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10 CFR Parts 429 and 430
Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnace Fans; Final Rule

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket Number EERE–2010–BT–STD–0011]

RIN 1904–AC22

Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnace Fans

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

ACTION: Final rule.

SUMMARY: Pursuant to the Energy Policy and Conservation Act of 1975 (EPCA), as amended, the U.S. Department of Energy (DOE) must prescribe energy conservation standards for various consumer products and certain commercial and industrial equipment, including residential furnace fans. EPCA requires DOE to determine whether such standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this final rule, DOE is adopting new energy conservation standards for residential furnace fans. DOE has determined that the prescribed energy conservation standards for these products would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is September 2, 2014. Compliance with the prescribed standards established for residential furnace fans in this final rule is required on and after July 3, 2019.

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.

A link to the docket Web page can be found at: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/41*. The *www.regulations.gov* Web page contains simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *Brenda.Edwards@ee.doe.gov*.

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SUPPLEMENTARY INFORMATION:

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I. Summary of the Final Rule

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles. Pursuant to EPCA, any new or amended energy conservation standard that DOE prescribes for certain products, such as furnace fans, must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)). Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)). In accordance with these and other statutory provisions discussed in this notice, DOE proposes amended energy conservation standards for furnace fans. The proposed standards shall have a fan energy rating (FER) value that meets or is less than the values shown in Table I.1. These standards would apply to all products listed in Table I.1 and manufactured in, or imported into, the United States on or after manufactured on and after July 3, 2019.

TABLE I.1.—ENERGY CONSERVATION STANDARDS FOR COVERED RESIDENTIAL FURNACE FANS

Product class	FER* (watts/cfm)	Percent increase over baseline (percent)
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC)	FER = 0.044 x Q_{Max} + 182	46
Non-Weatherized, Condensing Gas Furnace Fan (NWG–C)	FER = 0.044 x Q_{Max} + 195	46
Weatherized Non-Condensing Gas Furnace Fan (WG–NC)	FER = 0.044 x Q_{Max} + 199	46
Non-Weatherized, Non-Condensing Oil Furnace Fan (NWO–NC)	FER = 0.071 x Q_{Max} + 382	12
Non-Weatherized Electric Furnace/Modular Blower Fan (NWEF/NWMB)	FER = 0.044 x Q_{Max} + 165	46
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan (MH–NWG–NC)	FER = 0.071 x Q_{Max} + 222	12
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C)	FER = 0.071 x Q_{Max} + 240	12
Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB)	FER = 0.044 x Q_{Max} + 101	46
Mobile Home Non-Weatherized Oil Furnace Fan (MH–NWO)	Reserved	
Mobile Home Weatherized Gas Furnace Fan (MH–WG)	Reserved	

* Q_{Max} is the airflow, in cfm, at the maximum airflow-control setting measured using the final DOE test procedure at 10 CFR part 430, subpart B, appendix AA.

A. Benefits and Costs to Consumers

Table I.2 presents DOE's evaluation of the economic impacts of today's standards on consumers of residential furnace fans, as measured by the average life-cycle cost (LCC) savings and the median payback period (PBP). The average LCC savings are positive for all product classes.

TABLE I.2—IMPACTS OF ENERGY CONSERVATION STANDARDS ON CONSUMERS OF RESIDENTIAL FURNACE FANS

Product class	Average LCC savings (2013$)	Median payback period (years)
Non-Weatherized, Non-Condensing Gas Furnace Fan	$506	5.4
Non-weatherized, Condensing Gas Furnace Fan	$341	5.8
Weatherized Non-Condensing Gas Furnace Fan	$447	4.4
Non-Weatherized, Non-Condensing Oil Furnace Fan	$46	1.7
Non-weatherized Electric Furnace/Modular Blower Fan	$204	3.2
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	$36	2.7
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	$35	2.3
Mobile Home Electric Furnace/Modular Blower Fan	$85	4.1

B. Impact on Manufacturers

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 (2014 to 2048). Using a real discount rate of 7.8 percent, DOE estimates that the INPV for manufacturers of residential furnace fans is $349.6 million.[1] Under today's standards, DOE expects that manufacturers may lose up to 16.9 percent of their INPV, which is approximately $59.0 million. Total conversion costs incurred by industry prior to the compliance date are expected to reach $40.6 million.

C. National Benefits and Costs [2]

DOE's analyses indicate that today's standards would save a significant amount of energy. The lifetime energy savings for residential furnace fans purchased in the 30-year period that begins in the year of compliance with the standards (2019–2048) amount to

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[1] DOE calculated a present value in 2014; all monetary values in this document are expressed in 2013 dollars unless explicitly stated otherwise.

[2] All monetary values in this section are expressed in 2013$ and are discounted to 2014.

3.99 quadrillion Btu (quads [3]). The estimated annual energy savings in 2030 (0.07 quads) are equivalent to 0.3 percent of total U.S. residential energy use in 2012.

The cumulative net present value (NPV) of total consumer costs and savings of today's standards for residential furnace fans ranges from $10,024 million (at a 7-percent discount rate) to $28,810 million (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for residential furnace fans purchased in 2019–2048.

In addition, today's standards are expected to have significant environmental benefits. The energy savings would result in cumulative emission reductions of approximately 180.6 million metric tons (Mt) [4] of carbon dioxide (CO_2), 695.0 thousand tons of methane (CH_4), 235.7 thousand tons of sulfur dioxide (SO_2), 84.0 thousand tons of nitrogen oxides (NO_X), 6.2 thousand tons of nitrous oxide (N_2O), and 0.4 tons of mercury (Hg).[5] The cumulative reduction in CO_2 emissions through 2030 amounts to 34 million Mt.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent Federal interagency process.[6] The derivation of the SCC values is discussed in section IV.L. Using discount rates appropriate for each set of SCC values, DOE estimates that the net present monetary value of the CO_2 emissions reductions is between 1,134 million to 16,799 million. DOE also estimates that the net present monetary value of the NO_X emissions reductions is $53.1 million at a 7-percent discount rate, and $110.8 million at a 3-percent discount rate.[7]

Table I.3 summarizes the national economic costs and benefits expected to result from today's standards for residential furnace fans.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF RESIDENTIAL FURNACE FANS ENERGY CONSERVATION STANDARDS*

Category	Present value *million 2013 $*	Discount rate (percent)
Benefits		
Consumer Operating Cost Savings	13,409	7
	34,999	3
CO_2 Reduction Monetized Value ($12.0/t case)**	1,134	5
CO_2 Reduction Monetized Value ($40.5/t case)**	5,432	3
CO_2 Reduction Monetized Value ($62.4/t case)**	8,694	2.5
CO_2 Reduction Monetized Value ($119/t case)**	16,799	3
NO_X Reduction Monetized Value (at $2,684/ton)**	53	7
	111	3
Total Benefits†	18,894	7
	40,542	3
Costs		
Consumer Incremental Installed Costs	3,385	7
	6,189	3
Net Benefits		
Including CO_2 and NO_X† Reduction Monetized Value	15,509	7
	34,353	3

* This table presents the costs and benefits associated with residential furnace fans shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the products purchased in 2019–2048. The results account for the incremental variable and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule.

** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with 3-percent discount rate.

The benefits and costs of today's standards, for products sold in 2019–2048, can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) The annualized national economic value of the benefits from operating the product that meets the new or amended standard (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing consumer NPV), and (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[8]

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[3] A quad is equal to 10^{15} British thermal units (Btu).

[4] A metric ton is equivalent to 1.1 short tons. Results for NO_X and Hg are presented in short tons.

[5] DOE calculated emissions reductions relative to the Annual Energy Outlook 2013 (*AEO 2013*) Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of December 31, 2012.

[6] *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, United States Government (May 2013; revised November 2013) (Available at: *http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf*).

[7] DOE is investigating valuation of avoided Hg and SO_2 emissions.

[8] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2014, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.4. From the present value, DOE

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, whereas the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of residential furnace fans shipped in 2019–2048. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of today's standards are shown in Table I.4. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the SCC series that has a value of $40.5/t in 2015), the cost of the residential furnace fans standards in today's final rule is $358 million per year in increased equipment costs, while the benefits are $1416 million per year in reduced equipment operating costs, $312 million in CO_2 reductions, and $5.61 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,376 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series that has a value of $40.5/t in 2015, the cost of the residential furnace fans standards in today's rule is $355 million per year in increased equipment costs, while the benefits are $2010 million per year in reduced operating costs, $312 million in CO_2 reductions, and $6.36 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,973 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF STANDARDS FOR RESIDENTIAL FURNACE FANS

	Discount rate	Primary estimate *	Low net benefits estimate *	High net benefits estimate *
		million 2013$/year		
Benefits				
Consumer Operating Cost Savings.	7%	1416	1167	1718
	3%	2010	1626	2467
CO_2 Reduction (at $12.0/t case) **.	5%	90	77	108
CO_2 Reduction (at $40.5/t case) **.	3%	312	268	377
CO_2 Reduction (at $62.4/t case) **.	2.5%	459	393	555
CO_2 Reduction (at $119/t case) **.	3%	965	828	1166
NO_X Reduction (at $2,684/ton) **.	7%	5.61	4.80	6.82
	3%	6.36	5.35	7.86
Total Benefits †	7% plus CO_2 range	1,512 to 2,387	1,249 to 2,000	1,833 to 2,891
	7%	1,734	1,439	2,102
	3% plus CO_2 range	2,106 to 2,981	1,708 to 2,459	2,583 to 3,641
	3%	2,328	1,899	2,852
Costs				
Consumer Incremental Product Costs.	7%	358	314	410
	3%	355	304	419
Net Benefits				
Total †	7% plus CO_2 range	1,154 to 2,029	935 to 1,685	1,423 to 2,481
	7%	1,376	1,125	1,692
	3% plus CO_2 range	1,750 to 2,625	1,404 to 2,155	2,164 to 3,222
	3%	1,973	1,595	2,433

* This table presents the annualized costs and benefits associated with residential furnace fans shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the products purchased from 2019–2048. The results account for the incremental, variable, and fixed costs incurred by manufacturers due to the standard, some of which may be incurred in preparation for the rule. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices and housing starts from the *AEO 2013* Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a flat rate for projected product price trends in the Primary Estimate, a slightly increasing rate for projected product price trends in the Low Benefits Estimate, and a slightly declining rate for projected product price trends in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.

** The CO_2 values represent global monetized values of the SCC, in 2013$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the average SCC with a 3% discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

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then calculated the fixed annual payment over a 30-year period (2019 through 2048) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

D. Conclusion

Based on the analyses culminating in this final rule, DOE found the benefits to the nation of the standards (energy savings, consumer LCC savings, positive NPV of consumer benefit, and emission reductions) outweigh the burdens (loss of INPV and LCC increases for some users of these products). DOE has concluded that the standards in today's final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy.

II. Introduction

The following section briefly discusses the statutory authority underlying today's final rule, as well as some of the relevant historical background related to the establishment of standards for residential furnace fans.

A. Authority

Title III, Part B [9] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles, a program covering most major household appliances (collectively referred to as ''covered products''),[10] which includes the types of residential furnace fans that are the subject of this rulemaking. (42 U.S.C. 6295(f)(4)(D))

Pursuant to EPCA, DOE's energy conservation program for covered products consists of essentially of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required by EPCA to consider and establish energy conservation standards for ''electricity used for purposes of circulating air through duct work'' (which DOE has referred to in shorthand as residential ''furnace fans''). (42 U.S.C. 6295(f)(4)(D)) DOE is also required by EPCA to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product prior to the adoption of an energy conservation standard. (42 U.S.C. 6295(o)(A)(3) and (r)) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for residential furnace fans currently appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix AA.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including furnace fans. As indicated above, any standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and (3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) For certain products, including residential furnace fans, 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 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 factors:

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

(2) The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the standard;

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

(4) Any lessening of the utility or the performance of the covered products likely to result from the standard;

(5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;

(6) The need for national energy and water conservation; and

(7) Other factors the Secretary of Energy (Secretary) considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

Further, EPCA, as codified, 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. (*See* 42 U.S.C. 6295(o)(2)(B)(iii))

Additionally, under 42 U.S.C. 6295(q)(1), the statute specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type of class of covered product that has the same function or intended use, if DOE determines that products within such group: (A) Consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether 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))

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

[10] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (Dec. 18, 2012).

