evaluation of savings in operating costs to the period of the estimated average life of the covered product. (APGA, No. 387 at p. 15) In response, DOE clarifies that the LCC analysis only considers the costs and operating savings throughout the estimated average life of the covered product. This is explicitly in line with the direction of the statute. (42 U.S.C. 6295(o)(2)(B)(i)(II)) The commenter appears to be conflating the LCC with national impact analysis (NIA), which additionally considers the aggregated national impact of products shipped over a 30 year period (2029–2058), in order to evaluate the total projected energy savings and net present value of the rule. (42 U.S.C. 6295(o)(2)(B)(i)(III)) Products shipped in that final year will accrue costs and savings beyond 2058. Both the LCC and NIA are considered as part of the evaluation of economic justification of potential standards.

MHI asserted that DOE's assumption that the lifetime of a MHGF is the same as the lifetime of a manufactured home is incorrect, as the useful life of manufactured homes is increasing and is now equivalent to site-built housing for properly maintained homes. Therefore, MHI argued that manufactured homeowners will incur substantial costs when replacing their furnace that may be prohibitively expensive. MHI further argued that this could lead consumers to continue servicing old equipment rather than making improvements, which would negate any energy savings the potential standards under consideration might bring, as well as potentially increasing the risk of air quality concerns such as carbon monoxide exposure. (MHI, No. 365 at p. 4)

In response, DOE notes that its estimate of MHGF lifetime is approximately 21 years on average, which is the same as for NWGFs. It is not directly tied to the future life expectancy of a manufactured home. Additionally, DOE accounts for increased installation costs when replacing an existing MHGF in a manufactured home with a higher-efficiency MHGF. This accounts for the situation described by the commenter in which the useful life of the manufactured home is longer and the MHGF is replaced. DOE also acknowledges that some consumers may choose to continue servicing an existing MHGF rather than replace it, and includes this effect in its repair vs. replace methodology. This will reduce energy savings to some degree, although eventually, the MHGF will ultimately need to be replaced. Finally, DOE assumes that any licensed professional servicing an existing MHGF will correct any leaks or potential safety issues and will not allow any unsafe operation of a MHGF to persist.

7. Discount Rates

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

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[166] 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 analysis estimates net present value over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. 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 size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets. For commercial applications, DOE's method views the purchase of a higher-efficiency appliance as an investment that yields a stream of energy cost savings. DOE derived the discount rates for the LCC analysis by estimating the cost of capital for companies or public entities that purchase consumer boilers. For private firms, the weighted-average cost of capital (WACC) 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, as estimated from financial data for publicly-traded firms in the sectors that purchase consumer boilers. As discount rates can differ across industries, DOE estimates separate discount rate distributions for a number of aggregate sectors with which elements of the LCC building sample can be associated.

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 triennial Survey of Consumer Finances[167] (SCF) for 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019. 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 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. Alternatively, a consumer 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 final rule analysis across all types of household debt and equity and across all income groups, weighted by the shares of each type, is 4.0 percent for NWGFs and 4.5 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.[168] 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

[166] 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; interest rates at which a consumer is able to borrow or lend. The implicit discount rate is not appropriate for the LCC analysis because it reflects a range of factors that influence consumer purchase decisions, rather than the opportunity cost of the funds that are used in purchases.

[167] 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 August 1, 2023).

[168] Damodaran Online, Data Page: Costs of Capital by Industry Sector (2022) (available at: *pages.stern.nyu.edu/~adamodar/*) (last accessed August 1, 2023).

methodology described in a LBNL report, and the distribution varies by business activity.[169] The average rate for NWGFs used in commercial applications in this final rule analysis, across all business activity, is 6.7 percent.

See chapter 8 and appendix 8H of the final rule TSD for further details on the development of consumer and commercial discount rates.

8. 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) in the compliance year (2029). This approach reflects the fact that some consumers may purchase products with efficiencies greater than the baseline levels, such that even in a no-new-standards case, consumers will be purchasing higher-efficiency furnaces.

To estimate the effect of a potential standard, DOE must estimate not only the expected market share of products at varying efficiencies, but also estimate how such products will be used—that is, in what buildings. The base case reflects three analytical steps: (1) an estimate of the buildings likely to use furnaces, (2) an estimate of the efficiency of the furnaces that would be sold absent the rule; and (3) the matching of particular furnace efficiencies with particular building types.

Each building in the sample was assigned a furnace efficiency sampled from the no-new-standards-case efficiency distribution for the appropriate product class, either NWGFs or MHGFs. In assigning furnace efficiencies, DOE determined that, based on the presence of well-understood market failures (discussed at the end of this section), a random assignment of efficiencies, with some modifications discussed below, best accounts for consumer behavior in the consumer furnaces market. Random assignment of efficiencies reflects the full range of consumer behaviors in this market, including consumers who make economically beneficial decisions and consumers that, due to market failures, do not make such economically beneficial decisions.

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the consumer furnaces purchased by each sample household and commercial building in the no-new-standards case. The resulting percentage shares within the sample match the market shares in the efficiency distributions. But, as mentioned previously, DOE considered available data in determining whether any modifications should be made to the random assignment methodology, as discussed in the following sections.

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[170] and condensing (90-percent AFUE and greater) furnaces by State.[171] AHRI also provided data for non-condensing and condensing furnace shipments by region for 2004–2009[172] and nationally for 2010–2014.[173] 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.[174] DOE also obtained 2013–2022 HARDI shipments data by efficiency for most States.[175] 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 (2013–2022) to project the trends and to estimate the condensing furnace market share in 2029. This excludes years with a Federal tax incentive[176][177] 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. See chapter 8 and appendix 8I of the TSD for this final rule for further information on the derivation of the efficiency distribution projections.

APGA argued that DOE used insufficient shipments data to estimate the share of condensing furnaces in the country, relying only on data from 2010–2014, and as a result, there is considerable reason to doubt the results of the analysis. (APGA, No. 387 at p. 13) In response, DOE notes that the commenter misunderstands the analysis. As detailed above, DOE utilizes significantly more historical shipment data than only 2010–2014, data which are disaggregated by efficiency in order to estimate the current and projected market share of condensing furnaces in the no-new-standards case. In particular, DOE includes shipment data by efficiency up to 2022 in its analysis.

b. Market Shares of Different Condensing Furnace Efficiency Levels

DOE used data on the shipments by efficiency from the 2013–2022 HARDI shipments to disaggregate the condensing furnace shipments among

[169] Fujita, K. Sydny. Commercial, Industrial, and Institutional Discount Rate Estimation for Efficiency Standards Analysis: Sector-Level Data 1998–2022. 2023. (Available at: *eta-publications.lbl.gov/publications/commercial-industrial-and-2*) (last accessed August 1, 2023).

[170] 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.

[171] 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 August 1, 2023).

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

[173] 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 August 1, 2023).

[174] 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).

[175] Heating, Air-conditioning and Refrigeration Distributors International (HARDI), DRIVE portal (HARDI Visualization Tool managed by D+R International until 2022), proprietary Gas Furnace Shipments Data from 2013–2022 provided to Lawrence Berkeley National Laboratory (LBNL).

[176] 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).

[177] 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 August 1, 2023).

the different condensing efficiency levels. Based on stakeholder input, DOE assumed that the fraction of furnace shipments of 95-percent or higher AFUE would be double 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 50 States and Washington, DC.

The estimated market shares by region (North and rest of country) and market segment (replacement and new construction) for the no-new-standards case for NWGFs and MHGFs in 2029 are shown in Tables IV.11 and IV.12 of this document, respectively. DOE estimated that the national market share of condensing products would be 61 percent in 2029 for NWGFs, and 34 percent for MHGFs. *See* chapter 8 and appendix 8I of the final rule TSD for further information on the derivation of the efficiency distributions.

TABLE IV—10 AFUE EFFICIENCY DISTRIBUTION IN THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACES

Efficiency, AFUE (percent)	2029 Market share (percent)			
	North, repl	North, new	South, repl	South, new
Residential Market				
80	25.0	15.9	67.8	33.9
90	0.4	0.2	0.1	0.1
92	17.9	19.9	10.6	23.5
95	55.3	62.4	20.2	39.4
98	1.4	1.5	1.3	3.2
Commercial Market				
80	22.3	11.8	67.5	34.0
90	1.7	0.0	0.0	0.0
92	17.8	17.6	11.9	17.0
95	58.3	70.6	20.6	44.7
98	0.0	0.0	0.0	4.3
All				
80	24.8	15.6	67.8	33.9
90	0.5	0.2	0.1	0.1
92	17.8	19.7	10.7	23.2
95	55.5	63.1	20.2	39.6
98	1.4	1.4	1.2	3.2

Note: "Repl" means "replacement," and "New" means "new construction."

TABLE IV—11 AFUE EFFICIENCY DISTRIBUTION IN THE NO-NEW-STANDARDS CASE FOR MOBILE HOME GAS FURNACES

Efficiency, AFUE (percent)	2029 Market share (percent)			
	North, repl	North, new	South, repl	South, new
80	58.2	57.2	83.7	85.2
90	0.0	0.0	0.0	0.0
92	9.4	9.1	5.5	4.8
95	31.3	32.2	8.7	8.7
96	1.1	1.5	2.0	1.3

Note: "Repl" means "replacement," and "New" means "new construction."

MHI argued that manufactured homes already offer high-efficiency options, and that over 30 percent of manufactured homes meet or exceed EnergyStar Standards (MHI, No. 365 at p. 2)

The DCA commented that consumers are already installing higher-efficiency furnaces across the country. (DCA, No. 372 at p. 1) NYSERDA similarly stated that the proposed standard's efficiency levels are already being met by a significant share of the New York market. (NYSERDA, No. 379 at p. 1) CEC commented that furnaces capable of meeting the proposed standards are already commercially available on the market, and that condensing furnaces have been required in Canada for over a decade. (CEC, No. 382 at p. 2)

In response, DOE acknowledges that some consumers are already purchasing furnaces at an efficiency level equal to or greater than the standard level proposed in the NOPR and accounts for these consumers in the analysis. Such consumers are not impacted by the rule and are not included in the estimate of average LCC savings. As the commenters suggest, the availability of these high-efficiency furnaces on the market demonstrates their technological feasibility in the context of DOE's consideration of amended energy conservation standards for NWGFs and MHGFs pursuant to EPCA at a national level.

c. Assignment of Furnace Efficiency to Sampled Households

For this final rule, 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 2013–2022 HARDI data) and an estimated projection of trends between 2022 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. In some States, the market share of condensing furnaces is very high, and, therefore, most households in that State in the LCC analysis will be assigned a condensing furnace in the no-new-standards case. 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 2013–2022 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 that 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 submitted to DOE 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.[178] 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 final rule for more details). These data also suggest little to no correlation between furnace efficiency and household characteristics or economic factors. Finally, DOE considered the 2019 AHCS survey data.[179] 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, albeit weak, correlation: Households with larger square footage exhibited a slightly higher fraction of High or Super-High efficiency equipment installed. Specifically, the lower third of the square footage bins was five percent less likely to install higher efficiency units as compared to the middle third of the square footage bins, while the upper third of square footage bins was five percent more likely to do so than the middle square footage bin. Therefore, 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 five percentage points; and (2) the market share of condensing equipment for households above 2,500 sq. ft. was increased by five percentage points; however, DOE continued to maintain the same aggregate State-level efficiency distribution. For example, if a given State has a condensing market share of 50 percent based on the shipments data, the probability of any one household in that State being assigned a condensing furnace in the no-new-standards case is 50 percent. However, if the household is larger than 2,500 sq. ft., that probability increases to 55 percent instead. This adjustment preferentially assigns condensing furnaces within a given State to larger households (with presumably larger energy consumption) in the no-new-standards case, and preferentially assigns non-condensing furnaces to smaller households. This adjustment results in a more conservative estimate of potential energy savings.

Beyond this adjustment of the probability distribution, which is bounded by the shipments data, the assignment of furnace efficiency to a given household is performed according to the random-assignment method described in this section.

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, as discussed in the July 2022 NOPR and summarized below, that illustrate how purchasing decisions with respect to energy efficiency are unlikely to be perfectly correlated with energy use, as described subsequently. DOE maintains that the method of assignment, which is in part random, is a reasonable approach. It simulates behavior in the furnace market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, and it does so 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 by the available evidence.

The following discussion provides more detail about the various market failures that affect consumer furnace purchases. 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.[180] There are also several behavioral factors that can influence the purchasing decisions

[178] Gas Technology Institute (GTI), Empirical Analysis of Natural Gas Furnace Sizing and Operation, GTI–16/0003 (November 2016) (available at: *www.regulations.gov/document/EERE-2014-BT-STD-0031-0309*) (last accessed August 1, 2023).

[179] Decision Analysts, 2019 American Home Comfort Studies (available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (last accessed August 1, 2023).

[180] 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 August 1, 2023).

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 are presented for any given choice scenario.[181] 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.[182] 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.[183] 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 21.5 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, 18.1 percent of households with a NWGF and 19.8 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. For example, emergency replacements of essential equipment such as a furnace in the heating season are strongly biased toward like-for-like replacement (*i.e.,* replacing the non-functioning equipment with a similar or identical product). Time is a constraining factor during emergency replacements, and consumers may not consider the full range of available options on the market, despite their availability. The consideration of alternative product options is far more likely for planned replacements and installations in new construction.

Additionally, Davis and Metcalf[184] 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). Also, most consumers did not properly understand the labels (specifically whether energy consumption and cost estimates were national averages or specific to their State). As such, consumers did not make the most informed decisions.

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 *et al.*[185] show that consumers tend to underestimate the energy use of large energy-intensive appliances (such as central air conditioners), but overestimate the energy use of small appliances. Therefore, it is possible 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[186] 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 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

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

[182] 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).

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

[184] 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 August 1, 2023).

[185] 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 August 1, 2023).

[186] 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 August 1, 2023).

energy costs.[187] [188] Indeed, more than a quarter of commercial buildings in the CBECS 2018 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 similarly 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.[189] 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.[190] 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.[191]

Second, the nature of the organizational structure and design can influence priorities for capital budgeting, resulting in choices that do not necessarily maximize profitability.[192] 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.[193] 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.[194]

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.[195] Asymmetric information in financial markets is particularly pronounced with regard to energy efficiency investments.[196] 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,[197] 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 portfolio options assessed by financial managers, they are seen as weakly strategic and not seen as likely to increase competitive advantage.[198] 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).[199] 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

[187] 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.

[188] 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 August 1, 2023).

[189] 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).

[190] 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).

[191] 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 August 1, 2023).

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

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

[193] 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), pp. 2150–2159.

Muthulingam, S., et al. (2013). ''Energy Efficiency in Small and Medium-Sized Manufacturing Firms,'' *Manufacturing & Service Operations Management,* 15(4), pp. 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 U.S. manufacturing: Spillovers from firm management practices to energy efficiency,'' *Journal of Environmental Economics and Management,* 68(3), pp. 463–479.

[194] Lovins, A. (1992). Energy-Efficient Buildings: Institutional Barriers and Opportunities (available at: *rmi.org/insight/energy-efficient-buildings-institutional-barriers-and-opportunities/*) (last accessed August 1, 2023).

[195] 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.

[196] 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.

[197] 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 August 1, 2023).

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

[199] 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 August 1, 2023).

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.[200]

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 [201] and required payback periods of many firms are higher than the appropriate cost of capital for the investment.[202] 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.[203] 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.[204] 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,[205] supermarkets,[206] and the electric motor market.[207] 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. Thus, DOE concludes such a distribution would not be representative of the consumer 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 2020 or CBECS 2018).

DOE further notes that, in certain States, the current market is heavily weighted toward either baseline furnace efficiency or a condensing furnace efficiency. Therefore, most consumers in these States are either similarly impacted (for States with predominantly non-condensing furnaces) or minimally impacted (for States with predominantly condensing furnaces). This result is merely a reflection of the available market data. Therefore, any variation to DOE's efficiency assignment methodology would not produce substantially differing results than presented in this rule for these States, as most consumers would continue to be assigned the same efficiency regardless of the details of the methodology.

APGA commented that in the NOPR, despite intense criticisms and detailed evidentiary showings, DOE has continued to justify its approach on the theory that consumers do not act rationally, such that random assignment is as valid as using actual consumer choice data. APGA argued that although DOE acknowledges ''that economic factors may play a role'' when consumers decide on what type of furnace to install, DOE persists in maintaining that market failures render random assignment just as valid an approach. APGA argued that much of DOE's recitation on market failure misses the mark and lacks reference to current studies of how residential furnaces are purchased. APGA further argued that DOE relies upon ''inexplicit consumer patterns on all sorts of purchases.'' Although APGA noted that DOE's statement that it ''intends to investigate this issue further . . . [to] improve its assignment of furnace efficiency in its analyses,'' the commenter urged DOE to do so before acting on the subject NOPR because it argued that the agency's methodology does not produce results that accurately reflect the market. (APGA, No. 387 at pp. 25–27) Similarly, AGA argued that DOE's economic analysis suffers from a critical defect in the economic criteria of how gas furnace efficiencies are assigned to consumers in the no-new-standards case or ''base case.'' The commenter took issue with DOE's use of so-called ''random assignment'' to determine which consumers in the base case would be assigned specific furnace efficiencies and whether they install condensing or non-condensing furnaces. AGA claimed that DOE is assuming that consumers completely disregard economics when selecting a gas furnace, arguing that random assignment leads to an overstatement of benefits associated with the proposed rulemaking and an underestimation of the total costs. According to AGA, this defect in the development of the base case renders all of DOE's subsequent analyses of any proposed standard levels void and unusable. (AGA, No. 405 at pp. 54–57)

Spire argued that DOE's analysis of 10,000 trial cases does not represent the real world, where—as regional market share data for residential furnaces demonstrates—consumers generally purchase condensing gas furnaces when it is economically beneficial to do so and generally decline to purchase condensing gas furnaces where there are installation problems, insufficient economic returns, or insufficient resources for the initial investment required. Spire asserted that DOE's trial cases represent an alternative universe in which consumers choose their gas furnaces with no consideration of the economic consequences of those decisions. (Spire, No. 413 at p. 7) Spire asserted that DOE's use of random

[200] 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 August 1, 2023).

[201] 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.

[202] DeCanio 1994, op. cit.

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

[204] 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.

[205] 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.

[206] 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.

[207] 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 August 1, 2023).

assignment implies that consumer purchasing decisions are never influenced by the economics of potential efficiency investments. (Spire, No. 413 at p. 39)

NPGA commented that a key error in the economic analysis is the use of a ''random assignment'' process. NPGA stated that the examples of exceptions to the general rule of rational economic behavior relied upon in the rule are misplaced and do not justify ignoring that consumers do indeed act rationally in their own economic interest. (NPGA, No. 395 at pp. 11–12) Atmos Energy argued that DOE's economic analysis approach of using a random assignment of consumers across design options considered in the life-cycle analysis has no technical basis or justification. The company further commented that this results in an inaccurate overstatement of efficiency standards' potential to produce economic benefits for consumers. Atmos Energy argued that the use of random assignment results in consumers selecting furnaces that are suboptimal among available furnace options and artificially inflates the potential savings of the rule. (Atmos Energy, No. 415 at pp. 5–6)

Spire further argued that base-case investments should disproportionately include investments with attractive economic outcomes; that rule-outcome investments should disproportionately include investments with unattractive economic outcomes, and, therefore, the average economic outcome for base-case investments would be better (and the average for rule-outcome investments would be worse) than the average of all potential investments in standards-compliant products. Spire further argued that purchasers of gas furnaces have a significant preference for economically beneficial investments, as evident from the fact that the market share for furnaces compliant with the proposed standard level is dramatically higher than average in colder regions where the economic benefits of more-efficient gas furnaces tend to be greatest and is dramatically lower than average in warmer regions where those benefits tend to be lowest. Spire went on to claim that DOE's LCC analysis is based on a ''random assignment'' methodology that ''assigns'' particular efficiency investments to the ''base'' or ''standards'' case randomly, an approach that effectively assumes that purchasers of residential furnaces have no preference for economically beneficial efficiency investments—and no aversion to economically unfavorable investments. (Spire, No. 413 at pp. 22–23)

These commenters significantly mischaracterize the Department's analysis in this area. Most fundamentally, DOE does not assume that consumers act irrationally. As stated above, the use of a random assignment of furnace efficiency is a methodological approach that reflects the full range of consumer behaviors in this market, including consumers who make economically beneficial decisions and consumers who, due to market failures, do not or cannot make such economically beneficial decisions, both of which occur in reality. As explained in the proposed rule and previously, DOE begins its assignment of furnaces in the no-new standards case based on two empirical constraints: (1) historical shipment data, by State demonstrating regional variation, with some regions (*e.g.,* the North) having a higher market share of condensing furnaces; and (2) survey data demonstrating a correlation (albeit small) between home size and installed furnace efficiency. Within those constraints, DOE then models consumer behavior, consistent with the economics literature discussed previously, to reflect neither purely rational nor purely irrational decision-making. This approach presents a close approximation of the current market reality.

The alternative approach advanced by these commenters assumes consumer behavior that is not evidenced by the scientific literature surveyed above or by any data submitted in the course of this rulemaking. The commenters' approach depends on the assumption, for example, that homeowners know—as a rule—the efficiency of their homes' insulation and windows, such that they always make heating investments accordingly. Similarly, the commenters' approach assumes that, faced with a furnace failure, homeowners will always select as a replacement the most efficient available model. DOE's approach, by contrast, recognizes that assumptions like these hold for some consumers some of the time—but not all consumers and not at all times.

As part of the random assignment, some households or buildings with large heating loads will be assigned higher-efficiency furnaces, and some households or buildings with particularly low heating loads will be assigned baseline furnaces—*i.e.,* the economically rational investments. For example, at the adopted standard level, approximately 19 percent of NWGF consumers experience a net cost. These are consumers who would not financially gain from a more-efficient furnace and have a non-condensing furnace in the no-new-standards case, reflecting an economically optimal investment. Similarly, at the adopted standard level, approximately 45 percent of NWGF consumers are not impacted by the rule, as they already purchase higher-efficiency furnaces. Many of these consumers experience lifetime savings compared to a baseline furnace, and the adoption of higher efficiency furnaces in the no-new-standards case again reflects an economically optimal investment.

However, as DOE has noted, there is a complex set of behavioral factors, with sometimes opposing effects, affecting the furnace market. It is impractical to model every consumer decision incorporating all of these effects at this extreme level of granularity given the limited available data. Given these myriad factors, DOE estimates the resulting distribution of such a model, if it were possible, would be very scattered with high variability. It is for this reason DOE utilizes a random distribution (after accounting for market share constraints) to approximate these effects. The methodology is not an assertion of economic irrationality, but instead, it is a methodological approximation of complex consumer behavior. The analysis is neither biased toward high or low energy savings. The methodology does not preferentially assign lower-efficiency furnaces to households in the no-new-standards case where savings from the rule would be greatest, nor does it preferentially assign lower-efficiency furnaces to households in the no-new-standards case where savings from the rule would be smallest. Some consumers were assigned the furnaces that they would have chosen if they had engaged in the kind of perfect economic thinking upon which the commenters have focused. Others were assigned less-efficient furnaces even where a more-efficient furnace would eventually result in life-cycle savings, simulating scenarios where, for example, various market failures prevent consumers from realizing those savings. Still others were assigned furnaces that were *more* efficient than one would expect simply from life-cycle costs analysis, reflecting, say, ''green'' behavior, whereby consumers ascribe independent value to minimizing harm to the environment.

DOE cites the available economic literature of which it is aware on this subject, supporting the existence of the various market failures which would give rise to such a distribution, and has repeatedly requested more data or studies on this topic. There are no studies DOE is aware of specific to how consumer furnaces are purchased. Commenters have failed to provide any specific external data, information, or studies that could be incorporated into the analysis, but instead, they claim that DOE is assuming consumers are all making irrational decisions, which is incorrect and a mischaracterization of the analysis. DOE continues to evaluate the literature on this subject and is not aware of any new data or studies that contradict DOE's analysis. DOE also notes that in a separate comment regarding the usage of RECS, APGA acknowledges that households may not have perfect information regarding their own furnace. (APGA, No. 387 at p. 11)

Finally, DOE's analysis does incorporate and reflect regional market share data and reflects this larger correlation. For States with a large majority of consumers already purchasing more-efficient furnaces per the available market data (*e.g.,* in colder regions), the analysis assigns a correspondingly large majority of households with an efficient furnace at or above the adopted efficiency level in the no-new-standards case. The analysis also includes a greater probability that new construction is assigned higher-efficiency furnaces in the no-new-standards case, given the typically lower installation costs in new construction; however, this probability is constrained by actual market share data.

In response to Spire's assertion that most investments in the no-new-standards case should include those with attractive economic outcomes and most outcomes as a result of the standard should be biased toward unattractive outcomes, DOE firmly disagrees. This assertion presupposes that any energy conservation standard would primarily result in unattractive outcomes by definition. The logical extension of this assertion is that the current furnace market already allocates furnace efficiencies in a nearly optimum manner, and, therefore, there is little to no benefit from an energy conservation standard. As DOE has presented, there is a wealth of academic literature clearly demonstrating that this view of the market is incorrect, as there are a number of identified market failures and other behaviors that prevent some consumers from maximizing their economic outcome in the absence of new energy conservation standards, and, therefore, the allocation of furnace efficiency among households is not economically optimal in the real world. Systematically biasing the analysis to preferentially produce unfavorable results due to an energy conservation standard, as the commenter suggests, has no basis in any of the available data or literature. DOE also notes that the acknowledgement of market failures and the resulting distribution of energy efficiency in the no-new-standards case is commonplace in DOE's analyses for other energy conservation standards rulemakings.

DOE has further confirmed its determination that the proposed TSL is economically justified through additional analysis of the anticipated life-cycle costs. First, DOE presents total life-cycle costs at each efficiency level, averaged over all households, in section V.B of this document. This effectively compares costs for an average household in the sample, not an extreme outlier household. DOE also makes available total life-cycle costs for households at the 25th, 50th, 75th, and 95th percentile of the total life-cycle cost distribution in the LCC spreadsheet. Regardless of which value is considered, the total life-cycle cost of a furnace at the adopted standard level is lower than the total life-cycle cost of a baseline furnace or any lower-efficiency furnace. The claim that outlier results distort DOE's conclusions can also be refuted by considering the median LCC savings instead of the mean LCC savings, which are robust against outlier results. The median LCC savings at the adopted standard level across the entire NWGF sample, which accounts for the existing distribution of furnace efficiency in the market, remain positive. If DOE were to exclude outlier results from the average LCC savings (*e.g.,* both the top and bottom 10 percent of results), the average LCC savings would remain positive. If DOE were to adopt an even more conservative estimate and bias the results by excluding only the most favorable outcomes (*e.g.,* the top 10 percent) but maintain the least favorable outcomes, the average LCC would still remain positive, and DOE's conclusions would remain the same. Finally, none of these results include the estimated climate and health benefits, which as discussed in section V.C of this document are significant and only further reinforce the benefits of the rule.

Spire stated that the results of the LCC analysis are disproportionately impacted by a relatively small percentage of individual trial cases, due to the efficiency assignment methodology, thereby producing unreasonable impacts that bias the conclusions of the analysis. (Spire, No. 413 at pp. 25–34)

In response, DOE acknowledges that there are some LCC trials with very high LCC savings as part of the distribution of impacts. There are similarly some LCC trials with very high net LCC costs. However, when evaluating the median LCC impacts instead of the average LCC impacts, the effects of outlier results are minimized. The median LCC savings remain positive at the adopted standard level. The median LCC savings are available in the LCC spreadsheet and presented in chapter 8 of the final rule TSD. Although the absolute magnitude of total savings would decrease if such extreme trial cases were excluded, the conclusions of the analysis would remain the same.

APGA claimed that DOE's method of randomly assigning furnace efficiencies eliminates from the no-new-standards case those instances where consumers would elect the most efficient product that costs the least, which inflates LCC benefits when compared to the standards case. Without random assignment, APGA claims that the estimated LCC benefits decline significantly because the consumer will rationally take the lower cost furnace that also brings higher energy efficiency regardless of a new standard. APGA further argued that outlier cases control LCC outcomes, even though those outlier cases are the most likely to be avoided by rational consumer behavior. APGA claimed that the analysis fails to reflect the market share of natural gas customers by State or Census Division. (APGA, No. 387 at pp. 22–33) Spire argued that DOE's analysis inappropriately credits standards with the benefits of efficiency investments in which a higher-efficiency product selected as a result of a standard is the low-cost option in terms of initial costs and would provide additional economic benefits (in the form of operating cost savings) from day one. Because consumers would naturally select this result, Spire argued that DOE's modeling approach produces spurious regulatory benefits. (Spire, No. 413 at p. 27)

In response, DOE notes that the commenters are once again mischaracterizing the Department's analysis. First, the costs estimated in the analysis for higher-efficiency products reflect DOE's projection that such products are at the new baseline efficiency, produced in volume, and no longer offered as a ''premium'' product. As such, costs may deviate from those seen in the market today or in the no-new-standards case. In some regions, the market share of higher-efficiency products remains low, and they are generally perceived as a more premium product, with higher total installed costs. This will impact the existing market share by efficiency. If these higher-efficiency products become the new baseline, as DOE analyzes in the standards cases, their costs generally will be lower than seen in the market today. The costs developed in section IV.C of this document account for higher-efficiency products becoming the new baseline, produced at greater volume. The comparison made by the commenters does not account for this subtlety. Second, DOE notes that the assignment methodology is bounded by the available shipment data by efficiency, and, therefore, the market share of non-condensing/condensing furnaces reflects market data. Total installed costs for higher-efficiency products are generally lower in new construction, as discussed in section IV.F.2 of this document. However, in some States, the market share and estimated total shipments of condensing furnaces are lower than the estimated new construction; therefore, according to the data, some non-condensing furnaces must be installed in new construction. Thus, this market share constraint requires that some installations in new construction be assigned a baseline furnace even though a higher-efficiency furnace would cost less. Because such market shares are based upon real world data, this is not a spurious assumption on DOE's part, and such approach does not produce spurious regulatory benefits. This is a factual result based on the available data and representative of the market as it is, which is indicative of some of the market failures DOE has identified. Nevertheless, if DOE were to exclude all these trial results from the average LCC savings, the result would remain positive, and DOE's conclusions from the analysis would remain the same. Thus, the claim that outlier results control LCC outcomes—and, therefore, the justification for the rule—is incorrect. Finally, regarding the share of natural gas customers, DOE samples households and commercial buildings in RECS and CBECS that utilize natural gas furnaces. RECS and CBECS are large, nationally representative surveys with a representative sample of natural gas customers. DOE is not aware of any evidence to suggest these national surveys are systematically biased with respect to natural gas customers.

APGA argued that DOE has not addressed prior stakeholder analyses (*e.g.,* the GTI analysis) directly but only cataloged the stakeholder criticisms in defending its ''random assignment'' methodology. (APGA, No. 387 at p. 25) Those analyses, however, were based on LCC results presented as part of the 2015 NOPR and 2016 SNOPR, both of which were withdrawn and replaced by the 2022 NOPR. DOE is responding to all relevant comments, but comments related to the detailed results of the withdrawn analyses are no longer applicable.

Spire further argued that, for example, in a region in which 90 percent of consumers are already utilizing a furnace with an efficiency at or above the adopted standard level, the remaining 10 percent of consumers should disproportionately include the worst economic outcomes in the region as a result of the standard. (Spire, No. 413 at pp. 35–36) Again, DOE firmly disagrees with this assertion. Spire's assertion ignores the wealth of well-documented market failures and other behaviors that can explain why some of the remaining 10 percent of consumers may have favorable outcomes as a result of the energy conservation standard. There is no compelling evidence or data of which DOE is aware that would necessitate proactively biasing results toward unfavorable outcomes, as suggested by the commenter. Furthermore, DOE's assignment methodology already includes adjustments based on household square footage and based on new construction vs. replacement installations.

Spire argued that economic theory provides no basis to disregard fact. On this point, Spire asserted that if random assignment came close to representing the market as it is, the regional market share for condensing furnaces would not range from 5 percent to 95 percent in the replacement market (and 6 percent to 97 percent in the new construction market), with an obvious correlation to regional length and depth of the heating season. Spire further argued that if random assignment provided a reasonable simulation of base case purchasing behavior, there would not be a statistically significant correlation between the average regional LCC outcomes and regional market shares for condensing furnaces. (Spire, No. 413 at p. 42)

In response, DOE agrees that economic factors may play a role in purchasing decisions, but the commenter is mischaracterizing both the Department's analysis and its efficiency assignment methodology. DOE does not dispute that heating-degree days likely play a role in consumers choosing furnace efficiency, and, as stated previously, the Department incorporates this effect into the analysis at the State/regional level based on current market share data (*i.e.,* actual purchasing decisions). The efficiency assignment methodology is randomized as a last step, within a given State/region, to approximate a range of real-world effects and behaviors. Thus, the larger correlation based on region is taken into account. Consequently, at the next stage in the assignment methodology, the impact of large regional climate differences is no longer relevant, as most of those consumers experience a similar climate. Furthermore, the commenter did not acknowledge the role of historical incentive and rebate programs that have shaped consumer behavior and significantly increased the market share of higher-efficiency furnaces in some colder regions, beyond what consumers were adopting without those programs. Due to the bias toward like-for-like replacements, the estimated future market share in these regions is expected to remain dominated by higher-efficiency furnaces, but this market share is likely higher than what would have resulted had these past incentive and rebate programs not occurred. Therefore, the apparent correlation of efficiency with region would likely not be as evident without these programs.

APGA argued that DOE's inconsistent treatment of consumer behavior is arbitrary and capricious. On the one hand, APGA asserted that by using random assignment to predict consumer furnace selection, DOE assumes consumers to be ''virtual zombies.'' On the other hand, when it comes to fuel switching, APGA asserted that DOE assumes consumers to be rational and prescient by selecting the lowest cost option. (APGA, No. 387 at p. 24) Spire similarly commented that paradoxically, DOE employs a random assignment methodology that assumes that consumers never consider the economic consequences of choices between gas furnaces, but then included a fuel switching analysis that assumes consumers who do not (randomly) select a standards-compliant gas furnace on their own would always consider economics in deciding whether to switch from a gas appliance to an electric appliance. (Spire, No. 413 at pp. 49–50) AGA also argued that the assignment of furnace efficiency in the no-new-standards case does not adhere to the model logic related to consumer fuel switching to electricity, which assumes consumers consider economics when choosing to switch. Furthermore, AGA stated that some of the critical inputs in that model are derived from survey data which indicates that consumers do consider economics when making purchasing decisions. (AGA, No. 405 at pp. 54–57) Along these same lines, NPGA commented that DOE contradicts itself by assuming consumers will not act in their own self-interest when purchasing a gas furnace but will when switching from gas furnaces to electric alternatives. (NPGA, No. 395 at p. 2)

In response, DOE notes that the commenters are significantly misrepresenting the Department's analysis. As discussed in this section, DOE's approach for assigning efficiency in the no-new-standards case does not assume that purchasers of furnaces all make economically irrational decisions (*i.e.,* the lack of a correlation is not the same as a negative correlation). The use of a random assignment of furnace efficiency is merely a methodological approach that reflects the full range of consumer behaviors in this market, including consumers who make economically beneficial decisions and consumers that, due to market failures, do not make such economically beneficial decisions, both of which occur in reality. The Department's product switching analysis was incorporated into the analysis to address prior comments from stakeholders specifically regarding price-sensitive consumers opting to switch to alternative electric heating options in response to increased NWGF costs as discussed in section IV.F.10 of this document. DOE has conducted a fuel-switching analysis in this rule as a form of sensitivity analysis. That is, DOE has modeled the economic impacts of the rule assuming both no fuel switching and the maximum level of fuel switching reasonably foreseeable. To model that maximum level of fuel switching, DOE has assumed that consumers would act based solely on costs. DOE uses a simplified decision model based only on costs, in this very specific instance, to estimate the impact of product switching. The percentage of consumers who engage in product switching based on this simplified decision model is intended as an estimate of the maximum fuel switching reasonably likely to result from the rule. In any event, as discussed further below, the proportion of consumers expected to switch fuels is small, and any further refinements to DOE's modeling would be expected to lead to similar conclusions. That is, a further refined model, which incorporated the market failures likely to prevail in the market for fuel switching, would be unlikely to produce meaningfully different results. Given the limited purpose for which DOE has considered product switching, DOE has not found it necessary to further refine its assumptions about product-switching consumer behavior. Furthermore, DOE presents results both with and without incorporating this effect, as an upper and lower bound, and DOE's conclusions remain the same under both sets of results. The two approaches (assignment of efficiency in the no-new-standards case and estimating product switching) are not incompatible and are not inconsistent with each other. They simply reflect different levels of modeling approximation on different consumer samples. Further discussion of the product switching methodology is presented in section IV.F.10 of this document.

NPGA stated that consumers will often voluntarily choose to install condensing furnaces, without mandatory standards, when it makes economic sense. (NPGA, No. 395 at p. 11) The commenter further stated that this is evident in the fact that high-efficiency gas furnaces have a much higher market share where the economic benefits of such furnaces are greatest. (NPGA, No. 395 at pp. 11–12) In response, DOE agrees and incorporates the existing market share of condensing furnaces by State in its analysis. In States with a very high fraction of consumers with condensing furnaces at the adopted efficiency level or above in the current market (typically States with colder winters where the benefits of such furnaces are higher), most consumers in those States are not impacted by the rule and do not factor into the standards-case analysis. However, as noted previously, incentive and rebate programs have increased the market share of condensing furnaces beyond what consumers had been previously adopting, even in colder regions.

Spire commented that the issue of efficiency assignment in the no-new-standards case was raised in *American Public Gas Ass'n* v. *U.S. Dept. of Energy,* 22 F.4th 1018 (D.C. Cir. 2022) (*APGA* v. *DOE*)—a challenge to DOE's commercial packaged boiler standards—and the Court found that DOE had failed to respond to the ''substantial concerns'' about this ''crucial part of its analysis'' and that its ''failure to engage the arguments raised before it . . . bespeaks a failure to consider an important aspect of the problem.'' *Id.,* 22 F.4th at 1027–28. Spire claimed that the furnaces NOPR exhibits the same failing. (Spire, No. 413 at pp. 34–35)

In response, DOE disagrees with Spire's assertion that it has failed to adequately explain the choices made in its LCC analysis or has failed to provide sufficient opportunity for comment on those matters. Instead, DOE has extensively discussed the rationale and evidentiary basis for its LCC analysis in this both the July 2022 NOPR, as well as this final rule. DOE's detailed explanation has focused on the presence of numerous market failures that cause consumers to purchase commercial packaged boilers that do not maximize LCC savings. Furthermore, DOE provided and sought public comment on its thorough explanation in the July 2022 Furnaces NOPR as to why the assignment of efficiencies in the no-new-standards case, which is in part random, is a reasonable approach that simulates behavior in the furnace market, where market failures frequently result in purchasing decisions not being perfectly aligned with economic interests. 87 FR 40590, 40640–40643 (July 7, 2022).

AGA presented an analysis using DOE's LCC spreadsheet and claimed that it demonstrates that DOE's method of randomly assigning furnace efficiencies in its base case is improper. AGA further argued that its analysis demonstrates that any market failure results in greater adoption of high-efficiency equipment than would be expected by economics alone. AGA concluded that DOE, therefore, overstates the benefits of the proposed standards by assuming consumers do not consider economics at all when selecting furnaces. (AGA, No. 405 at pp. 59–67)

In response, as discussed above, DOE notes that this is a mischaracterization of the analysis. DOE does not assume consumers never consider the economics of the purchase. DOE acknowledges that there are several market failures in the furnace market affecting some consumers, while other consumers are making economically beneficial decisions. Indeed, the existence of consumers experiencing a net cost in the standards case is an illustration of this. Such consumers are assigned a baseline efficiency furnace in the no-new-standards case and do not benefit from a higher efficiency furnace, reflecting an economically beneficial decision in the no-new-standards case. Similarly, some consumers are already purchasing a higher-efficiency furnace because it is beneficial to them and as a result are not impacted in the standards case. The characterization of the analysis as assuming all consumers are irrational is incorrect.

AGA's analysis of the NOPR results is flawed in several respects. Their analysis identifies a relationship that is known and discussed in the TSD, namely that regions with a higher current market share of condensing furnaces are more likely to be colder and, thus, have higher space-heating energy consumption. Therefore, it is no surprise that LCC savings for households or buildings in those regions that have not yet adopted condensing furnaces are likely to be higher. Similarly, regions with a lower current market share of condensing furnaces are more likely to be warmer, and consumers there may have negative LCC savings in the standards case. The analysis incorporates these regional market share trends as part of the efficiency assignment methodology. The commenter is attempting to highlight these relationships in the LCC, which is a reflection of the current market, as evidence that DOE cannot assume consumers never consider the economics of their purchasing decisions. However, this is a mischaracterization, and DOE is not making an assumption that consumers never consider the economics of their purchasing decision. The efficiency assignment is a methodological simplification that takes into account existing market trends, such as the regional trends identified by the commenter, and acknowledges a range of consumer behaviors and market failures. The LCC produces relationships in the results that AGA's own analysis shows are reasonable and expected, given the current market shares of condensing and non-condensing furnaces.

AGA noted that there are examples in the LCC where the total installed cost of a non-condensing furnace is higher than the total installed cost of a condensing furnace for an individual household or building, and yet DOE's methodology assigns a non-condensing furnace in the no-new-standards case to this household or building. AGA argues this is an illogical scenario that ignores consumer rationality and biases the overall results to overly favorable outcomes. (AGA, No. 405 at pp. 57–58) APGA pointed to the inclusion of LCC trials where a higher efficiency furnace costs less than a baseline furnace, but for which the LCC assigns a baseline furnace in the no-new-standards case, as unreasonably inflating LCC benefits. (APGA, No. 387 at pp. 22–23) Spire also commented that the LCC includes LCC trials where the higher-efficiency furnace is the lower-cost option, but it argued that the LCC erroneously assigns benefits to such trial cases by assigning a baseline furnace in the no-new-standards case. (Spire, No. 413 at pp. 27–28)

In response, DOE acknowledges that there are scenarios in which the total installed cost is lower for higher-efficiency condensing furnaces. This situation primarily occurs in new construction, where a new vent is required for all installations, and condensing furnaces can often take advantage of a shorter vent length that is incorporated into the construction design from the beginning. This scenario can also occur in replacement installations where the existing vent has reached the end of its life and requires replacement, even when replacing a non-condensing furnace with another non-condensing furnace. With respect to the LCC assigning a non-condensing furnace in some of these instances, DOE once again notes that the efficiency assignment methodology is constrained by the State-level shipments market share data. For example, in States with a low current market share of condensing furnaces, the methodology will be constrained to assign mostly non-condensing furnaces in the no-new-standards case, reflecting the current market, and, therefore, some new construction will be assigned non-condensing furnaces in the no-new-standards case. The commenters argue that this is an illogical outcome, but the methodology is simply reflecting the reality of the current market. This situation can also occur in replacement installations due to, for example, familiarity bias on the part of the consumer or contractor, biasing replacements to familiar technology options even if a lower cost option is available. However, the percentage of individual LCC trial outcomes where this situation occurs is limited to only a few percent in the final rule analysis, predominately in new construction. Even if DOE were to exclude these individual outcomes as extreme outlier results, the LCC analysis would demonstrate economic justification, as seen from the median LCC savings (as opposed to the average), available in the LCC spreadsheet and in chapter 8 of the final rule TSD. The median LCC savings are robust to outlier results, and they remain positive at the adopted standard level. Additionally, excluding these individual outcomes as extreme outlier results would not substantially change the percent of consumers with a net cost and would not alter the conclusion of economic justification.

PHCC commented that DOE should reconsider its assumptions regarding consumer awareness of products, as the studies used for reference are 20–30 years old, and trends for LED lighting that indicate that consumers choose higher levels of performance in cases of lower cost and lower maintenance. (PHCC, No. 403 at p. 3) In response, DOE notes that it cites the relevant available literature, which is still applicable to consumers of furnaces even if published 20–30 years ago. DOE also cites studies performed with respect to appliances and HVAC equipment, which are more relevant than studies related to lighting. The lighting market and associated technology are very different than the furnaces market.

PHCC commented that DOE's conclusion that commercial customers will not value higher efficiency because typically owners do not pay operating bills or consider operating costs as write-offs is inaccurate. Because their clients seek out best-case operating expenses, owners seek to offer high-quality facilities in order to give themselves an advantage in the market. PHCC further commented that write-offs are not desirable, as owners benefit from keeping their income and paying taxes in full rather than overspending. The commenter stated that there are contractors who have successfully marketed high-efficiency equipment. (PHCC, No. 403 at pp. 3–4) In response, DOE clarifies that it does not assert that commercial customers will not value higher-efficiency equipment. DOE merely notes that there are market failures prevalent in the commercial sector, similar to the residential sector, that may cause some commercial customers to undervalue the benefits of higher-efficiency equipment. DOE agrees that some commercial customers will highly value the benefits of efficient furnaces, and the efficiency assignment methodology approximates this range in commercial customer behavior.

Sierra Club and Earth Justice commented that the claims of internal inconsistency posed by some commenters ignores that the DOE's method of modeling the base-case furnace efficiency distribution reflects available data showing only a modest correlation between high-efficiency furnace installations and applications where those high-efficiency products are more likely to be cost-effective. (Sierra Club and Earth Justice, No. 401 at pp. 1–2) DOE agrees with the comment in support of the agency's approach.

NYSERDA expressed support for DOE's methodology and approaches presented in the NOPR, particularly around random distribution. NYSERDA disagreed with commenters who argue that the random nature of DOE's LCC distributions is problematic. NYSERDA further stated that using a random distribution in the no-new-standards case to model the assignment of furnace efficiency is a valid method, driven by the best available data. NYSERDA emphasized that DOE used AHRI and HARDI data to accurately capture the existing market distributions of furnaces at different efficiency levels, informing the efficiency distributions in the no-new-standards case. NYSERDA further noted that DOE includes a correlation of efficiency with household square footage, using available data to inform the structure of the probabilistic distribution. Consequently, NYSERDA concludes that the stochastic approach is valid and viable. (NYSERDA, No. 379 at pp. 11–12) DOE agrees with this comment.

Similarly, Joint Efficiency Commenters stated that DOE's assignment of efficiency levels in the no-new-standards case reasonably reflects actual consumer behavior and is more representative than assigning efficiencies based solely on cost-effectiveness. Joint Efficiency Commenters noted that there are various market failures, as well as aspects of consumer preference, that significantly impact how products are chosen by consumers, including misaligned incentives for rental properties, the influence of contractors during replacement installations, and the very infrequent nature of furnace replacements impacting information transparency with respect to costs. (Joint Efficiency Commenters, No. 381 at pp. 6–7) DOE agrees.

9. 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 2020 and CBECS 2018. 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 [208] 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 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) [209] 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). If the input capacity of the furnace determined using a reduced oversize factor of 10 to 40 percent is less than or equal to the input capacity limit for small furnaces, DOE assumed that the consumer would downsize his or her furnace. DOE believes that an oversize factor of 10–40 percent is realistic because ACCA recommends a maximum oversize factor of 40 percent.[210] Note that the 10 percent is the maximum downsizing, but in many cases, the actual downsizing is less because the resulting input capacity is rounded up to the nearest input capacity bin in 5 kBtu/h increments, and the unit is downsized up to the maximum small furnace size limit criteria.

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.[211] DOE acknowledges that the oversizing varies among furnace installations, and, thus, DOE assigned an oversizing factor to each household based on the furnace sizing methodology described in section IV.E.2 of this document (which rank ordered the estimated design heating load and matched to furnace shipments by input capacity). The actual oversizing factor in the analysis for a given existing household or building varies from 0 percent to 275 percent (85 percent on average).

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 10–40 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 the Department's approach. DOE acknowledges that there could be cases where downsizing might not be advantageous. Therefore, for this final rule, DOE assumed that not all consumers would downsize when the oversize factor of 10–40 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 the final rule TSD for further details.

PHCC commented that current furnace models (both condensing and non-condensing) will have problems with oversizing, as excessive temperature rise can be detrimental to the life of the furnace, and that selecting excessive fan speed to compensate for the excess temperature rise will produce very drafty conditions. The commenter further stated that professional contractors have been accurately sizing equipment, despite ACCA references to limit oversizing to 40 percent. Finally,

[208] 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.

[209] 10 CFR part 430, subpart B, appendix N.

[210] ACCA recommends oversizing by a maximum of 40 percent. ACCA. *See* Manual S—Residential Equipment Selection (2nd Edition). (Available at *https://www.acca.org/standards/technical-manuals/manual-s*) (Last accessed August 1, 2023)

[211] 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 August 1, 2023).

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 August 1, 2023). Energy Center of Wisconsin, Electricity Use by New Furnaces: A Wisconsin Field Study (2003) (available at: *www.proctoreng.com/dnld/WIDOE2013.pdf*) (last accessed August 1, 2023). 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 August 1, 2023). Ecovent, When Bigger is not Better (August 2014) (available at: *docplayer.net/13225631-When-bigger-isn-t-better.html*) (last accessed August 1, 2023). Energy Center of Wisconsin, Central Air Conditioning in Wisconsin (May 2008) (available at: *www.focusonenergy.com/sites/default/files/centralairconditioning_report.pdf*) (last accessed August 1, 2023). Washington State University, Efficient Home Cooling (2003) (available at: *www.energy.wsu.edu/documents/AHT_Energy%20Efficient%20Home%20Cooling.pdf*) (last accessed August 1, 2023).

although PHCC acknowledged that the exact furnace size required for a space is not always available, the commenter stated that contractors will select the next incremental size and be reluctant to select equipment below the ''design day capacity,'' as weather and needs vary. (PHCC, No. 403 at p. 4)

DOE acknowledges that complex factors are relevant when contractors size equipment. However, as discussed previously, DOE has found multiple sources of data to indicate an average oversizing factor in historical installations and has used those data in the analysis.

PHCC commented that DOE's assumption that consumers have financial incentive to downsize products indicates that costs are a concern for them and that consumers are aware of the economic impacts of furnace sizing. (PHCC, No. 403 at p. 4)

In response, DOE acknowledges that the initial total installed cost of a consumer furnace may result in a consumer making an alternative choice instead of a like-for-like replacement. For potential standard levels that include a capacity cutoff, below which the standard is not amended, DOE estimates some fraction of consumers would instead opt to purchase a slightly lower capacity furnace at a lower efficiency instead of a higher capacity furnace at the new efficiency level. DOE's analysis similarly accounts for consumers who may choose to extend the life of their existing furnace with additional repairs, or switch to an electric space heat alternative altogether. All of these potential options are accounted for in the analysis, as discussed in further detail in chapter 8 of the final rule TSD.

For this final rule, DOE analyzed the potential for similar separate energy conservation standards for small and large MHGFs as it did for NWGFs.

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.14 under the criteria of various ''small furnace'' definitions. For further details regarding this downsizing methodology, *see* appendix 8M of the TSD for this final rule. This appendix also presents sensitivity analysis results.

TABLE IV.11—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 downsizing (percent)	Without amended standards (percent)	With separate small furnace tandard and with downsizing (percent)
≤40 kBtu/h	3.0	13.6	5.6	14.6
≤45 kBtu/h	4.4	16.7	9.7	18.4
≤50 kBtu/h	6.2	19.7	12.7	21.9
≤55 kBtu/h	7.4	21.4	13.8	23.6
≤60 kBtu/h	18.8	29.5	29.0	35.2
≤65 kBtu/h	20.3	31.5	32.8	39.0
≤70 kBtu/h	30.4	38.7	43.6	48.5
≤75 kBtu/h	41.5	47.1	59.6	63.3
≤80 kBtu/h	54.6	57.5	82.9	84.4
≤85 kBtu/h	56.4	59.4	85.9	87.3
≤90 kBtu/h	63.7	65.8	92.0	92.4
≤95 kBtu/h	63.7	66.2	92.0	92.5
≤100 kBtu/h	81.7	82.2	98.7	98.7

10. Accounting for Product Switching Under Potential Standards

During the development of the 2006 NOPR for consumer furnaces, manufacturers commented that when presented with potential standards for non-weatherized gas furnaces set at a level effectively requiring condensing technology, they expect consumers to switch to heat pumps or repair their existing equipment due to the increased cost of condensing non-weatherized gas furnaces. 71 FR 59204, 59230–59231 (Oct. 6, 2006). During the development of the 2011 direct final rule for consumer furnaces, some commenters again stated that a furnace standard set at a level effectively requiring condensing furnaces would cause some consumers to switch from gas furnaces to electric resistance heating or heat pumps. 76 FR 37408, 37483 (June 27, 2011). For the 2011 direct final rule, DOE did not explicitly quantify this potential for product switching, assuming that such switching was likely minimal in response to standards. *Id.* at 76 37483–37484. As part of the development of the March 2015 NOPR during informal workshops, some commenters again stated that consumers might switch to alternative electric heating systems due to a standard set at a level effectively requiring condensing furnaces.

As noted previously, DOE recognizes that consumers may elect to switch from one heating source to another. Those consumer choices are affected by many factors. As commenters to this proposed rule and prior rules have noted, one such factor is the furnace efficiency standard itself. Accordingly, in this rulemaking, DOE has 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. The central assumption is that, for consumers to switch, the total installed cost of the alternative heating equipment would be less than the cost of a new consumer furnace at the amended standard level (operating costs may or may not be higher).

In conducting this analysis, DOE has remained focused on the covered products subject to this rulemaking—consumer furnaces. That is, this analysis is intended to inform DOE's assessment of whether the standard level proposed is ''economically justified'' ''for [the] type (or class) of covered product.'' 42 U.S.C. 6295(o)(2)(A).

To assess the effect of fuel switching, DOE modeled the proposed standard under two scenarios. The first scenario assumed no switching at all; that is, it assumed that consumers faced with negative LCCs as a result of the standard would nevertheless make those investments (the zero-switching scenario). Under the second scenario, DOE assumed that every consumer for whom switching would be economically justified (according to simplified assumptions, detailed below), would do so (the maximum-switching scenario). These scenarios are intended to bookend the range of reasonably plausible switching results foreseeable as a result of this rule.

The assumptions underlying the maximum-switching scenario are intentionally simplified. The purpose of this scenario is not to model consumers' *actual* expected behavior, but rather to estimate an outer bound for the possible range of responses. Accordingly, DOE has not attempted to incorporate into this model the market inefficiencies and consumer biases known to shape consumers' actual purchasing decisions. Instead, by assuming perfect economic rationality, this model produces an estimate of the most switching reasonably foreseeable as a result of this rule.

The results of these two estimates confirm DOE's conclusion that the proposed standard level is economically justified. That is, whether DOE assumes that no consumers will switch fuels as a result of the rule or assumes that the maximum reasonably foreseeable number of consumers will do so, the rule is economically justified. The analysis underlying that conclusion is explained further below.

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

In order to estimate the impact of potential product switching resulting from amended standards, 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. (Potential product switching for MHGFs is discussed in the following subsection.) However, the potential consumer switching response is highly uncertain, as this represents a significant change in residential heating equipment. Given this uncertainty, DOE chose to bound the range of potential impacts by analyzing several scenarios, including a scenario with no product switching, scenarios with a moderate amount of product switching, and an additional scenario with a much higher percentage of consumers switching to heat pump systems due to the potential availability of tax credits. By analyzing this range of scenarios, DOE can determine whether the potential for product switching affects its evaluation of economic justification.

For the purposes of the reference case analysis, DOE assumed a moderate level of product switching. 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, by including its residual value in the choice model. If an 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.[212] 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 central air conditioners (''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 direct final rule,[213] assuming 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 2022$ and the installation costs were updated using the same labor costs as discussed in section IV.F.2 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). If consumers were to instead install higher efficiency heat pumps, this would generally increase heat pump installation costs, lowering the rate of equipment switching. DOE estimated the price of electric furnaces in the engineering analysis (see section IV.C 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). 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).[214] 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.

For the purposes of the reference case analysis, the consumer choice model

[212] Electric furnaces are estimated to have the same lifetime as NWGFs (21.5 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.

[213] U.S. Department of Energy-Office of Energy Efficiency and Renewable Energy, Residential Central Air Conditioners and Heat Pumps Technical Support Document (available at: *www.regulations.gov/document/EERE-2014-BT-STD-0048-0098*) (last accessed August 1, 2023).

[214] 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 August 1, 2023).

needs to be calibrated to an available data point. The decision criterion in DOE's model was based on proprietary survey data from Decision Analyst, collected from five separate surveys conducted between 2006 and 2022.[215] 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. This resulting payback period requirement is very short, consistent with other studies discussed in section IV.F.8.c of this document that found consumers and organizations often have very short payback period requirements, despite the longer-term economic benefits, thereby leading to suboptimal allocation of energy efficiency as a decisional factor. This relatively low payback period requirement means that consumers are quite sensitive to first costs, and as such, this will tend to dominate the switching criterion.

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.[216] In the case of switching to an electric heating option, the model selects the most economically beneficial product. For the proposed energy conservation standard, the switching fraction of NWGF consumers is 8.9 percent, and the switching fraction of MHGF consumers is 8.5 percent.

This consumer model may overestimate the level of product switching that would occur, as not every consumer is likely to run through this PBP calculation to determine whether to switch or not. Familiarity bias and like-for-like replacement bias may reduce the impact of product switching. However, as previously mentioned, DOE developed several scenarios in order to place upper and lower limits on this effect, including a scenario in which no product switching occurs and a scenario with significantly more product switching. Analyzing all these scenarios allows DOE to account for the identified uncertainty in this consumer response.

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 (see appendix 8J of the final rule 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 also analyzed a scenario in which potential tax credits (up to $2,000) significantly reduce the cost of installing a heat pump system, thereby incentivizing even more consumers to switch from non-weatherized gas furnaces to heat pumps. This scenario represents an upper bound on the fraction of consumers switching to alternative heating equipment in response to amended energy conservation standards for NWGFs.[217]

The relative comparison of the standard levels analyzed for NWGFs remains similar, regardless of the switching scenario (including the scenario with no switching), as shown in appendix 8J of the final rule TSD. The average LCC savings and percentage of consumers experiencing a net cost vary between the different switching scenarios; however, at the adopted standard level, the average LCC savings are positive, and the percentage of consumers experiencing a net cost is below 25 percent in all scenarios. Therefore, DOE's evaluation of economic justification for NWGFs does not depend on the specific details or assumptions regarding product switching, and DOE would come to the same conclusions regarding economic justification even if the impacts of the fuel switching analysis were not included.

In response to the NOPR, APGA commented that DOE's statutory interpretation that the incorporation of the results of fuel switching into the LCC analysis is permissible is contrary to clear intent of Congress. (APGA, No. 387 at pp. 19–20) APGA further commented that it is unlawful for DOE to compel fuel switching in a rule and that Congress intentionally designed EPCA to be fuel neutral—and specifically between gas furnaces and electric alternatives. APGA argued that EPCA requires DOE to consider the possibility of fuel switching and set a standard that ''is not likely to result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacement.'' APGA claimed that DOE allows fuel switching in some cases and not in others—for example depending on degree. APGA disagreed with DOE's interpretation given a plain reading of the statute and upon the strength of the legislative history. (APGA, No. 387 at pp. 36–39)

AGA similarly stated that it is improper for DOE to include LCC savings associated with fuel switching in the energy saving and economic justification of a consumer natural gas furnace standard. (AGA, No. 405 at pp. 74–77) AGA further argued, similarly to APGA, that the proposed rule would unlawfully compel many consumers to switch from gas to electric appliances. AGA argued that when Congress gave the Department authority to establish new standards for furnaces, it specified that those standards must not be ''likely to result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacement,'' and, therefore, the legislative history demonstrates that Congress did not intend for energy conservation standards to allow DOE to favor one fuel

[215] Decision Analysts, 2006, 2008, 2010, 2013, 2016, 2019, and 2022 American Home Comfort Studies (available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (last accessed August 1, 2023). Non-proprietary data of a similar nature were not available.