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

Finally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) The furnace fan energy rating metric does not account for the electrical energy consumption in standby mode and off mode, because energy consumption in those modes is being fully accounted for in the DOE energy conservation standards for residential furnaces and residential central air conditioners (CAC) and heat pumps (HP). Manufacturers will be required to use the new metrics and methods adopted in those rulemakings for the purposes of certifying to DOE that their products comply with the applicable energy conservation standards adopted pursuant to EPCA and for making representations about the efficiency of those products. (42 U.S.C. 6293(c); 42 U.S.C. 6295(s))

B. Background

1. Current Standards

Currently, no Federal energy conservation standards apply to residential furnace fans.

2. History of Standards Rulemaking for Residential Furnace Fans

Pursuant to 42 U.S.C. 6295(f)(4)(D), DOE must consider and prescribe new energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work. DOE has interpreted this statutory language to allow regulation of the electricity use of any electrically-powered device applied to residential central heating, ventilation, and air-conditioning (HVAC) systems for the purpose of circulating air through duct work.

DOE initiated the current rulemaking by issuing an analytical Framework Document, ''Rulemaking Framework for Furnace Fans'' (June 1, 2010). DOE then published the Notice of Public Meeting and Availability of the Framework Document for furnace fans in the **Federal Register** on June 3, 2010. 75 FR 31323. See *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/41.* The Framework Document explained the issues, analyses, and process that DOE anticipated using to develop energy conservation standards for residential furnace fans. DOE held a public meeting on June 18, 2010 to solicit comments from interested parties regarding DOE's analytical approach. DOE originally scheduled the comment period on the Framework Document to close on July 6, 2010, but due to the large number and broad scope of questions and issues raised, DOE subsequently published a notice in the **Federal Register** reopening the comment period from July 15, 2010 until July 27, 2010, to allow additional time for interested parties to submit comments. 75 FR 41102 (July 15, 2010).

As a concurrent effort to the residential furnace fan energy conservation standard rulemaking, DOE also initiated a test procedure rulemaking for residential furnace fans. On May 15, 2012, DOE published a notice of proposed rulemaking (NOPR) for the test procedure in the **Federal Register**. 77 FR 28674. In that NOPR, DOE proposed to establish methods to measure the performance of covered furnace fans and to obtain a value for the proposed metric, referred to as the ''fan efficiency rating'' (FER).[11] DOE held the test procedure NOPR public meeting on June 15, 2012, and the comment period closed on July 30, 2012. After receiving comments on the NOPR alleging significant manufacturer burden associated with the proposed test procedure, DOE determined that an alternative test method should be developed. DOE published in the **Federal Register** an SNOPR on April 2, 2013, which contained its revised test procedure proposal and an explanation of the changes intended to reduce burden. 78 FR 19606. DOE proposed to adopt a modified version of the alternative test method recommended by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) and other furnace fan manufacturers to rate the electrical energy consumption of furnace fans. DOE concluded that the AHRI-proposed method provides a framework for accurate and repeatable determinations of FER that is comparable to the test method previously proposed by DOE, but at a significantly reduced test burden. DOE published in the **Federal Register** a final rule on January 3, 2014, which contained the final test procedure for residential furnace fans. 79 FR 500.

To further develop the energy conservation standards for residential furnace fans, DOE gathered additional information and performed a preliminary technical analysis. This process culminated in publication in the **Federal Register** of a Notice of Public Meeting and the Availability of the Preliminary Technical Support Document (TSD) on July 10, 2012. 77 FR 40530. DOE published a NOPR in the **Federal Register** and made available an accompanying NOPR TSD on October 25, 2013. 78 FR 64068. In that document, DOE requested comment on the following matters discussed in the TSD: (1) Additional FER values; (2) the methodology for accounting for the relationship between FER and airflow capacity; (3) the reasonableness of the values that DOE used to characterize the rebound effect with high-efficiency residential furnace fans; (4) DOE's estimate of the base-case efficiency distribution of residential furnace fans in 2018; (5) the long-term market penetration of higher-efficiency residential furnace fans; (6) data regarding manufacturer product costs for furnace fan equipment and components; (7) the effect of standards on future furnace fan equipment shipments; (8) whether there are features or attributes of the more energy-efficient furnace fans that manufacturers would produce to meet the standards in the proposed rule that might affect how they would be used by consumers; (9) data that would refine the analytical timeline; (10) input on average equipment lifetimes; (11) the new SCC values used to determine the social benefits of CO_2 emissions reductions over the rulemaking analysis period; and (12) input on the cumulative regulatory burden. *Id.* DOE also invited written comments on these subjects, as well as any other relevant issues. A PDF copy of the NOPR TSD is available at *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0011-0068.*

The NOPR TSD provided an overview of the activities DOE undertook in developing proposed energy

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[11] In the May 15, 2012 NOPR for the test procedure, DOE referred to FER as ''fan efficiency rating.'' However, in the April 2, 2013 test procedure SNOPR, DOE proposed to rename the metric as ''fan energy rating,'' thereby keeping the same abbreviation (FER).

conservation standards for residential furnace fans, and discussed the comments DOE received in response to the Preliminary Analysis. It also described the analytical methodology that DOE used and each analysis DOE had performed up to that point. These analyses were as follows:

- A *market and technology assessment* addressed the scope of this rulemaking, identified the potential product classes of residential furnace fans, characterized the markets for these products, and reviewed techniques and approaches for improving their efficiency;
- A *screening analysis* reviewed technology options to improve the efficiency of furnace fans, and weighed these options against DOE's four prescribed screening criteria;
- An *engineering analysis* developed relationships that show the manufacturer's cost of achieving increased efficiency;
- A *markups analysis* developed distribution channel markups that relate the manufacturer production cost (MPC) to the cost to the consumer;
- An *energy use analysis* estimated the annual energy use of furnace fans at various potential standard levels;
- A *life-cycle cost (LCC) analysis* calculated, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the product, compared to any increase in installed costs likely to result directly from the adoption of a given standard;
- A *payback period (PBP) analysis* estimated the amount of time it would take consumers to recover the higher expense of purchasing more-energy-efficient products through lower operating costs;
- A *shipments analysis* estimated shipments of residential furnace fans over the time period examined in the analysis (30 years), which were used in performing the national impact analysis;
- A *national impact analysis* assessed the aggregate impacts at the national level of potential energy conservation standards for residential furnace fans, as measured by the net present value of total consumer economic impacts and national energy savings;
- A *manufacturer impact analysis* estimated the financial impact of new energy conservation standards on manufacturers and calculated impacts on competition, employment, and manufacturing capacity;
- A *consumer subgroup analysis* evaluated variations in customer characteristics that might cause a standard to affect particular consumer sub-populations (such as low-income households) differently than the overall population;
- An *emissions analysis* assessed the effects of the considered standards on emissions of carbon dioxide (CO_2), sulfur dioxide (SO_2) nitrogen oxides (NO_X), mercury (Hg), nitrous oxide (N_20), and methane (CH_4);
- An *emissions monetization* estimated the economic value of reductions in CO_2 and NO_X emissions from the considered standards;
- A *utility impact analysis* estimated selected effects of the considered standards on electric utilities;
- An *employment impact analysis* assessed the impacts of the considered standards on national employment; and
- A *regulatory impact analysis* (RIA) evaluated alternatives to amended energy conservation standards in order to assess whether such alternatives could achieve substantially the same regulatory goal at a lower cost.

The NOPR public meeting took place on December 3, 2013. At this meeting, DOE presented the methodologies and results of the analyses set forth in the NOPR TSD. The numerous comments received since publication of the October 2013 NOPR, including those received at the NOPR public meeting, have contributed to DOE's resolution of the issues raised by interested parties.

The submitted comments include a comment from the American Council for an Energy-Efficiency Economy (ACEEE); a joint comment from the American Fuel and Petrochemical Manufacturers (AFPM), the U.S. Chamber of Commerce (the Chamber), the Council of Industrial Boiler Owners (CIBO), the American Forest and Paper Association (AF&PA), and the American Petroleum Institute (API); a comment from the American Gas Association (AGA); a comment from the Air-Conditioning, Heating, and Refrigeration Institute (AHRI); a comment from the American Public Gas Association (APGA); a joint comment from the Appliance Standards Awareness Project (ASAP), Alliance to Save Energy (ASE), National Consumer Law Center (NCLC) and the Natural Resources Defense Council (NRDC); a second joint comment from California Investor-Owned Utilities (CA IOUs) including Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCGC), and San Diego Gas and Electric (SDGE); a comment from the Cato Institute; a comment from China WTO (WTO); a comment from Earthjustice; a comment from Edison Electric Institute (EEI); a comment from the George Washington University Regulatory Studies Center; a comment from Goodman Global, Inc. (Goodman); a comment from Heating, Air-Conditioning and Refrigeration Distributers International (HARDI); a comment from Johnson Controls; a comment from Laclede Gas Company (Laclede); a comment from a comment from Lennox International, Inc. (Lennox); a comment from the Mercatus Center at George Mason University; a comment from Morrison Products, Inc. (Morrison); a comment from Mortex Product, Inc. (Mortex); a comment from the National Association of Manufacturers (NAM); a joint comment from the Northwest Energy Efficiency Alliance (NEEA) and the Northwest Power and Conservation Council (NPCC); a comment from the Northeast Energy Efficiency Partnerships (NEEP); a comment from Rheem Manufacturing Company (Rheem); a comment from Southern Company; a comment from Ingersoll Rand; and a comment from Unico, Incorporated. Comments made during the public meeting by those not already listed include Nidec Motor Corporation (Nidec) and the motor manufacturer Regal Beloit. This final rule summarizes and responds to the issues raised in these comments. A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.

III. General Discussion

A. Test Procedures

DOE published the furnace fan test procedure final rule in the **Federal Register** on January 3, 2014. 79 FR 499. DOE's test procedure for furnace fans (hereinafter referred to as ''the test procedure'') is codified in appendix AA of subpart B of part 430 of the code of federal regulations (CFR).The test procedure is applicable to circulation fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers. The test procedure is not applicable to any non-ducted products, such as whole-house ventilation systems without ductwork, central air-conditioning (CAC) condensing unit fans, room fans, and furnace draft inducer fans.

DOE aligned the test procedure with the DOE test procedure for furnaces by incorporating by reference specific provisions from an industry standard that is also incorporated by reference in the DOE test procedure for furnaces. DOE's test procedure for furnaces is codified in appendix N of subpart B of part 430 of the CFR. The DOE furnace test procedure incorporates by reference American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air Conditioning

Engineers (ASHRAE) 103–1993, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers* (ASHRAE 103–1993). The DOE furnace fan test procedure incorporates by reference the definitions, test setup and equipment, and procedures for measuring steady-state combustion efficiency provisions of the 2007 version of ASHRAE 103 (ASHRAE 103–2007). In addition to these provisions, the test procedure includes provisions for apparatuses and procedures for measuring temperature rise, external static pressure, and furnace fan electrical input power. The test procedure also incorporates by reference provisions for measuring temperature and external static pressure from ANSI/ASHRAE 37–2009, *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment* (ASHRAE 37–2009). There are no differences between the 2005 version (which is already incorporated by reference in the CFR) and the 2009 version of the ASHRAE 37 provisions incorporated by reference for the furnace fan test procedure. The test procedure also establishes calculations to derive the rating metric, fan energy rating (FER), for each furnace fan basic model based on the results of testing per the test method for furnace fans codified in appendix AA of subpart B of part 430 of the CFR.

FER is the estimated annual electrical energy consumption of a furnace fan normalized by: (a) The estimated total number of annual fan operating hours (1,870); and (b) the airflow in the maximum airflow-control setting. For the purposes of the furnace fan test procedure, the estimated annual electrical energy consumption is the sum of the furnace fan electrical input power (in Watts), measured separately for multiple airflow-control settings at different external static pressures (ESPs), multiplied by national average operating hours associated with each setting. These ESPs are determined by a reference system, based on operation at maximum airflow that represents national average ductwork system characteristics. Table III.1 includes the reference system ESP values by installation type that are specified by the test procedure. In previous rulemaking documents for the furnace fan test procedure and energy conservation standard rulemaking, DOE used the term ‘‘manufactured home furnace’’ to be synonymous with ‘‘mobile home furnace,’’ as defined in the Code of Federal Regulation (CFR). 10 CFR 430.2. DOE will use the term ‘‘mobile home’’ hereinafter to be consistent with the CFR definition for ‘‘mobile home furnace.’’ All provisions and statements regarding mobile homes and mobile home furnaces are applicable to manufactured homes and manufactured home furnaces.