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

[217] DOE notes that any product switching that may occur in the absence of amended energy conservation standards due to tax credits is discussed in section IV.G of this document. Such switching would not be relevant in the LCC analysis as those consumers would switch in the no-new-standards case and thus not be part of the furnaces LCC sample anymore.

over another or limit consumer choice. (AGA, No. 405 at pp. 102–103) AGA argued that Congress designed the energy conservation standard program to be fuel-neutral and prevent fuel switching. (AGA, No. 405 at p. 105)

HARDI commented that the NOPR did not meet the requirements outlined by EPCA, stating that the statute prescribes that standards cannot ''result in a significant shift from gas heating,'' and that the fuel-switching analysis does not demonstrate this requirement has been met. (HARDI, No. 384 at pp. 3–4)

NPGA stated that because the proposed minimum efficiency level can only be achieved using condensing technology that requires a condenser and venting configurations that differ from atmospherically drafted furnaces, the proposal exceeds authority under EPCA, unlawfully compels fuel switching from gas furnaces to electric alternatives, and imposes design requirements. (NPGA, No. 395 at p. 2) NPGA further stated that Congress gave DOE authority to promulgate standards, but such standards must not be ''likely to result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacement.'' NPGA commented that the proposed standard is contrary to this requirement because it is so uneconomical that it is predicted to force consumers from gas furnaces to electric alternatives, such as electric resistance heating or heat pumps. (NPGA, No. 395 at p. 4) NPGA cited Senate and Congressional reports from 1986 and 1987 discussing the standards to be set for small gas furnaces, in order to show that Congress did not want to set standards for small gas furnaces that would impact competition between fuel sources and cause a significant switch to electric resistance heating. (NPGA, No. 395 at pp. 4–8) NPGA commented that contrary to the intent of Congress, DOE's proposal embraces fuel switching, biases against gas in favor of electricity, and harms an important industry vital to consumer wellbeing. (NPGA, No. 395 at pp. 8–9) The Heartland Institute expressed concern that consumers will switch from natural gas to less-efficient electricity or heat their homes in a dangerous or more inefficient manner, stating that this is unlawful and that EPCA is designed to be fuel-neutral. (Heartland Institute, No. 376 at pp. 1–2) The Georgia Gas Authority commented that the lack of economic justification and the effect of driving consumers towards fuel-switching makes the proposed rule unlawful under EPCA. (Georgia Gas Authority, No. 367 at p. 2) Spire commented that DOE's fuel switching analysis is inconsistent with EPCA's statutory scheme because it fails to provide comparisons between the cost of furnaces with the required efficiency improvements and the value of the operating cost savings those efficiency improvements would provide as a result of the standard. (Spire, No. 413 at pp. 45–46) Spire also commented that the proposed standards promote electrification rather than conserve energy through efficiency in gas products, thereby conflicting with EPCA and being inconsistent with the overall statutory scheme. (Spire, No. 413 at pp. 2, 43–49) Finally, Spire commented that the fuel-switching analysis occurs in instances without new standards, and that the fuel-switching numbers provided include those instances. (Spire, Public Meeting Webinar Transcript, No. 4099 at p. 15)

The following paragraphs explain DOE's rationale as to why the Department's amended standard and fuel switching analysis are appropriate and are consistent with EPCA.

First, DOE has concluded that the amended standards it is adopting for NWGFs and MHGFs are performance-based energy conservation standards that meet all relevant statutory requirements. As explained in section II.B of this document, DOE has determined that non-condensing technology and associated venting do not constitute a performance-related ''feature'' under 42 U.S.C. 6295(o)(4), consistent with the Department's December 2021 Final Interpretive Rule. Consequently, DOE is not making any covered product with a performance-related feature unavailable as a result of this rulemaking. These furnace standards are AFUE-based standards, which reflect efficiencies that are achieved by furnaces currently on the market. Although such levels are typically achieved by use of condensing technology, DOE does not mandate any specific technology or design to be used for meeting the standard, thereby allowing manufacturers maximum flexibility in terms of incorporating future technological advancements they deem appropriate. In the end, DOE has determined that the adopted furnace standards would result in the maximum energy savings that are technologically feasible and economically justified. Because these standards have been set in accordance with the applicable statutory criteria, DOE finds Spire's and NPGA's assertions that DOE has exceeded its statutory authority to be without merit. So, too, DOE finds without merit Spire's comments that these standards seek to promote electrification rather than to improve the energy efficiency of gas furnaces or that DOE's rule evidences a bias against gas. Consistent with EPCA's mandate, DOE has established product classes for each fuel source—gas, oil, and electricity—and set standards for those classes based on the criteria EPCA requires, *i.e.,* to achieve the maximum improvement in energy efficiency which the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A))

Second, DOE has concluded that an analysis of potential fuel switching effects is appropriate and consistent with EPCA. Initially, DOE notes that its analysis of fuel switching in the context of furnaces was initiated at the request of commenters who urged the Department to analyze such effects. As discussed previously, even in the absence of standards, consumers of HVAC appliances have a number of choices in terms of product selection in the current marketplace. For example, some number of consumers voluntarily switch their home heating system in any given year to a heat pump from a gas furnace, and some number of consumers switch from a gas furnace to an electric furnace. Understanding such routine changes is necessary for DOE to properly analyze the base case in any standards rulemaking, particularly as it relates to annual product shipments. DOE sees no reason why such real-world effects should be ignored in the standards cases. Instead, the failure to properly account for such effects would be inconsistent with EPCA's direction to consider whether the standard is economically justified, accounting for, among other things, future product shipments. (*See* 42 U.S.C. 6295(o)(2)(B)(i)(I) and (III)) Consistent with that recognition, DOE has analyzed potential changes in consumer behavior in a number of other rulemakings—and without controversy in terms of the permissibility under EPCA of considering such effects. DOE has analyzed the impacts of a potential standard on out-of-scope products as well as cross-elasticities between different product classes in other rulemakings.[218] DOE cautions that any primary analysis that refuses to acknowledge the potential for fuel switching (product switching) ignores reality, so DOE has continued to include the fuel switching model as part of its analysis, in order to provide the most accurate assessment of the costs and benefits of this rulemaking. However, as

[218] For example, general service fluorescent lamps, motors, and clothes washers.

discussed in the paragraph that follows, DOE has performed sensitivity analyses which assessed the effects of DOE's proposed standards if there were to be no fuel switching (see appendix 8J of the final rule TSD).

DOE's sensitivity analysis shows that the rule would be economically justified even if consumers were assumed to forgo economically beneficial opportunities to switch from gas furnaces to electric heat pumps. For example, with the reference case switching assumptions, DOE estimates that 18.7 percent of NWGF consumers would experience a net cost with average LCC savings of $350. Assuming no switching, DOE estimates that 21.6 percent of consumers would experience a net cost with an overall average LCC savings of $164 across all consumers. In either case, DOE considers the amended standard level to be economically justified. Thus, even if EPCA required the Department to ignore the likely real-world effects of its standards, and instead compelled an analysis that assumed consumers would eschew all fuel-switching, the resulting analysis would produce the same results: the standards adopted for gas-fired furnaces by this rule would still be the standards that achieve the maximum improvement in energy efficiency and that are technologically feasible and economically justified.

The amended standards plainly do not compel fuel switching. DOE's rule does not ban gas furnaces, and the Department has concluded that there are technological solutions available to allow continued installation of gas-fired furnaces for virtually all installation scenarios, as discussed in section IV.F.2 of this document. Consequently, DOE's rule does not compel any consumer to convert to an electric space-heating product, and consumers continue to have a variety of choices to suit their needs. DOE does acknowledge (and accounts for in its analysis) that in certain difficult installation situations with higher costs, consumers may choose to change their HVAC equipment to a product using a different fuel type, but as previously discussed, DOE expects this percentage to be small. Furthermore, newer technology options such as DuraVent FasNSeal may further reduce the prevalence and cost of such problematic installations. Although gas industry commenters have made numerous qualitative arguments regarding such installations, they have provided no data to demonstrate the quantitative impacts or to show that DOE's estimates are incorrect. DOE also finds no basis to support the Heartland Institute's assertion that consumers who choose to change their home heating product would face safety challenges or encounter a lack of energy-efficient alternatives; DOE's energy conservation standards for any of its covered space-heating products set minimum energy efficiency requirements for those products, and there are typically a variety of even more efficient products available on the market. DOE further has found that there are trained and qualified personnel available to adequately install and service such products, thereby alleviating any potential safety or reliability concerns.

Finally, DOE clarifies the concept of fuel neutrality. Contrary to commenters' arguments, EPCA does not contain a general fuel-neutrality provision. In addition, in several specific provisions, EPCA requires particular consideration of fuel switching and the utility consumers derive from different fuels. DOE has adhered to these requirements of EPCA, as applicable. The Department has made clear in other rules that ''DOE does not agree that EPCA, as amended, mandates fuel neutral energy conservation standards.'' *See* Full-Fuel-Cycle Final Statement of Policy, 76 FR 51281, 51284 (August 18, 2011). In that document, DOE confirmed that it will continue to consider comparable products that use different fuels in separate classes as required by 42 U.S.C. 6295(q)(1). *Id.*

As explained in DOE's August 2021 proposed interpretive rule, fuel switching is a natural part of market operation for the subject appliances, and it may occur even in the absence of amended energy conservation standards. The Department has recognized that ''fuel switching occurs frequently and most certainly in the context of new energy conservation standards.'' 86 FR 48049, 40856 (August 27, 2021). Installation costs may influence consumer decisions regarding fuel choice, and at any time, a segment of consumers may choose replacement products that rely on a different fuel source than that of the unit being replaced. *Id.* Because fuel switching may be impacted by the adoption of standards, when conducting an energy conservation standards rulemaking, the Department routinely accounts for potential fuel switching in its consumer choice model, which is one part of its full suite of analyses. Accordingly, ''[a]lthough DOE typically analyzes fuel-switching effects, the agency is generally free to set an appropriate level under the applicable statutory criteria regardless of any ancillary fuel switching effects.'' *Id.* Consequently, to the extent EPCA imposes a general principle of fuel-neutrality, DOE has understood that principle to be ''violate[d]'' only by ''a degree of fuel switching that is much greater than typically found in DOE energy conservation standards rulemakings.'' *Id.*

The specific provision to which gas industry commenters cite in support of their fuel-neutrality argument is not applicable to this rulemaking. Specifically, commenters rely on a provision requiring DOE to determine that a particular energy conservation standard not ''result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacements'' (*see* 42 U.S.C. 6295(f)(1)(B)(iii)). However, commenters ignore the limited applicability of that provision. That limitation is one of three requirements applicable to DOE's issuance of an energy conservation standard for *small* furnaces (*i.e.,* less than 45,000 BTUs) (*see* 42 U.S.C. 6295(f)(1)(B)(i)), for which DOE was required to establish standards no later than January 1, 1989 (*see Id.* at 42 U.S.C. 6295(f)(1)(B)). DOE discharged that obligation by rulemaking in 1989. See Energy Conservation Program for Consumer Products: Energy Conservation Standards for Two Types of Consumer Products, 54 FR 47916 (Nov. 17, 1989). The statutory provision to which commenters point demonstrates that Congress knew how to address concerns about fuel neutrality, doing so explicitly at the relevant place in the statute; Congress did not choose to adopt fuel neutrality provisions in other, broader provisions of EPCA's rulemaking authority.

The commenters seek to expand the reach of that provision to all subsequent furnace rulemakings. As explained subsequently, neither the language of the statute nor the legislative history support such a broad expansion of this fuel-neutrality limitation.

Congress did not place this fuel neutrality requirement in a provision of EPCA applicable to all rulemakings or even in a separate provision applicable to all furnace rulemakings. Instead, this specific limitation was included in a grant of authority for a single rulemaking to be completed by January 1, 1989, establishing an energy conservation standard for furnaces (other than furnaces designed solely for installation in mobile homes) having an input of less than 45,000 Btu per hour and manufactured on or after January 1, 1992. (42 U.S.C. 6295(f)(1)(B)(i)) The statute further provided that DOE's final rule must be set at an AFUE between 71 percent and 78 percent. (42 U.S.C. 6295(f)(1)(B)(ii)) Congress set specific

AFUE levels for most consumer furnaces by statute. (See *Id.* at 42 U.S.C. 6295(f)(1) and (2)) For this specific small furnaces rulemaking, however, Congress granted DOE discretion, but nevertheless imposed unusually prescriptive guidelines. Those specific guidelines make sense against a backdrop of otherwise congressionally mandated standards. However, they are entirely inconsistent with the general rulemaking authority Congress conferred upon the Department to set new or amended standards for covered products. The previous subsection makes this plain. Subsection (f)(1)(B)(ii) mandates that a January 1, 1989, regulation for ''such furnaces''—*i.e.,* small furnaces manufactured after January 1, 1992—must set an AFUE between 71 and 78 percent. (*Id.* at 42 U.S.C. 6295(f)(1)(B)(ii)) But that provision is obviously inapplicable to *all* future furnace rulemakings. In its 1989 regulation, DOE established a standard for the small furnaces to which these provisions apply with an AFUE of 78 percent. In 2007, pursuant to EPCA's requirement that DOE consider amended standards for consumer furnaces, DOE promulgated amended standards for furnaces—including both these small furnaces and furnaces of other sizes—which raised the AFUE standard 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. Such a rule would have been impossible if the efficiency range specified by 42 U.S.C. 6295(f)(1)(B)(ii)—71–78 percent AFUE—applied to that rulemaking. Of course, it did not, because 42 U.S.C. 6295(f)(1)(B)(ii) applied only to the Department's initial small-furnace rulemaking in 1989. Commenters never explain why subsection (f)(1)(B)(iii)—proscribing a significant shift to electric resistance heating—should apply to future rulemakings while subsection (f)(1)(B)(ii) should not.

Further, even if applicable to this rulemaking, the specific prohibition of 42 U.S.C. 6295(f)(1)(B)(iii) would have far less effect here than commenters assert. That section prevented DOE from setting a standard that would likely result in a significant shift from gas heating to ''electric *resistance* heating.'' Although that statutory requirement to avoid a shift to electric resistance heating was limited to the past rulemaking conducted under 42 U.S.C. 6295(f)(1)(B)(iii), DOE has concluded that the current rulemaking is also unlikely to drive a shift to electric resistance heating. To the extent the standard at issue here may result in a shift, it is far more likely to result in a shift from gas heating to electric heat pumps, a different technology with very different characteristics. At the time these particular statutory provisions were adopted, electric heat pumps were not as common with low market share in regions traditionally heated by furnaces, but in the intervening years, the heat pump market has seen considerable development. Heat pumps are far more efficient than electric resistance heating and can be more energy efficient than gas-fired furnaces. It would pervert EPCA's energy-savings purpose to infer from a prohibition on setting a standard likely to result in an *inefficient* shift an additional, a textual prohibition on setting a standard likely to result in an *efficient* one.

Although the relevant statutory text is clear and controls, DOE nonetheless examined the legislative history to confirm its reading of the text, particularly since certain commenters advanced a contrary reading based at least in part on legislative history. This inquiry confirmed DOE's understanding of the statutory text and likewise confirmed that the contrary reading espoused by those commenters is incorrect, for the reasons discussed subsequently. The legislative history that commenters cite supports the Department's interpretation. In one set of remarks regarding amendments to EPCA, Senator Bennett Johnston, Chairman of the Senate Committee on Energy and Natural Resources, stated:

We were concerned that if the Secretary establishes a standard for small gas furnaces at 78 percent, as originally proposed, the first cost differential between electric resistance heat and natural gas will increase to the point where builders will not even consider gas heat, particularly in southern areas where heating is a minor part of the overall residential energy requirement. With regard to the first cost, according to AGA, a 71-percent efficient gas furnace costs $475. Electric-resistance-heating equipment costs on an average $350, a difference of $125. By contrast, a 78-percent efficient gas furnace entails additional installation and duct work cost estimated conservatively at $150 to $200. Thus, the builder could save some $500 per living unit by choosing electric resistance heat over a 78-percent efficient gas furnace.

One of the main goals of this legislation is to encourage energy conservation without unduly altering the economics of fuel choices. This goal will be impaired unless the *standard for small gas furnaces* is set so as to avoid raising the cost of these furnaces to the point where builders are forced to select electric resistance heat instead of a gas furnace purely on the basis of first cost.

That is why I added language in our Energy and Natural Resources Committee report making it clear that the Secretary must pay due consideration to the need for utilities to continue to compete fairly *when DOE considers setting the standard for small gas* furnaces. I made it clear the *committee was concerned that setting a standard for small gas furnaces* at or near the 78-percent level mandated in the bill for larger gas furnaces would increase the first cost of the small gas furnace sufficiently to induce a significant switch to electric resistance heating.

The report language goes on to say that the bill will, upon a sufficient showing, * * * forbid a standard for small gas furnaces being set at a level that would increase the price to the point that the product would be noncompetitive, resulting in minimal demand for the product.[219]

In Senate Report No. 99–497, the report states in relevant part:

In addition, the *Committee agreed to adopt specific report language clarifying its intent with respect to small furnaces;* those having an input of less than 45,000 Btu's per hour.

The Committee did not establish an initial standard for *small gas furnaces* in the statute and instead directed the DOE to establish the standard by rule at an annual fuel utilization efficiency of not less than 71 percent and not more than 78 percent. The Committee was concerned that setting a standard for *small gas furnaces,* at or near 78 percent (the level for larger gas furnaces), would increase their initial price. Because of the *competition between small gas furnaces and electric resistance heating* in some areas of the Nation, such a price increase for *small gas furnaces* could induce builders or consumers to switch to electric resistance heating. No specific standard for electric resistance heating is included in this bill.

Section 325(j) provides several safeguards against a standard for *small gas furnaces* being set at a level that results in a buying preference or significant switching from gas heating to electric resistance heating. The Secretary must consider the impact of any lessening of competition that is likely to result from the establishment of a standard for *small furnaces.* He must consider the economic impact of the standard on manufacturers and consumers. In addition, the Secretary must consider the total projected amount of energy savings likely to result from the establishment or revision of a standard for *small furnaces.*

Finally, section 325(j)(4) forbids a standard being set so as to result in the unavailability in the United States in any covered product type (or class) of performance charact[e]ristics, such as size or capacity. This paragraph, upon a sufficient showing, would forbid a standard for *small gas furnaces* being set at a level that would increase the price to the point that the product would be noncompetitive and that would result in minimal demand for the product.'' [220] Language from Senate Report

[219] 132 Cong. Rec. 31328 (Oct. 15, 1986) (emphasis added).

[220] S. Rep. No. 99–497, at 5 (1986) (emphasis added).

No. 100–6 similarly reflects Congress's specific focus on small gas furnaces: ''On page 23, lines 13 through 18, the Committee modified the language of the bill amending section 325(f)(1)(B) of EPCA to include an additional clause (iii). The purpose of the new clause is to clarify that, in setting an energy conservation standard *for small gas furnaces* (those having an input of less than 45,000 Btu's per hour), the Secretary of Energy shall, in a manner which is otherwise consistent with this Act, establish the standard at a level between 71 percent and 78 percent AFUE 'which the Secretary determines is not likely to result in a significant shift from gas heating to electric resistance heating with respect to either residential construction or furnace replacement.

The Committee did not establish an initial standard *for small gas furnaces* in the statute and instead directed the DOE to establish the standard by rule at an annual fuel utilization efficiency of not less than 71 percent and not more than 78 percent. The Committee was concerned that setting a standard *for small gas furnaces,* at or near 78 percent (the level for larger gas furnaces), would increase their initial price. Because of the competition between *small gas furnaces* and electric resistance heating in some areas of the Nation, such a price increase *for small gas furnaces* could induce builders or consumers to switch to electric resistance hearing. No specific standard for electric resistance heating is included in this bill.

Section 325(j) provides additional safeguards against a standard *for small gas furnaces* being set at a level that results in a buying preference or significant switching from gas heating to electric resistance heating (see section-by-section analysis).[221]

Although the legislative history reveals a broader statement [222] by one individual member of Congress, once again Senator Bennett Johnston, its breadth is an outlier which contrasts with his own later statements and committee report language which demonstrates a focus on the small furnaces standard. The grants of rulemaking authority at 42 U.S.C. 6295(f)(4) and 42 U.S.C. 6295(m)(1), on which this rulemaking relies, do not limit the Department's discretion in the manner of 42 U.S.C. 6295(f)(1)(B)(iii). As relevant here, rather, the Department's discretion under those provisions is constrained by the generally applicable limits found in 42 U.S.C. 6295(m), (o), (p), and (q). Those provisions disallow establishment of a standard likely to result in the unavailability of a feature (*see* 42 U.S.C. 6295(o)(4)), and require establishment of a separate standard for any covered products that ''consume a different kind of energy from that consumed by other covered products within'' the regulated type of products (42 U.S.C. 6295(q)(1)(A)). The standards established by this final rule comport with these statutory requirements.

AGA stated that it is improper for DOE to consider fuel switching as one of the benefits of the proposed standards. To be consistent with EPCA's text, purpose, structure, and intent, AGA argued instead that the purported savings due to fuel switching must be subtracted from the analysis of whether the standards would be economically justified. (AGA, No. 405 at p. 105) In response, DOE notes that the impacts of fuel switching are not necessarily benefits. There are differences in costs and energy consumption compared to the no-new-standards case, and DOE is merely accounting for these differences in the sensitivity analysis described in this section. DOE has evaluated a variety of fuel-switching scenarios (including a scenario with no switching). The relative comparison of the standard levels analyzed for NWGFs remains similar, regardless of the switching scenario. The results for all scenarios are found in appendices 8J and 10E of the final rule TSD. Therefore, DOE's evaluation of economic justification for NWGFs does not depend on the specific details or assumptions regarding product switching, and DOE comes to the same conclusions even if the impacts of fuel switching are not included.

AGA argued that DOE also fails to acknowledge that with a condensing furnace, consumers will use more electricity, counteracting the fuel savings. AGA asserted that DOE should recognize that fuel switching, under the proposed rule, would increase overall energy consumption, which runs counter to the objectives of an energy conservation standard. (AGA, No. 405 at pp. 74–77) In response, DOE finds AGA's claim to be incorrect and without merit. DOE's analysis does account for the slight increase in electricity consumption for condensing furnaces compared to non-condensing furnaces, as presented in section IV.E.4 of this document, and the estimated energy savings of the rule incorporate this impact. DOE also accounts for the increase in electricity consumption if a consumer switches to a heat pump or electric furnace. These effects are incorporated in both the LCC analysis and national impact analysis. However, the energy savings from reduced natural gas consumption vastly outweigh the slight increase in electricity consumption. Furthermore, DOE fully accounts for these impacts in all fuel-switching scenarios. Even in scenarios where some fraction of consumers switch to an electric heating alternative, the energy savings from reduced natural gas consumption vastly outweigh the increase in electricity consumption. It would run counter to the purposes of EPCA to forgo such energy savings unnecessarily.

Spire commented that forced transition to electric alternatives would increase energy consumption. (Spire, No. 413 at pp. 5–14) In response, DOE accounts for the increased electricity consumption as a result of product switching to electric alternatives in its analysis.

APGA commented that DOE's analysis fails to appropriately account for the increased emissions from the electricity sector that results from increased electrical energy consumption caused by fuel switching. (APGA, No. 387 at p. 29) AGA commented that DOE should fully examine the impacts fuel switching would have on the entire energy system, including utilities and end-use residential consumers. According to the commenter, fuel switching can impact existing and future natural gas utility and electricity consumers, so, therefore, the Department should thoroughly examine how fuel switching would impact future electricity generation, transmission, or distribution infrastructure requirements. (AGA, No. 405 at pp. 105–106) In response, DOE emphasizes that the impacts of fuel switching are incorporated in all parts of its analysis (as part of the reference new-standards scenario). This includes the impacts on end-use residential consumers, electric utilities, natural gas utilities, and emissions reductions or increases. The results do account for increased emissions from the electricity sector. The utility impact analysis specifically accounts for the effects of fuel switching.

APGA opined that the estimates of potential switching in the TSD remain low, especially given financial incentives just passed by Congress in the Inflation Reduction Act, various initiatives of DOE to support low-income households, and numerous State initiatives. According to APGA, another reason that DOE's estimate of fuel switching is low is that DOE continues to underestimate the cost of difficult retrofits. The commenter reasoned that additional fuel switching to electric appliances decreases energy savings under DOE's analysis. (APGA, No. 387 at pp. 33–34) As discussed more fully

[221] S. Rep. No. 100–6, at 5–6 (emphasis added).

[222] At 133 Cong. Rec. 545 (Jan. 6, 1987), Senator Johnston states, ''One very sensitive aspect of this bill has been to minimize the effect it might have on the intense competition between the electric and gas industries. We don't want the bill to have the effect of creating a significant bias against any fuel—be it oil, gas, or electricity—so as to favor one over the other.''

subsequently, DOE has amended its shipments projection to account for existing policy initiatives with known impacts (*see* section IV.G.2 of this document), which has resulted in adjustments to the no-new-standards shipments projection. For the final rule, the shipments projected in 2050 are approximately 3 percent lower than was estimated in the NOPR. With respect to costs, DOE estimates its installation costs based on the best available data and information submitted by commenters, as discussed in section IV.F.2 of this document. DOE has evaluated all relevant information and data and has not identified any data that contradict its cost estimates. DOE concludes that its installation cost estimates are reasonable and representative and, therefore, that the resulting fuel-switching impacts are reasonable and representative. Finally, DOE accounts for all energy consumption differences compared to the no-new-standards case. In fuel-switching scenarios where some fraction of consumers switch to an electric heating alternative, the energy savings from reduced natural gas consumption vastly outweigh the increase in electricity consumption.

Spire claimed that DOE employs a fuel-switching analysis that assumes that consumers facing higher initial costs will engage in fuel-switching and does not consider the economic outcome of an investment in a standards-compliant furnace. Spire further argued that this is statutorily prohibited, as it is not fuel-neutral and is not comparing directly within classes because the technology is changing (non-condensing to electric). Spire claimed that DOE's fuel-switching analysis seeks to justify standards imposing economically unjustified efficiency by driving consumers to choose alternatives to gas furnaces. (Spire, No. 413 at pp. 43–44) In response, DOE finds that Spire is incorrect in its characterization of the analysis. The analysis considers the economic outcome of an investment in a standards-compliant furnace. Only a small fraction of consumers then opt for an electric alternative after this consideration. Even in the absence of amended standards, some portion of consumers with furnaces will choose to convert their home's heating system to a heat pump, changes which reflect consumer choice and the availability of alternative space-heating appliances in the marketplace. As commenters acknowledge, amended standards are likely to have some effect on such consumer purchasing decisions, so it would be inappropriate for DOE to fail to analyze these effects in both the no-new-standards case and standards cases. Furthermore, DOE evaluates a range of sensitivity scenarios with respect to fuel-switching assumptions, including a scenario with no fuel switching. The relative comparison of the standard levels analyzed for NWGFs remains similar, regardless of the switching scenario. The results for all scenarios are found in appendices 8J and 10E of the final rule TSD. Therefore, DOE's evaluation of economic justification for NWGFs does not depend on the specific details or assumptions regarding product switching, and DOE would reach the same conclusions even if the impacts of fuel switching are not included. To be clear, contrary to the assertions of Spire and others, justification for the amended standards set by DOE in this final rule does not hinge on fuel-switching results.

Spire commented that DOE's analysis does not appear to account for base case fuel switching (*i.e.,* fuel switching that would occur in the absence of new standards). (Spire, No. 413 at p. 50) In response, DOE notes that this assertion is incorrect. As previously mentioned, DOE incorporates existing market trends, including a shift to heat pumps and other heating alternatives in the absence of new standards, in its shipments projection and national impact analysis (see section IV.G of this document for further discussion). The LCC analysis specifically analyzes existing furnace consumers and the impacts on them due to a standard. Consumers that have already switched in the absence of a standard are not part of the LCC analysis, as they are not directly impacted by the rule; however, the reduction of future furnace shipments due to product switching will reduce overall energy savings in the national impact analysis, and that is accounted for in the analysis.

Spire further argued that DOE's assumptions appear to be designed to maximize LCC savings rather than to simulate actual consumer purchasing behavior. (Spire, No. 413 at p. 51) In response, DOE notes that this is a significant mischaracterization of the analysis. The incorporation of product switching is intended to capture a potential effect raised in previous comments. DOE evaluated a variety of fuel-switching scenarios (including a scenario with no switching). The relative comparison of the standard levels analyzed for NWGFs remains similar, regardless of the switching scenario. The results for all scenarios are found in appendices 8J and 10E of the final rule TSD. Therefore, DOE's evaluation of economic justification for NWGFs does not depend on the specific details or assumptions regarding product switching, and DOE reaches the same conclusions even if the impacts of fuel switching are not included.

Spire argued that DOE's fuel-switching analysis understates the adverse impacts of fuel switching resulting from the standards by significantly understating the costs associated with switching to heat pumps and ignoring the extent to which high initial costs and installation constraints can be expected to drive fuel-switching consumers to the worst option from an energy conservation perspective: electric resistance heating. (Spire, No. 413 at p. 15) Spire further argued that DOE arbitrarily limits the fuel-switching options to heat pumps and electric furnaces, ignoring the fact that baseboard heating is readily available, easy to install, and has extremely low initial costs. (Spire, No. 413 at p. 52)

In response, DOE notes that its estimates of heat pump costs are based on the 2016 final rule technical support document for central air conditioners and heat pumps and adjusted to 2022$. These are the most recently published estimates by DOE. Heat pump costs are unlikely to have changed significantly in the intervening years, other than due to the dollar value (which was accounted for). DOE's current analysis is consistent with the prior analysis specific to heat pumps. DOE further notes that the product-switching analysis considers alternative heating options that work with the existing ducted HVAC system. For a stand-alone gas furnace, the only other option is an electric furnace (*i.e.,* electric resistance heating). For a system that includes both an air conditioner and a furnace, a heat pump becomes another comparable option. DOE also considers switching options related to a water heater that formerly shared an exhaust vent with a NWGF. Switching from a NWGF to electric baseboard heating requires extensive electrical work in all rooms of a home and a likely upgrade of the electrical panel, which likely costs several thousands of dollars. DOE disagrees that this is a low-cost option and estimates that very few consumers, if any, would switch to this option as a result of amended energy conservation standards, given the availability of other lower-cost alternatives. Additionally, DOE does not consider electric resistance space heaters as a viable space-heating alternative to a NWGF, because such heaters provide only localized heating utility as opposed to whole-home heating.

Spire argued that fuel switching substantially increases overall carbon emissions and claimed that DOE is understating the adverse energy consumption and emissions impacts due to product switching. (Spire, No. 413 at pp. 5–6) In response, DOE notes that these assertions are incorrect and a mischaracterization of the analysis. Product switching does not substantially increase carbon emissions, and DOE evaluates a full range of energy savings and emissions impacts for all the switching sensitivity scenarios (including a scenario with no switching). The national impact analysis results for all scenarios are presented in appendix 10E of the final rule TSD. Although incorporating product switching decreases national energy savings (due to increased electricity consumption), in all scenarios, the rule will result in significant energy savings and emissions reductions compared to the no-new-standards case. The energy savings from reduced natural gas consumption vastly outweigh the increase in electricity consumption, when addressed on a comparable FFC basis.

APGA stated that a 95-percent AFUE furnace costs nearly three times as much as an 80-percent AFUE natural gas furnace and that an average air-source heat-pump system could cost $5,000 to $10,000 to install, which the commenter claimed is several times more than a gas furnace. (APGA, No. 387 at p. 65) APGA further commented that the heat pumps and central air conditioners test procedure final rule that the July 2022 NOPR cited for its product prices did not clearly explain how the prices were developed. APGA questioned whether DOE used a different methodology to predict the future prices of heat pumps, and the commenter stated that these matters should be clearly explained in the final rule. (APGA, No. 387 at p. 53) DOE has described how it estimated furnace costs previously in significant detail. With respect heat pumps, as noted, DOE utilized the estimated costs published in the January 2017 direct final rule for central air conditioners and heat pumps. 82 FR 1786 (Jan. 6, 2017). The heat pump product switching analysis is only relevant for households with an existing air conditioning system, because adding an air conditioner or heat pump requires significant additional installation costs, as well as space requirements (including adding a concrete pad). Households without an existing air conditioning system are unlikely to switch to a heat pump in response to an amended standard for consumer furnaces, whereas households with an existing (and aging) air conditioning system might opt to switch to a heat pump for both their heating and cooling needs.