TABLE III.1—REQUIRED REFERENCE SYSTEM CRITERIA (I.E., ESP AT MAXIMUM AIRFLOW) BY FURNACE FAN INSTALLATION TYPE

Installation type	ESP at maximum airflow (in. wc)
Units with an internal evaporator coil	0.50
Units designed to be paired with an evaporator coil	0.65
Units designed to be installed in a mobile home [12]	0.30

The test procedure requires measurements for the airflow-control settings that correspond to fan operation while performing the cooling function (which DOE finds is predominantly associated with the maximum airflow-control setting), heating function, and constant-circulation function. Table III.2 describes the required airflow-control settings by product type.

TABLE III.2—AIRFLOW-CONTROL SETTINGS AT WHICH MEASUREMENTS ARE REQUIRED FOR EACH PRODUCT TYPE

Product type	Airflow-control setting 1	Airflow-control setting 2	Airflow-control setting 3
Single-stage Heating	Default constant-circulation	Default heat	Absolute maximum.*
Multi-stage or Modulating Heating	Default constant-circulation	Default low heat	Absolute maximum.

* For the purposes of the test procedure, ‘‘absolute maximum’’ airflow-control setting refers to the airflow-control setting that achieves the maximum attainable airflow at the operating conditions specified by the test procedure.

As shown in Table III.2, for products with single-stage heating, the three airflow-control settings to be tested are: The default constant-circulation setting; the default heating setting; and the absolute maximum setting. For products with multi-stage heating or modulating heating, the airflow-control settings to be tested are: The default constant-circulation setting; the default low heating setting; and the absolute maximum setting. The absolute lowest airflow-control setting is used to represent constant circulation if a default constant-circulation setting is not specified. DOE defines ‘‘default airflow-control settings’’ as the airflow-control settings for installed use specified by the manufacturer in the product literature shipped with the product in which the furnace fan is integrated. *See* Section 2.2 of Appendix AA to Subpart B of 10 CFR part 430. Manufacturers typically provide detailed instructions for setting the default heating airflow-control setting to ensure that the product in which the furnace fan is integrated operates safely. In instances where a manufacturer specifies multiple airflow-control settings for a given function to account for varying installation scenarios, the highest airflow-control setting specified for the given function shall be used for the DOE test procedure. High heat and reduced heat shall be considered different functions for multi-stage heating units. Manufacturer installation guides also provide detailed instructions regarding compatible thermostats and how to wire them to achieve the specified default settings.

The Watt measurements for calculating FER are weighted using designated annual operating hours for each function (*i.e.,* cooling, heating, and constant circulation) that represent national average operation. Table III.3 shows the estimated national average operating hours for each function.

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[12] Mobile home external static pressure is much lower because there is no return air ductwork in mobile homes. Also, the United States Department of Housing and Urban Development (HUD) requirements for mobile homes stipulate that the ductwork for cooling should be designed for 0.3 in. water column (wc). 24 CFR 3280.715.

TABLE III.3—ESTIMATED NATIONAL AVERAGE OPERATING HOUR VALUES FOR CALCULATING FER

Operating mode	Variable	Single-stage (hours)	Multi-stage or modulating (hours)
Heating	HH	830	830/HCR
Cooling	CH	640	640
Constant Circulation	CCH	400	400

For multi-stage heating or modulating heating products, the specified operating hours for the heating mode are divided by the heating capacity ratio (HCR) to account for variation in time spent in this mode associated with turndown of heating output. The HCR is the ratio of the measured reduced heat input rate to the measured maximum heat input rate.

The FER equation is:

$$FER = \frac{(CH \times E_{Max}) + (HH \times E_{Heat}) + (CCH \times E_{Circ})}{(CH + 830 + CCH) \times Q_{Max}} \times 1000$$

Where:

CH = annual furnace fan cooling operating hours;

E_{Max} = furnace fan electrical consumption at maximum airflow-control setting operating point;

HH = annual furnace fan heating operating hours;

E_{Heat} = furnace fan electrical consumption at the default heating airflow-control setting operating point for units with single-stage heating or the default low-heating airflow control setting operating point for units with multi-stage heating;

CHH = annual furnace fan constant circulation hours;

E_{Circ} = furnace fan electrical consumption at the default constant-circulation airflow-control setting operating point (or minimum airflow-control setting operating point if a default constant-circulation airflow-control setting is not specified);

Q_{Max} = airflow at maximum airflow-control setting operating point; and

1000 = constant to put metric in terms of watts/1000cfm, which is consistent with industry practice.

DOE received comments from interested parties regarding the furnace fan test procedure in response to the furnace fan energy conservation standard (ECS) NOPR. Interested parties' comments on the test procedure are summarized below. DOE addressed many of these issues in the test procedure final rule, published in the **Federal Register** on January 3, 2014. (79 FR 514). The publication of the test procedure final rule occurred after the standards NOPR public meeting, held on December 3, 2013, but before the close of the standards NOPR comment period on January 23, 2014. For comments that were addressed in the test procedure final rule, a reference to the applicable discussion contained in the test procedure final rule document is provided. DOE's detailed response is provided in this document for comments that were not addressed in the test procedure final rule document.

AHRI, Goodman, Morrison, Rheem, Southern Company, Johnson Controls, and Ingersoll Rand commented that DOE's schedule for finalizing the test procedure did not provide interested parties with sufficient time to evaluate product performance in accordance with the final test procedure in order to develop and submit substantive comments on the standards proposed in the NOPR. (AHRI, No. 98 at p. 2, 3; Goodman, No. 102 at pp. 7, 8; Morrison, No. 108 at p. 3; Rheem, No. 83 at p. 1; Southern Company, No. 85 at p. 2; Johnson Controls, No. 95 at p. 3; Ingersoll Rand, No. 43 at p. 33) Ingersoll Rand added that the comments they have submitted to date are based on the proposed test procedure, not the final test procedure. (Ingersoll Rand, No. 107 at pp. 2, 10) AGA and Allied Air agree and recommend that DOE delay promulgation of standards to give interested parties and DOE more time to conduct analyses using the final test procedure. (AGA, No. 110 at pp. 3, 4; Allied Air, Public Meeting Transcript, No. 43 at p. 48) Goodman recommended a delay of three months for this type of product and testing. (Goodman, No. 102 at p. 3) Prior to publication of the test procedure final rule, EEI expressed support for DOE issuing a supplemental notice of proposed rulemaking (SNOPR) for the standard if changes were made to the test procedure final rule that had significant impacts on DOE's analyses results. (EEI, No. 87 at p. 3) APGA and Southern Company also recommended that DOE publish a standards SNOPR. (APGA, No. 90 at p. 2; Southern Company, No. 43 at p. 37)

DOE recognizes that interested parties need sufficient time to collect and evaluate relevant fan performance data in order to submit meaningful comments on the proposed energy conservation standard for furnace fans. Thus, on December 24, 2013, DOE posted a pre-publication test procedure final rule notice to regulations.gov and issued a 30-day extension of the standards NOPR comment period to provide interested parties with time to evaluate DOE's proposed standards using the final test procedure.

AHRI, Johnson Controls, and Morrison stated that, even with the comment period extension, the 20 days between the publication of the test procedure final rule on January 3, 2014 and the close of the standards NOPR comment period on January 23, 2014 did not provide interested parties with sufficient time to assess the energy conservation standards NOPR based on the provisions within the final test procedure. AHRI added that DOE was obligated to issue the NOPR on the proposed energy conservation standards after the issuance of the final rule on the furnace fan test procedures per Section 7(c) of Appendix A to Subpart C of 10 CFR part 430. (AHRI, No. 98 at pp. 2, 3; Johnson Controls, No. 95 at p. 3; Morrison, No. 108 at p. 3) Mortex stated that they were not able to test any of their products according to the final test procedure by the time the energy conservation standard NOPR comment period closed. (Mortex, No. 104 at p. 2) Ingersoll Rand commented that DOE's standards NOPR analyses are invalid because they were not based on the test procedure final rule. (Ingersoll Rand, No. 107 at p. 2, 10). NEEA and NPCC provided there is a need for product testing using the final test procedure, and a re-assessment of the derivation of the proposed FER equations and standard levels. NEEA and NPCC added that they do not support a decision on standards before there is sufficient data with which to verify that the proposed FER values will not disqualify from compliance the majority of the very products upon which they are founded, and for which DOE's economic analyses are valid. (NEEA and NPCC, No. 96 at p. 2)

DOE disagrees with AHRI and Morrison that the extended comment period was insufficient. DOE issued a test procedure SNOPR for furnace fans on April 2, 2013. 78 FR 19606. DOE did not make changes to the test procedure between the SNOPR and final rule that would significantly alter FER values for most products. Interested parties that conducted testing in accordance with the test procedure SNOPR proposal should not have to retest most furnace models to derive an FER value that is consistent with the final test procedure. For most furnaces, the FER value should not change or the FER value can be recalculated per the final test procedure requirements using the raw data measured according to the SNOPR test method. Therefore, notwithstanding the 20 days between the test procedure final rule and the close of the standards NOPR comment period, interested parties still had over nine months between the publication of the test procedure SNOPR and the close of the standards NOPR comment period to collect and evaluate fan performance data that is relevant to DOE's proposed standards. DOE received data that could be used to derive FER values that meet the final test procedure requirements from multiple manufacturers during this period.

DOE agrees with NEEA and NPCC that its proposed standards should be assessed based on FER values that are reflective of performance as measured by the final test procedure. For the reasons stated above, DOE was able to use much of the FER data it has collected in previous phases of this rulemaking to generate FER values that meet the requirements of the final test procedure. DOE also conducted testing prior to and during the development of the test procedure final rule that generated a broad set of results to enable DOE to derive FER values that are consistent with the requirements of the final test procedure. In addition, DOE continued to collect and use data from publicly-available product literature. DOE relied on the mathematical methods outlined in the test procedure NOPR for using this data to model fan performance and estimate FER values that meet the final test procedure requirements. 77 FR 28690 (May 15, 2012). DOE recognizes that this method is not identical to the final test procedure method. However, DOE believes the FER values generated in this manner are still relevant because the final test method is similar to the test method proposed by AHRI (with support from Goodman, Ingersoll Rand, Lennox, and Morrison) in response to the test procedure NOPR, which they argued would result in accurate and repeatable FER values that are comparable to the FER values resulting from the methods proposed in the NOPR. (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Morrison, No. 21 at p. 3.) For these reasons, Ingersoll Rand's comment stating that DOE's standards NOPR analyses are invalid because they are not based on the test procedure final rule is inaccurate. The standards proposed in the NOPR and those established by this final rule are based on relevant FER data.

Goodman stated that DOE's modifications to the test procedure since the April 2013 test procedure SNOPR will have a significant impact on FER. Goodman referred specifically to the modification in the test procedure that specifies that airflow be calculated based on firing the product in the absolute maximum airflow-control setting if that setting is a default heating setting. According to Goodman, most furnaces allow heating operation at the highest airflow setting. Thus, instead of heating airflow setting being a mid-range temperature rise as typically set by factory default, it will now be a low-range temperature rise at a much higher and less efficient setting for FER calculation (and a setting that will not be typical of a field installation). (Goodman, No. 102 at p. 7) Ingersoll Rand echoed Goodman's statement, adding that the modification would also result in higher watts in heating mode and a higher FER value than would have resulted using the procedure in the SNOPR for a majority of furnaces. (Ingersoll Rand, No. 107 at pp. 2, 10).

DOE disagrees with Goodman's and Ingersoll Rand's comments. DOE expects that both interested parties have misinterpreted the test procedure requirement. DOE recognizes that product controls can be altered from factory settings to allow heating in the absolute maximum airflow-control setting. The test procedure does not allow for this practice. The test procedure only requires testing in factory-set configurations. Specific to the modification in question, the test procedure requires heating in the absolute maximum airflow-control setting only if that setting is a default heat setting. *See* Section 8.6.1.2 of Appendix AA to Subpart B of 10 CFR part 430. By definition, as outlined in the test procedure, a default heating airflow-control setting is factory-set and specified for installed-use as a heat setting by the manufacturer. *See* Section 2.2 of Appendix AA to Subpart B of 10 CFR part 430. Consequently, the resulting temperature rise is also factory-set by the manufacturer, and the measured performance will be representative of field use. In addition, the test procedure SNOPR and final rule requirements for E_{Heat} (the watts in heating mode input for FER) are consistent and the measured values for this input should not change. The impacts of the modification in question are explained in more detail in the test procedure final rule. 79 FR 514 (January 3, 2014).

AHRI commented that in the final test procedure that was published on January 3, 2014, DOE introduced a change within the test procedure that increases the measured FER. AHRI stated that DOE decided not to implement AHRI's recommendation that a furnace be fired at the maximum airflow rate to calculate the maximum airflow. Instead, according to AHRI, the final rule specifies that the maximum airflow is determined by applying the airflow equation for a heating setting and adjusting to the maximum setting based on pressure measurements. AHRI claims that this approach results in an increase of the measured FER and was not accounted within the analyses associated with the energy conservation standards NOPR TSD that was issued on October 25, 2013. AHRI recommends that DOE reevaluate the analyses within the entire TSD due to this single change. (AHRI, No. 98 at p. 3, 4)

DOE introduced the change referred to by AHRI in the April 2, 2013 test procedure SNOPR. A detailed discussion of DOE's reasoning for that change are provided in that notice. 78 FR 19616. DOE made additional changes to this provision in the test procedure final rule by requiring that the product under test be fired at the maximum airflow rate to calculate the maximum airflow for furnaces for which the maximum airflow-control setting is a default heat setting (consistent with AHRI's recommendation). *See* Section 8.6.1.2 of Appendix AA to Subpart B of 10 CFR part 430. DOE disagrees with AHRI that the change in question will result in higher FER values. DOE fan performance tests, including tests following the final test procedure, show that the maximum airflow calculated when firing the product under test in the maximum airflow control setting is typically lower than when applying the airflow equation for a heating setting and adjusting to the maximum setting based on pressure measurements. Consequently, FER values would be lower if they were derived using airflow values calculated when firing in the maximum airflow-control setting. AHRI did not provide data to the contrary. As stated above, DOE's proposed standards and the standards established by this document are valid because they are based on FER values that are consistent with the final test procedure (to include FER values employing the airflow adjustment method in question).

AHRI, Morrison, and Ingersoll Rand commented that they are opposed to DOE eliminating the HCR from the denominator of the FER equation. According to AHRI, DOE did not provide a sound technical justification for such a modification and unnecessarily penalized the FER values associated with multi-stage and modulating units. (AHRI, No. 98 at p. 2, 3; Morrison, No. 108 at p. 3, 4; Ingersoll Rand, No. 107 at p. 2, 10)

As discussed in the test procedure final rule, DOE found that including HCR in the denominator of the FER equation resulted in percent reductions in estimated annual energy consumption, as calculated for FER, of 15 percent. 79 FR 515 (January 3, 2014). Further, DOE found percent reductions in FER of approximately 30 percent when comparing single-stage products using constant-torque brushless permanent magnet (BPM) motors to multi-stage products using constant-torque BPM motors. DOE eliminated HCR from the FER equation because, as a result, percent reductions in FER dropped to 15 percent on average, which is consistent with percent reduction in estimated annual energy consumption. 79 FR 515 (January 3, 2014). DOE did not receive any new FER values for products that use a constant-torque BPM motor and multi-stage heating. DOE was also unable to find data in the public domain with which to calculate new FER values to represent such products. In the absence of new data, DOE used the raw airflow, ESP, and fan electrical energy consumption data for single-stage furnaces with constant-torque BPM motors to generate FER values reflecting the addition of theoretical multi-stage heating capabilities. Single-stage furnaces using constant-torque BPM motors typically have additional airflow-control settings that provide less airflow than the factory-set heating airflow-control setting. Theoretically, these airflow-control settings could be used for a low heat setting in a multi-stage heating configuration. DOE identified as many models as possible that meet this criterion and for which DOE has sufficient data to calculate theoretical FER values for a multi-stage configuration. For each model, DOE first calculated the temperature rise in the default heating setting based on the airflow, thermal efficiency and input heat rating in that setting. Next, DOE used a variation of the same relationship between these parameters to calculate the theoretical low input capacity that would achieve the same temperature rise for each available airflow-control setting below the heat setting. DOE then evaluated the HCR for each of the lower airflow-control settings based on the theoretical input capacity of the lower setting and the rated input capacity of the default heat setting. DOE selected the low airflow-control setting that produced an HCR between 0.4 and 0.9 that was closest to 0.7 to represent the theoretical low heating setting. DOE chose these criteria based on investigation of typical HCR values observed in currently available products. Finally, DOE calculated estimated annual energy consumption and an FER value using the single-stage model's data for the absolute maximum and constant circulation airflow-control settings and the data for the theoretical low heating setting for the heating airflow-control setting. DOE's new data shows that multi-staging reduces estimated annual energy consumption by an average of 14 percent and FER by an average of 12 percent. These findings are consistent with DOE's previous findings and support its decision to eliminate HCR from the denominator of the FER calculation.

Ingersoll Rand stated that the final test procedure reduces the estimated savings associated with BPM motors. Ingersoll Rand commented that BPM motors consume more power as static pressure increases than permanent-split capacitor (PSC) motors. (Ingersoll Rand, No. 107 at p. 2, 10)

DOE addressed this issue in the energy conservation standards NOPR. 78 FR 64084 (October 25, 2013). While BPM motors consume more power as static pressure increases, they also provide more airflow. FER is normalized by airflow to account for this difference in behavior between BPM and PSC motors. In addition, the standards established in this document are a function of airflow. BPM motor-driven fan performance is evaluated relative to PSC motor-driven fans that provide the same amount of airflow at the same reference system static pressure as a result. Interested parties did not provide any evidence that these methods are inappropriate for evaluating relative fan performance.

China WTO commented that FER includes factors, such as HCR, to account for multi-stage heating but does not include analogous factors for multi-stage cooling. (China WTO, No. 92 at p. 1)

DOE considered accounting for fan performance during multi-stage cooling operation for the test procedure NOPR. 77 FR 28680. DOE did not include factors for multi-stage cooling in the final test procedure because the presence and capacity of low-stage cooling is dependent on the cooling system with which a product containing a furnace fan is paired. DOE found in its review of publicly-available product literature that detailed characteristics of the cooling system are not typically provided. Consequently, entities performing the DOE furnace fan test procedure cannot identify the airflow-control setting that would be designated for low-stage cooling operation. In addition, multi-stage heating is not necessarily associated with multi-stage cooling capability (e.g., multi-stage cooling equipment is much less common than multi-stage heating equipment).

China WTO stated that the final test procedure does not provide a method for calculating the maximum airflow when the maximum airflow-control setting is only designated for cooling. (China WTO, No. 92 at p. 1)

The method for calculating the maximum airflow when the maximum airflow-control setting is only designated for cooling is provided in the final rule and in Section 9 of appendix AA of subpart B of part 430 of the CFR. 79 FR 524 (January 3, 2014).

The California Investor Owned Utilities (CA IOU) commented that they observed a potential error in the calculation of airflow in the final test procedure. Specifically, CA IOU recommended that DOE include the humidity ratio in pounds water vapor per pounds dry air. CA IOU submits that this addition will increase the accuracy of the calculation of specific volume of test room air in cubic feet per pound of dry air to calculate airflow. (CA IOU, No. 106 at p. 4)

The equation for calculating airflow in the final test procedure already includes the humidity ratio in pounds water vapor per pounds dry air as codified in Section 9 of appendix AA of subpart B of part 430 of the CFR.

CA IOU recommended that in addition to reporting FER, which is the basis for the performance standard, DOE require manufacturers to report individual mode electrical energy consumption values (e.g., E_{Heat}, E_{Max}, and E_{Circ}). According to CA IOU, reporting these values would greatly facilitate the development of more targeted energy efficiency incentive programs, and manufacturers already have to measure and perform these calculations for the composite FER. CA IOU recognizes that E_{Max} could represent fan electrical energy consumption in either heating or cooling mode depending on the product. Nonetheless, CA IOU also recommends that DOE require manufacturers to report fan electrical energy consumption in cooling mode even if not included in FER because having it as an additional data point could be useful for the development of utility programs across the country. CA IOU stated that energy efficiency incentive programs typically require a rigorous level of review and justification for implementation. Gaps in performance data of commercially available equipment is one of the main limiting factors in program development, contributing to the lengthy and resource-intensive data collection and verification processes. In the case of this rulemaking, manufacturers will already be required to test their products in heating, cooling, and constant circulation modes. CA IOU believes that the minimal extra effort required by manufacturers to report these values would be outweighed by the opportunity for utilities and other public agencies to develop incentive programs using these performance metrics, which in turn would positively impact manufacturers of high performing products. For these reasons, CA IOU strongly urge DOE to require manufacturers to report tested and calculated metrics that feed into a composite metric for the standard. ASAP, ASE, NCLC, and NRDC, hereinafter referred to as ASAP, *et al.*, agree. (ASAP, *et al.*, No. 105 at p. 3)

At this time, DOE is declining to adopt reporting requirements for individual mode electrical consumption values as the CA IOU suggests. While DOE is open to considering additional reporting metrics in the future, DOE believes that establishing a Federal test procedure and metric (*i.e.*, FER) will provide utility programs with a basis for establishing meaningful incentive programs as the CA IOUs desire. Further, DOE believes that reporting the aggregated electrical consumption (*i.e.*, the FER metric) will provide market differentiation amongst currently-available models, thereby allowing the utility programs to set voluntary levels for incentive programs at meaningful levels to obtain energy savings. If data and analyses are provided, which show the disaggregated levels are necessary for the proper execution of utility incentive programs, DOE will consider modifying the certification requirements for furnace fans.

Unico pointed out that DOE presents the required minimum reference system ESP values inconsistently across rulemaking documents. Unico noticed that in some documents DOE presents these values as a range for each installation type, and in other rulemaking documents DOE presents only the lower value within each range with an asterisk. (Unico, No. 93 at p. 6)

As explained in the test procedure final rule, DOE's test experience confirms manufacturer concerns that specific ESP values are difficult to achieve and maintain when measuring airflow. The final test procedure specifies that products maintain an ESP level between the minimum reference system value and 0.05 in. wc. above that minimum value to allow for slight variations. 79 FR 508 (January 3, 2014). Consequently, DOE presents the minimum required ESP values as a range in Section 8.6.1.2 in appendix AA of subpart B of part 430 in the CFR or as the minimum value with an asterisk accompanied by the explanation above in other DOE documents.

AHRI commented that DOE should provide the option of employing an alternative efficiency determination method (AEDM) to determine FER. AHRI insists that an AEDM is critical for manufacturers to implement new requirements on a timely basis while minimizing burden. AHRI believes that the number of furnace fan basic models will be greater than the number of furnace basic models. According to AHRI, the pressure drop due to the gas heat exchanger will require that each furnace basic model also be considered as a furnace fan basic model. AHRI added that additional furnace fan basic models would be created in order to account for the type of installation. AHRI also pointed out that many furnace fan manufacturers also produce several other DOE regulated products. AHRI submits that rather than requiring manufacturers to spend valuable resources on conducting several tests, DOE should recognize that those resources could be better spent on innovating more efficient products. (AHRI, No. 98 at p. 13)

DOE provided a detailed discussion of this issue in the test procedure final rule. 79 FR 513 (January 3, 2014). DOE currently does not allow the use of AEDMs for residential products, with the exception of central air conditioners and heat pumps due to the uniquely large number of combinations of split-system air conditioners and heat pumps that are rated. DOE recognizes that the number of furnace fan basic models may outnumber furnace basic models for the reasons AHRI lists. Even so, DOE expects the number of basic models of furnace fans to be significantly less than the number of basic models of residential central air conditioners and heat pumps (CAC and HP) for which alternative rating methods are currently allowed. DOE has not found the residential furnace fan market to be highly customized (*i.e.*, containing many unique built-to-order designs) and expects that manufacturers will be able to group similar individual furnace fan types into basic models to reduce testing burden. DOE notes that it currently has over 1 million CAC combinations certified in the Compliance Certification Management System (CCMS) compared to approximately 12,500 certified furnace basic models. Consequently, DOE does not agree with AHRI's assertion that an alternative rating method needs to be considered at this time. Should AHRI or the industry provide additional data or substantiation for its requests demonstrating why testing furnace fans are unique, as compared to the majority of other residential products for which AEDMs are not allowed, then DOE may consider such requests in a separate rulemaking.