PHCC commented that DOE's assumption that heat pump equipment costs will go down is incorrect, as material prices have increased due to the COVID–19 pandemic and resulting supply chain issues. PHCC further stated that heat pump costs are too low as estimated in the NOPR, and that the costs for adding power capacity and estimates of the number of homes that require additional power capacity are also too low. (PHCC, No. 403 at p. 5) In response, DOE acknowledges the supply chain issues that were prevalent during the COVID–19 pandemic; however, DOE estimates that by the first year of compliance (*i.e.,* 2029) these constraints will no longer be relevant. DOE has also adjusted all cost estimates to $2022 to reflect recent inflation trends. Lastly, no additional data were submitted to support further adjustment of the number of homes that require additional power capacity.

PHCC expressed uncertainty as to whether DOE's updates related to heat pumps and to its fuel-switching analysis are sufficient, including whether the Department considered the impacts on the recent proposal to require a new refrigerant. (PHCC, No. 403 at pp. 4–5) In response, DOE notes that it incorporates the latest refrigerant requirements for heat pumps in its fuel-switching estimates.

PHCC commented that the fuel-switching and repair information in Tables V.3 and V.4 of the NOPR are understated. (PHCC, No. 403 at p. 6) In response, DOE notes that the commenter did not provide any meaningful information or data to update or improve the analysis. DOE's analysis is based on the best available data and information, including that submitted by commenters. DOE has evaluated all relevant information and data and has not identified any data that contradicts its estimates. Therefore, DOE concludes that its estimate of the percentage of consumers switching to an electric heating alternative or opting for extended repair are reasonable and representative.

NGA of Georgia commented that the proposed rule will create a competitive disadvantage because the high initial cost of the installation requirements for condensing furnaces will cause consumers to switch from natural gas to less-efficient home heating alternatives such as oil, kerosene, and electric resistance furnaces. (NGA of Georgia, No. 380 at p. 3) In response, DOE disagrees that consumers will likely switch to oil or kerosene alternatives, as there are significantly higher operating and installation costs for those fuels. For example, as projected in *AEO2023,* the cost of fuel oil per MMBtu is more than double that of natural gas. Therefore, DOE does not include these fuels in its fuel-switching estimates. With respect to electric furnaces, DOE already accounts for a fraction of consumers that opt to switch to an electric furnace and includes these impacts in its analysis.

The Georgia Gas Authority stated that the residential customers served by its members continue to choose the non-condensing furnace as the most economical and energy-efficient option. The commenter stated that this is evidenced by the number of non-condensing furnaces financed through the Georgia Gas Authority's on-bill financing program and the responses of HVAC contractors interviewed throughout the various regions their members serve. According to the commenter, the interviewed HVAC contractors indicated that the unavailability of non-condensing furnaces would cause widespread fuel switching to electric heating. Furthermore, the Georgia Gas Authority stated that many natural gas customers would face higher monthly energy costs without any improved energy efficiencies by switching to electric appliances. (The Georgia Gas Authority, No. 367 at p. 2) In response, DOE estimates the total costs and benefits associated with existing non-condensing furnace consumers moving to a condensing furnace. DOE's analysis is national in scope but captures regional variability. DOE's analyses show that a majority of consumers, nationally, are expected to receive a net LCC benefit under this rulemaking, and DOE disagrees with the commenter that most consumers would switch to an electric alternative. In particular, the availability of condensing furnaces will change in the new-standards case, and, therefore, it is highly unlikely that consumers will switch to electric alternatives due to the unavailability of products. Furthermore, DOE's analysis estimates that only a modest fraction of consumers would switch to an electric alternative. The full impacts of this switch, including all operating costs and energy consumption impacts, are accounted for in DOE's analysis and evaluation of economic justification.

The DCA also commented that this proposed rulemaking would lead to customers switching to electric furnaces. The commenter further added that this switch would lead to higher operating costs and necessitate upgrades to electrical systems. (DCA, No. 372 at

p. 2) In response, DOE has evaluated this possibility of consumers switching to electric furnaces as part of the fuel-switching analysis, including the impacts of potentially higher operating costs and the need for upgrades to electrical systems.

Edison Electric Institute commented that the fuel-switching analysis should account for the other standards that have been implemented for related products such as heat pumps. (Edison Electric Institute, Public Meeting Webinar Transcript, No. 363 at p. 85) Edison Electric Institute similarly commented that the fuel-switching model should include technologies such as oil furnaces or other technologies besides electric heating systems. (Edison Electric Institute, Public Meeting Webinar Transcript, No. 4099 at p. 18) In response, DOE notes that the fuel-switching analysis does account for relevant and up-to-date standards for heat pumps. DOE further estimates that switching from gas-fired to oil-fired furnaces is highly unlikely, given the installation costs necessary to do so and significantly higher fuel oil prices. As a general matter, there has been an overall market shift away from oil-fired furnaces.

HARDI commented that DOE's analysis fails to adequately measure the impact of the NOPR. Specifically, HARDI commented that the LCC model and its fuel-switching analysis contain incorrect assumptions that will make it more difficult for distributors to predict the market changes and warehouse the appropriate inventory. (HARDI, No. 384 at p. 2) In response, DOE notes that in the standards case, the market for furnaces will be more predictable in terms of furnace efficiency options. DOE acknowledges the uncertainty in how consumers may respond in terms of product switching, which is why there are several product switching sensitivity scenarios, but in all cases, DOE concludes that the rule is economically justified.

Sierra Club and Earthjustice commented that the modeling of consumers' decisions to switch to electric space-heating appliances in response to amended consumer furnace standards is solidly grounded in the available data. (Sierra Club and Earthjustice, No. 401 at p. 2) Sierra Club and Earthjustice further commented that industry stakeholders misapprehend DOE's objective in modeling consumer decisions about fuel switching. These commenters stated, as long-term industry trends suggest, some portion of consumers will switch to heat pumps no matter what standard DOE selects. Further, Sierra Club and Earthjustice stated that the amended standard would not be driving the broader shift to electric heating appliances, but it may encourage customers to invest in cost-effective electric alternatives to consumer furnaces. These organizations commented that the base-case efficiency and consumer fuel-switching analysis serve different roles in the analysis of impact. (Sierra Club and Earthjustice, No. 401 at p. 2) In response, DOE clarifies that there are indeed separate aspects to fuel switching addressed in the analysis. To the extent that the existing NWGF market is shifting to electric heating alternatives, such as heat pumps, in the absence of any amended energy conservation standard for NWGFs, that is reflected in the no-new-standards case shipments projection, as discussed in more detail in section IV.G of this final rule. The second aspect of fuel switching is in response to an amended energy conservation standard for NWGFs. DOE agrees with Sierra Club and Earth Justice that an amended energy conservation standard will not drive a significantly broader shift to electric heating alternatives. As explained previously, the estimated fraction of consumers that switch to an electric heating alternative in response to an amended energy conservation standard for NWGFs is expected to be modest.

Joint Efficiency Commenters stated that DOE's sensitivity analyses demonstrate that the proposed standards are cost-effective even with alternative assumptions for key parameters. These groups further commented that, while higher product switching was found to result in greater LCC savings and a lower simple payback period, assuming no product switching still resulted in positive LCC savings for the proposed standard level. (Joint Efficiency Commenters, No. 381 at pp. 4–5) DOE agrees.

b. Product Switching Resulting From Amended Standards for Mobile Home Gas Furnaces

As in the NOPR analysis, DOE has included product switching in its analysis for MHGFs for this final rule, including a variety of sensitivity scenarios. The MHGF product-switching methodology is similar to the product-switching methodology for NWGFs, except that the model does not assume any 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 final rule for more details regarding the product-switching model for MHGFs.

The relative comparison of the standard levels analyzed for MHGFs in this final rule remains similar, regardless of the switching scenario (including the scenario with no switching), as presented in appendix 8J of the final rule TSD. The average LCC savings and percentage of consumers experiencing a net cost vary between the different switching scenarios. However, at the adopted standard level, the average LCC savings are positive, and the percentage of consumers experiencing a net cost is below 25 percent in all scenarios. Therefore, DOE's evaluation of economic justification demonstrates that MHGFs are not significantly impacted by the specific details or assumptions regarding product switching.

MHI suggested that the standards proposed in the July 2022 NOPR could lead consumers to adopt less-efficient, and sometimes dangerous, heating methods. (MHI, No. 344 at p. 1) JCI similarly commented that DOE should evaluate whether the proposed MHGF standards would drive homeowners to unsafe heating alternatives such as portable space heaters. (JCI, No. 411 at p. 2) In response, DOE has not found data to suggest that MHGF standards would drive homeowners to unsafe heating alternatives such as portable space heaters. In addition, DOE notes that the commenters did not provide, and that DOE was unable to identify, data to support the claim that consumers would switch to dangerous heating methods in response to an amended efficiency standard for the subject furnaces. While homeowners of manufactured homes could purchase multiple portable space heaters to fulfill their heating needs throughout the winter in various rooms, switching to portable electric resistance heating would substantially increase operating costs for most consumers to maintain the same level of comfort and increase monthly utility bills for most owners of manufactured homes. DOE believes this occurrence will be rare because homeowners are unlikely to forgo the use of heat throughout the winter, are unlikely to choose unsafe heating alternatives where warnings regarding their constant use are readily available and apparent, and are sensitive to monthly expenses on utility bills. Thus, DOE believes any occurrences of the type posited by MHA and JCI would be rare in practice. DOE has identified and evaluated the likely heating alternatives for consumers of MHGFs, based on existing and safe products on the market, in its switching analysis.

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

For this final rule, 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.[223] Thus, for example, a price increase of 10 percent would result in a shipment 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 was 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 final rule for more details on the repair vs. replace consumer choice model for NWGFs and MHGFs.

[223] 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 August 1, 2023).

HARDI commented that the proposed standards would increase repairs of older equipment, which would make it more challenging to stock repair parts, make these repairs more expensive, and take longer due to more product shipments. Finally, HARDI argued that many consumers would still opt for these higher repair costs rather than replace their furnace due to the increased cost of a new, standards-compliant unit. (HARDI, No. 384 at pp. 2–3) ACCA also stated its expectation that the proposals in the July 2022 NOPR would result in a significant increase in homeowners opting to repair their existing equipment rather than working with a licensed professional to replace it. (ACCA, No. 398 at p. 3)

In response, DOE acknowledges that some consumers may opt to extend the lifetime of an existing lower-efficiency furnace rather than replace it, and the Department includes this effect in its analysis as part of its repair vs. replace methodology. Incorporating this effect into DOE's analysis reduces the total energy savings expected as a result of the standards. However, DOE estimates that only a few percent of consumers will opt for an extended repair, which will only delay the replacement by a few years given that the furnace will ultimately need to be replaced (see results presented in section V.B of this document). DOE's shipments projection accounts for these extended repair situations. With respect to the availability of non-condensing furnace replacement parts, DOE acknowledges that as the share of non-condensing furnaces in the building stock decreases over time, the availability of replacement parts will decrease as well, but the Department expects that manufacturers will have both an economic incentive to continue to make such parts available, as well as a desire to maintain good relations with their customer base.

PHCC expressed disagreement with DOE's conclusion that new standards will not cause consumers to repair products or use alternate heating methods. The commenter surmised that DOE's rationale relates to contractors not doing much of this type of repair work in the market now, but PHCC argued that the relatively low rate of repair is likely tied to consumers currently having other non-condensing furnace options. PHCC pointed to the air-conditioning industry, where repairs increased when refrigerant requirements changed. Finally, the commenter argued that low- and fixed-income consumers would be impacted by these increased costs, and that these costs should be considered as a part of the LCC and PBP analysis. (PHCC, No. 403 at p. 5)

In response, DOE clarifies that it does include repair and maintenance costs as part of the analysis, differentiated by efficiency level. DOE also considers that a fraction of consumers may choose to repair a furnace, rather than replace it, at the end of its lifetime, in response to an amended energy conservation standard, as described previously. DOE also clarifies that it considered the possibility that consumers may adopt alternative heating methods in response to an amended energy conservation standard for consumer furnaces, as described in section IV.F.10 of this document.

12. Payback Period Analysis

The payback period is the amount of time (expressed in years) it takes the consumer to recover the additional installed cost of more-efficient products, compared to baseline products, through energy cost savings. Payback periods that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis when deriving first-year operating costs, except that discount rates are not needed.

As noted previously in section III.F.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 standards would be required.

APGA argued that since the product switching decision criterion is based on a simple payback period calculation, the inclusion of product switching biases the average PBPs to be more attractive than they should be. (APGA, No. 387 at pp. 57–58) In response, DOE notes that it has performed a sensitivity scenario with no product switching, including calculating the resulting PBPs, and the conclusions of economic justification remain the same regardless of whether product switching is included or not.

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, NPV, and future manufacturer cash flows.[224] 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.[225] 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 final rule.

An anonymous commenter stated that with recent shortages, it has been hard to find air-conditioner or furnace units that meet the ultra-low NO_X requirement in areas that require them. (Anonymous 2, No. 346 at p. 1) The anonymous commenter further recommended that more resources should be made available to manufacturers so that availability is no longer an issue. (*Id.*) The same anonymous commenter also stated that heat pumps alleviate the issue of not having available resources to meet ultra-low NO_X requirements. (*Id.*) The same anonymous commenter referenced a blog from Lee's Air, Plumbing, and Heating that may serve as a resource for helping residential homeowners upgrade old furnaces to ultra-low NO_X systems. (*Id.*) In response, DOE acknowledges recent supply chain constraints but assumes that all such constraints will be resolved by the first year of compliance (2029), as such constraints were heavily tied to the COVID–19 pandemic. DOE assumes that current supply chain issues will not persist out to 2029 and beyond, given that such issues are already in the process of resolving and current supply chains are not as constrained as they were during the pandemic.

The Georgia Gas Authority stated that over the past 15 years, the average residential natural gas consumption per customer has dropped from 72 MMBtu per year to 65 MMBtu per year. The Georgia Gas Authority commented that condensing units are currently 50 percent of the market and 60 percent of shipped NWGFs. (Georgia Gas Authority, No. 367 at p. 2)

Citing a report from the Bonneville Power Administration, NEEA stated that 65 percent of gas furnace sales in the Northwest in 2020 were at an efficiency of 95 percent AFUE or higher. Similarly, NEEA added that less than one-third of gas furnaces sales in the Northwest are non-condensing, and that this figure has been stable and declining from 2016 to 2020. (NEEA, No. 368 at p. 3)

The Heartland Institute commented that condensing furnaces capture more than half the market, with six in ten NWGFs shipped being condensing models. Accordingly, the commenter argued that the proposed standards for NWGFs and MHGFs are not needed. (Heartland Institute, No. 376 at p. 2)

APGA asserted that growth in the market share for condensing furnaces is likely to be higher than DOE's estimate and undermines DOE's economic justification for further market intervention in the form of new standards. (APGA, No. 387 at pp. 7–8)

In contrast, NYSERDA further commented that DOE's condensing furnace national projections are lower than as described in the 2021 HARDI data for the Northeast and New York, which shows 76 percent and 64 percent of natural gas furnace shipments as being condensing systems, respectively. (*Id.*) NYSERDA also commented that HARDI sales data for New York show that over 50 percent of furnaces sold in the Northeast and over 45 percent of those sold in New York are at 96-percent AFUE. (NYSERDA, No. 379 at p. 2)

DOE acknowledges the increasing market saturation of condensing furnaces and has included this trend as part of the shipments analysis based on historical shipments data. These data do indicate a high fraction of condensing furnaces in the Northeast.

Evergreen Action commented that condensing furnaces represent about half of the new purchases on the current market; the other half of purchases are made by landlords or builders who are not responsible for the utility bills, or by homeowners who are making a quick decision when replacing a broken furnace. (Evergreen Action, No. 364 at p. 1) In response, although DOE acknowledges that a mix of landlords or homeowners purchase consumer furnaces, the Department bases its shipments projection on historical shipment and saturation data. DOE further notes that these observations regarding landlords and builders, as well as homeowners making quick replacement decisions, are consistent with DOE's discussion of market failures in section IV.F.8 of this document.

Nortek commented that the proposed furnace standards could lead the already relatively small retail market for MHGFs to shrink, which could cause companies to stop making them. The commenter further stated that this could reduce competition and, in turn, cause problems for manufactured homeowners who would have to turn to more expensive alternatives. (Nortek, No. 406 at p. 6)

Mortex commented that DOE's shipments estimates for MHGFs are too high, and estimating that these values should be closer to 36,000 (consistent with 2021 shipments). In contrast to DOE's projection of increasing shipments, Mortex forecasted that shipments of MHGFs will decline, reaching 19,000 by 2040. (Mortex, No. 410 at p. 2)

As discussed in the subsections that fellow, DOE's shipments projections for MHGFs are based on historical shipment data submitted to DOE by manufacturers and trade associations and historical and projected manufactured housing data (existing and new construction), as described in chapter 9 and appendix 9A of the final rule TSD. Projected housing trends are based on *AEO2023.* These data indicate that MHGF shipments are unlikely to decrease to the level suggested by Mortex, primarily due to replacements needed for existing manufactured homes.

AGA inquired about how the modeled market correlates to the 2020 RECS data, pointing out that the modeled market

[224] 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.

[225] 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.

share of the Pacific Region in 2029 differs from the 2020 RECS data. (AGA, Public Meeting Transcript, No. 363 at p. 55) In response, DOE clarifies that it includes market share trends into its analysis, such that the market shares projected for 2029 will not exactly match 2020 market shares. Furthermore, RECS data represent the market share of the existing stock, whereas the market share for 2029 represents new shipments of consumer furnaces.

a. Historical Shipments Data

DOE assembled historical shipments data for NWGFs and MHGFs from Appliance Magazine for 1954–2012,[226] AHRI from 1996–2022,[227] HARDI from 2013–2022,[228] and BRG from 2000–2022.[229] DOE also used the 1992 and 1994–2003 shipments data by State provided by AHRI [230] and 2004–2009 and 2010–2015 shipments data by North and rest of country regions provided by AHRI,[231] as well as HARDI shipments data that is disaggregated by region and most States to disaggregate shipments by region. DOE also used CBECS 2018 data and BRG shipments data to estimate the commercial fraction of shipments. 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 [232] [233] American Housing Survey (AHS),[234] and RECS.[235]

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 21.5 years). In addition, DOE adjusted replacement shipments by taking into account demolitions, using the estimated changes to the housing stock from *AEO2023.*

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 *AEO2023* housing starts and commercial building floor space projections and data from U.S. Census Characteristics of New Housing,[236] [237] Home Innovation Research Labs Annual Builder Practices Survey,[238] RECS 2020, AHS 2021, and CBECS 2018 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 2022.[239]

To project shipments to the new-owner market, DOE estimated the new owners based on the residual shipments from the calculated replacement and new construction shipments compared to historical shipments over five years (2016–2020 for this final rule). DOE compared this with data from Decision Analysts' 2002 to 2019 American Home Comfort Study,[240] 2023 BRG data,[241] and AHRI's estimated shipments in 2000,[242] 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.12 shows the fraction of shipments for the replacement, new construction, and new owner markets in 2029. For NWGFs in residential applications, 59 percent of shipments are projected to be in the North and 41 percent in the rest of the country. For NWGFs in commercial applications, 51 percent of shipments are projected to be in the North and 49 percent in the rest of the country. For MHGFs, 70 percent of shipments are projected to be in the North and 30 percent in the rest of the country. See chapter 9 of the final rule TSD for more details on the shipments analysis.

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

[227] Air-Conditioning, Heating, & Refrigeration Institute, *Furnace Historical Shipments Data.* (1996–2022) (Available at: *www.ahrinet.org/resources/statistics/historical-data/furnaces-historical-data*) (last accessed August 1, 2023).

[228] Heating, Air-conditioning and Refrigeration Distributors International (HARDI). DRIVE portal (HARDI Visualization Tool managed by D+R International until 2022), proprietary Gas Furnace Shipments Data from 2013–2022 proprietary Gas Furnace Shipments Data from 2013–2022 provided to Lawrence Berkeley National Laboratory (LBNL).

[229] BRG Building Solutions. The North American Heating & Cooling Product Markets (2023 Edition) (available at: *www.brgbuildingsolutions.com/reports-insights*) (last accessed August 1, 2023).

[230] 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 August 1, 2023).

[231] 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.

[232] U.S. Census Bureau, Manufactured Homes Survey: Annual Shipments to States from 1994–2022 (available at: *www.census.gov/data/tables/time-series/econ/mhs/shipments.html*) (last accessed Aug. 1, 2023).

[233] 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 August 1, 2023).

[234] U.S. Census Bureau—Housing and Household Economic Statistics Division, American Housing Survey, multiple years from 1973–2021 (available at: *www.census.gov/programs-surveys/ahs/data.html*) (last accessed August 1, 2023).

[235] Energy Information Administration (EIA). Residential Energy Consumption Survey (RECS), multiple years from 1979–2020 (available at: *www.eia.gov/consumption/residential/*) (last accessed August 1, 2023).

[236] U.S. Census. Characteristics of New Housing from 1999–2022 (available at: *www.census.gov/construction/chars/*) (last accessed August 1, 2023).

[237] U.S. Census. Characteristics of New Housing (Multi-Family Units) from 1973–2022 (available at: *www.census.gov/construction/chars/mfu.html*) (last accessed August 1, 2023).

[238] 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 August 1, 2023).

[239] U.S. Census Bureau, Characteristics of New Housing (available at: *www.census.gov/construction/chars/*) (last accessed August 1, 2023).

[240] Decision Analysts, 2002, 2004, 2006, 2008, 2010, 2013, 2016, 2019, and 2022 American Home Comfort Study (available at: *www.decisionanalyst.com/Syndicated/HomeComfort/*) (last accessed August 1, 2023).

[241] BRG Building Solutions. The North American Heating & Cooling Product Markets (2023 Edition) (available at: *www.brgbuildingsolutions.com/reports-insights*) (last accessed August 1, 2023).

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

TABLE IV—12 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	%	Million	%	Million	%
NWGF (Residential)	Replacements *	1.412	82	0.948	79	2.360	81
	New Construction	0.316	18	0.255	21	0.571	19
	Total	1.728	100	1.202	100	2.930	100
NWGF (Commercial)	Replacements *	0.057	74	0.052	72	0.109	73
	New Construction	0.020	26	0.020	28	0.040	27
	Total	0.077	100	0.072	100	0.149	100
MHGF	Replacements *	0.050	70	0.020	64	0.070	68
	New Construction	0.021	30	0.011	36	0.032	32
	Total	0.071	100	0.031	100	0.102	100

* Includes new owners.
Note: percentages may not add up to 100 percent due to rounding

Regarding the proposed California 2016 Air Quality Management Plan (AQMP),[243] which targets ozone-depleting NO_X emissions, DOE notes that the proposed control measure has two components: (1) implementing the existing Rule 1111 [244] 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.

For the NOPR, assumptions regarding future policies encouraging electrification of households were speculative at that time, so such policies were not incorporated into the shipments projection. For the final rule, DOE accounted for the 2022 update to Title 24 in California [245] and also the decision of the California Public Utilities Commission to eliminate ratepayer subsidies for the extension of new gas lines beginning in July 2023. Together, these policies are expected to lead to the eventual phase-out of NWGFs and MHGFs in new single-family homes in California. The California Air Resources Board has adopted a 2022 State Strategy for the State Implementation Plan that would effectively ban sales of new gas furnaces beginning in 2030.[246] However, because a final decision on a rule would not happen until 2025, DOE did not include this latter policy in its analysis for the final rule.

DOE understands that ongoing electrification policies at the Federal, State, and local levels are likely to encourage installation of heat pumps in some new homes and adoption of heat pumps in some homes that currently use NWGFs and MHGFs. However, there are many uncertainties about the timing and effects of these policies that make it difficult to fully account for their likely impact on NWGF and MHGF market shares in the time frame for this analysis (*i.e.,* 2029 through 2058). Nonetheless, DOE has modified some of its projections to attempt to account for impacts that are most likely in the relevant time frame. The assumptions are described in chapter 9 and appendix 9A of the final rule TSD. The changes result in a decrease of NWGF and MHGF shipments in the no-new-standards case in 2029 compared to the NOPR analysis, with a corresponding decrease in estimated energy savings resulting from the standards. DOE acknowledges that electrification policies may result in a larger decrease in shipments of NWGFs and MHGFs than projected in this final rule, especially if stronger policies are adopted in coming years. However, this would occur in the no-new-amended-standards case and, thus, would only reduce the energy savings estimated in this rule. For example, if incentives and rebates shifted five percent of shipments in the no-new-amended-standards case from NWGFs to heat pumps, then the energy savings estimated and associated monetized benefits for NWGFs in this rule would decline by approximately five percent. The estimated consumer impacts are likely to be similar, however, except that the percentage of consumers with no impact at a given efficiency level would increase. Nor does DOE expect that a modest shift in shipments would have a significant effect on manufacturers. DOE notes that the economic justification for the rule would be unlikely to significantly change even if DOE were to include these larger impacts of incentives and rebates in the no-new-standards case, although the absolute magnitude of the savings might decline.

Regarding this aspect of the July 2022 NOPR, Lennox commented that Resolution 22–14 (*i.e.,* the 2022 State SIP Strategy in California), the New York State scoping plan, and the incentives and tax credits for electric HVAC in the Inflation Reduction Act

[243] 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).

[244] See *www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1111.pdf* (last accessed May 31, 2023).

[245] The 2022 update includes heat pumps as a performance standard baseline for water heating or space heating in single-family homes, as well as space heating in multi-family homes. Under the California Code, builders will need to either include one high-efficiency heat pump in new constructions or subject those buildings to more-stringent energy efficiency standards.

[246] See *https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy#:~:text=The%202022%20State%20SIP%20Strategy,all%20nonattainment%20areas%20across%20California* (last accessed August 1, 2023).

will contribute to additional shifting towards electrification for heating and cooling. The commenter asserted that DOE should consider these factors in the shipment estimates and related analysis for consumer furnaces. (Lennox, No. 389 at p. 3)

In response, as noted in the previous discussion, DOE has accounted for some policies encouraging the electrification of homes, such as the 2022 update to Title 24 in California. The shipments analysis reflects these initiatives. With respect to the California 2022 State Strategy for the State Implementation Plan, a rule specific to NWGFs and MHGFs is not yet final and remains uncertain at this time. Similarly, the specific implementation of any incentives or rebates as part of the New York State Scoping Plan and Inflation Reduction Act remain speculative at this time. Therefore, DOE did not incorporate either of these initiatives in the shipments projections for this rulemaking. As DOE has noted, however, the economic justification for the rule would be unlikely to change significantly, even if DOE were to include these larger impacts of incentives and rebates in the no-new-standards case, although the absolute magnitude of the savings might decline.

Rheem commented that it does not agree with DOE's shipment projections that predict a 30-percent increase in furnace sales between 2035 and 2050, arguing that they are inaccurate because of the Federal and State-level policy trends toward electric appliances which is largely buoyed by manufacturers. (Rheem, No. 394 at p. 2) In response, DOE clarifies that at the proposed standard levels in the NOPR, total furnace shipments (NWGFs and MHGFs) only increased by approximately 15 percent between 2035 and 2050, not 30 percent. DOE notes, however, that it has revised its shipments projection to reflect Federal, State, and local-level initiatives currently in effect, as described previously, which results in a smaller increase in furnace sales. Accordingly, for the final rule shipments projection, total furnace shipments (NWGFs and MHGFs) are expected to increase by approximately 5 percent between 2035 and 2050.

Atmos Energy commented that the proposed rule would likely reduce the effectiveness of existing rebate programs, arguing that it would undermine the overall goals of the energy efficiency program. The commenter added that the proposed rule would reduce the pool of customers able to take advantage of available incentive programs. (Atmos Energy, No. 415 at p. 4) Atmos Energy further stated that it currently offers conservation and energy efficiency programs in its Louisiana, Mississippi, Colorado, and Mid-Tex divisions, adding that it provides financial incentives to purchase high-efficiency natural gas equipment, smart thermostats, and home weatherization upgrades. Atmos Energy stated that in 2020, 1.39 million therms of natural gas were conserved and 8,117 tons of CO_2 emissions were avoided annually as a result of energy efficiency programs. (Atmos Energy, No. 415 at p. 5) In response, DOE acknowledges that rebate programs incentivizing the purchase of higher efficiency condensing furnaces will no longer be needed after energy conservation standards for consumer furnaces come into effect.

2. Impact of Potential Standards on Shipments

a. Impact of Equipment Switching

DOE applied the consumer choice model described in section IV.F.10 of this document to estimate the impact on NWGF and MHGF 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 or MHGF that meets a particular standard level, (2) a heat pump, or (3) an electric furnace.[247]

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 and MHGF product price trend described in section IV.F.1 of this document to project prices in 2058. DOE used the appropriate energy prices over the lifetime of products installed in each year. Although the inputs vary, the decision criteria were the same in each year. For each considered standard level, the number of NWGFs or MHGFs shipped in each year is equal to the base shipments in the no-new-standards case minus the number of NWGF or MHGF 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

As discussed in section IV.F.11 of this document, for this final rule, 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. For purposes of this analysis, DOE assumes that the demand for space heating is inelastic and, therefore, that no modeled 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). While DOE recognizes that edge cases exist, DOE believes that its analytical assumption of inelasticity is representative of the vast majority of households.

For details on DOE's shipments analysis, product and fuel switching, and the repair option, see chapter 9 of the final rule TSD.

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended energy conservation standards at specific efficiency levels.[248] (''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.[249] 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

[247] DOE also accounted for situations when installing a condensing furnace could leave an ''orphaned'' gas storage 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 storage water heater along with a new furnace.

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

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

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 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 will already have a condensing furnace.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. *AEO2023* 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.13 summarizes the inputs and methods DOE used for the NIA analysis for the final rule. Discussion of these inputs and methods follows the table. See chapter 10 of the final rule TSD for further details.

TABLE IV.13—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 *AEO2023* projections for HDD/cooling degree days (CDD) and building shell efficiency index.
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 Price Trends	*AEO2023* projections (to 2050) and extrapolation thereafter. Natural gas and electricity marginal prices based on EIA and RECS 2020 and CBECS 2018 billing data.
Energy Site-to-Primary and FFC Conversion.	A time-series conversion factor based on *AEO2023.*
Discount Rate	Three and seven percent.
Present Year	2023.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) 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 III.F.8 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 final rule, DOE estimated that the national market share of condensing products would grow from 61 percent in 2029 to 71 percent by 2058 for NWGFs, and from 34 percent to 48 percent for MHGFs during those same years. The market shares of the different condensing efficiency levels (*i.e.,* 90-, 92-, 95-, and 98-percent AFUE for NWGFs and 92-, 95-, and 96-percent AFUE for MHGFs) are maintained in the same proportional relationship as in 2029. The approach is further described in appendix 8I and chapter 10 of the final rule TSD.

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 AFUE 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.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each potential standards level (TSL) case 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 standards 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 *AEO2023.* For natural gas and LPG, DOE assumed that site energy consumption is the same as primary energy consumption. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

The per-unit annual energy use is adjusted with the building shell improvement index, which results in a decline of three percent in the heating load from 2029 to 2058, and the climate index, which results in a decline of nine percent in the heating load.

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.3 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.

NYSERDA expressed support for DOE's methodology and approaches used for this NOPR, particularly around the rebound effect, stating that it is consistent with documented behaviors. The commenter further stated agreement with DOE's use of the 15-percent estimate for rebound effect. (NYSERDA, No. 379 at pp. 11–12) DOE agrees and maintains a 15-percent rebound effect estimate for the final rule.

NYSERDA recommended that DOE should qualitatively discuss the indirect rebound effect in the rebound section of the TSD. (NYSERDA, No. 379 at p. 13)

In response, DOE acknowledges that indirect rebound (increased energy consumption by consumers in other areas due to the monetary savings from efficiency standards) may be a factor warranting consideration in the context of amended energy conservation standards for the subject furnaces, but quantifying such a macroeconomic effect is particularly challenging and subject to inherently large uncertainties. However, regardless of the specific magnitude of this effect, DOE notes that it is very likely to be welfare-increasing even if energy savings are reduced.[250]

In the standards cases, there are fewer shipments of NWGFs or MHGFs compared to the no-new-standards case because of product switching and product repairs, but there are also 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 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 announcement, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[251] 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 the final rule TSD.

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.1 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 final rule 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 1990–2006 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 final rule 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 final rule TSD for details on DOE's treatment of the monetary valuation of the rebound effect.

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 *AEO2023,* 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 *AEO2023* Reference

[250] For example, see *www.journals.uchicago.edu/doi/abs/10.1093/reep/rev017?journalCode=reep* (last accessed August 1, 2023).

[251] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2023,* DOE/EIA–0581(2023) (available at: *www.eia.gov/forecasts/aeo/index.cfm*) (last accessed August 1, 2023).

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 final rule TSD.

In considering the consumer welfare gained due to the direct rebound effect, DOE accounted for change in consumer surplus attributed to additional heating from the purchase of a more efficient unit. Overall consumer welfare 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 final rule TSD for details on DOE's treatment of the monetary valuation of the rebound effect.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, 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.[252] 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 final rule, DOE analyzed the impacts of the considered standard levels on three subgroups: (1) low-income households, (2) senior-only households, and (3) small businesses. The analysis used subsets of the RECS 2020 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 final rule TSD describes the consumer subgroup analysis.

1. Low-Income Households

Low-income households are significantly more likely to be renters and/or live in subsidized housing units, compared to homeowners. DOE notes that in these cases, the landlord purchases the equipment and may pay the gas bill as well. RECS 2020 includes data on whether a household pays for the gas bill, allowing DOE to categorize households appropriately in the analysis.[253] For this consumer subgroup 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 costly product switching, that is, when landlords switch to products that have lower upfront costs but higher operating costs, which will be incurred by tenants. Table IV.19 summarizes the low-income statistics and potential impacts. For the low-income subgroup, renters account for more than half of the NWGF installations and close to thirty percent of the MHGF installations.

TABLE IV.19—LOW-INCOME SUBGROUP CHARACTERISTICS AND POTENTIAL NET BENEFITS

Type of household * (pay for gas?) **	Percentage of low-income sample *		Benefits from energy cost savings	Responsibility for incremental cost
	NWGF	MHGF		
Renters (Pay for Gas Bill)	43.0	27.8	Full	None.
Renters (Pay for Part of Gas Bill)	1.5	0.0	Partial savings	None.
Renters (Do Not Pay for Gas Bill)	8.6	2.0	None	None.
Owners (Pay for Gas Bill)	45.9	64.3	Full	Full.
Owners (Pay for Part of Gas Bill)	0.1	0.0	Partial savings	Full.
Owners (Do Not Pay for Gas Bill)	0.9	5.9	None	Full.

* RECS 2020 lists three categories: (1) Owned or being bought by someone in your household (classified as ''Owners'' in this table); (2) Rented (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 2020 does not distinguish homes in subsidized or public housing.

** RECS 2020 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.'' Note that DOE also takes into account if the occupant pays for electricity, as for some higher-efficiency options, electricity use can vary compared to baseline equipment.

Atmos Energy commented that in fulfilling its statutory obligations, DOE cannot rely on potential external measures to mitigate the negative impacts of its standards, including rebate programs so as to improve its analytical outcomes and reduce the burden on low-income households. (Atmos Energy, No. 415 at p. 3)

In response, DOE clarifies that it does not rely on potential measures, such as rebate programs, to justify a standard. These measures are not part of the low-income subgroup analysis. DOE merely

[252] United States Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) Section E (available at: *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/*) (last accessed August 1, 2023).

[253] RECS 2020 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 operating cost benefits of an amended energy conservation standard.

notes their possible existence, which would improve the assessed impacts to low-income households as presented in section V.B of this document.

MHI commented that it stands ready to work with DOE to ensure that standards for consumer furnaces do not negatively impact potential manufactured homeowners. (MHI, No. 365 at p. 5)

In response, DOE analyzed the impact of the considered amended energy conservation standards on manufactured-home households, including low-income manufactured-home households, and the Department has concluded that these standards are economically justified, as discussed in section V.C of this document.

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 forgoing 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.

Commenting on the NOPR, a number of commenters opposed the proposed rule based on, in part, the potential impacts to low-income households.

Southwest Gas Corporation commented that for low-income and vulnerable populations, the appliance replacement and retrofit costs would be a financial burden. Southwest estimated that the NOPR would not be economically justifiable for a majority of its customers. (Southwest, No. 353 at p. 2)

The Georgia Gas Authority recognized the importance of appliance efficiency but argued that energy conservation standards should not sacrifice the well-being of low-income families to achieve such goals. (The Georgia Gas Authority, No. 367 at p. 2)

NGA of Georgia stated that DOE's proposed rule would place an undue burden on those who can afford it the least, including seniors and low-income consumers. (NGA of Georgia, No. 380 at p. 1) The commenter more specifically argued that the rule would unfairly impact low- and fixed-income homeowners and renters, seniors, and small businesses. NGA of Georgia added that low- and fixed-income homeowners are less likely to purchase a new home and, thus, would be forced to endure costly retrofit installations. Additionally, the commenter stated, that low- and fixed-income homeowners typically live in smaller spaces requiring less energy to heat, which diminishes the value of a high-efficiency product in such applications. Further, NGA of Georgia stated that low-income renters would be forced to deal with increased rent when landlords try to recoup the high cost of retrofitting apartments with condensing furnaces. (NGA of Georgia, No. 380 at p. 2)

APGA claimed that DOE's analysis shows that low-income households fare much worse than average consumers under the proposed rule. APGA further claimed that DOE has not fully accounted for the impacts on low-income residents. The commenter asserted that regional differences in the impact of the proposed rule would create even more unfavorable results for low-income households in certain negatively affected regions; for example, the South, where APGA has many members, would be expected to be more adversely affected than average. APGA further argued that the impact of fuel switching on low-income households is not clear in the NOPR. (APGA, No. 387 at pp. 45–47)

Spencer and Dayaratna stated that the amended standards proposed in the July 2022 NOPR will unjustifiably reduce consumer choice. The commenters added that the economic value of energy efficiency is best determined by individual consumers and businesses. The commenters also added that the flexibility to assess individual economic tradeoffs is even more important to low-income Americans, citing statements from OMB and research studies. Spencer and Dayaratna argued that a nine-year payback period may not make sense for many Americans who would be better served by having additional resources available for food or housing. The commenters opined that DOE should not compel Americans to take on these extra costs or degrade the livability of their homes. (Spencer and Dayaratna, No. 390 at pp. 8–9)

Black Hills Energy commented that, if adopted, the proposed rule would negatively impact individual homeowners, including senior and low-income households, small business, and the overall furnace market. The commenter stated that DOE should not issue a rule with such negative impacts as those described in the proposal that would affect low-income households, seniors, and energy insecure consumers. (Black Hills Energy, No. 397 at pp. 1–2)

PHCC commented that energy insecurity is a significant concern and that access to gas products and non-condensing products remains an important solution to this issue. (PHCC, No. 403 at p. 5)

AHRI stated that the impacts of a full condensing furnace standards would fall disproportionately on lower-income and senior households. AHRI referenced a statement from MHI that the median income for mobile home purchasers is $35,000 and that manufactured homeowners comprise a disproportionate amount of the Nation's fixed-income citizens and first-time homebuyers. (AHRI, No. 414–2 at p. 3)

Atmos Energy commented that DOE should amend the proposed furnace standards to address the significant adverse impacts on low-income households, adding that DOE's assessment on this matter is insufficient. (Atmos Energy, No. 415 at p. 2) Atmos Energy further commented that the proposed rule burdens low-income households because it would cause an increase in furnace costs. Atmos Energy stated that condensing furnaces cost consumers around $1,300 more than non-condensing furnaces, adding that this increase in cost would burden homeowners and place upward pressure on rents by adding to maintenance costs. (Atmos Energy, No. 415 at p. 3)

Several commenters expressed concern regarding the July 2022 NOPR's potential impacts on housing affordability and consumers. AGA *et al.,* The Coalition, The Heartland Institute, Plastics Pipe Institute, ACCA, and DCA all commented that the proposed rule would have significant adverse impacts, especially on low-income or fixed-income households, seniors, energy insecure consumers, small businesses, and/or the overall furnace market. (AGA *et al.,* No. 391 at p. 1; The Coalition, No. 378 at p. 2; The Heartland Institute, No. 376 at pp. 1–2; Plastics Pipe Institute, No. 404 at p. 1; ACCA, No. 398 at pp. 1–2; DCA, No. 372 at pp. 1–2) Strauch objected to the life-cycle methodology of DOE's proposed rulemaking due to concerns about consumer impacts. (Strauch, No. 366 at p. 1) Strauch stated that poorer individuals or those with fixed incomes may not be able to afford the up-front investment that would allow them access to the future dollar savings of a more-efficient product. (*Id.*) Strauch also noted that the elderly population similarly may not live long enough to recover these additional costs through energy savings. (*Id.*) Strauch also argued that the July 2022 NOPR will reduce consumer choice. (*Id.*)

MTNGUD, WMU, Consumer Energy Alliance, LANGD, Georgia Gas Authority, and the Heartland Institute stated that the potential negative impacts of the proposals in the July 2022 NOPR on consumers, including senior-only households, low-income households, and small business consumers, are inconsistent with the Biden-Harris Administration's priority of achieving environmental justice in Federal programs. (MTNGUD, No. 350 at p. 1; WMU, No. 350 at p. 1; Consumer Energy Alliance, No. 354 at p. 1; LANGD, No. 355, at p. 1; Georgia Gas Authority, No 367 at p. 2; The Heartland Institute, No. 376 at p. 1) Also, several commenters noted that manufactured housing provides a source of affordable homeownership, which is impacted by this rulemaking. (Nortek, No. 406 at p. 5; MHI, No. 344 at p. 1; MHI, Public Meeting Webinar Transcript, No. 363 at p. 25–29; MHI, No. 365 at p. 1) Nortek commented that the median annual income of manufactured homeowners is below the national average, and that these individuals and families make up a larger group of America's fixed-income citizens and first-time homebuyers. Nortek stated that this makes the demographic more vulnerable to changes that could price them out of the homebuying market. (Nortek, No. 406 at p. 5) MHI similarly argued that the July 2022 NOPR could reduce the affordability of manufactured homes without providing substantial energy-efficiency or cost-saving benefits. (MHI, No. 344 at p. 1; MHI, Public Meeting Webinar Transcript, No. 363 at pp. 25–27) Also, MHI asserted that should furnaces become less affordable, some manufactured housing owners may switch to less efficient and less safe heating methods. (MHI, No. 365 at p. 1) Nortek further stated that additional regulation that increases the cost to purchase or maintain a home could prevent some financially vulnerable consumers from achieving homeownership. (Nortek, No. 406 at p. 2) The Coalition commented that, given current housing prices, many potential homebuyers have been priced out of the market. (The Coalition, No. 378 at p. 3) The Coalition also stated that these proposed standards place added pressure on households that are simultaneously struggling with rapidly rising prices for food, utilities, transportation, and other basic needs. (*Id.*)

In contrast, a number of other commenters supported the proposed rule based on, in part, the potential benefits to low-income households.

NCEL stated that outdated and inefficient gas furnaces generate high energy bills that particularly burden lower-income households. The State legislators commented that heating bills are one of the biggest energy expenses for most households, and those with inefficient gas furnaces face annual average heating bills of about $700. Furthermore, NCEL stated that increasing gas furnace efficiency will go a long way towards easing the burden of energy costs. (NCEL, No. 359 at p. 1)

GHHI stated that due to historic underinvestment in low-income communities of color, residents often lack the resources to fix their aging and deteriorating homes, leading to poor insulation, drafts, and outdated HVAC systems. Consequently, GHHI stated that low-income communities, disproportionately of Black, Hispanic, and Native backgrounds, end up paying three times as much of their income on energy bills compared to those with higher income. (GHHI, No. 371 at p. 2) While GHHI acknowledged that newer appliances have greater upfront costs, GGHI argued that the savings from reduced utility costs mean the payback period from low-income families averages just over two years. (GHHI, Public Meeting Webinar Transcript, No. 363 at p. 18) The State Agencies commented that a 95-percent AFUE would help to decrease the energy burden for low-income households that spend a large portion of their income on energy bills. (State Agencies, No. 375 at p. 2)

NYSERDA commented that, based on their review of DOE's LCC analysis, the commenter has concluded that for New York and the rest of the U.S., establishing a standard at TSL 8 would yield significant consumer benefits that outweigh potential costs, especially for low-income consumers and those living in disadvantaged communities. (NYSERDA, No. 379 at p. 3) The commenter stated that DOE's LCC analysis demonstrates the importance of this standard for low-income households. NYSERDA further commented that it found that adopting TSL 8 would not unfairly burden low-income or disadvantaged communities in the Northeast but instead would provide significant benefits, especially to renters who pay for utility bills. (NYSERDA, No. 379 at pp. 6–7)

NYSERDA commented that in September 2022, Con Edison reported that, for that winter, electricity bills in their territory are expected to increase by 22 percent (to an average of $116 per month), and natural gas bills are expected to increase by 32 percent (to an average of $460 per month). NYSERDA emphasized the importance of transitioning to more efficient appliances for the general New York population, especially low-income households. (NYSERDA, No. 379 at p. 6)

NCLC *et al.* commented on a 2021 analysis by the Pew Research Center, stating that 60 percent of those in the lowest income quartile are renters and that only 10 percent of households in the highest income quartile rent. NCLC *et al.* added that since tenants cannot dictate the efficiency of furnaces that owners purchase, strong standards are often the only way to ensure that tenants will benefit from having efficient furnaces. (NCLC *et al.,* No. 383 at pp. 4–5)

The Pennsylvania Groups commented in support of improved efficiency standards because they expect that such standards would help reduce energy burden disparities for systematically marginalized communities across the Commonwealth. These commenters stated that communities of color and low-income families face high energy burdens and often struggle to afford and maintain energy services to their homes. (The Pennsylvania Groups, No. 396 at p. 2)

The Pennsylvania Groups stated that to achieve baseline affordability standards, a family's total housing costs—including utility costs—should account for no more than 30 percent of the household's total income. These commenters further stated that throughout Pennsylvania, families living at or below 150 percent of the Federal Poverty Line spend as much as 29 percent of their income on utility costs alone. (The Pennsylvania Groups, No. 396 at p. 2)

The Pennsylvania Groups stated that these households often forgo other basic necessities in order to pay their heating bills, and when they cannot keep up with payments, their heat is shut off. These commenters further stated that this shut-off creates serious risks to the health and well-being of family members and threatens stable employment and education. (The Pennsylvania Groups, No. 396 at p. 3)

The Pennsylvania Groups commented that low-income and BIPOC (Black, Indigenous, and People of Color) residents disproportionately occupy older, lower-quality housing, and these homes are more likely to use less-efficient, natural gas-fueled appliances. These commenters stated that Pennsylvania has some of the oldest housing stock in the country and that 55 percent of homes are heated with gas or propane. The Pennsylvania Groups pointed out that renters may bear even more of the negative impacts of wasteful furnaces than homeowners. (The Pennsylvania Groups, No. 396 at p. 3) They stated that the increased demand for rental housing and escalating rental costs have resulted in a market with limited access to safe, healthy, and quality housing, with significant cost burdens to low-income households. (The Pennsylvania Groups, No. 396 at pp. 3–4)

The Pennsylvania Groups stated that their Commonwealth has over 435,000 low-income renters whose home heating is up to their landlords. Additionally, these commenters stated that the estimated savings under DOE's proposed standard would be a significant amount to low-income families. (The Pennsylvania Groups, No. 396 at p. 4)

Climate and Health Coalition stated that high heating bills can force a terrible choice upon consumers between paying for heat and other necessities, particularly for low-income households which pay three times as much of their incomes on energy costs than non-low-income households and are disproportionately Black, Hispanic, and Native American. (Climate and Health Coalition, No. 399 at p. 4)

The NCLC commented that low-income rental properties are more likely to have less-efficient furnaces and pass the associated larger energy bill on to tenants. (NCLC, Public Meeting Webinar Transcript, No. 363 at pp. 8–10)

NEEA stated that the proposals in the July 2022 NOPR will improve equitable outcomes by ensuring that rental units have efficient heating, thereby benefiting the larger portion of lower-income rental units, and better insulating lower-income households from variable energy prices. (NEEA, No. 368 at pp. 3–4) The Joint Efficiency Commenters stated that DOE's analysis shows that the majority of consumers, and especially low-income consumers, will benefit from the proposed standard level for MHGFs. (Joint Efficiency Commenters, No. 381 at p. 5) Climate Smart Missoula *et al.* stated that DOE's proposal would lead to health benefits through the emissions reductions and by lowering utility bills for low-to-moderate income households, thereby freeing up resources that can be spent on food and medicine. (Climate Smart Missoula *et al.,* No. 393 at pp. 1–2) NCLC commented that increased efficiency standards will benefit low-income families by lowering utility bills and mitigating harms caused by global warming, which provides both pocketbook savings and health benefits. (NCLC *et al.,* No. 383 at p. 2)

CFA stated that all of the conclusions about consumer benefits in the aggregate (*i.e.,* payback period less than half the appliance lifetime, many more consumers with net benefits than with net costs, and individual who benefit having larger gains than the losses of individuals who do not) apply to low-income consumers as well. (CFA, Public Meeting Webinar Transcript, No. 363 at p. 20)

PSEA stated that high-efficiency condensing furnaces dramatically reduced the energy costs of low-income Philadelphians while also reducing indoor air pollution, and stated that the proposed standards would bring tremendous financial benefits and health benefits to low-income people nationwide. (PSEA, Public Meeting Webinar Transcript, No. 363 at p. 37)

In response, DOE acknowledges the importance of considering the potential impacts on low-income households from energy conservation standards for consumer furnaces. As discussed in further detail in section V.C of this document, DOE concludes that low-income households are not disproportionately negatively impacted compared to the national average. DOE's analysis takes into account a variety of factors, as described in detail in section IV.F of this document, that are important to consider for low-income households, including typical equipment price, installation costs, furnace sizing, heating load, discount rate. DOE also considers the possibility of equipment switching to alternative options that meet all safety requirements. DOE finds no evidence that consumers are likely to switch to less-safe heating methods, and even if some consumers do so, such switching is likely to be very rare.

A significantly higher fraction of low-income households are renters compared to the national average. Renters are unlikely to be responsible for the selection and purchase of a consumer furnace but are often responsible for energy costs. The main LCC results assume all equipment costs are ultimately paid for by the household, as an upper-bound estimate of costs paid for by each household, and the low-income subgroup analysis represent a lower-bound estimate by assuming no passthrough. DOE did not make this upper-bound assumption in the low-income subgroup analysis in order to better understand the likely impacts on this specific subgroup, excluding the impact to landlords, who are not part of the low-income subgroup. There is no evidence DOE is aware of that suggests a price increase on the installation of a consumer furnace, paid for by a landlord, would be passed down to any significant extent to low-income renters. Rental markets are a separate market determined by their own supply and demand, and low-income rents can be further restricted by local requirements or subsidies. There are some indications that premium, efficient appliances can result in higher rents, but this correlation mostly applies to premium rental properties, not low-income households. Therefore, DOE assumes that landlords are very likely to bear the increased installation costs, not the low-income renter households.

The main LCC results and the low-income subgroup results provide an upper and lower bound on the likely impacts to low-income renter households, either assuming 100 percent of equipment and installation costs are passed through to renters or 0 percent of costs are passed through. Even if costs are passed through to renters to some extent in practice, DOE concludes that low-income renters are very likely to disproportionately benefit from an energy conservation standard for consumer furnaces as a result of significant operating cost savings. DOE acknowledges that for low-income owner households, there are some consumers with a net LCC cost and some households with a net LCC savings. Those are included as part of the overall low-income subgroup results. In addition, these results are all considered as part of DOE's evaluation of economic justification, balancing the various burdens and benefits of a potential standard.

ACCA recommended that DOE should focus on educating and incentivizing homeowners to demand that HVAC systems are installed according to the industry's recommended minimum standards (including proper equipment sizing, duct redesign and sealing, and appropriate refrigerant charge levels). (ACCA, No. 398 at p. 2) ACCA commented that implementing such changes would result in a 25 to 30 percent efficiency improvement and would result in fewer negative consumer impacts. (*Id.*)

APGA asserted that to the extent that a landlord incurs net costs under the proposed rule, landlords will flow those cost increases through to their low-income tenants, but DOE's methodology intentionally excludes that negative impact in its analysis. APGA argued that DOE's failure even to try to consider how much of the cost will be passed down to low-income renters is unreasonable. (APGA, No. 387 at pp. 47–48)

As discussed previously, DOE does not agree with comments asserting that furnace cost increases will pass through to low-income tenants. DOE is not aware of any evidence to suggest this is the case. Rental markets are a separate market and not dictated by the cost of furnace (especially low-income rental properties), particularly when all rental properties are subject to the same energy conservation standards for furnaces, and, thus, there is no differentiation between rental properties based on the installed furnace. Furthermore, even if some fraction of total installed costs were passed through to tenants through rent increases, the benefits of a higher-efficiency furnace would still vastly outweigh the costs. Any increase in rent would be averaged over many months and years, such that increases in first cost for lower income households would be constrained with higher than average discount rates.

DOE also notes that a program based on educating and incentivizing homeowners is highly unlikely to achieve the level of energy savings in this rule, as evaluated in the discussion of alternative programs to energy conservation standards, presented in chapter 17 of the final rule TSD.

AGA claimed that the reported percentage impacts for low-income consumers only include the results of low-income renters that pay their gas bills. According to the commenter, the remainder of low-income households is substantial and includes owner-occupied units and renters that do not pay their bills. AGA stated that the inclusion of fuel switching in the overall LCC savings significantly impacts the total and average LCC savings for low-income and senior households. AGA also pointed out that low-income consumers in four separate regions have negative LCC savings under a no-switching scenario. (AGA, No. 405 at pp. 98–102)

In response, DOE notes that the commenter's assertions are incorrect. The low-income subgroup results include all low-income households that meet the definition, including renters (both renters who pay and who do not pay their energy bills) and owner-occupied households. A significant fraction of low-income households are renters, as shown in section IV.I of this document. For owner-occupied low-income households, DOE acknowledges that some households will experience a net savings and that some will experience a net cost, but the Department considers this distribution of impacts, including regional variability, in its evaluation of economic justification. DOE has also considered all of the product switching sensitivity scenarios as part of its evaluation. DOE acknowledges there is a range of potential impacts across these scenarios, but as discussed in section V.C of this document, they do not alter DOE's conclusions.

NCP pointed out that in DOE's LCC analysis, savings were negative for housing types with more than five units, which are frequently occupied by consumers with lower incomes. (NCP, No. 370 at p. 2)

In response and as noted previously, DOE has conducted its main LCC analysis to assume 100 percent of total installed costs of a standards-compliant furnace are passed through to renters. Again, this is likely to provide a very conservative estimate of the impacts to renters, including those who live in housing types with more than five units. However, when assuming that the landlord is likely to bear most if not all of these costs, those households disproportionately benefit from an energy conservation standard for consumer furnaces.

Atmos Energy commented that the proposed rule burdens low-income households because of the physical differences that become more problematic in multifamily dwelling units and smaller or older homes. The commenter elaborated that when switching to a condensing furnace, there are physical design changes required in the house, such as larger cabinets, different venting/combustion air intake systems, and the addition of condensate drain systems. (Atmos Energy, No. 415 at p. 3)

As discussed in more detail in section IV.F of this document, DOE accounts for a variety of factors in its analysis, including the need for different venting/combustion air intake systems and possible alterations such as larger cabinets, and installation of condensate drain systems. These factors are considered for all households, including low-income households.

Atmos Energy commented that the proposed rule burdens low-income households because eliminating more affordable classes of furnaces that can be accommodated without renovations would make furnace replacements out of reach for many households with modest incomes. The commenter added that this would advantage wealthier households that can afford to replace less-efficient furnaces with newer models and reap the accompanying energy savings benefits. (Atmos Energy, No. 415 at p. 3)

As discussed previously, DOE acknowledges that total installed costs for a standards-compliant furnace is expected to increase, but the commenter fails to acknowledge that operating costs will decrease. DOE evaluates the full impact on households, including both the initial total installed costs and operating costs, when evaluating economic justification. DOE acknowledges that some low-income households may have a particularly high discount rate, and this is reflected in the discount rate distribution for the lowest income bin (see section IV.F.7 of this document). DOE also has no evidence that the majority of low-income households who are renters who will to be burdened with an increase in total installed costs, and, thus, DOE disagrees with the assertion that the rule is primarily advantageous to wealthier households.

The Coalition commented that regulatory requirements, including the amended standards proposed in the July 2022 NOPR, collectively create a substantial financial burden for the development and rehabilitation of housing. The commenter pointed to studies suggesting that regulatory requirements account for almost 25 percent of the average cost of a new single-family home and account for an average of 40.6 percent of the total development costs of new multi-family communities. The Coalition argued that these proposed furnace standards would add to these regulatory burdens. (The Coalition, No. 378 at pp. 3–4)

The Coalition further commented that the proposed furnace standards would have adverse impacts on housing providers, renters, and manufacturers by effectively eliminating non-condensing furnaces as an option for home heating. The Coalition added that these standards would increase the cost of a furnace, stating that condensing furnaces cost consumers approximately $1,300 more than non-condensing furnaces. The commenter predicted that this additional cost would need to be absorbed by new home buyers and would increase maintenance costs, arguing that these added costs would be significant for households with modest incomes and providers of affordable housing. (The Coalition, No. 378 at p. 4)

In response, DOE notes that installation cost of a 95-percent AFUE furnace in new construction can be less expensive than the installation cost of an 80-percent AFUE furnace, as discussed in section IV.F.2 of this document. This is primarily due to lower costs to install venting systems in new construction, with shorter vent lengths and without the need to remove an existing venting system. Despite this, market data show that 80-percent AFUE furnaces continue to be installed in new construction. Therefore, DOE does not agree that an energy conservation standard will have an adverse impact on builders or housing providers, nor will it negatively impact the development of more affordable housing options. To the extent that an amended energy conservation standard for consumer furnaces adds to total construction costs, which are then absorbed by new home buyers, that is included in DOE's analysis. Those new home buyers would then also benefit from reduced operating costs as part of the LCC analysis. Finally, other regulatory requirements on builders and developers would apply in both the no-new-standards case as well as the new-standards case, and, therefore, such requirements do not factor in DOE's analysis.

NGA of Georgia stated that the proposed rule would negatively impact Georgians and reduce competition. The commenter stated that the proposal disproportionately prioritizes uncertain CO_2 emissions reductions over the broader negative impacts to consumers. NGA of Georgia argued that affordability, end-user utility, and resiliency cannot be deprioritized in favor of increased emissions reductions. (NGA of Georgia, No. 380 at p. 1)

In response, DOE acknowledges that some fraction of consumers will experience net savings, whereas others will experience net costs. DOE's analyses account for regional variation, and consumers in different States (as represented in the RECS and CBECS surveys) are represented in the LCC. Thus, DOE's evaluation of economic justification considers a distribution showing the full range of consumer impacts. DOE further notes that its conclusions would be the same even without considering the monetized benefits of emissions reductions. Accordingly, DOE concludes that affordability, end-user utility, and resiliency will not be negatively impacted by the standards being adopted in this final rule.

ACCA expressed concern that a landlord will not see a return on their cost for a more expensive but higher efficiency furnace. ACCA argued that landlords will likely turn to alternative heating options resulting in increased monthly utility bills for their tenants and additional safety concerns. (ACCA, No. 398 at p. 3) DOE notes that this comment is not specific to the low-income subgroup. In the main LCC results, the product switching analysis includes examples of households experiencing higher operating costs after switching to lower cost electric alternatives. The product switching analysis only considers alternative options that meet all safety requirements.

Joint Efficiency Commenters stated that there are other energy efficiency programs that can help offset the costs of switching to a higher-efficiency gas furnace or electric heating system, adding that there are particular programs for low- and moderate-income households. These commenters further stated that these types of programs would reduce the number of low-income consumers that may be disproportionately impacted by the proposed standard. (Joint Efficiency Commenters, No. 381 at p. 3)

NCLC *et al.* commented that with passage of the Inflation Reduction Act, Public Law 117–169, there will be funding to help consumers install efficient heating products, as well as assistance from rebate and subsidy programs offered by many State agencies and utility companies. Furthermore, NCLC *et al.* agreed that there will often be programs available for mitigating the cost impact of purchasing and installing efficient furnaces, particularly for low-income households. (NCLC *et al.,* No. 383 at p. 7)

In response, DOE acknowledges that rebate and incentive programs may assist low-income owner households with the purchase of more-efficient consumer furnaces. However, as discussed in section IV.G of this document, the implementation details of such future programs remain unknown at the time of the analysis, and DOE did not include them in its analysis. However, DOE notes that if such programs were to be deployed after the compliance date of an amended standard, the consumer benefits of the amended standards would be even higher. If such programs were implemented prior to the compliance date of an amended standard, incentivizing low-income households to adopt more efficient furnaces, such households would no longer be impacted by the amended standard.