B. Product Classes and Scope of Coverage

Although the title of 42 U.S.C. 6295(f) refers to ''furnaces and boilers,'' DOE notes that 42 U.S.C. 6295(f)(4)(D) was written using notably broader language than the other provisions within the same section. Specifically, that statutory provision directs DOE to ''consider and prescribe energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work.'' Such language could be interpreted as encompassing electrically-powered devices used in any residential HVAC product to circulate air through duct work, not just furnaces, and DOE has received numerous comments on both sides of this issue. However, in this rulemaking, DOE is only covering those circulation fans that are used in furnaces and modular blowers. DOE is using the term ''modular blower'' to refer to HVAC products powered by single-phase electricity that comprise an encased circulation blower that is intended to be the principal air-circulation source for the living space of a residence. A modular blower is not contained within the same cabinet as a residential furnace, CAC, or heat pump. Instead, modular blowers are designed to be paired with separate residential HVAC products that provide heating and cooling, typically a separate CAC/HP coil-only unit. DOE finds that modular blowers and electric furnaces are very similar in design. In many cases, the only difference between a modular blower and electric furnace is the presence of an electric resistance heating kit. DOE is aware that some modular blower manufacturers offer electric resistance heating kits to be installed in their modular blower models so that the modular blowers can be converted to stand-alone electric furnaces. In addition, FER values for modular blowers can be easily calculated using the final test procedure. DOE addresses the furnace fans used in modular blowers in this rulemaking for these reasons. As a result of the extent of the current rulemaking, DOE is not addressing public comments that pertain to fans in other types of HVAC products.

When evaluating and establishing energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify a different standard. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)) For this rulemaking, DOE differentiates between product classes based on internal structure and application-specific design differences that impact furnace fan energy consumption. Details regarding how internal structure and application-specific design differences that impact furnace fan energy consumption are included in chapter 3 of the final rule technical support document (TSD). DOE includes the following product classes for this rulemaking.

- Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC)
- Non-Weatherized, Condensing Gas Furnace Fan (NWG–C)
- Weatherized Non-Condensing Gas Furnace Fan (WG–NC)
- Non-Weatherized, Non-Condensing Oil Furnace Fan (NWO–NC)
- Non-Weatherized Electric Furnace/Modular Blower Fan (NWEF/NWMB)
- Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan (MH–NWG–NC)
- Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C)
- Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB)
- Mobile Home Weatherized Gas Furnace Fan (MH–WG)
- Mobile Home Non-Weatherized Oil Furnace Fan (MH–NWO)

Each product class title includes descriptors that indicate the application-specific design and internal structure of its included products. ''Weatherized'' and ''non-weatherized'' are descriptors that indicate whether the HVAC product is installed outdoors or indoors, respectively. Weatherized products also include an internal evaporator coil, while non-weatherized products are not shipped with an evaporator coil but may be designed to be paired with one. ''Condensing'' refers to the presence of a secondary, condensing heat exchanger in addition to the primary combustion heat exchanger in certain furnaces. The presence of an evaporator coil or secondary heat exchanger significantly impacts the internal structure of an HVAC product, and in turn, the energy performance of the furnace fan integrated in that HVAC product. ''Mobile home'' products meet certain design requirements that allow them to be installed in mobile homes (*e.g.,* a more compact cabinet size). Descriptors for ''gas,'' ''oil,'' or ''electric'' indicate the type of fuel that the HVAC product uses to produce heat, which determines the type and geometry of the primary heat exchanger used in the HVAC product.

C. Technological Feasibility

1. General

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

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) Practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, Section 4(a)(4)(ii)–(iv). Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this document discusses the results of the screening analysis for residential furnace fans, particularly the designs DOE considered, those it screened out, and those that are the basis for the tcrial standard levels (TSLs) 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 a new 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 residential furnace fans, 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.

D. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the products that are the subjects of this rulemaking purchased during a 30-year period that begins in the year of compliance with amended standards (2019–2048).[13] The savings are measured over the entire lifetime of products purchased in the 30-year period.[14] DOE used the NIA model to estimate the NES for products purchased over the above period. The model forecasts total energy use over the analysis period for each representative product class at efficiency levels set by each of the considered TSLs. DOE then

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

[14] In the past, DOE presented energy savings results for only the 30-year period that begins in the year of compliance. In the calculation of economic impacts, however, DOE considered operating cost savings measured over the entire lifetime of products purchased during the 30-year period. DOE has chosen to modify its presentation of national energy savings to be consistent with the approach used for its national economic analysis.

compares the aggregated energy use at each TSL to the base-case energy use to obtain the NES. The NIA model is described in section IV. H of this document and in chapter 10 of the final rule TSD.

DOE used its NIA spreadsheet model to estimate energy savings from amended standards for the products that are the subject of this rulemaking. The NIA spreadsheet model (described in section IV. H of this notice) calculates energy savings in 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 the primary (source) energy savings, which are the savings in the energy that is used to generate and transmit the site electricity. To convert site energy to primary energy, DOE derives annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) *Annual Energy Outlook 2013* (*AEO 2013*).

DOE also has begun to estimate full-fuel-cycle energy savings. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012). The full-fuel-cycle (FFC) metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy efficiency standards. DOE's evaluation of FFC savings is driven in part by the National Academy of Science's (NAS) report on FFC measurement approaches for DOE's Appliance Standards Program.[15] The NAS report discusses that FFC was primarily intended for energy efficiency standards rulemakings where multiple fuels may be used by a particular product. In the case of this rulemaking pertaining to residential furnace fans, only a single fuel—electricity—is consumed by the product. DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products. Although the addition of FFC energy savings in the rulemakings is consistent with the recommendations, the methodology for estimating FFC does not project how fuel markets would respond to this particular standards rulemaking. The FFC methodology simply estimates how much additional energy, and in turn how many tons of emissions, may be displaced if the estimated fuel were not consumed by the products covered in this rulemaking. It should be noted that inclusion of FFC savings has not affected DOE's choice of the energy conservation standards adopted in today's final rule. For more information on FFC energy savings, see section IV. H.2.

2. Significance of Savings

EPCA prohibits DOE from adopting a standard for a covered product that would not result in significant energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term ''significant'' is not defined in EPCA, the U.S. Court of Appeals for the District of Columbia, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985), opined that Congress intended ''significant'' energy savings in this context to be savings that were not ''genuinely trivial.'' The energy savings for today's standards (presented in section V of this notice) are nontrivial, and, therefore, DOE considers them ''significant'' within the meaning of section 325 of EPCA.

E. Economic Justification

1. Specific Criteria

As discussed in section II.A, 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 generally discuss how DOE is addressing each of those seven factors in this rulemaking. For further details and the results of DOE's analyses pertaining to economic justification, see sections IV and V of today's document.

Economic Impact on Manufacturers and Commercial Customers

In determining the impacts of a potential new or amended energy conservation standard on manufacturers, DOE conducts a manufacturer impact analysis (MIA), as discussed in section IV.J. DOE first determines a potential standard's quantitative impacts using an annual cash flow approach. This step includes both a short-term assessment (based on the cost and capital requirements associated with new or amended standards during the period between the announcement of a regulation and the compliance date of the regulation) and a long-term assessment (based on the costs and marginal impacts over the 30-year analysis period). The impacts analyzed include: (1) Industry net present value (INPV) (which values the industry based on 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 potential impacts on different types of manufacturers, paying particular attention to impacts on small manufacturers. Third, DOE considers the impact of new or amended standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for new or amended standards to result in plant closures and loss of capital investment, as discussed in section IV.N. Finally, DOE takes into account cumulative impacts of other DOE regulations and non-DOE regulatory requirements on manufacturers.

For individual customers, measures of economic impact include the changes in LCC and the 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 economic impacts applicable to a particular rulemaking. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard.

Savings in Operating Costs Compared to Increase in Price (Life-Cycle Costs)

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 the covered product that are likely to result from the 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 the cost of its installation) and the operating costs (including energy, maintenance, and repair costs) discounted over the lifetime of the equipment. 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. For its analysis, DOE assumes that consumers will purchase the covered product in the first year of compliance with new standards.

The LCC savings and the PBP for the considered efficiency levels are calculated relative to a base-case scenario, which reflects likely market trends in the absence of new or amended standards. DOE identifies the percentage of consumers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular

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[15] ''Review of Site (Point-of-Use) and Full-Fuel-Cycle Measurement Approaches to DOE/EERE Building Appliance Energy-Efficiency Standards,'' (Academy report) was completed in May 2009 and included five recommendations. A copy of the study can be downloaded at: *http://www.nap.edu/catalog.php?record_id=12670.*

standard level. DOE's LCC analysis is discussed in further detail in section IV.F.

Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA also 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)) DOE uses NIA spreadsheet results in its consideration of total projected savings. For the results of DOE's analyses related to the potential energy savings, see section V.B of this notice and chapter 10 of the final rule TSD.

Lessening of Utility or Performance of Equipment

In establishing product classes, and in evaluating design options and the impact of potential standard levels, DOE follows EPCA's requirement to develop standards that would not lessen the utility or performance of the products under consideration. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) DOE has determined that none of the TSLs presented in today's final rule would reduce the utility or performance of the products under consideration in this rulemaking. During the screening analysis, DOE eliminated from consideration any technology that would adversely impact customer utility. See section IV.B of this notice and chapter 4 of the final rule TSD for further details.

Impact of Any Lessening of Competition

EPCA requires DOE to consider any lessening of competition that is likely to result from setting new or amended standards. It also 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 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)(i)(V) and (ii))

To assist the Department of Justice (DOJ) in making such a determination, DOE provided DOJ with copies of both the NOPR and NOPR TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for residential furnace fans are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

Need of the Nation To Conserve Energy

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

Energy savings from energy conservation standards are also likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production (*i.e.,* from power plants). For a discussion of the results of the analyses relating to the potential environmental benefits of today's standards, see sections IV.K, IV.L and V.B.6 of this notice. DOE reports the expected environmental effects from today's standards, as well as from each TSL it considered, in chapter 13 of the final rule TSD. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs in chapter 14 of the final rule TSD.

Other Factors

EPCA allows the Secretary, in determining whether a new or amended standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) There were no other factors considered for today's final rule.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA provides for a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the new or amended standard is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values that calculate the PBP for consumers of products subject to potential new and amended energy conservation standards. These analyses include, but are not limited to, the 3-year PBP contemplated under the rebuttable presumption test. However, 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 these analyses 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 rulemaking and chapter 8 of the final rule TSD.

IV. Methodology and Discussion

A. Market and Technology Assessment

DOE develops information 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 residential furnace fans rulemaking include: (1) A determination of the scope of this rulemaking; (2) product classes; (3) manufacturers; (4) quantities and types of products sold and offered for sale; (5) retail market trends; (6) regulatory and non-regulatory programs; and (7) technologies or design options that could improve the energy efficiency of the product(s) under examination. The key findings of DOE's market assessment are summarized below. See chapter 3 of the final rule TSD for further discussion of the market and technology assessment.

1. Definition and Scope of Coverage

EPCA provides DOE with the authority to consider and prescribe new energy conservation standards for electricity used to circulate air through duct work. (42 U.S.C. 6295(f)(4)(D)) DOE adopted the term ''furnace fan'' as shorthand to describe the range of products encompassed by this statutory mandate. In the preliminary analysis, DOE interpreted its statutory mandate by defining ''furnace fan'' to include ''any electrically-powered device used in residential central heating, ventilation, and air-conditioning (HVAC) systems for the purpose of circulating air through duct work.'' 77 FR 40530, 40532 (July 10, 2012). DOE considered a typical furnace fan as consisting of a fan motor and its controls, an impeller, and a housing, all of which are components of an HVAC product that includes additional components, including the cabinet.