NCLC *et al.* commented that the proposed TSL 8 standard will significantly reduce greenhouse gas and other emissions, adding that this reduction will benefit low-income households and racial minorities. (NCLC *et al.,* No. 383 at p. 7) DOE agrees with this comment.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of amended energy conservation standards on manufacturers of NWGFs and MHGFs and to estimate the potential impacts of such standards on domestic employment, manufacturing capacity, and cumulative regulatory burden for those manufacturers. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA includes analyses of projected industry cash flows, 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 manufacturing capacity and competition, as well as how standards contribute to manufacturers' overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM),[254] 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 the INPV, which is the sum of industry annual cash flows over 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 manufacturing employment between the no-new-standards case and the various standards cases (*i.e.,* TSLs). To capture the uncertainty relating to manufacturer pricing strategies following amended standards, the GRIM estimates a range of possible impacts under different markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics

[254] 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.*

and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative regulatory burden impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the final rule TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the NWGF and MHGF manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly-available information. This included a top-down cost analysis of NWGF and MHGF manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (SG&A); R&D expenses; and tax rates). DOE also used public sources of information to further calibrate its initial characterization of the NWGF and MHGF manufacturing industry, including company filings of form 10–K from the SEC,[255] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* (*ASM*),[256] and prior NWGF and MHGF rulemakings, as well as subscription-based market research tools (*i.e.,* reports from Dun & Bradstreet[257]).

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of new or amended energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the compliance date of the standard. 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) creating a need for increased investment; (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes.

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of NWGF and MHGF in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the anticipated effects of amended energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and manufacturer subgroup impacts.

In Phase 3 of the MIA, DOE's contractor conducted structured, detailed interviews with representative NWGF and MHGF manufacturers. These interviews discussed 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. As part of Phase 3, DOE also 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. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers, niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average, all of whom could be more negatively affected by amended energy conservation standards. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B, ''Review Under the Regulatory Flexibility Act,'' of this document and in chapter 12 of the final rule 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 that result in a higher or lower INPV for the standards cases as compared to the no-new-standards case. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, manufacturer markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the base year of the analysis) and continuing to 2058 (the terminal year of the analysis). DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of NWGFs and MHGFs, DOE used a real discount rate of 6.4 percent, which was derived from industry corporate annual reports and public filings to the Securities and Exchange Commission (SEC 10–Ks) and then modified according to feedback received during manufacturer interviews.

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.

The GRIM results are presented in section V.B.2 of this document. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient products is typically more expensive than manufacturing baseline products due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the shipments, revenue, gross margins, and cash flow of the industry. 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* section IV.C of this document or chapter 5 of the final rule TSD.

b. Shipments Projections

The GRIM estimates industry revenues based on total unit shipment projections and the distribution of those shipments by efficiency level and product class. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2023 (the base year) to 2058 (the end year of the analysis period). In the shipments analysis, DOE estimates the distribution of efficiencies

[255] 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 August 1, 2023).

[256] U.S. Census Bureau's Annual Survey of Manufactures: 2018–2021 (available at: *www.census.gov/programs-surveys/asm/data/tables.html*) (last accessed August 1, 2023).

[257] The Dun & Bradstreet Hoovers subscription login is accessible online at: *app.dnbhoovers.com/login* (last accessed August 1, 2023).

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 amended energy conservation standard is assumed to be unaffected by that 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 final rule 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 needed to comply with each considered 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 costs manufacturers would likely incur to comply with amended 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 were 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. Once again, manufacturer data were aggregated to better reflect the industry as a whole and to protect confidential information.

DOE adjusted the conversion cost estimates developed in support of the July 2022 NOPR to 2022$ for this analysis. Industry conversion costs for the adopted standard total $162.0 million. It consists of $117.3 million in capital conversion costs and $44.8 million in product conversion costs.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. For additional information on the estimated capital and product conversion costs, see chapter 12 of the final rule TSD.

d. Manufacturer Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied manufacturer markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case scenarios to represent 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; and (2) a tiered scenario.[258] These scenarios lead to different manufacturer 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 manufacturer 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.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform ''gross margin percentage'' markup across all efficiency levels, which assumes that following amended standards, manufacturers would be able to maintain the same amount of profit as a percentage of revenues 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 percent for NWGFs and 21.3 percent for MHGF.[259] 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.

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

[258] DOE analyzed the preservation of per-unit operating profit scenario for the proposed standby mode and off mode standards in the July 2022 NOPR. DOE is not analyzing the preservation of per-unit operating profit scenario for this final rule, as DOE is not adopting the standby mode/off mode power standards for NWGFs/MHGFs proposed in the July 2022 NOPR at this time.

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

situation in which amended standards result in a reduction of product differentiation, compression of the markup tiers, and an overall reduction in profitability.

A comparison of industry financial impacts under the two scenarios is presented in section V.B.2.a of this document.

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 in 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 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 final rule TSD. The analysis presented in this document uses projections from *AEO2023.* Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the Environmental Protection Agency (EPA).[260]

The on-site operation of the subject 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.[261]

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 final rule TSD.

The emissions intensity factors are expressed in terms of physical units per MWh or 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.

GHHI stated that the reductions in nitrous oxide emissions will create more than $21 billion in health benefits from reduced medical spending on treatment and improved economic productivity. (GHHI, No. 371 at p. 2)

NCLC *et al.* commented that reducing the combustion of natural gas in furnaces would reduce emissions of CO_2, nitrogen oxides, and methane, which in turn would yield health benefits. NCLC *et al.* further commented that these benefits are important for low-income communities and racial minorities, stating that these groups already experience higher rates of negative health outcomes, have limited healthcare access, and struggle with higher amounts of medical debt. These commenters added that the reduction of heating-energy bills would further benefit low-income households who are forced to cut back on other necessities to pay energy bills. (NCLC *et al.,* No. 383 at p. 8)

Climate and Health Coalition expressed support for the eventual elimination of gas use within the home, and during the transition, Climate and Health Coalition stated that DOE's proposed rule would reduce pollutants that harm human health, reduce climate change emissions, and save all customers (including disadvantaged and low-income communities) money. (Climate and Health Coalition, No. 399 at p. 1) Climate and Health Coalition further commented that exposure to air pollutants caused by burning natural gas contributes to premature mortality and increased risk for illness, including ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), lung cancer, heart attack, type-2 diabetes, headache, fatigue, unconsciousness, lower-respiratory infections, and even death. (Climate and Health Coalition, No. 399 at pp. 1–3) Additionally, these commenters stated that there is a growing body of evidence showing an association between long-term exposure to air pollution and adverse birth outcomes. (Climate and Health Coalition, No. 399 at pp. 1–2) Furthermore, Climate and Health Coalition stated that air pollution can exacerbate asthma and cardiopulmonary symptoms, are associated with upper respiratory infections and cough, increase lower respiratory tract illnesses, and reduce lung function in children. (Climate and Health Coalition, No. 399 at pp. 2–3)

In response, DOE acknowledges the potential health and climate benefits of reducing emissions and continues to estimate site and power plant emissions reductions for CO_2, CH_4, N_2O, NO_X, SO_2, and Hg in this final rule.

APGA expressed concerned that DOE's assumed fuel sulfur content leads to overstatements of SO_2 emissions from on-site operation of furnaces, especially as utilities across the country can have much less total sulfur in their gas and still meet odorant requirements. (APGA, No. 387 at pp. 29–30)

DOE acknowledges that there is some uncertainty in the sulfur content of fuel. However, the resulting site emission reductions of SO_2 are over an order of magnitude smaller than the corresponding increases in SO_2 emissions due to increased electricity consumption in the amended standards case, and, therefore, any changes to the sulfur content assumptions would have very little impact on overall results and would not alter DOE's evaluation of economic justification.

APGA noted that EPA is in the process of promulgating regulations to impose a methane fee (*i.e.,* a charge on methane emissions from the petroleum and natural gas sector, where methane emissions from an applicable facility (upstream of gas distribution) exceed a pre-determined waste emissions threshold). APGA argued that given that such a fee would reduce methane emissions, DOE's estimates are likely overstated and must be recalculated to account for the impact of EPA's new methane fee. (APGA, No. 387 at p. 30)

In response, DOE notes that its estimates of emissions reductions, including methane, are based on various projections from the latest *AEO. AEO'*s methodology incorporates all regulations affecting the energy sector, if they are finalized. If a rule is proposed but not yet finalized, it will not be incorporated into the reference case of *AEO,* as it may ultimately differ from its proposed rule (or not be finalized). Should EPA finalize a regulation regarding a methane fee, it will be incorporated into future publications of *AEO. AEO2023* does not incorporate this regulation. DOE notes that, even if methane emissions were lower than estimated in this final rule, the

[260] Available at: *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed August 1, 2023).

[261] 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#Proposed/*) (last accessed August 1, 2023).

Department's conclusions regarding economic justification and technological feasibility of the rule would be the same.

Spencer and Dayaratna cited a report from the U.S. Environmental Protection Agency indicating that U.S. air quality has been improving for decades, suggesting that this weakens DOE's finding that the air quality benefits associated with DOE's proposal would outweigh the costs. (Spencer and Dayaratna, No. 390 at pp. 5–6)

In response, DOE notes that this assertion is incorrect. DOE acknowledges that air quality is generally improving, but this would occur in the no-new-standards case as well as the new-standards-case. DOE's analysis specifically considers the difference between the two cases (*i.e.,* emissions reductions from an energy conservation standard on consumer furnaces only). This difference between the no-new-standards and new-standards cases is the same regardless of the background air quality. Furthermore, DOE incorporates projections from *AEO* with respect to the fuel mix of future electricity generation, which includes a greater fraction of renewable sources with no emissions. Therefore, improving emissions from the power sector are included in DOE's analysis.

Atmos Energy commented that DOE's analysis should differentiate between the carbon dioxide emissions from natural gas-fueled and propane-fueled furnaces and evaluate them separately. (Atmos Energy, No. 415 at p. 7)

DOE acknowledges that propane and natural gas have different carbon dioxide emissions. However, this difference is orders of magnitude smaller than the total emissions reductions estimated in the analysis. Furthermore, as discussed in section V.C of this document, DOE comes to the same conclusions with or without taking into consideration the impact of emissions reductions, and, therefore, any adjustments to the emissions analysis for propane would not change DOE's conclusions.

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2023* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2023,* including the emissions control programs discussed in the following paragraphs.[262]

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 (August 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[263] *AEO2023* 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). 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, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by 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. In order to continue operating, coal 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 will generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2023*.

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, NO_X emissions would remain near the limit even if electricity generation goes down. Depending on the configuration of the power sector in the different regions and the need for allowances, however, NO_X emissions might not remain at the limit in the case of lower electricity demand. That would mean that standards might reduce NO_X 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.[264] DOE used *AEO2023* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

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 *AEO2023,* which incorporates the MATS.

L. Monetizing Emissions Impacts

As part of the development of this final rule, for the purpose of complying with the requirements of Executive

[262] For further information, see the Assumptions to *AEO2023* 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 August 1, 2023).

[263] 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 published a supplemental rule in the **Federal Register** that included an additional five States in the CSAPR ozone season program, 76 FR 80760 (Dec. 27, 2011).

[264] See footnote 246.

Order 12866, DOE considered the estimated net monetary benefits from changes in 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 final rule.

1. Monetization of Greenhouse Gas Emissions

To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.[265]

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the social cost (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 final rule in the absence of the social cost of greenhouse gases. That is, the social costs of greenhouse gases, whether measured using the February 2021 interim estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases or by another means, did not affect the rule ultimately being adopted by DOE.

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC–GHGs) using SC–GHG values that were based on the interim values 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. 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, 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 a 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, which included 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.*[266] 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).[267] Shortly thereafter, 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-

[265] See *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf* (last accessed August 1, 2023).

[266] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold, and A. Wolverton. Incremental CH_4 and N_2O mitigation benefits consistent with the U.S. Government's SC–CO_2 estimates. *Climate Policy* (2015) 15(2): pp. 272–298.

[267] National Academies of Sciences, Engineering, and Medicine. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.* 2017. The National Academies Press: Washington, DC.

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 rulemaking. 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 omitted effects 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, as well as 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 final rule DOE centers attention on a global measure of the 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,[268] 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 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.

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

[268] Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866* (2010) United States Government (last accessed August 1, 2023) (available at: *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf*); 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) (78 FR 70586) (last accessed August 1, 2023) (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*); 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) (last accessed August 1, 2023) (available at: *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf*); 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 (last accessed August 1, 2023) (available at: *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf*).

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 the above 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 were 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.[269] 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 final rule are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section V.B of this document.

A number of commenters expressed concern over DOE's estimates of the SC–GHG, as discussed in the paragraphs that follow.

The Joint Market and Consumer Organizations argued that climate change considerations do not play a role under EPCA and that DOE should not use the IWG SC–GHGs analysis to calculate net regulatory benefits. The commenters claimed that climate change is mentioned nowhere in EPCA's detailed instructions to DOE on how to set and amend appliance efficiency standards. They suggest that DOE acted extra-statutorily by relying on Executive Order 13990 to account for greenhouse gas emissions in their net benefit analysis. (Joint Market and Consumer Organizations, No. 373 at p. 6) The commenters also question how DOE attempted to calculate the net benefits, claiming the SC–GHG is too speculative and subjective, and that it is too easily manipulated to be weighed in the same scales with the near-term consumer costs of the proposed standards. They claimed the IWG estimates are biased due to reliance on overheated climate models, inflated emission scenarios, and pessimistic adaptation assumptions. These commenters concluded that using biased SC–GHG estimates to estimate net benefits is arbitrary and capricious. (*Id.* at pp. 3, 7–10) They also claimed, even if the IWG's methodology were not biased in multiple ways, that DOE's finding that the furnace efficiency standards will deliver the estimated climate benefits would be unlikely. (*Id.* at p. 11)

APGA asserted that flaws in the interim SC–GHG values could lead to miscalculations in monetary benefits from the proposed rule for NWGFs and MHGFs. APGA claimed that the process used by the IWG to develop the estimates was inconsistent with the Administrative Procedure Act, failed to fully consider recommendations from a related National Academies of Sciences, Engineering, and Medicine review, and did not follow current Office of Management and Budget bulletins and circulars, each of which is intended to ensure the underlying data used to develop the SC–GHGs are based on the best available science and economics. Accordingly, APGA asserted that failure to ensure that these procedural shortcomings are fully addressed before applying any SC–GHG estimates in a final rule will result in inappropriately calculated and, thus, misapplied values. APGA argued that DOE's speculative projections regarding emission reductions benefits should not be part of any final rule. (APGA, No. 387 at pp. 31–32)

Spencer and Dayaratna stated that the SC–GHGs obscures regulatory costs. These commenters referenced studies exploring the sensitivity of assessment models to changes in assumptions, which they said could make such models prone to user manipulation. Additionally, Spencer and Dayaratna stated that accurately accounting for costs and benefits, even those that do

[269] 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 August 1, 2023).

not impact DOE's final decision (such as the SC–GHGs), is important for providing transparency. The commenters also suggested that DOE's use of the SC–GHGs creates bias and is misleading. (Spencer and Dayaratna, No. 390 at pp. 6–8)

The Associations urged DOE to reconsider the use of the SC–GHGs estimates in this rulemaking based on three core concerns. First, these commenters argued that before DOE considers applying the SC–GHG estimates to the proposed rule (and, likewise, to any final rule resulting from this rulemaking), the SC–GHG estimates should be subject to a proper administrative process, including a full and fair public comment process, as well as a robust independent peer review. Second, these commenters argued that there are statutory limitations on using the SC–GHG estimates, and the Associations urged DOE to fully consider the applicable limits before applying those estimates. Third, the Associations urged DOE to carefully consider whether the ''major questions'' doctrine precludes the application of the SC–GHG estimates in the proposed rule, given the political and economic significance of the estimates. (The Associations, No. 392 at p. 2)

In response, DOE first notes that it would reach the same conclusion presented in this final rule in the absence of the social cost of greenhouse gases. DOE notes that, as stated in section III.F.1.f of this document, DOE maintains that environmental and public health benefits associated with the more efficient use of energy, including those connected to global climate change, are important to take into account when considering the ''need for national energy . . . conservation,'' which is one of the factors that EPCA requires DOE to evaluate in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)); *Zero Zone, Inc.* v. *United States DOE,* 832 F.3d 654, 677 (7th Cir. 2016) (pointing to 42 U.S.C. 6295(o)(2)(B)(i)(VI) in concluding that ''[w]e have no doubt that Congress intended that DOE have the authority under the EPCA to consider the reduction in SCC.'') DOE has been analyzing the monetized emissions impacts from its rules, for over 10 years. In addition, Executive Order 13563, ''Improving Regulation and Regulatory Review,'' which was re-affirmed on January 20, 2021, states that each agency, among other things, must, to the extent permitted by law: ''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).'' E.O. 13563, section 1(b). Furthermore, as noted previously, E.O. 13990, ''Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,'' 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. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, 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. For these reasons, DOE includes monetized emissions reductions in its evaluation of potential standard levels. Finally, DOE notes that the ''major questions'' doctrine raised by the Associations applies only in ''extraordinary cases'' concerning Federal agencies claiming highly consequential regulatory authority beyond what Congress could reasonably be understood to have granted. *West Virginia* v. *EPA,* 142 S. Ct. 2587, 2609 (2022); *N.C. Coastal Fisheries Reform Grp.* v. *Capt. Gaston LLC,* 2023 U.S. App. LEXIS 20325, *6–8 (4th Cir., Aug. 7, 2023) (listing the hallmarks courts have recognized to invoke the major questions doctrine, such as a hesitancy ''to recognize new-found powers in old statutes against a backdrop of an agency failing to invoke them previously,'' ''when the asserted power raises federalism concerns,'' or ''when the asserted authority falls outside the agency's traditional expertise, . . . or is found in an 'ancillary provision.' ''). DOE has clear authorization under EPCA to regulate the energy efficiency or energy use of a variety of consumer products, including the subject furnaces. Although DOE routinely conducts an analysis of the anticipated emissions impacts of potential energy conservation standards under consideration, *see, e.g., Zero Zone,* 832 F.3d at 677, DOE does not purport to regulate such emissions, and as stated elsewhere in this document, DOE's selection of standards would be the same without consideration of emissions. Where DOE applied the factors it was tasked to consider under EPCA and the rule is justified even absent use of the SC–GHG analysis, the major questions doctrine has no bearing.

In contrast to the commenters on this topic discussed previously, The Climate Commenters stated that DOE appropriately applies the social cost estimates developed by the IWG on the SC–GHGs to its analysis of emissions reduction benefits generated by the proposed rule for NWGFs and MHGFs. These commenters stated that DOE should expand upon its rationale for adopting a global damages valuation and for the range of discount rates it applies to climate effects, as there are additional legal, economic, and policy reasons for such methodological decisions that can further bolster and support DOE's rationale for these choices. These commenters added that DOE should consider conducting sensitivity analysis using a sound domestic-only social cost estimate as a backstop, and the Department should explicitly conclude that the rule is cost-benefit justified even using a domestic-only valuation that may still undercount climate benefits. These commenters also urged DOE to consider providing additional sensitivity analysis using discount rates lower than two percent for climate impacts. (The Climate Commenters, No. 388 at pp. 1–3)

In response, DOE maintains that the reasons for using global measures of the SC–GHG previously discussed are sufficient for the purposes of this rulemaking. DOE notes that further discussion of this topic is contained in the February 2021 SC–GHG TSD, and DOE agrees with the assessment therein. Regarding conducting sensitivity analysis using a domestic-only social cost estimate, climate change harms U.S. interests both domestically and abroad through (1) impacts within U.S. borders; (2) impacts outside U.S. borders that affect the welfare of U.S. citizens and residents; and (3) spillover impacts of climate actions elsewhere on U.S. interests. Focusing on climate impacts occurring solely within U.S. borders, as commenters suggest, would ''underestimate'' benefits of greenhouse-gas mitigation for U.S. citizens and residents and ignore the reality that a Nation's interests extend beyond its borders. See *Zero Zone, Inc.* v. *U.S. Dep't of Energy,* 832 F.3d 654, 678–79 (7th Cir. 2016) (upholding consideration of global impacts in climate analysis). DOE also agrees with the assessment in the February 2021 SC–GHG TSD that the only currently available quantitative characterization of domestic damages from GHG emissions is both incomplete and an underestimate of the share of total damages that accrue to the citizens and residents of the United States.

Therefore, it would be of questionable value to conduct the suggested sensitivity analysis at this time. DOE considered performing sensitivity analysis using discount rates lower than two percent for climate impacts, as suggested by the IWG, but it concluded that such analysis would not add meaningful information or impact the rationale in the context of this rulemaking.

The Climate Commenters further stated that DOE should provide additional justification for combining climate effects discounted at an appropriate consumption-based discount rate, with other costs and benefits discounted at a capital-based rate (*i.e.,* 7 percent). (The Climate Commenters, No. 388 at p. 2)

In response, DOE notes that the reasons for using consumption-based discount rates for future climate effects were discussed previously and are further elaborated in the February 2021 SC–GHG TSD. Combining climate benefits with health benefits and consumer economic benefits is in keeping with the guidance of OMB Circular A–4 to count all significant costs and benefits. DOE is aware that there are different approaches to combining climate benefits with other cost and benefits estimates that may use different discount rates, and the approach applied in this document (as well as in numerous other past DOE rulemaking notices) is among those discussed in the National Academies 2017 report (p. 182).[270]

Finally, The Climate Commenters recommend that DOE should clearly state that any criticisms of the social cost of greenhouse gases are moot in this rulemaking, because the proposed rule is easily cost-justified without any climate benefits. (The Climate Commenters, No. 388 at p. 3)

In response, DOE acknowledges that its conclusions regarding economic justification and technological feasibility would be the same without including climate benefits. When those benefits are accounted for, the justification becomes stronger still.

PHCC commented that it is a mistake to include the estimated social and health cost in the rulemaking because they are currently under litigation, which could affect the rule's viability. (PHCC, No. 403 at p. 5)

In response, DOE notes that on April 5, 2023, the Fifth Circuit Court of Appeals (No. 22–30087) ruled that the plaintiffs lacked standing, dismissed the case for lack of jurisdiction, and vacated the February 11, 2022, preliminary injunction issued by the District Court in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized greenhouse gas abatement benefits where appropriate and permissible under law.

Furthermore, DOE bases its factors on the best available estimates for both climate and health benefits. The commenter did not provide any alternative data sources for DOE's consideration, and, therefore, DOE has maintained its current approach from the NOPR for this final rule.

a. Social Cost of Carbon

The SC–CO_2 values used for this final rule were based on the values developed for the IWG's February 2021 TSD, which are shown in Table IV.14 in five-year increments from 2020 to 2050. DOE notes that it has exercised its discretion in adopting the IWG's estimates, and as previously stated, DOE finds 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 set of annual values that DOE used, which was adapted from estimates published by EPA,[271] is presented in appendix 14A of the final rule TSD. These estimates are based on methods, assumptions, and parameters identical to the estimates published by the IWG (which were based on EPA modeling), and include values for 2051 to 2070. DOE expects additional climate benefits to accrue for products still operating after 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.

TABLE IV.14—ANNUAL SC–CO_2 VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per metric ton CO_2]

Year	Discount rate and statistic			
	5% Average	3% Average	2.5% Average	3% 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

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. DOE adjusted the values to 2022$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. 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 of the final rule TSD for the annual emissions reduction and *see also* appendix 14A of the final rule TSD for the annual SC–CO_2 values.

[270] National Academies of Sciences, Engineering, and Medicine. Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide. 2017. The National Academies Press: Washington, DC. (Available at: *https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of*) (last accessed August 1, 2023).

[271] *See* EPA, Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis, Washington, DC, December 2021. Available at *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed August 1, 2023).

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this final rule were based on the values developed for the February 2021 TSD. DOE notes that it has exercised its discretion in adopting the IWG's estimates, and as previously stated, DOE finds 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. Table IV.16 shows the updated sets of SC–CH_4 and SC–N_2O estimates from the latest interagency update in five-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the final rule 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 previously for the SC–CO_2.

TABLE IV.16—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% Average	3% Average	2.5% Average	3% 95th percentile	5% Average	3% Average	2.5% Average	3% 95th percentile
2020	670	1,500	2,000	3,900	5,800	18,000	27,000	48,000
2025	800	1,700	2,200	4,500	6,800	21,000	30,000	54,000
2030	940	2,000	2,500	5,200	7,800	23,000	33,000	60,000
2035	1,100	2,200	2,800	6,000	9,000	25,000	36,000	67,000
2040	1,300	2,500	3,100	6,700	10,000	28,000	39,000	74,000
2045	1,500	2,800	3,500	7,500	12,000	30,000	42,000	81,000
2050	1,700	3,100	3,800	8,200	13,000	33,000	45,000	88,000

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. DOE adjusted the values to 2022$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. 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 of the final rule TSD for the annual emissions reduction, and see also appendix 14A of the final rule TSD for the annual SC–CH_4 and SC–N_2O values.

2. Monetization of Other Emissions Impacts

For the final rule, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[272] 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, 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 range; for years beyond 2040, the values are held constant. DOE combined the EPA regional benefit-per-ton estimates with regional information on electricity consumption and emissions from *AEO2023* to define weighted-average national values for NO_X and SO_2 (see appendix 14B of the final rule 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.[273] The EPA document provides high and low estimates for 2025 and 2030 at 3- and 7-percent discount rates.[274] 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.

GHHI stated that increasing furnace efficiency will have direct health benefits for American families, particularly in low-income and vulnerable communities. GHHI explained that fossil fuel burning furnaces release pollutants that can affect indoor air quality, including nitrogen oxides, carbon monoxide, $PM_{2.5}$, and formaldehyde, all of which are associated with asthma, cardiovascular disease, birth defects, and even death. (GHHI, No. 371 at p. 1) In addition, GHHI stated that hazardous air conditions in dense cities have led to disproportionately higher rates of chronic conditions such as heart disease and respiratory disease in low-income and Black and Brown communities. (*Id.*)

GHHI also commented that older unsafe systems can lead to carbon monoxide leaks. GHHI stated that 450 Americans are killed annually from these leaks, disproportionately effecting Hispanic and black populations. (GHHI, Public Meeting Webinar Transcript, No. 363 at pp. 15–16) GHHI commented that low-income homes are twice as likely to use a gas stove or oven for heating, which results in higher indoor pollution and increased rick of fire-related death and injury. (*Id.*) According to GHHI, access to more-efficient furnaces may help to prevent these hazards, and that

[272] 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 August 1, 2023).

[273] ''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.

[274] ''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/sourceapportionmentbpttsd_2018.pdf* (last accessed August 1, 2023).

increasing furnace standards will directly benefit low-income communities and people of color. (*Id.*)

The Pennsylvania Groups stated that inefficient and faulty furnaces expose household members to unsafe levels of indoor air pollution. These commenters further stated that families living in homes with polluted air frequently experience more hospital visits, with causes ranging from cardiovascular disease, heart attacks, asthma attacks, and premature death, among others. Moreover, the Pennsylvania Groups stated, that individuals exposed to indoor air pollution have increased COVID–19 infection incidences, hospitalizations, and deaths. (The Pennsylvania Groups, No. 396 at p. 3)

Climate and Health Coalition commented that although gas furnaces are vented outside, that does not prevent back drafting of these pollutants back into the home when indoor air pressure is reduced due to kitchen exhaust hoods or bathroom ventilation fans. Additionally, Climate and Health Coalition stated that venting pollutants outdoors can cause community-wide harm, particularly among low-income communities and communities of color who are already saddled with increased levels of ambient air pollution. (Climate and Health Coalition, No. 399 at p. 1)

Climate and Health Coalition stated that gas heating appliances account for about two-thirds of household gas use and related emissions. The commenter added that nearly half of U.S. homes are heated with gas or propane furnaces. Additionally, Climate and Health Coalition commented that many homes use inefficient furnaces, which cause excess methane, carbon dioxide, and nitrogen dioxide emissions into the indoor and outdoor environment. (Climate and Health Coalition, No. 399 at p. 1) Climate and Health Coalition further mentioned that uncombusted methane gas, which can leak into homes, was found to contain varying levels of at least 21 different hazardous pollutants that are undetectable by smell. Additionally, Climate and Health Coalition stated that methane is a potent greenhouse gas that drives health harms related to climate change. (Climate and Health Coalition, No. 399 at p. 2)

In response, DOE has not quantitatively assessed the health benefits of reducing in-home exposure to particulate matter, nitrogen dioxide, and other hazardous air pollutants. DOE acknowledges that in-home emissions may carry different health risks than the risks assumed in the monetized health benefits calculations. Such in-home emissions may be associated with a variety of serious respiratory and cardiovascular conditions and other health risks. Not all the public health and environmental benefits from the reduction of greenhouse gases, NO_X, and SO_2 are captured in the values reflected in DOE's analysis, and there may be additional unquantified benefits from the reductions of those pollutants, as well as from the reduction of Hg, direct PM, and other co-pollutants. However, DOE assumes in its analysis that furnaces will be installed by licensed professionals and that all appropriate safety standards will be met, including indoor air pollutant exposure. DOE further assumes that a properly ventilated furnace will not result in any significant in-home emissions and, therefore, does not estimate any additional health benefits from reducing in-home emissions. Furnaces are not simple appliances that are purchased in stores and installed by average consumers. They require licensed gas plumbers and experienced contractors to properly size and install a system, especially in new construction. It is highly unlikely that an unlicensed individual, with little knowledge of gas plumbing, would install a furnace. However, DOE does account for site emissions that are vented outdoors and includes those emissions in its analysis.

GHHI stated that the improved furnace efficiency standards would reduce use of dangerous heating methods. The commenter stated that low-income, energy insecure homes are twice as likely to use a gas stove or oven as a supplemental method to generate heat when money is short. Furthermore, GHHI stated that these practices often lead to levels of indoor pollution that are above what is recommended by public health guidelines, and accordingly, are a main risk factor for pediatric asthma. The commenter continued that children under age 6 in homes that use a gas stove or oven for heat are 80 percent more likely to have asthma than children in other homes. Additionally, GHHI commented that families that use a gas stove or oven as supplementary heat are also at an increased risk of fire-related death and injury. (GHHI, No. 371 at p. 2)

In response, DOE is not aware of any data supporting the claim that the amended standards would increase the use of gas stoves being used to supplement heating from a furnace, and accordingly, the Department has not included any emissions impact of supplemental heating in the analysis for this rule.

M. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2023*. 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 *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the final rule 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.

The utility analysis also estimates the impact on gas utilities in terms of projected changes in natural gas deliveries to consumers for each TSL.

APGA commented that DOE's procedures state: ''The analysis of utility impacts will include estimated marginal impacts on electric and gas utility costs and revenues.'' According to APGA, DOE contends that ''rate decoupling'' insulates gas utilities' revenues from change resulting from the actions by the Department in this proceeding. APGA pointed out that rate decoupling is not a factor in most States and that few of its over 730 members employ rate decoupling. Furthermore, APGA argued that rate decoupling does not insulate retail customers from higher rates, as fixed costs are spread across reduced volumes due to fuel switching that would be caused by the elimination of non-condensing furnaces. The commenter recommended that DOE should conduct better sensitivity analyses based on the fuel switching that its own analysis shows will occur, as well as the fuel switching that will occur if the DOE analysis is corrected as APGA has suggested. (APGA, No. 387 at p. 58)

AGA similarly asserted that DOE's Process Rule requires the Department's utility impact analysis to ''include estimated marginal impacts on electric and gas utility costs and revenues.''

According to AGA, the analysis presented in the NOPR is insufficient. Consequently, AGA argued that DOE should conduct a complete impact analysis that quantifies and evaluates the marginal impacts to gas utility costs and revenues of a reduction in gas deliveries due to fuel switching driven by the proposed rule. In addition, AGA stated that DOE should evaluate whether the loss of demand for natural gas local distribution companies could lead to higher rates on remaining consumers in order to cover fixed distribution costs. (AGA, No. 405 at pp. 107–108)

In response, DOE acknowledges that rate decoupling does not apply to all utilities, but for those utilities that are subject to rate decoupling, changes in natural gas deliveries will not impact revenues. Analysis of the impact of standards on rates is very difficult, given the diversity of regulatory structures in the U.S. and the many factors that go into setting utility rates. DOE notes that the Process Rule is non-binding and is intended to guide DOE in the consideration and promulgation of new or revised appliance energy conservation standards and test procedures. The analyses it describes are not necessarily those that are needed to meet EPCA's requirements for evaluating the economic justification of potential new or amended standards. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) Nevertheless, DOE includes an estimate of impacts on gas utility deliveries as part of the utility impact analysis in chapter 15 of the final rule TSD, in addition to estimates of impacts to installed capacity and generation for electric utilities. DOE notes that the impacts on gas deliveries does include the effects of product switching.

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.[275] 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 final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (ImSET).[276] 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 that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, 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 final rule 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 adopting in this final rule. Additional details regarding DOE's analyses are contained in the TSD supporting this final rule.

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 standard levels are set. For the subject 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 final rule, DOE analyzed the consumer impacts of four efficiency levels for NWGFs, four efficiency levels for MHGFs, and the national impacts of

[275] *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: *https://www.bea.gov/resources/methodologies/RIMSII-user-guide*) (last accessed August 1, 2023).

[276] 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.

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 amended standard would remain at the current efficiency level of 80-percent AFUE. Because the impact of a potential standard on different consumers can depend on the region of the country, for one of these six cases, DOE considered a regional TSL such that the amended standard would remain at an efficiency level of 80-percent AFUE outside the Northern region. For other TSLs (three cases), DOE examined a national standard level for NWGFs and MHGFs not differentiated by input capacity. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the final rule 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 (98-percent AFUE) and MHGFs (96-percent AFUE) and represents the maximum energy savings possible among the specific efficiency levels analyzed by DOE (see section IV.C.1 of this final rule). 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. Similar 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%.

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.10 of this document.

Inputs used for calculating the LCC and PBP include total 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 final rule 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 Tables V.2 and V.3 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.10 of this document, DOE also conducted sensitivity analyses using no-switching, high, and low switching estimates. See appendix 8J of the final rule TSD for more details. For the adopted standards (TSL 8), the total switching and repair vs. replace is 6.8 percent for NWGFs and 4.8 percent for MHGFs.

TABLE V.2—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	99.4	99.2	98.5	98.4	98.1	93.2	98.1	93.2	89.2
Switch to Heat Pump *	0.1	0.2	0.7	0.8	1.0	4.1	1.0	4.2	7.3
Switch to Electric Furnace *	0.1	0.1	0.2	0.1	0.2	0.8	0.2	0.8	1.2
Repair vs. Replacing	0.4	0.5	0.6	0.8	0.7	1.9	0.7	1.8	2.3
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.3—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	100.0	99.9	99.7	99.0	99.6	95.4	99.6	95.2	90.2
Switch to Heat Pump	0.0	0.0	0.1	0.6	0.2	2.4	0.2	2.6	2.3
Switch to Electric Furnace	0.0	0.0	0.1	0.1	0.1	1.4	0.1	1.5	1.5
Repair vs. Replacing	0.0	0.0	0.1	0.4	0.1	0.7	0.1	0.7	6.0
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.

Tables V.4 through V.7 show the LCC and PBP results for the TSLs considered for each product class. 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.8 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 final rule TSD. LCC Results for the alternative product switching scenarios are reported in appendix 8J of the final rule 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.4—AVERAGE LCC AND PBP RESULTS FOR NON-WEATHERIZED GAS FURNACES

TSL	AFUE (%)	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	92/80 *	3,733	578	9,300	13,033	6.4	21.5
2	92/80 *	3,786	571	9,173	12,959	6.6	21.5
3	92/80 *	3,810	568	9,114	12,924	6.7	21.5

TABLE V.4—AVERAGE LCC AND PBP RESULTS FOR NON-WEATHERIZED GAS FURNACES—Continued

TSL	AFUE (%)	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
4	95/80 **	3,832	566	9,075	12,907	7.0	21.5
5	92/80 *	3,835	566	9,077	12,912	7.0	21.5
6	92 †	3,947	563	8,958	12,905	9.4	21.5
7	95/80 *	3,845	556	8,924	12,769	5.8	21.5
8	95 †	3,962	552	8,788	12,750	7.6	21.5
9	98 (Max-Tech) †	4,156	545	8,620	12,776	10.1	21.5

* The first number refers to the standard for large NWGFs; the second refers to the standard for small NWGFs. The input capacity threshold definitions for small NWGFs are as follows:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 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.5—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR NON-WEATHERIZED GAS FURNACES

TSL	AFUE (%)	Life-cycle cost savings	
		Average LCC savings (2022$)	Percentage of consumers that experience net cost (%)
1	92/80 *	577	3.2
2	92/80 *	571	4.7
3	92/80 *	580	5.8
4	95/80 **	390	5.6
5	92/80 *	551	6.8
6	92 †	320	19.2
7	95/80 *	479	6.8
8	95 †	350	18.7
9	98 (Max-Tech) †	169	62.3

* 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.6—AVERAGE LCC AND PBP RESULTS FOR MOBILE HOME GAS FURNACES

TSL	AFUE (%)	Average costs (2022$)				Simple payback (years)	Average lifetime (years)
		Installed cost	First year's operating cost	Lifetime operating cost	LCC		
1	92/80 *	2,429	545	9,126	11,556	2.2	21.5
2	92/80 *	2,484	525	8,804	11,288	2.5	21.5
3	92/80 *	2,499	518	8,709	11,209	2.5	21.5
4	95/80 **	2,510	513	8,577	11,087	2.4	21.5
5	92/80 *	2,514	515	8,647	11,161	2.6	21.5
6	92 †	2,564	511	8,547	11,111	3.6	21.5
7	95/80 *	2,528	505	8,492	11,020	2.4	21.5
8	95 †	2,583	500	8,374	10,956	3.2	21.5
9	96 (Max-Tech) †	2,592	517	8,312	10,904	4.8	21.5

* 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.7—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR MOBILE HOME GAS FURNACES

TSL	AFUE (%)	Life-cycle cost savings	
		Average LCC savings (2022$)	Percentage of consumers that experience net cost (%)
1	92/80 *	846	0.6
2	92/80 *	805	2.5
3	92/80 *	736	3.7
4	95/80 **	908	3.9
5	92/80 *	675	5.0
6	92 †	532	16.2
7	95/80 *	760	5.0
8	95 †	616	15.3
9	96 (Max-Tech) †	529	18.6

* 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 savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households, senior-only households, and small businesses (for NWGF only). Tables V.8 and V.9 compare the average LCC savings 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 percentage 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 final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.8—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS FOR NON-WEATHERIZED GAS FURNACES

TSL	Average LCC savings (2022$)				Simple payback period (years)				% of consumers experiencing net cost (%)			
	Low-income	Senior-only	Small business	All	Low-income	Senior-only	Small business	All	Low-Income	Senior-only	Small business	All
1 *	332	354	767	577	2.9	6.2	1.0	6.4	2.0	2.6	3.5	3.2
2 *	384	394	457	571	2.6	5.8	2.2	6.6	2.6	3.6	8.2	4.7
3 *	383	402	689	580	2.4	5.8	2.3	6.7	3.4	4.3	8.9	5.8
4 **	277	160	298	390	1.7	6.2	1.5	7.0	4.0	4.7	2.5	5.6
5 *	392	387	630	551	2.5	6.0	2.2	7.0	4.8	5.7	10.4	6.8
6 †	207	321	402	320	3.0	7.1	2.4	9.4	15.4	16.5	16.1	19.2
7 *	372	250	626	479	2.0	5.0	1.9	5.8	5.7	5.5	8.7	6.8
8 †	254	254	460	350	2.5	6.0	2.1	7.6	15.9	15.5	13.7	18.7
9 †	153	412	269	169	3.4	7.6	3.1	10.1	39.7	54.0	58.0	62.3

* 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.9—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS FOR MOBILE HOME GAS FURNACES

TSL	Average LCC savings (2022$)			Simple payback period (years)			% of consumers experiencing net cost (%)		
	Low-income	Senior-only	All	Low-income	Senior-only	All	Low-income	Senior-only	All
1 *	1,175	697	846	1.2	2.0	2.2	0.1	0.4	0.6
2 *	1055	865	805	1.4	2.0	2.5	1.0	3.2	2.5
3 *	888	820	736	1.4	2.0	2.5	2.2	3.9	3.7
4 **	931	764	908	1.0	1.1	2.4	3.6	3.4	3.9
5 *	699	702	675	1.5	2.2	2.6	4.6	6.7	5.0
6 †	472	546	532	2.0	3.0	3.6	15.9	19.1	16.2
7 *	775	648	760	1.3	2.1	2.4	4.7	6.9	5.0
8 †	552	537	616	1.8	2.7	3.2	15.3	19.2	15.3
9 †	476	1,493	529	2.7	3.7	4.8	18.0	21.7	18.6

* 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.F.2 of this document, 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 of this document were calculated using distributions that reflect the range of energy use in the field.

Table V.10 present the rebuttable-presumption payback periods for the considered TSLs for NWGFs and MHGFs. The payback periods for most NWGF and MHGF TSLs do not meet the rebuttable-presumption criterion. While DOE examined the rebuttable-presumption criterion, it determined 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.10—REBUTTABLE-PRESUMPTION PAYBACK PERIODS (YEARS) FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACES

TSL	Non-weatherized gas furnaces	Mobile home gas furnaces
1 *	2.64	1.52
2 *	2.86	1.62
3 *	2.94	1.68
4 **	1.03	0.54
5 *	3.06	1.69
6 †	3.20	1.80
7 *	2.92	1.56
8 †	3.05	1.63
9 †	3.67	1.67

* Refers to TSLs with separate standards for small and large NWGFs and MHGFs. The input capacity threshold definitions for small NWGFs and 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.

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 final rule 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.11 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 two manufacturer markup scenarios that correspond to the range of anticipated market responses to amended standards. DOE modeled a preservation of gross margin percentage markup scenario and a tiered 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 (2023) 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 percent for NWGFs and 21.3 percent for MHGFs.[277] 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 will be able to maintain the same gross margin percentage. DOE has determined 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 manufacturer 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.

Table V.11 presents the financial impacts of the analyzed 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.11—MANUFACTURER IMPACT ANALYSIS RESULTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

	Units	No-new-standards case	TSL 1	TSL 2	TSL 3	TSL 4
INPV	*2022$ millions*	1,371.8	1,263.7 to 1,351.3	1,226.3 to 1,345.3	1,207.2 to 1,337.0	1,088.7 to 1,342.5
Change in INPV	*2022$ millions*		(107.8) to (20.5)	(145.3) to (26.5)	(164.3) to (34.9)	(282.8) to (29.4)
	%		(7.9) to (1.5)	(10.6) to (1.9)	(12.0) to (2.5)	(20.6) to (2.1)
Free Cash Flow (2028)	*2022$ millions*	84.6	60.3	53.8	50.7	38.4
Change in Free Cash Flow (2028).	%		(28.8)	(36.4)	(40.1)	(54.6)
Product Conversion Costs.	*2022$ millions*		28.8	28.8	28.8	44.8
Capital Conversion Costs	*2022$ millions*		31.6	46.0	52.9	67.7
Total Investment Required.	*2022$ millions*		60.4	74.8	81.7	112.5
	Units	**TSL 5**	**TSL 6**	**TSL 7**	**TSL 8**	**TSL 9**
INPV	*2022$ millions*	1,199.6 to 1,341.4	1,201.0 to 1,337.9	1,014.8 to 1,339.1	1,004.2 to 1,338.0	702.8 to 1,352.7
Change in INPV	*2022$ millions*	(172.0) to (30.4)	(170.5) to (34.0)	(356.8) to (32.7)	(367.3) to (33.8)	(668.7) to (19.1)
	%	(12.5) to (2.2)	(12.4) to (2.5)	(26.0) to (2.4)	(26.8) to (2.5)	(48.7) to (1.4)
Free Cash Flow (2028)	*2022$ millions*	47.9	40.1	28.0	16.1	(54.4)

[277] The gross margin percentage values correspond to manufacturer markups of 1.34 for NWGFs and 1.27 for MHGFs.

TABLE V.11—MANUFACTURER IMPACT ANALYSIS RESULTS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES—Continued

	Units	No-new-standards case	TSL 1	TSL 2	TSL 3	TSL 4
	Units	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Change in Free Cash Flow (2028).	%	(43.4)	(52.6)	(66.9)	(81.0)	(164.3)
Product Conversion Costs.	*2022$ millions*	28.8	28.8	44.8	44.8	86.8
Capital Conversion Costs	*2022$ millions*	59.2	76.4	90.8	117.3	241.1
Total Investment Required.	*2022$ millions*	87.9	105.2	135.6	162.0	328.0

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. Tables V.12 and V.13 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.

TABLE V.12—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	45.4	69.5	81.1	100.0	92.5	100.0	92.5	100.0	100.0
Small	54.6	30.5	18.9	0.0	7.5	0.0	7.5	0.0	0.0

TABLE V.13—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	18.9	61.1	76.0	100.0	89.4	100.0	89.4	100.0	100.0
Small	81.1	38.9	24.0	0.0	10.6	0.0	10.6	0.0	0.0

TSL 1, TSL 2, TSL 3, and TSL 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 $28.8 million in product conversion costs to develop such models at each of TSL 1, TSL 2, TSL 3, and TSL 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 AFUE for NWGFs and 96-percent AFUE 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 −$107.8 million to −$20.5 million, or a change of −7.9 percent to −1.5 percent. At this level, industry free cash flow in 2028 (the year before the compliance date) is estimated to decrease to $60.3 million, or a decrease of 28.8 percent compared to the no-new-standards case value of $84.6 million.

Small furnaces with input capacities of 80 kBtu/h or less account for approximately 54.6 percent of NWGF shipments and 81.1 percent of MHGF shipments in 2028, a year before the standard goes into effect. In the no-new-standards case, approximately 60.6 percent of NWGF shipments and 33.3 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 70.0 percent of NWGF shipments and 44.2 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 $31.6 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 $60.4 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 −$145.3 million to −$26.5 million, or a change in INPV of −10.6 percent to −1.9 percent. At this level, free cash flow in 2028 is estimated to decrease to $53.8 million, or a decrease of 36.4 percent compared to the no-new-standards-case value of $84.6 million in the year 2028.

Small furnaces with input capacities of 70 kBtu/h or less account for approximately 30.5 percent of NWGF shipments and 38.9 percent of MHGF shipments in the year before standards go into effect. At TSL 2, once the standard goes into effect, DOE expects 75.2 percent of NWGF shipments and 66.1 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 $31.6 million at TSL 1 to $46.0 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 $74.8 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 −$164.3 million to −$34.9 million, or a change in INPV of −12.0 percent to −2.5 percent. At this level, free cash flow is estimated to decrease to $50.7 million, or a decrease of 40.1 percent compared to the no-new-standards case value of $84.6 million in the year 2028.

Small furnaces with input capacities of 60 kBtu/h or less account for approximately 18.9 percent of NWGF shipments and 24.0 percent of MHGF shipments in the year before standards take effect. At TSL 3, once standards go into effect, DOE expects 78.6 percent of NWGF shipments and 75.3 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 $46.0 million at TSL 2 to $52.9 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 $81.7 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 −$282.8 million to −$29.4 million, or a change in INPV of −20.6 percent to −2.1 percent. At this level, free cash flow is estimated to decrease to $38.4 million, or a decrease of 54.6 percent compared to the no-new-standards case value of $84.6 million in the year 2028.

In the year before the standard goes into effect, DOE expects that the North region will account for approximately 58.8 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 74.7 percent of NWGFs and 74.5 percent of MHGFs would be sold at condensing levels in 2029. Capital conversion costs are expected to reach $67.7 million as manufacturers increase secondary heat exchanger production line capacity. Product conversion costs reach $44.8 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 $112.5 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 −$172.0 million to −$30.4 million, or a change in INPV of −12.5 percent to −2.2 percent. At this level, free cash flow is estimated to decrease to $47.9 million, or a decrease of 43.4 percent compared to the no-new-standards case value of $84.6 million in the year 2028.

Small furnaces with input capacities of 55 kBtu/h or less account for approximately 7.5 percent of NWGFs and 10.6 percent of MHGFs in the year before the standard goes into effect. At TSL 5, 81.5 percent of NWGF shipments and 82.4 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 $52.9 million at TSL 3, the previous TSL with a separate standard level for small furnaces, to $59.2 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 $87.9 million at TSL 5.

TSL 6, TSL 8, and TSL 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 TSL 6 to TSL 8 to TSL 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. As previously noted, TSL 6 does not have a small furnace capacity threshold. At this level, DOE estimates the change in INPV to range from −$170.5 million to −$34.0 million, or a change in INPV of −12.4 percent to −2.5 percent. At this level, free cash flow is estimated to decrease to $40.1 million, or a decrease of 52.6 percent compared to the no-new-standards case value of $84.6 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 $28.8 million at TSL 6, as manufacturers develop 92-percent AFUE furnaces that are competitive at reduced markups. Capital conversion costs would total $76.4 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 $105.2 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 −$356.8 million to −$32.7 million, or a change in INPV of −26.0 percent to −2.4 percent. At this level, free cash flow is estimated to decrease to $28.0 million, or a decrease of 66.9 percent compared to the no-new-standards case value of $84.6 million in the year 2028.

Small furnaces with input capacities of 55 kBtu/h or less account for approximately 7.5 percent of NWGF shipments and 10.6 percent of MHGF shipments before the standard goes into effect. At this level, 81.5 percent of NWGF shipments and 82.4 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 $90.8 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 $44.8 million, driven by the development necessary to create compliant, cost-competitive products. Total conversion costs could reach $135.6 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 −$367.3 million to −$33.8 million, or a change in INPV of −26.8 percent to −2.5 percent. At this level, free cash flow is estimated to decrease to $16.1 million, or a decrease of 81.0 percent compared to the no-new-standards case value of $84.6 million in the year 2028.

DOE estimates that approximately 41.6 percent of the annual NWGF shipments and approximately 19.5 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 $117.3 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 $44.8 million, as manufacturers develop a cost-optimized 95-percent AFUE for NWGF and MHGF models that are competitive at reduced markups. Total industry conversion costs could reach $162.0 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 −$668.7 million to −$19.1 million, or a change in INPV of −48.7 percent to −1.4 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 1.4 percent of NWGFs and 0.9 percent of MHGFs are sold at this level today. Manufacturers would incur $86.8 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 $241.1 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 $328.0 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.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the NWGF and MHGF industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. DOE calculated these values using the most up-to-date statistical data from the U.S. Census Bureau's 2021 *ASM*,[278] the U.S. Bureau of Labor Statistics' (''BLS'') employee compensation data,[279] 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 for Pay Period, 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.

The number of 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. Consistent with the July 2022 NOPR, 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.[280] DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking.

Non-production workers account for the remainder of the direct employment figure. The non-production employees cover 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-new-standards case and standards cases.

Using the GRIM, DOE estimates that in the absence of new energy conservation standards, there would be 1,470 domestic production and non-production workers for NWGFs and MHGFs in 2029. Table V.14 shows the range of the impacts of potential amended energy conservation standards on U.S. manufacturing employment in the NWGF and MHGF industry. The discussion below provides a qualitative evaluation of the range of potential impacts presented in the table.

TABLE V.14—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).	1,470	435 to 1,514	453 to 1,532	451 to 1,530	487 to 1,566.
Potential Changes in Direct Employment Workers in 2029 *.		(1,079) to 44	(1,079) to 62	(1,079) to 60	(1,079) to 96.

[278] U.S. Census Bureau's Annual Survey of Manufactures: 2018–2021 (available at *www.census.gov/programs-surveys/asm/data/tables.html*) (last accessed March 21, 2023).

[279] U.S. Bureau of Labor Statistics, *Employer Costs for Employee Compensation* (March 17, 2023) (available at: *www.bls.gov/news.release/pdf/ecec.pdf*) (last accessed March 21, 2023).

[280] The comprehensive description of production and non-production workers is available online at: *www2.census.gov/programs-surveys/asm/technical-documentation/questionnaire/2021/instructions/MA_10000_Instructions.pdf,* ''Definitions and Instructions for the Annual Survey of Manufacturers, MA–10000'' (pp. 13–14). (Last accessed June 1, 2023).

TABLE V.14—POTENTIAL CHANGES IN THE TOTAL NUMBER OF NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE PRODUCTION AND NON-PRODUCTION WORKERS IN 2029—Continued

	Trial standard level				
	No-new-standards case	TSL 1	TSL 2	TSL 3	TSL 4
	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Direct employment in 2029 (Production Workers + Non-Production Workers).	473 to 1,552	470 to 1,549	547 to 1,626	571 to 1,650	549 to 1,628.
Potential Changes in Direct Employment Workers in 2029 *.	(1,079) to 82	(1,079) to 79	(1,079) to 156	(1,079) to 180	(1,079) to 158.

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative values.

The direct employment impacts shown in Table V.14 represent the potential domestic employment changes that could result following the compliance date of the amended standards for NWGFs and MHGFs. 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 all production moved to lower labor-cost countries or if domestic 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.

Additional detail on the analysis of direct employment can be found in chapter 12 of the final rule 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 final rule 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 five-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 to increase the capacity of production lines that meet required efficiency levels at TSL 1 through TSL 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. However, because TSL 8 (the adopted level) would not require max-tech efficiencies, DOE does not expect manufacturers to face long-term capacity constraints due to the standard levels detailed in this final rule.

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 final rule as part of the Regulatory Flexibility Analysis. In summary, the Small Business Administration (SBA) defines a ''small business'' as having 1,250 employees or less for North American Industry Classification System (''NAICS'') code 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 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 final rule and chapter 12 of the final rule 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.15 presents the DOE energy conservation standards that would impact manufacturers of

NWGF and MHGF products in the 2026 to 2032 timeframe.

TABLE V.15—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 by this rule**	Approx. standards compliance year	Industry conversion costs (millions)	Industry conversion costs/product revenue*** (%)
Consumer Clothes Dryers † 87 FR 51734 (August 23, 2022)	15	1	2027	$149.7 (2020$)	1.8
Residential Clothes Washers † 88 FR 13520 (March 3, 2023)	19	1	2027	$690.8 (2021$)	5.2
Refrigerators, Freezers, and Refrigerator-Freezers † 88 FR 12452 (February 27, 2023)	49	1	2027	$1,323.6 (2021$)	3.8
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	2	2026	$24.8 (2021$)	0.4
Miscellaneous Refrigeration Products † 88 FR 19382 (March 31, 2023)	38	1	2029	$126.9 (2021$)	3.1
Dishwashers † 88 FR 32514 (May 19, 2023)	22	1	2027	$125.6 (2021$)	2.1
Consumer Water Heaters † 88 FR 49058 (July 28, 2023)	22	3	2030	$228.1 (2022$)	1.3
Consumer Pool Heaters 88 FR 34624 (May 30, 2023)	20	1	2028	$48.4 (2021$)	1.5
Commercial Water Heating Equipment ‡	15	3	2026	$42.7 (2022$)	5.3
Consumer Boilers † 88 FR 55128 (August 14, 2023)	24	4	2030	$98.0 (2022$)	3.6
Walk-in Coolers and Freezers † 88 FR 60746 (September 5, 2023)	79	4	2027	$89.0 (2022$)	0.8
Microwave Ovens 88 FR 39912 (June 20, 2023)	18	1	2026	$46.1 (2021$)	0.7

* This column presents the total number of OEMs identified in the energy conservation standard rule that is 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 that is 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 energy conservation standard. The conversion period typically ranges from three to five years, depending on the rulemaking.

† These rulemakings are at the NOPR stage, and all values are subject to change until finalized through publication of a final rule.

‡ At the time of issuance of this consumer furnaces final rule, the commercial water heating equipment energy conservation standards final rule has been issued but not yet published in the **Federal Register**. Once published, the commercial water heating equipment final rule will be available at: *www.regulations.gov/docket/EERE-2021-BT-STD-0027.*

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 standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for NWGFs and MHGFs, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2029–2058). Table V.16 presents DOE's projections of the national energy savings for each TSL considered for NWGFs and MHGFs. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.16—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES; 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	1.33	1.81	2.06	2.60	2.24	3.00	3.09	3.98	5.17
	MHGF	0.02	0.07	0.08	0.11	0.09	0.10	0.12	0.13	0.15
	Total	1.35	1.88	2.14	2.72	2.34	3.10	3.21	4.11	5.32
FFC Energy	NWGF	1.49	2.04	2.33	2.97	2.54	3.51	3.50	4.62	6.10
	MHGF	0.03	0.08	0.09	0.13	0.10	0.12	0.14	0.15	0.17
	Total	1.52	2.11	2.42	3.10	2.65	3.63	3.63	4.77	6.26

For the adopted standards (TSL 8), the FFC energy savings of 4.77 quads are the FFC natural gas savings minus the increase in FFC energy use associated with higher electricity use due primarily to some consumers switching to electric heating.

The results reflect the use of the reference product switching scenario and repair vs. replace trend for NWGFs and MHGFs (as described in sections IV.F.10 and IV.F.11 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 final rule TSD.

OMB Circular A–4 [281] 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.[282] 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 for standards. The impacts are counted over the lifetime of NWGFs and MHGFs purchased in 2029–2037.

TABLE V.17—CUMULATIVE NATIONAL ENERGY SAVINGS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES; 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	0.35	0.50	0.57	0.69	0.62	0.85	0.87	1.14	1.56
	MHGF	0.01	0.02	0.03	0.04	0.03	0.04	0.04	0.05	0.05
	Total	0.36	0.52	0.60	0.73	0.65	0.89	0.91	1.19	1.62
FFC Energy	NWGF	0.40	0.56	0.64	0.79	0.70	1.00	0.98	1.33	1.85
	MHGF	0.01	0.03	0.03	0.05	0.04	0.04	0.05	0.05	0.06
	Total	0.41	0.58	0.68	0.84	0.74	1.04	1.03	1.38	1.91

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,[283] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.18 shows the consumer NPV results for standards with impacts counted over the lifetime of products purchased in 2029–2058.

TABLE V.18—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES; 30 YEARS OF SHIPMENTS (2029–2058)

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		(billion 2022$)								
7 percent	NWGF	1.25	1.85	2.14	2.76	2.43	2.90	3.70	4.41	3.60
	MHGF	0.06	0.19	0.24	0.35	0.27	0.29	0.36	0.40	0.44
	Total	1.31	2.04	2.38	3.11	2.70	3.20	4.06	4.81	4.04
3 percent	NWGF	4.31	6.21	7.20	9.05	8.18	11.06	11.76	15.28	16.03
	MHGF	0.17	0.50	0.63	0.92	0.71	0.78	0.94	1.06	1.17
	Total	4.48	6.71	7.83	9.97	8.88	11.84	12.70	16.34	17.21

These results reflect the use of the default product switching trend for NWGFs (as described in section IV.F.10 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

[281] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) (available at: *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/*) (last accessed August 1, 2023).

[282] 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.

[283] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) (available at: *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/*) (last accessed August 1, 2023).

presented in appendix 10 E of the final rule TSD.

The NPV results for standards based on the aforementioned 9-year analytical period are presented in Table V.19. 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.19—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE STANDARDS; 9 YEARS OF SHIPMENTS (2029–2037)

Energy savings	Product class	Trial standard level								
		1	2	3	4	5	6	7	8	9
		(billion 2022$)								
7 percent	NWGF	0.57	0.90	1.06	1.48	1.19	1.43	1.99	2.41	2.01
	MHGF	0.04	0.11	0.15	0.21	0.16	0.18	0.22	0.24	0.27
	Total	0.61	1.01	1.21	1.69	1.36	1.62	2.20	2.65	2.28
3 percent	NWGF	1.46	2.21	2.62	3.49	2.94	3.93	4.60	5.97	6.37
	MHGF	0.08	0.24	0.30	0.44	0.34	0.38	0.45	0.50	0.56
	Total	1.53	2.45	2.92	3.92	3.28	4.31	5.05	6.47	6.92

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.1 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 final rule 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 adopted 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 final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section III.F.1.d of this document, DOE has concluded that the standards adopted in this final rule 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 adopted 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.F.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 provided DOJ with copies of the proposed rule and the accompanying TSD for review. DOE considered DOJ's comments on the proposed rule in determining whether to proceed to a final rule. DOE is publishing and responds to DOJ's comments in this final rule.

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 final rule 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.20 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The increase in emissions of SO_2 and Hg 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. 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 final rule TSD.

TABLE V.20—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 and Site Emissions									
CO_2 (*million metric tons*)	75	106	125	173	139	234	189	290	413
CH_4 (*thousand tons*)	1.5	2.0	2.3	2.9	2.5	3.1	3.4	4.2	5.2
N_2O (*thousand tons*)	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
NO_X (*thousand tons*)	67	95	112	157	124	218	169	268	385
SO_2 (*thousand tons*)	(0)	(1)	(1)	(4)	(2)	(10)	(2)	(10)	(19)
Hg (*tons*)	(0.00)	(0.01)	(0.01)	(0.03)	(0.02)	(0.08)	(0.02)	(0.08)	(0.15)
Upstream Emissions									
CO_2 (*million metric tons*)	11	15	18	25	20	34	27	42	59
CH_4 (*thousand tons*)	1,080	1,528	1,801	2,519	2,005	3,473	2,725	4,282	6,139
N_2O (*thousand tons*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
NO_X (*thousand tons*)	167	237	279	389	310	534	422	660	944
SO_2 (*thousand tons*)	0.04	0.05	0.05	0.04	0.05	(0.01)	0.08	0.02	(0.04)
Hg (*tons*)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total FFC Emissions									
CO_2 (*million metric tons*)	86	121	142	197	158	268	215	332	472
CH_4 (*thousand tons*)	1,082	1,531	1,803	2,522	2,007	3,476	2,728	4,286	6,144
N_2O (*thousand tons*)	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4
NO_X (*thousand tons*)	234	331	390	546	435	752	591	928	1329
SO_2 (*thousand tons*)	(0)	(1)	(1)	(4)	(2)	(10)	(2)	(10)	(19)
Hg (*tons*)	(0.00)	(0.01)	(0.01)	(0.03)	(0.02)	(0.08)	(0.02)	(0.08)	(0.15)

Note: Negative values (shown in parentheses) refer to an increase in emissions.