In response to the preliminary analysis, many interested parties disagreed with DOE's definition of ''furnace fan'' and corresponding approach to set component-level regulations, which they warned would ignore system effects that could impact both fan and HVAC system energy consumption. California investor-owned utilities CA IOUs suggested that ''furnace fan'' should be defined as a unit consisting of a fan motor, its controls, an impeller, shroud, and cabinet that houses all of the heat exchange material for the furnace. According to CA IOUs, their suggested definition would reduce ambiguity and ensure that the components in HVAC products that affect furnace fan energy consumption are considered in this rulemaking. (CA IOUs, No. 56 at p. 1) Ingersoll Rand went further and suggested a system-level regulatory approach, where the entire duct and furnace system would be regulated, maintaining that such approach would produce a more useful metric to consumers when evaluating performance. (Ingersoll Rand, PA Public Meeting Transcript, No. 43 at p. 42) Conversely, NEEP observed that by regulating fan energy use separately, the individual efficiency of the component is considered when it would otherwise be ignored by manufacturers. (NEEP, No. 51 at p. 3) Rheem commented that some designs require higher air velocity to improve heat transfer but also require more electrical consumption to drive the blower at the higher velocity. (Rheem, PA Public Meeting Transcript, No. 43 at p. 63) Rheem commented that turbulent flow is considerably more efficient for heat transfer than laminar flow,[16] but more energy is required to move turbulent air. (Rheem, No. 54 at p. 10) Similarly, Lennox and Morrison commented that in order to improve heating and cooling efficiency, often a second heating coil is added, but this also leads to higher electrical consumption by the furnace fan. (Lennox, No. 43 at p. 64; Morrison, No. 43 at p. 64) Ingersoll Rand argued that as the efficiency of the furnace fan motor increases, it dissipates less heat, and consequently, the furnace will consume more gas to compensate and meet the desired house heat load. (Ingersoll Rand, No. 43 at p. 66)

In the NOPR, DOE responded by explaining that DOE is required by EPCA to consider and prescribe new energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work. (42 U.S.C. 6295(f)(4)(D)) Consequently, in the context of furnace fans, DOE does not have latitude to apply only a single standard for the larger HVAC product (which is already regulated). Pursuant to this statutory mandate, DOE issued a NOPR which proposed energy conservation standards for circulation fans used in residential central HVAC systems (78 FR 64068 (Oct. 25, 2013)). DOE added that it did not interpret its authority as including regulating the duct work itself. DOE recognized that component-level regulations could have system-level impacts. Accordingly, DOE conducted its NOPR analyses and selected the standard levels proposed in the NOPR in such a way that meets the statutory requirements set forth by EPCA without ignoring system effects, which otherwise might compromise the thermal performance of the HVAC products that incorporate furnace fans. For example, the final test procedure codified in DOE's regulations at 10 CFR part 430, subpart B, appendix AA specifies that the furnace fan be tested as factory-installed in the HVAC product, thereby enabling the rating metric, FER, to account for system effects on airflow delivery and, ultimately, energy performance. In addition, the product class structure proposed in the NOPR allowed for differentiation of products with designs that achieve higher thermal efficiency but may have lower fan performance, such as condensing furnaces. 78 FR 64068, 64082 (Oct. 25, 2013).

In the January 3, 2014 test procedure final rule, DOE broadened its definition of ''furnace fan'' to mean ''an electrically-powered device used in a consumer product for the purpose of circulating air through ductwork.'' 79 FR 500, 521.

In response to the NOPR, DOE did not receive comments from interested parties regarding the definition of ''furnace fan'' established by the test procedure final rule. Consequently, in this standards final rule, DOE is maintaining the definition for ''furnace fan,'' codified at 10 CFR 430.2. However, DOE did receive comments on its definitions for certain product types that include furnace fans. DOE summarizes and responds to these comments later in this section of the notice.

The scope of the preliminary analysis included furnace fans used in furnaces, modular blowers, and hydronic air handlers. Even though DOE has interpreted its authority as encompassing any electrically-powered device used in residential HVAC products to circulate air through duct work, the preliminary analysis scope excluded single-package central air conditioners (CAC) and heat pumps (HP) and split-system CAC/HP blower-coil units. At the time of the preliminary analysis, DOE determined that it may consider these and other such products in a future rulemaking as data and information to develop credible analyses becomes available.

In response to the preliminary analysis, efficiency advocates expressed concern at DOE's exclusion of packaged and split-system CAC products because advocates believe current standards for these products do not maximize the technologically feasible and economically justified energy savings for the circulation fans integrated in these products. ASAP and Adjuvant stated that the metric used for CAC products does not accurately represent field conditions and requested that they be added to the scope. 78 FR 64068, 64080 (Oct. 25, 2013).

In contrast, many manufacturers submitted comments in response to the preliminary analysis that they believe that the scope of coverage presented in the preliminary analysis exceeds the statutory authority granted to DOE because the statutory language for this rulemaking is found in 42 U.S.C 6295(f) under the title ''Standards for furnaces and boilers.'' Consequently, manufacturers stated that DOE should not include any non-furnace products such as central air conditioners, heat pumps, or condensing unit-blower-coil combinations. Manufacturers also claimed that the electricity used to circulate air through duct work is already adequately accounted for in existing energy efficiency metrics for CAC and HP products that use circulation fans. 78 FR 64068, 64080–81 (Oct. 25, 2013).

In the October 25, 2013 furnace fan energy conservation standard NOPR, DOE noted that, although the title of this statutory section refers to ''furnaces and boilers,'' the applicable provision at 42 U.S.C. 6295(f)(4)(D) was written using notably broader language than the other provisions within the same section. 78

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[16] ''Laminar flow'' is as term to describe when all fluid particles move in paths parallel to the overall flow direction (*i.e.,* in layers). Laminar flow may occur when the flow channel is small and the speed is low. ''Turbulent flow'' is characterized by a three-dimensional movement of the fluid particles superimposed on the overall direction of motion. Turbulent flow may occur when the flow speed is higher and when there are obstacles in the channel that disrupt the flow profile. The turbulent flow intensifies the heat transfer, thus resulting in more efficient heat exchange.

FR 64068, 64081. Specifically, that statutory provision directs DOE to ''consider and prescribe energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work.'' *Id.* Such language could be interpreted as encompassing electrically-powered devices used in any residential HVAC product to circulate air through duct work, not just furnaces, and DOE has received numerous comments on both sides of this issue. In the standards NOPR, however, DOE only proposed energy conservation standards for those circulation fans that are used in residential furnaces and modular blowers (see discussion below). As a result, DOE did not address public comments that pertain to fans in other types of HVAC products (other than to clarify instances where there was uncertainty as to whether a given product fits within the scope of the current rulemaking). The following list describes the furnace fans which DOE proposed to address in the standards NOPR.

- *Products addressed in this rulemaking:* Furnace fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers.
- *Products not addressed in this rulemaking:* Furnace fans used in other products, such as split-system CAC and heat pump indoor units, through-the-wall indoor units, small-duct, high-velocity (SDHV) indoor units, energy recovery ventilators (ERVs), heat recovery ventilators (HRVs), draft inducer fans, exhaust fans, or hydronic air handlers.

Id.

In the October 25, 2013 NOPR, DOE also maintained its proposal to account for the electrical consumption of furnace fans while performing all active mode functions (*i.e.,* heating, cooling, and constant circulation) because furnace fans are used not just for circulating air through duct work during heating operation, but also for circulating air during cooling and constant-circulation operation. In DOE's view, in order to obtain a complete assessment of overall performance and a metric that reflects the product's electrical energy consumption during a representative average use cycle, the metric must account for electrical consumption in a set of airflow-control settings that spans all active mode functions. This would ensure a more accurate accounting of the benefits of improved furnace fans. *Id.*

China WTO commented that DOE's definition for ''furnace fan'' and the proposed scope show that residential furnace fans primarily perform the heating function. For this reason, China WTO recommended that DOE exclude fan performance for cooling operation to avoid unnecessary test procedure burden. (China WTO, No. 92 at pp. 1–2).

For the reasons stated above, the energy conservation standards established by this notice account for the electrical consumption of furnace fans while performing all active mode functions (*i.e.,* heating, cooling, and constant circulation). The commenter did not dispute the fact that fans will operate in cooling or constant-circulation mode, often for non-trivial periods of time. Because the electrical energy consumption of the fan may vary substantially depending on its mode of operation, DOE has concluded that testing fan operation in all these modes is necessary to reflect the product's energy consumption during a representative use cycle and that such testing would not be unduly burdensome to conduct.

Unico submitted comments regarding concerns with DOE's test procedure and proposed standard levels as they apply to SDHV systems. Unico explains that DOE proposed to exclude SDHV products from the rulemaking but included modular blowers and electric furnaces, resulting in a potential conflict. Unico added that most of their SDHV air handlers are modular in construction. Unico also offers an add-on electric furnace to provide secondary or backup heat, but very few systems are installed as an electric furnace. As a result, Unico expressed uncertainty whether this rule applies to SDHV modular blowers and SDHV electric furnaces. Unico provided data showing that SDHV blowers operate at different conditions compared to the products proposed to be covered and cannot meet the proposed FER levels. Ultimately, Unico expressed concerns that this rule could potentially eliminate many SDHV products from the market if they are subject to DOE's proposed standards. (Unico, No. 93 at pp.1–4)

In response to the comment, DOE clarifies that the furnace fan test procedure and the energy conservation standards established by this final rule do not apply to SDHV products, including SDHV modular blowers and electric furnaces. DOE recognizes that these products operate at different conditions which significantly impact their fan performance, as compared to the products addressed in this rulemaking. While DOE's regulations at 10 CFR 430.2 include a definition for ''small duct high velocity systems,'' it does not include a definition for small duct high velocity modular blowers or SDHV electric furnaces. Absent clarification, DOE realizes that confusion may result regarding which products are and are not covered by today's standards. Accordingly, DOE is adopting the following definition of ''small-duct high-velocity (SDHV) modular blower,'' which has been drafted to be consistent with the existing definition of ''SDHV system'' at 10 CFR 430.2:

Small-duct high-velocity (SDHV) modular blower means a product that:

- Meets the definition of ''modular blower,'' as set forth in 10 CFR part 430, subpart B, appendix AA;
- Is designed for, and produces, at least 1.2 inches of external static pressure when operated at the certified air volume rate of 220–350 CFM per rated ton of cooling in the highest default cooling airflow-controls setting; and
- When applied in the field, uses high velocity room outlets generally greater than 1,000 fpm that have less than 6.0 square inches of free area.

Similarly, DOE is adopting a definition for ''small-duct high-velocity (SDHV) electric furnace'' to read as follows:

Small-duct high-velocity (SDHV) electric furnace means a product that:

- Meets the definition of ''electric furnace,'' as set forth in 10 CFR 430.2;
- Is designed for, and produces, at least 1.2 inches of external static pressure when operated at the certified air volume rate of 220–350 CFM per rated ton of cooling in the highest default cooling airflow-control setting; and
- When applied in the field, uses high velocity room outlets generally greater than 1,000 fpm that have less than 6.0 square inches of free area.

DOE has concluded that these amendments should eliminate any confusion associated with DOE not addressing SDHV modular blowers and SDHV electric furnaces in the present rulemaking. Unico also submitted other SDHV-related concerns, but DOE need not discuss those issues further because SDHV products are not addressed in this rulemaking.

AHRI, Morrison, Goodman, Johnson Controls, and Mortex stated that modular blowers should be excluded from the scope of this rulemaking. (AHRI, No. 98 at pp. 1, 2; Morrison, No. 108 at p. 1; Goodman, No. 102 at p. 5; Johnson Controls, No. 95 at p. 2; and Mortex, NOPR Public Meeting Transcript, No. 91 at pp. 78–79). AHRI, Morrison, and Johnson Controls continue to advance an interpretation of 42 USC 6295(f)(4)(D) as being only applicable to furnaces, and these commenters argued that absent a legislative change, DOE has exceeded its statutory authority in terms of the NOPR's proposed coverage of modular blowers. (AHRI, No. 98 at pp. 1–2; Morrison, No. 108 at p. 1; and Johnson Controls, No, 95 at p. 2). AHRI and Johnson Controls added that some modular blowers in today's marketplace are not designed to operate with electric resistance heat kits, rendering the final test procedure insufficient for these products. (AHRI, No. 98 at pp. 1, 2; and Johnson Controls, No. 95 at p. 3).