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.21 presents the present value of the CO_2 emissions reduction at each TSL.

TABLE V.21—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 2022$)			
1	676	3,059	4,860	9,253
2	965	4,357	6,917	13,181
3	1,137	5,130	8,142	15,522
4	1,543	6,989	11,104	21,139
5	1,266	5,709	9,060	17,274
6	2,165	9,735	15,433	29,464
7	1,721	7,767	12,327	23,500
8	2,684	12,076	19,149	36,550
9	3,857	17,311	27,429	52,406

As discussed in section IV.L.1.b of this document, DOE estimated monetary benefits likely to result from the reduced emissions of methane (CH_4) and N_2O that DOE estimated for each of the considered TSLs for furnaces. Table V.22 presents the value of the CH_4 emissions reduction at each TSL, and Table V.23 presents the value of the N_2O emissions reduction at each TSL.

TABLE V.22—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 2022$)			
1	403	1,284	1,817	3,395
2	576	1,829	2,588	4,838
3	681	2,160	3,054	5,712
4	935	2,976	4,213	7,872
5	760	2,408	3,405	6,370
6	1,333	4,199	5,930	11,108
7	1,032	3,271	4,626	8,652
8	1,641	5,177	7,314	13,695
9	2,378	7,473	10,549	19,771

TABLE V.23—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 2022$)			
1	0.5	2.0	3.2	5.4
2	0.7	2.8	4.4	7.5
3	0.7	3.1	4.9	8.4
4	0.8	3.6	5.7	9.7
5	0.8	3.4	5.3	9.0
6	0.8	3.3	5.2	8.8
7	1.1	4.7	7.4	12.6
8	1.1	4.9	7.7	13.1
9	1.3	5.5	8.7	14.7

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 adopted standards are economically justified even without inclusion of monetized benefits of reduced GHG emissions.

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.24 shows the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates. This table presents results that use the low benefit-per-ton values, which reflect DOE's primary estimate.

TABLE V.24—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 2022$)	
1	2,195	6,868
2	3,157	9,777
3	3,735	11,520
4	5,031	15,773
5	4,164	12,822
6	7,251	21,994
7	5,651	17,432
8	8,950	27,227

TABLE V.24—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 2022$)	
9	12,980	39,089

Note: Results are based on the low benefit-per-ton values.

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.25 presents the present value of SO_2 emission changes for each TSL calculated using 7-percent and 3-percent discount rates. This table presents results that use the low benefit-per-ton values, which reflect DOE's primary estimate.

TABLE V.25—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 2022$)	
1	(7)	(20)
2	(15)	(44)
3	(28)	(81)
4	(76)	(226)
5	(39)	(112)
6	(214)	(608)
7	(43)	(131)
8	(214)	(616)
9	(401)	(1,142)

Note: Parentheses indicate negative (−) values.

The benefits of reduced CO_2, CH_4, and N_2O emissions are collectively referred to as ''climate benefits.'' The effects 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 final rule 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.26 presents the NPV values that result from adding the monetized estimates of the potential economic, climate, and health net benefits resulting from GHG, NO_X, and SO_2 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.26—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 2022$)									
5% d.r., Average SC–GHG case	12.4	18.0	21.1	28.0	23.6	36.7	32.8	47.3	61.4
3% d.r., Average SC–GHG case	15.7	22.6	26.6	35.5	29.7	47.2	41.0	60.2	79.9
2.5% d.r., Average SC–GHG case	18.0	26.0	30.5	40.8	34.1	54.6	47.0	69.4	93.1
3% d.r., 95th-percentile SC–GHG case	24.0	34.5	40.5	54.5	45.2	73.8	62.2	93.2	127.3
7% discount rate for NPV of Consumer and Health Benefits (billion 2022$)									
5% d.r., Average SC–GHG case	4.6	6.7	7.9	10.5	8.8	13.7	12.4	17.9	22.9
3% d.r., Average SC–GHG case	7.8	11.4	13.4	18.0	14.9	24.2	20.7	30.8	41.4
2.5% d.r., Average SC–GHG case	10.2	14.7	17.3	23.4	19.3	31.6	26.6	40.0	54.6
3% d.r., 95th-percentile SC–GHG case	16.2	23.2	27.3	37.1	30.5	50.8	41.8	63.8	88.8

Note: ''d.r.'' means discount rate.

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 final rule, DOE considered the impacts of amended standards for NWGFs and MHGFs at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of: (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forgo the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers or increases consumer use of energy, such as through a rebound rate, 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 final rule 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.[284]

1. Benefits and Burdens of TSLs Considered for Non-Weatherized Gas Furnaces and Mobile Home Gas Furnaces

Tables V.27 and V.28 summarize the quantitative impacts estimated for each 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.

TABLE V.27—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE 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	1.52	2.11	2.42	3.10	2.65	3.63	3.63	4.77	6.26
Cumulative FFC Emissions Reduction (total FFC emission)									
CO_2 (*million metric tons*)	86	121	142	197	158	268	215	332	472
CH_4 (*thousand tons*)	1,082	1,531	1,803	2,522	2,007	3,476	2,728	4,286	6,144
N_2O (*thousand tons*)	0.16	0.22	0.24	0.28	0.26	0.26	0.36	0.38	0.43
NO_X (*thousand tons*)	234	331	390	546	435	752	591	928	1,329
SO_2 (*thousand tons*)	(0)	(1)	(1)	(4)	(2)	(10)	(2)	(10)	(19)
Hg (*tons*)	(0.00)	(0.01)	(0.01)	(0.03)	(0.02)	(0.08)	(0.02)	(0.08)	(0.15)
Present Value of Benefits and Costs (3% discount rate, billion 2022$)									
Consumer Operating Cost Savings	6.3	9.3	10.9	13.9	12.4	18.8	17.3	24.8	32.8
Climate Benefits *	4.3	6.2	7.3	10.0	8.1	13.9	11.0	17.3	24.8
Health Benefits **	6.8	9.7	11.4	15.5	12.7	21.4	17.3	26.6	37.9
Total Benefits †	17.4	25.2	29.7	39.4	33.2	54.1	45.6	68.7	95.5
Consumer Incremental Product Costs ‡	1.8	2.5	3.1	3.9	3.5	7.0	4.6	8.5	15.6
Consumer Net Benefits	4.5	6.7	7.8	10.0	8.9	11.8	12.7	16.3	17.2
Total Net Benefits	15.7	22.6	26.6	35.5	29.7	47.2	41.0	60.2	79.9

[284] 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 August 1, 2023).

TABLE V.27—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE TSLS: NATIONAL IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Present Value of Benefits and Costs (7% discount rate, billions 2022$)									
Consumer Operating Cost Savings	2.3	3.4	4.1	5.1	4.6	7.0	6.4	9.3	12.5
Climate Benefits *	4.3	6.2	7.3	10.0	8.1	13.9	11.0	17.3	24.8
Health Benefits **	2.2	3.1	3.7	5.0	4.1	7.0	5.6	8.7	12.6
Total Benefits †	8.8	12.7	15.1	20.1	16.8	28.0	23.1	35.3	49.8
Consumer Incremental Product Costs ‡	1.0	1.4	1.7	2.0	1.9	3.8	2.4	4.5	8.4
Consumer Net Benefits	1.3	2.0	2.4	3.1	2.7	3.2	4.1	4.8	4.0
Total Net Benefits	7.8	11.4	13.4	18.0	14.9	24.2	20.7	30.8	41.4

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. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** 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.

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

TABLE V.28—SUMMARY OF ANALYTICAL RESULTS FOR NON-WEATHERIZED GAS FURNACE AND MOBILE HOME GAS FURNACE 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 2022$*) (No-new-standards case INPV = 1,371.8).	1,264.0 to 1,351.3.	1,226.7 to 1,345.3.	1,207.5 to 1,337.0.	1,089.0 to 1,342.5.	1,199.9 to 1,341.4.	1,201.3 to 1,337.9.	1,015.1 to 1,339.1.	1,004.6 to 1,338.0.	703.1 to 1,352.7
Industry NPV (*% change*)	(7.9) to (1.5)	(10.6) to (1.9).	(12.0) to (2.5).	(20.6) to (2.1).	(12.5) to (2.2).	(12.4) to (2.5)	(26.0) to (2.4).	(26.8) to (2.5).	(48.7) to (1.4)
Consumer Average LCC Savings (2022$)									
NWGF	577	571	580	390	551	320	479	350	169
MHGF	846	805	736	908	675	532	760	616	529
Shipment-Weighted Average *.	583	580	587	406	557	327	487	357	176
Consumer Simple PBP (years)									
NWGF	6.4	6.6	6.7	7.0	7.0	9.4	5.8	7.6	10.1
MHGF	2.2	2.5	2.5	2.4	2.6	3.6	2.4	3.2	4.8
Shipment-Weighted Average *.	6.4	6.5	6.6	6.9	7.0	9.2	5.7	7.5	10.0
Percentage of Consumers That Experience a Net Cost									
NWGF	3.2	4.7	5.8	5.6	6.8	19.2	6.8	18.7	62.3
MHGF	0.6	2.5	3.7	3.9	5.0	16.2	5.0	15.3	18.6
Shipment-Weighted Average *.	3.1	4.6	5.8	5.6	6.8	19.2	6.8	18.7	61.4

Note: Parentheses indicate negative (−) values.

* Weighted by shares of each product class in total projected shipments in 2029.

DOE first considered the 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 6.26 quads of energy, an amount DOE considers significant. Under TSL 9, the NPV of consumer benefit would be $4.0 billion using a discount rate of 7 percent, and $17.2 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 9 are 472 Mt of CO_2, 6.1 million tons of CH_4, 0.4 thousand tons of N_2O, and 1.3 million tons of NO_X. Projected emissions show an increase of 19 thousand tons of SO_2 and 0.15 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces by some consumers 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 $24.8 billion. The estimated monetary value of the net health benefits from changes to NO_X and SO_2 emissions at TSL 9 is $12.6 billion using a 7-percent discount rate and $37.9 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, net 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 $41.4 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 9 is $79.9 billion.

At TSL 9, the average LCC impact on affected consumers is a savings of $169 for NWGFs and $529 for MHGFs. The simple payback period is 10.1 years for NWGFs and 4.8 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 62.3 percent for NWGFs and 18.3 percent for MHGFs. The fraction of low-income consumers experiencing a net LCC cost is 39.7 percent for NWGFs and 18.0 percent for MHGFs.

At TSL 9, the projected changes in INPV range from a decrease of $668.7 million to a decrease of $19.1 million. If the more severe end of this range is realized, TSL 9 could result in a net loss of 48.7 percent in INPV. Industry conversion costs could reach $328.0 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 1.4 percent of NWGF shipments and 0.9 percent of MHGF shipments are currently sold (2023) 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 is 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 concludes that at TSL 9 for NWGFs and MHGFs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the net 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 decision, DOE notes that a large fraction of both NWGF and MHGF consumers (62.3 percent and 18.6 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. DOE also notes the consumer impacts are similar across the range of sensitivity analyses performed, particularly with respect to the fraction of consumers who may switch to alternative space-heating products. A large fraction of NWGF and MHGF consumers in the sensitivity analyses experience a net cost at TSL 9 as well. Therefore, DOE's conclusions would not change if based on any of the sensitivity scenarios. 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 concluded that TSL 9 is not economically justified.

DOE then considered the 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 4.77 quads of energy, an amount DOE considers significant. Under TSL 8, the NPV of consumer benefit would be $4.8 billion using a discount rate of 7 percent, and $16.3 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 8 would be expected to be 332 Mt of CO_2, 4.3 million tons of CH_4, 0.4 thousand tons of N_2O, and 0.9 million tons of NO_X. Projected emissions show an increase of 10 thousand tons of SO_2 and 0.08 tons of Hg. The increase is due to projected switching from gas furnaces to electric heat pumps and electric furnaces by some consumers 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 $17.3 billion. The estimated monetary value of the net health benefits from changes to NO_X and SO_2 emissions at TSL 8 is $8.7 billion using a 7-percent discount rate and $26.6 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, net 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 $30.8 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 8 is $60.2 billion.

At TSL 8, the average LCC impact on affected consumers is a savings of $350 for NWGFs and $616 for MHGFs. The simple payback period is 7.6 years for NWGFs and 3.2 years for MHGFs. The fraction of consumers experiencing a net LCC cost is 18.7 percent for NWGFs and 15.3 percent for MHGFs. The fraction of low-income consumers experiencing a net LCC cost is 15.9 percent for NWGFs and 15.3 percent for MHGFs.

At TSL 8, the projected changes in INPV range from a decrease of $367.3 million to a decrease of $33.8 million. If the more severe end of this range is realized, TSL 8 could result in a net loss of 26.8 percent in INPV. Industry conversion costs would reach $162.0 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 41.6 percent of the annual NWGF shipments and approximately 19.5 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 concluded that a 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 18.7 percent of NWGF consumers and 15.3 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.8 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. DOE also notes the consumer impacts are similar across the range of sensitivity analyses performed, particularly with respect to the fraction of consumers who may switch to alternative space-heating products. A much smaller fraction of NWGF and MHGF consumers in the sensitivity analyses experience a net cost at TSL 8 as compared to TSL 9 as well. Therefore, DOE's conclusions would not change if based on any of the sensitivity scenarios. 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 13 times higher than the maximum estimated manufacturers' loss in INPV. The shipment-weighted average LCC savings are 2 times higher than at TSL 9. The standard levels at TSL 8 are economically justified even without weighing the estimated monetary value of the net health benefits of emissions reductions. When those emissions reductions are included—representing $17.3 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $26.6 billion (using a 3-percent discount rate) or $8.7 billion (using a 7-percent discount rate) in net 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 final rule). The adopted 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 in terms of 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 has relevance to the U.S.

DOE acknowledges that an estimated 15.9 percent of low-income NWGF and 15.3 percent of low-income MHGF consumers experience a net cost at TSL 8, whereas an estimated 5.7 percent of low-income NWGF and 4.7 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 1.14 quads and additional net health benefits of $9.3 billion (using a 3-percent discount rate) or $3.1 billion (using a 7-percent discount rate). The national consumer NPV similarly increases at TSL 8, compared to TSL 7, by $0.7 billion using a 7-percent discount rate and $3.6 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.

Accordingly, the Secretary has 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 adopted 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 concluded they are economically justified, as discussed for TSL 8 in the preceding paragraphs.

Therefore, based on the considerations discussed, DOE adopts the energy conservation standards for NWGFs and MHGFs at TSL 8. The adopted energy conservation standards for NWGFs and MHGFs, which are expressed as AFUE, are shown in Table V.29.

TABLE V.29—ADOPTED 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. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is: (1) the annualized national economic value (expressed in 2022$) of the benefits from operating products that meet the adopted 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 net health benefits from emission reductions.

Table V.30 shows the annualized values under TSL 8, expressed in 2022$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and net 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 adopted standards is $511 million per year in increased equipment costs, while the estimated annual benefits would be $1,054 million in reduced equipment operating costs, $1,021 million in climate benefits, and $987 million in net health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $2,551 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards is $500 million per year in increased equipment costs, while the estimated annual benefits would be $1,467 million in reduced operating costs, $1,021 million in climate benefits, and $1,574 million in net health benefits (accounting for reduced NO_X emissions and increased SO_2 emissions). In this case, the net benefit amounts to $3,561 million per year.

TABLE V.30—ANNUALIZED MONETIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR NON-WEATHERIZED GAS FURNACES AND MOBILE HOME GAS FURNACES

[TSL 8]

	Million 2022$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	1,467	1,528	1,440
Climate Benefits *	1,021	1,003	1,028
Net Health Benefits **	1,574	1,546	1,585
Total Monetized Benefits †	4,061	4,077	4,053
Consumer Incremental Product Costs ‡	500	520	489
Net Monetized Benefits	3,561	3,557	3,564
Change in Producer Cashflow (INPV ‡‡)	(27)–(2)	(27)–(2)	(27)–(2)
7% discount rate			
Consumer Operating Cost Savings	1,054	1,094	1,051
Climate Benefits * (3% discount rate)	1,021	1,003	1,028
Health Benefits **	987	972	994
Total Monetized Benefits †	3,062	3,069	3,073
Consumer Incremental Product Costs ‡	511	528	501
Net Monetized Benefits	2,551	2,541	2,572
Change in Producer Cashflow (INPV ‡‡)	(27)–(2)	(27)–(2)	(27)–(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 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. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** 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 disbenefits 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.

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

‡‡ Operating Cost Savings are calculated based on the LCC analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 6.4 percent that is estimated in the manufacturer impact analysis (see chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For NWGFs and MHGFs, those values are −$27 million to −$2 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table, and the Tiered scenario, where DOE assumed amended standards would result in a reduction of product differentiation and a compression of the markup tiers. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A–4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this final rule, the annualized net benefits would range from $3,534 million to $3,559 million at 3-percent discount rate and would range from $2,524 million to $2,549 million at 7-percent discount rate. Parentheses ( ) indicate negative values.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order (E.O.) 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011), and E.O. 14094, ''Modernizing Regulatory Review,'' 88 FR 21879 (April 11, 2023), 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 this preamble, this final 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 final regulatory action constitutes a ''significant regulatory action'' under section 3(f)(1) of E.O. 12866, as amended by E.O. 14094. 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 final regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this rulemaking.

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) and a final regulatory flexibility analysis (FRFA) 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 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 FRFA 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. Need for, and Objectives of the Rule

DOE is amending the energy conservation 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 six 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 six-year-lookback review.

2. Significant Issues Raised in Response to the IRFA

In response to the July 2022 NOPR, NGA of Georgia stated that DOE's proposal fails to capture the negative effects on small businesses that manufacture venting and accessories for non-condensing furnaces. (NGA of Georgia, No. 380 at p. 2) HARDI commented that the proposed standards also do not meet the requirements under the Regulatory Flexibility Act, as DOE only assessed the impact on four small manufacturers, but not on distributors, contractors, or manufacturers of furnace supplies. HARDI stated that there are a number of small businesses that serve as furnace suppliers. (HARDI, No. 384 at pp. 3–4)

DOE conducted an IRFA in support of the July 2022 NOPR. The Regulatory Flexibility Act requires an agency to perform a regulatory flexibility analysis of small entity impacts only when a rule directly regulates the small entities. This final rule regulates manufacturers of consumer furnaces, and, as such, DOE's analysis is scoped to the original equipment manufacturers (OEMs) of the covered products directly affected by this rulemaking.

3. Description and Estimated Number of Small Entities Affected

DOE reviewed this final 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 Compliance Certification Database (CCD),[285] California Energy Commission's Modernized Appliance Efficiency Database System (MAEDbS),[286] Air Conditioning, Heating, and Refrigeration Institute's (AHRI) Directory of Certified Product Performance database,[287] 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 (*e.g.,* bills of lading from Panjiva[288]), and basic model numbers, to identify 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)[289] 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.

For the IRFA, DOE identified 15 OEMs selling NWGFs and/or MHGFs in the United States. Of those 15 OEMs, DOE tentatively determined that four companies qualified as small businesses and were not foreign-owned or operated. For this FRFA, DOE refreshed its database of model listings to include the most up-to-date information on NWGF and MHGF models currently available on the market. Through its review of the updated product database and other public sources, DOE determined that one MHGF OEM and that one small domestic NWGF OEM no longer offer products covered by this rulemaking. Additionally, DOE identified a new entrant to the NWGF market that qualifies as a "small business." Therefore, for this FRFA, DOE identified 14 OEMs that sell NWGFs and/or MHGFs in the United States. Of the 14 OEMs identified, DOE determined that four companies qualify as small businesses and are not foreign-owned or operated.

4. Description of Compliance Requirements

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 this rule on the four manufacturers.

DOE adjusted the small business conversion cost estimates developed in the IRFA to 2022$ for this FRFA. As previously discussed, DOE also refreshed its database of model listings to include updated information on NWGF and MHGF models currently available on the market.

One of the small NWGF manufacturers ("Company A") 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 standard, as the company currently offers their niche product at 95-percent AFUE.

The other small NWGF manufacturer ("Company B") introduced new products into the CCD after DOE conducted its NOPR analysis. Since the July 2022 NOPR, this small NWGF manufacturer now offers approximately 10 basic models of both non-condensing and condensing NWGFs. The non-condensing models are rated at 81-percent AFUE, and the condensing models are rated between 93-percent and 96-percent AFUE. The non-condensing models and condensing models have identical dimensions and share many components. Given the product similarities, DOE expects this manufacturer would likely ramp up production of its compliant models and discontinue models that do not meet the adopted level. However, to avoid underestimating the potential investments, DOE used model counts to scale industry product conversion costs and market share estimates to scale industry capital conversion costs for this FRFA. As discussed in this final rule, 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

[285] DOE's Compliance Certification Database is available at: *www.regulations.doe.gov/certification-data/* (last accessed March 8, 2023).

[286] California Energy Commission's MAEDbS (available at: *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx*) (last accessed July 15, 2021).

[287] AHRI's Directory of Certified Product Performance (available at: *www.ahridirectory.org/Search/SearchHome*) (last accessed March 8, 2023).

[288] S&P Global. Panjiva Market Intelligence is available at: *panjiva.com/import-export/United-States* (last accessed March 24, 2023).

[289] D&B Hoovers subscription login is available at: *app.dnbhoovers.com/* (last accessed March 24, 2023).

energy conservation standards. The eight NWGF models that would require redesign or retirement is an estimated 1.0 percent of the 825 NWGF models with an AFUE below 95-percent in the product database developed for this rulemaking. DOE estimates that this small business could incur approximately $0.4 million in product conversion costs and $1.1 million in capital conversion costs as they work to develop a condensing NWGF product line. The total conversion costs of $1.6 million are approximately 0.3 percent of company revenues over the 5-year conversion period.[290]

The small MHGF manufacturer, Mortex (''Company C''), sells non-condensing furnaces into the manufactured housing replacement market. DOE identified this small business through its review of DOE's CCD and the withdrawn September 2016 SNOPR. Of the six MHGF OEMs identified, Mortex is the only MHGF company that does not currently offer any condensing products. 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 set up its own manufacturing line to produce secondary heat exchangers. Setting up in-house production is the significantly more capital-intensive option. For this FRFA, DOE estimated the investments required for the company to set up 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 $5.3 million to set up manufacturing of condensing MHGFs. Additionally, the design and product development (*e.g.,* engineering resources, testing costs) 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 $6.7 million are approximately 2.2 percent of company revenues over the 5-year conversion period and are considered significant.[291]

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, on average. Sourcing the heat exchanger could put the company at a pricing disadvantage relative to manufacturers that produce 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 remaining small manufacturer of NWGFs and MHGFs (''Company D'') is one of the five MHGF companies that offer condensing products. Of these five companies with condensing MHGFs, one manufacturer only offers products at or above the adopted standard and would, therefore, likely incur no conversion costs. The remaining four 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 four manufacturers. The small domestic business has six MHGF models that would require redesign or retirement, which is an estimated 14.6 percent of the 41 MHGF models with an AFUE below 95 percent in the product database developed for this rulemaking.

DOE estimated industry conversion costs of $3.1 million for the MHGF standard when excluding the conversion costs attributable to Mortex.[292] For the purposes of this FRFA, DOE assumes the $3.1 million in conversion costs are evenly allocated across the four companies that may incur MHGF conversion costs. The MHGF-related conversion costs are approximately $0.8 million per company. DOE has determined 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.[293]

As noted earlier, this small domestic manufacturer also produces NWGFs. The company offers four NWGF models, out of over 1,300 NWGFs in the product database developed for this rulemaking. All four of their NWGF offerings are at or above the adopted standard and would not likely incur conversion costs due to the 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 adopted standard level.

[290] According to D&B Hoovers, this small business has an estimated annual revenue of $119.8 million. DOE calculated total conversion costs as a percent of revenue over the 5-year conversion period using the following calculation: ($0.4 million + $1.1 million)/(5 years × $119.8 million).

[291] According to D&B Hoovers, this small business has an estimated annual revenue of $60.4 million. DOE calculated total conversion costs as a percent of revenue over the 5-year conversion period using the following calculation: ($1.4 million + $5.3 million)/(5 years × $60.4 million).

[292] Excluding the conversion costs attributable to Mortex, DOE estimates industry MHGF capital conversion costs of $2.6 million and industry MHGF product conversion costs of $0.5 million, for a total of $3.1 million, at the adopted level (TSL 8).

[293] According to D&B Hoovers, this small business has an estimated annual revenue of $240.6 million. DOE calculated total conversion costs as a percent of revenue over the 5-year conversion period using the following calculation: ($0.1 million + $0.6 million)/(5 years × $240.6 million).

TABLE VI.1—ESTIMATED SMALL BUSINESS IMPACTS

[TSL 8]

Company	Product conversion costs ($ millions)	Capital conversion costs ($ millions)	Annual revenue ($ millions)	Conversion period revenue ($ millions)	Conversion costs as a % of conversion period revenue
Company A	0.0	0.0	77.0	385.0	0.0
Company B	0.4	1.1	119.8	599.0	0.3
Company C	1.4	0.0	60.4	302.0	0.5
Company D	0.1	0.6	240.6	1,202.8	0.1

5. Significant Alternatives Considered and Steps Taken To Minimize Significant Economic Impacts on Small Entities

The discussion in the previous section analyzes impacts on small businesses that would result from the adopted standards, represented by TSL 8. In reviewing alternatives to the adopted standards, DOE examined a range of different efficiency levels and their respective impacts to both manufacturers and consumers. 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. However, 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 generally, and multiple orders of magnitude greater than the conversion costs to small manufacturers. DOE has determined that establishing standards at the adopted level, TSL 8, balances the benefits of energy savings with the potential burdens placed on manufacturers of covered products, including small business manufacturers.

DOE has determined that establishing standards at 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 is not adopting one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the final rule TSD.

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 conservation 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

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) These requirements were also discussed in some detail in the July 2022 NOPR. 87 FR 40590, 40702 (July 7, 2022). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 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.

DOE is not amending the existing reporting requirements or establishing new DOE reporting requirements. If determined to be necessary, DOE may consider associated reporting and certification requirements in a future rulemaking. Therefore, DOE has concluded that the amended energy conservation standards for NWGFs and MHGFs will 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

Pursuant to the National Environmental Policy Act of 1969 (NEPA), DOE has analyzed this action in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, subpart D, appendix B, categorical exclusion B5.1, because it is a rulemaking that establishes 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. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an environmental assessment or an environmental impact statement.

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 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 final 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 E.O. 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 E.O. 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 E.O. 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 final 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, sec. 201 (codified at 2 U.S.C. 1531). For a 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 *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

DOE has concluded that this final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include (1) investment in research and development and in capital expenditures by NWGF and MHGF manufacturers in the years between the final rule and the compliance date for the new standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency NWGFs and MHGFs starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this document and the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, DOE is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule, unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by EPCA, this final rule establishes amended energy conservation standards for NWGFs and MHGFs that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 42 U.S.C. 6295(o)(2)(A) and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), DOE has determined that this 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 final rule 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

E.O. 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 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 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 concluded that this regulatory action, which sets forth amended energy conservation standards for NWGFs and MHGFs, is not a significant energy action because the 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 final 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.[294] 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 DOE's analyses. DOE is in the process of evaluating the resulting December 2021 report.[295]

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that it has been determined that the rule falls within the scope of 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Small businesses.

[294] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed Feb. 16, 2022).

[295] The December 2021 NAS report is available *at www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards* (last accessed August 14, 2023).

Signing Authority

This document of the Department of Energy was signed on September 28, 2023, by Jeffrey Marootian, 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 November 14, 2023.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons stated in the preamble, DOE amends part 430 of chapter II, 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. Amend § 430.32 by:
■ a. Revising paragraph (e)(1)(ii);
■ b. Redesignating paragraph (e)(1)(iii) as paragraph (e)(1)(iv); and
■ c. Adding a new paragraph (e)(1)(iii).

The revision and addition 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 December 18, 2028; mobile home gas furnaces manufactured on or after November 19, 2015, but before December 18, 2028; 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 the following:

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).

(iii) The AFUE for non-weatherized gas (not including mobile home gas furnaces) manufactured on and after December 18, 2028; and mobile home gas furnaces manufactured on and after December 18, 2028, shall not be less than the following:

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).

* * * * *

Note: The following appendix will not appear in the Code of Federal Regulations.

Appendix A—Letter From the Department of Justice to the Department of Energy

U.S. Department of Justice

Antitrust Division
RFK Main Justice Building
950 Pennsylvania Avenue NW
Washington, DC 20530–0001
September 6, 2022

Ami Grace-Tardy
Assistant General Counsel for Legislation, Regulation and Energy Efficiency
U.S. Department of Energy
Washington, DC 20585
Ami.Grace-Tardy@hq.doe.gov

Dear Assistant General Counsel Grace-Tardy:

I am responding to your July 7, 2022, letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for consumer furnaces, specifically for non-weatherized gas furnaces (''NWGFs'') and mobile-home gas furnaces (''MHGFs'').

Your request was submitted under Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (EPCA), 42 U.S.C. 6295(o)(2)(B)(i)(V) and 42 U.S.C. 6316(a), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR 0.40(g). The Assistant Attorney General for the Antitrust Division has authorized me, as the Policy Director for the Antitrust Division, to provide the Antitrust Division's views regarding the potential impact on competition of proposed energy conservation standards on his behalf.

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice or increasing industry concentration. A lessening of competition could result in higher prices to manufacturers and consumers. We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking (87 FR 40591, July 7, 2022). We have also interviewed industry participants, reviewed public comments and information provided by industry participants, reviewed comments submitted to DOJ, have spoken with DOE staff, and have listened to the Webinar of the Public Meeting held on August 3, 2022.

Based on our review of the information currently available, we do not believe that the proposed energy conservation standards for consumer furnaces are likely to substantially lessen competition in any particular product or geographic market. In the course of our review, we were told that the MHGF market may be more highly concentrated than DOE's analysis suggests. Given the necessarily short time-frame for our review, we are not in a position to confirm the level of concentration increase that may be caused by the rule, but encourage DOE to closely examine and consider potential competitive issues that commenters may raise with respect to this rulemaking.

Sincerely,

/s/

David G.B. Lawrence,

Director of Policy.

[FR Doc. 2023–25514 Filed 12–15–23; 8:45 am]

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