ASAP, *et al.,* on the other hand, expressed support for the inclusion of modular blowers in the scope of coverage. ASAP, *et al.* stated that they understand that the strip heat used with electric furnaces is often installed in the field, which means that an ''electric furnace'' is often sold by the manufacturer as a ''modular blower.'' ASAP, *et al.* cite DOE's finding that non-weatherized and mobile home electric furnace/modular blower furnace fans represent 10 percent of all furnace fan sales. According to ASAP, *et al.,* excluding modular blowers from the scope of coverage would not only reduce energy savings from this rulemaking, but would also create a loophole—*i.e.,* manufacturers would have an incentive to sell electric furnaces as modular blowers (without strip heat installed) in order to avoid compliance with the furnace fan energy conservation standards. (ASAP, *et al.,* No. 105 at pp. 1, 2)

As stated above, DOE maintains its interpretation that the relevant statutory language at 42 U.S.C. 6295(f)(4)(D) is broader in its applicability than just furnaces, and consequently, it provides DOE authority to cover modular blowers in this rulemaking. These same arguments were already addressed in some detail in the NOPR (see 78 FR 64068, 64081 (Oct. 25, 2013)). DOE also disagrees with the contention of AHRI and Johnson Controls that the final test procedure is not sufficient to address all modular blowers. All modular blower models of which DOE is aware can be operated in conjunction with an electric resistance heat kit, and commenters did not identify any models of modular blowers that cannot. Even assuming *arguendo* that modular blowers do exist that are not designed to operate with an electric resistance heat kit, DOE expects that number of such models would be *de minimis* and that manufacturers producing modular blowers that cannot be operated in conjunction with an electric resistance heat kit would apply for a waiver from the test procedure. DOE provides more details regarding this issue in the January 3, 2014 test procedure final rule. 79 FR 504.

In its comments, Johnson Controls stated that DOE's use of the phrase ''primary heat source'' is too ambiguous, especially when certain products might be modified in the field. According to Johnson Controls, DOE's characterizations of air handlers and modular blowers when an air handler or modular blower is the primary heating source is still confusing and brings uncertainty to the NOPR market assessment. Johnson Controls commented that none of the residential air handlers, modular blowers, or residential single-package finished good models built by Johnson Controls includes factory-installed electric heat kits. Therefore, according to the commenter, electric heat kits installed in these products cannot be considered to be the primary source for heat in their applications, and so none of these products should be included in this rulemaking. Johnson Controls added that while field-installed electric heat kits are available and used frequently, the use of field kits is outside of the air handler or modular blower manufacturer's control, unlike gas furnaces where the application is known to usually be the primary heating source in the vast number of situations. (Johnson Controls, No. 95 at p. 2) NEEA, Mortex, and Daikin agreed that the contractor determines whether a CAC/HP blower-coil unit with electric resistance heat is the principal source of heating for a residence, rendering any such determination speculative for other entities. (NEEA, NOPR Public Meeting Transcript, No. 91 at pp. 64–65; Mortex, NOPR Public Meeting Transcript, No. 91 at pp. 78–79; and Daikin, NOPR Public Meeting Transcript, No. 91 at pp. 75–76)

Modular blowers are not a source of heat per DOE's definition of ''modular blower'' as provided in 10 CFR part 430, subpart B, appendix AA. Consequently, the ''principal heating source'' qualifier (per the definition of ''furnace'' at 10 CFR 430.2) does not apply to modular blowers, so this part of the ''furnace'' definition has the effect of excluding modular blowers from that definition. However, the ''furnace'' definition is not the only factor in deciding whether modular blowers are covered in this rulemaking, contrary to what Johnson Controls suggests. If electric resistance heat is added to a modular blower product, that product no longer meets DOE's definition of a ''modular blower.'' Instead, DOE considers the modified product an electric furnace, absent other design changes. Regardless of whether the electric resistance heat is factory-installed, both product variations are covered in the final test procedure and this energy conservation standard.

DOE recognizes that interested parties may have trouble determining whether a CAC/HP blower-coil unit with electric resistance heating is considered an electric furnace and thereby covered by the energy conservation standards established by this final rule. Strictly following the DOE definition for ''electric furnace'' (which references the DOE definition of ''furnace'') as set forth at 10 CFR 430.2, coverage in this final rule of a CAC/HP blower-coil with electrical resistance heating depends on whether the electric resistance heating is the ''principal heating source for the residence.'' As Johnson Controls points out, this is not as easily determined as for gas and oil furnaces. DOE expects that in the significant majority of CAC/HP blower-coil models that have electric resistance heat, the electric resistance heat is supplemental in nature and not the principal heating source for the residence. For this reason, DOE has decided that the energy conservation standards established by this rule will not cover CAC/HP blower-coil units, regardless of whether they include electric resistance heat.

Lennox argued that including weatherized commercial products in this rulemaking is unrealistic and improper. Specifically, Lennox expressed concerns that DOE mischaracterizes single-package weatherized products as ''residential'' when these products are offered with a single-phase power source. The commenter stated that these products are often used in commercial applications, explaining that single-phase weatherized products are often designed to have higher duct static pressure capability than a traditional residential furnace. Lennox commented that they have single-phase belt-drive products that are capable of operating up to 2 inches water column external static pressure to meet commercial duct static requirements. According to Lennox, BPM motors (including both constant-torque and constant-airflow BPM motors) typically used in residential products cannot achieve the high static pressures required in these commercial installations. Therefore, Lennox recommended that DOE should exclude all products marked not for residential use from standards coverage. (Lennox, No. 100 at p. 4).

DOE recognizes that industry may differentiate between residential products and commercial equipment differently than DOE. The standards established by this final rule do not cover all single-phase, single-package HVAC products, only single-phase weatherized furnaces (*i.e.,* single-phase, single-package HVAC products that include a ''furnace'' as defined at 10 CFR 430.2). Lennox did not identify, and after additional research, DOE is not aware of any weatherized gas furnace models that operate at the static pressures mentioned by the commenter. DOE expects that the operating conditions mentioned by Lennox are typical of single-package heat pump equipment, which is not covered by this rule. DOE expects the number of models covered by this rule that DOE defines as residential but are designed and operated in commercial applications to be *de minimis.* Any manufacturer which can substantiate its case that it would suffer serious hardship, gross inequity, and an unfair distribution of burdens if required to comply with the furnace fan standards may seek exception relief from DOE's Office of Hearings and Appeals (OHA).[17]

ACEEE commented that if manufacturers offered air handlers as a separate product, without the coil, the modified product would not be inherently different than a modular blower. ACEEE stated that DOE should cover CAC/HP blower-coil units following the same logic that DOE used to justify covering modular blowers (*i.e.,* because of their similarities to electric furnaces). ACEEE also commented that the DOE definition for ''modular blower'' is confusing because, in their experience, all (or almost all) conventional indoor blower units—whether furnaces, HP, or CAC—use a separate assembly (or field-fabricated 'plenum') to house the coil used as the evaporator (CAC) or evaporator and condenser (HP). (ACEEE, No. 94 at pp. 1–2, 4).

DOE disagrees with ACEEE's assessment that a CAC/HP blower-coil unit with the coil removed and an electric furnace are equally comparable to a modular blower. For example, modular blowers are typically designed to accommodate the addition of electric resistance heating kits (after which DOE would consider them as electric furnaces) without modifying the product envelope. Modular blower envelope dimensions are similar, and in many cases identical, to electric furnace dimensions as a result. In addition, the final test procedure requires an electric resistance heat kit to be installed in modular blowers to produce a temperature rise allowing for calculation of airflow for the rating metric, FER. The test configurations for electric furnaces and modular blowers are almost identical as a result. In turn, the FER values for an electric furnace and modular blower with no other design difference other than the presence of an electric resistance heat kit are expected to be approximately equivalent. On the other hand, the coils typically included in CAC/HP blower-coil units are larger than heat resistance kits. Consequently, blower-coil unit envelope dimensions are different than modular blower dimensions, which impacts fan performance. CAC/HP blower-coil unit design, as it relates to fan performance, cannot be compared to modular blower design for this reason. The final test procedure does not include methods for deriving an FER value for CAC/HP blower-coil units. Furthermore, the coil and envelope dimension differences mentioned would preclude the circulation fan performance of a CAC/HP blower-coil unit from being deemed equivalent to an otherwise similarly-designed modular blower. In addition, modular blowers and electric furnaces are product configurations installed in the field. DOE doubts that a CAC/HP blower-coil unit with the coil removed would be offered by manufacturers or purchased and installed in the field. Regarding the criticism of its definition of ''modular blower,'' DOE recognizes that the definition for ''modular blower'' as set forth at 10 CFR part 430, subpart B, appendix AA may be confusing because it does not explicitly state that a modular blower does not include an indoor refrigerant coil, only that it does not provide heating or cooling. An ''indoor unit,'' on the other hand, is defined at 10 CFR 430.2 as containing a ''coil.'' This notice modifies the definition of ''modular blower'' to explicitly exclude products that contain an indoor refrigerant coil in order to eliminate ambiguity between the two definitions.

ACEEE, Earthjustice, and CA IOU stated that DOE's decision to exclude products such as CAC/HP and hydronic air handlers is inappropriate and in conflict with DOE's interpretation of the statutory language. These interested parties also commented that DOE does not provide a justification for its decision to exclude products for which DOE claims to have authority to set energy conservation standards. (ACEEE, No. 94 at pp. 1–2, 4; and CA IOU, No. 106 at pp. 1, 2) According to Earthjustice, DOE's decision to exclude products for which it claims authority to cover represents a failure to carry out EPCA's command to adopt ''standards for electricity used for purposes of circulating air through ductwork'' and does not comply with the statute's requirement that standards ''shall be designed to achieve the maximum improvement in energy efficiency'' that is ''technologically feasible and economically justified.'' (42 U.S.C. 6295(o)(2)(A). Earthjustice adds that EPCA authorizes DOE not to prescribe an amended or new standard for a type or class of covered product in three situations: (1) The standard will eliminate certain product features from the market; (2) the standard will not result in significant conservation of energy or is not technologically feasible or economically justified; or (3) for certain products, test procedures have not been established. (42 U.S.C. 6295(o)(3) and (4)). Earthjustice states that DOE has failed to show that the products it is not addressing in this rule meet those criteria. (Earthjustice, No. 101 at p. 1).

ASAP, *et al.* encouraged DOE to adopt standards and/or test procedure changes to drive improved efficiency of furnace fans that are part of single-package and blower-coil central air conditioners and heat pumps in the future. According to ASAP, *et al.,* CA IOU and ACEEE, the operating conditions and metrics used in the DOE test procedures for CAC/HP (*i.e.,* SEER and HSPF) are insufficient for representing furnace fan performance in the field for those products. (ASAP, *et al.,* No. 105 at pp. 2, 3; CA IOU, No. 106 at pp. 1, 2; and ACEEE, No. 94 at pp. 1–2, 4). Further, ASAP, *et al.* are concerned that heat pump indoor units will increasingly be installed and operated as electric furnaces (without an outdoor unit) to avoid both the DOE standard for CAC/HP and the standards established by this rule. ASAP, *et al.* added that consumers will have greater incentive to install heat pump indoor units to operate as electric furnaces if a heat pump indoor unit with a PSC motor is less expensive than an electric furnace/modular blower with a constant-torque BPM motor. (ASAP, *et al.,* No. 105 at pp. 2, 3) Earthjustice also identified CAC/HP blower-coil units installed without an outdoor unit and operated as an electric furnace as a potential loophole. (Earthjustice, No. 101 at p. 1) While ASAP, *et al.,* stated that they recognize that it may be too late to include furnace fans that are part of single-package and blower-coil central air conditioners and heat pumps in the scope of coverage in the current rulemaking, they encourage

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[17] For information about obtaining exception relief, see 10 CFR part 1003 (available at *http://www.ecfr.gov/cgi-bin/text-idx?SID=d95bf6ed9cd849253fab734656f80c2e&node=10:4.0.3.5.3&rgn=div5*).

DOE to address furnace fan efficiency in these products in the future through one of two options: (1) Amend the test procedures for central air conditioners and heat pumps to incorporate more realistic external static pressure values; or (2) include furnace fans that are part of single-package and blower-coil central air conditioners and heat pumps in a future rulemaking for furnace fans. ASAP, *et al.,* submitted that if DOE pursued the second option, changing the external static pressure values in the central air conditioner and heat pump test procedures would be less critical, because fan efficiency would be addressed through standards for furnace fans. (ASAP, *et al.,* No. 105 at pp. 2, 3) CA IOU also expressed support for a separate, expedited rulemaking to set energy conservation standards for products not addressed in this rule. CA IOU claims that such a rule would ensure that the entire market for furnace fans is regulated, thereby avoiding the negative market impacts due to the prevalence of unregulated products. (CA IOU, No. 106 at pp. 1, 2). NEEA and NPCC also expressed disappointment that DOE is choosing to cover only two-thirds of furnace fan products by excluding indoor blower/cool units used with split system heat pump and air conditioning systems and hydronic air handlers, which leaves substantial energy savings on the table. (NEEA and NPCC, No. 96 at p. 3). ACEEE estimated that approximately two quads of potential cumulative energy savings are left uncaptured by DOE's decision to exclude CAC/HP blower-coil units, which ACEEE claims could jeopardize achievement of the Administration's goal of 3 billion tons of CO_2 avoided. (ACEEE, No. 94 at p. 1–2, 4). CA IOU cited these potential energy savings as another reason that a separate, expedited rulemaking is warranted. (CA IOU, No. 106 at pp. 1, 2). Laclede, APGA, and AGA also recommended that DOE expand the scope of this rule to include products such as split-system central air conditioners, heat pump air handlers, through-the-wall air handlers, and small-duct high-velocity air handlers that compete with the types of natural gas furnaces covered by this rules. Each cited concerns that DOE's decision to exclude fans used in these products could lead to fuel switching. (Laclede, No. 89 at p. 2; APGA, No. 90 at p. 2; and AGA, No. 110 at p. 2). Laclede believes the Department failed to adequately explain why fans in heat pumps are excluded and to clearly demonstrate how this exclusion serves the best interests of the American public.

EEI, on the other hand, supports DOE's exclusion of CAC/HP blower-coils and hydronic air handlers from this rulemaking. EEI commented that the energy used by the fans operating in the cooling mode is part of the calculation of SEER, EER, and HSPF. EEI explains that manufacturers have already made design decisions that reduce the energy usage of such fans for these systems to meet the higher air conditioner and heat pump energy conservation standards (based on SEER and HSPF) that took effect in 1992 and 2006, and will take effect in 2015. EEI stated that including these fans in this rule would be a form of ''double regulation'' of the same product. (EEI, No. 87 at p. 3) Southern Company agreed that CAC/HP fan energy is already covered by the SEER and HSPF rating. (Southern Company, NOPR Public Meeting, No. 43 at p. 70).

As explained previously, DOE has noted the relatively broad scope of the language of 42 U.S.C. 6295(f)(4)(D), which provides DOE authority to regulate ''electricity used for purposes of circulating air through duct work.'' At the present time, however, DOE is only adopting energy conservation standards for those circulation fans that are used in residential furnaces and modular blowers. The DOE test procedure for furnace fans is not currently equipped to address fans contained in central air conditioners, heat pumps, or other products, as would be required for the adoption of standards under 42 U.S.C. 6295(o)(3). Consequently, DOE is not considering standard setting for other products beyond the current scope of the rulemaking at this time.

2. Product Classes

DOE identified nine key product classes in the preliminary analysis, each of which was assigned its own candidate energy conservation standard and baseline FER. DOE identified twelve additional product classes that represent significantly fewer shipments and significantly less overall energy use. DOE grouped each non-key product class with a key product class to which it is closely related in application-specific design and internal structure (*i.e.,* the primary criteria used to differentiate between product classes). DOE assigned the analytical results of each key product class to the non-key product classes with which it is grouped because DOE expected the energy use and incremental manufacturer production costs (MPCs) of improving efficiency to be similar within each grouping. Table IV.1 lists the 21 preliminary analysis product classes.

TABLE IV.1—PRELIMINARY ANALYSIS PRODUCT CLASSES

Key product class	Additional product classes
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC).	
Non-weatherized, Condensing Gas Furnace Fan (NWG–C).	
Weatherized Non-Condensing Gas Furnace Fan (WG–NC)	Weatherized, Non-Condensing Oil Furnace Fan (WO–NC). Weatherized Electric Furnace/Modular Blower Fan (WEF/WMB). Mobile Home Weatherized Gas Furnace Fan (MH–WG). Mobile Home Weatherized Oil Furnace Fan (MH–WO). Mobile Home Weatherized Electric Furnace/Modular Blower Fan (MH–WEF/WMB).
Non-weatherized, Non-Condensing Oil Furnace Fan (NWO–NC)	Non-Weatherized, Condensing Oil Furnace Fan (NWO–C). Mobile Home Non-Weatherized Oil Furnace Fan (MH–NWO).
Non-weatherized Electric Furnace/Modular Blower Fan (NWEF/NWMB).	
Heat/Cool Hydronic Air Handler Fan (HAH–HC)	Heat-Only Hydronic Air Handler Fan (HAH–H). Hydronic Air Handler Fan with Coil (HAH–C). Mobile Home Heat/Cool Hydronic Air Handler Fan (MH–HAH–HC). Mobile Home Heat-Only Hydronic Air Handler Fan (MH–HAH–H). Mobile Home Hydronic Air Handler Fan with Coil (MH–HAH–C).
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan (MH–NWG–NC).	

TABLE IV.1—PRELIMINARY ANALYSIS PRODUCT CLASSES—Continued

Key product class	Additional product classes
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C). Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB).	

Manufacturers agreed that the selected key product classes are an accurate representation of the market. Some manufacturers disagreed with DOE's approach to specify additional product classes within a key product class, stating that shipment data indicates that the additional product classes are too small to be covered.

In the NOPR, DOE agreed with manufacturers' assertion that the additional non-key product classes represent products with few and in many cases, no shipments. 78 FR 64082. Individual discussions with manufacturers for the MIA confirmed this assertion. Additionally, review of the AHRI appliance directory revealed that only two of the additional non-key product classes have active models listed: (1) Mobile home weatherized gas furnace fans (MH–WG) and (2) mobile home non-weatherized oil furnace fans (MH–NWO). The number of active basic models for MH–WG and MH–NWO are 4 and 16, respectively. For this reason, DOE proposed in the NOPR to eliminate the additional non-key product classes except for MH–WG and MH–NWO. Due to the limited number of basic models for MH–WG and MH–NWO, DOE did not have data to directly analyze and establish standards for these additional product classes. As a result, DOE proposed to reserve space to establish standards for MH–WG and MH–NWO furnace fans in the future as sufficient data become available. DOE also proposed to exclude hydronic air handlers from consideration in this rulemaking, thereby further reducing the number of product classes addressed in the NOPR to 10. 78 FR 64082. Table IV.2 includes a list of the revised set of product classes for residential furnace fans used in the NOPR.

DOE did not receive comment or additional information on the proposed product classes, thus, DOE is not making changes to the product classes in this Final Rule. Table IV.2 includes a list of the product classes for residential furnace fans used in the Final Rule.

TABLE IV.2—PRODUCT CLASSES FOR RESIDENTIAL FURNACE FANS

Product class
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC)
Non-Weatherized, Condensing Gas Furnace Fan (NWG–C)
Weatherized Non-Condensing Gas Furnace Fan (WG–NC)
Non-Weatherized, Non-Condensing Oil Furnace Fan (NWO–NC)
Non-Weatherized Electric Furnace/Modular Blower Fan (NWEF/NWMB)
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan (MH–NWG–NC)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C)
Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB)
Mobile Home Weatherized Gas Furnace Fan (MH–WG)
Mobile Home Non-Weatherized Oil Furnace Fan (MH–NWO)

3. Technology Options

In the preliminary analysis, DOE considered seven technology options that would be expected to improve the energy efficiency of furnace fans: (1) Fan housing and airflow path design modifications; (2) high-efficiency fan motors (in some cases paired with multi-stage or modulating heating controls); (3) inverter-driven permanent-split capacitor (PSC) fan motors; (4) backward-inclined impellers; (5) constant-airflow brushless permanent magnet (BPM) motor control relays; (6) toroidal transformers; and (7) switching mode power supplies. In the NOPR, DOE revised its proposed scope of coverage to no longer address hydronic air handlers, the only furnace fan product class for which standby mode and off mode energy consumption is not already fully accounted for in the DOE energy conservation standards rulemakings for residential furnaces and residential CAC and HPs. 76 FR 37408 (June 27, 2011); 76 FR 67037 (Oct. 31, 2011). Consequently, the standby mode and off mode technology options (options 5 through 7 in the list above) are no longer applicable. In addition, DOE found that multi-staging and modulating heating controls can also improve FER, so DOE evaluated multi-staging and modulating heating controls as a separate technology option for the NOPR. 78 FR 64083.

DOE did not receive comment or additional information regarding the evaluated technology options, so DOE did not make any changes to the list of technology options identified in the NOPR. The resultant list of technology options identified to be evaluated in the screening analysis before consideration in the engineering analysis for the Final Rule include: (1) Fan housing and airflow path design modifications; (2) inverter-driven PSC fan motors; (3) high-efficiency fan motors; (4) multi-staging and modulating heating controls; and (5) backward-inclined impellers. Each identified technology option is discussed below and in more detail in chapter 3 of the Final Rule TSD.

Fan Housing and Airflow Path Design Improvements

The preliminary analysis identified fan housing and airflow path design modifications as potential technology options for improving the energy efficiency of furnace fans. Optimizing the shape of the inlet cone[18] of the fan housing, minimizing gaps between the impeller and fan housing inlet, and optimizing cut-off location and manufacturing tolerances were identified as enhancements to a fan

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[18] The inlet cone is the opening of the furnace fan housing through which return air enters the housing. The inlet cone is typically curved inward, forming a cone-like shape around the perimeter of the opening, to provide a smooth surface to direct air from outside the housing to inside the housing and into the impeller.

housing that could improve efficiency. Separately, modification of elements in the airflow path, such as the heat exchanger, could reduce internal static pressure and as a result, reduce energy consumption. Manufacturer input was requested to determine the use and practicability of these potential technology options.

Interested parties expressed support for DOE's consideration of the aerodynamics of furnace fan cabinets in its initial analysis of technology options. In particular, ASAP cited a 2003 GE study[19] that quantified energy savings produced by modifying fan housing as justification for its inclusion as an option. ACEEE, *et al.* also cited a Lawrence Berkeley National Laboratory (LBNL) study[20] that linked changes in efficiency to modifying the clearance between fan housing and an air handler cabinet wall. Ingersoll Rand stated that there are proprietary fan housing designs on the market that already improve mechanical efficiency by 10–20 percent at a cost much lower than the cost to implement high-efficiency motors or make changes to the impeller and its tolerances. 78 FR 64083.

DOE is aware of the studies cited by ASAP and ACEEE, as well as the proprietary housing design mentioned by Ingersoll Rand. For the NOPR, DOE decided to include fan housing design modifications as a technology to be evaluated further in the screening analysis because of these indications that each could improve fan efficiency. 78 FR 64083.

Many interested parties requested that DOE keep airflow path design as a technology option. Manufacturers stated that improving airflow path design, like modifying fan housing, is highly cost-effective when compared to other enhancements. Similar to the fan housing design modifications, DOE decided to include airflow path design as a technology option to be evaluated further in the screening analysis as a result of these claims of potential fan efficiency improvement. 78 FR 64083. DOE believes including airflow path design is appropriate because of its potential to impact fan efficiency. Airflow path design will impact the rating metric, FER, because the DOE test procedure requires the furnace fan to be tested as it is factory-installed in the HVAC product.

DOE did not receive comment or additional information on fan housing about including airflow path design improvements as a technology option, thus, DOE is including these as technologies to be evaluated further in the screening analysis. Chapter 3 of the Final Rule TSD provides more technical detail regarding fan housing and airflow path design modifications and how these measures could reduce furnace fan energy consumption.

Inverter Controls for PSC Motors

In the preliminary analysis, DOE identified inverter-driven PSC motors as a technology option. DOE is aware of a series of non-weatherized gas furnaces with inverter-driven PSC furnace fan motors that was once commercially available. DOE has determined that inverter controls provide efficiency improvement by offering additional intermediate airflow-control settings and a wider range of airflow-control settings (*i.e.,* lower turndown ratio) than conventional PSC controls. The additional airflow-control settings and range enable the furnace fan to better match demand. Publically-available performance data for the series of furnaces using inverter-driven PSCs demonstrate that the use of this technology results in reduced FER values compared to baseline PSC furnace fans. Consequently, DOE considered inverter-driven PSCs as a technologically feasible option for reducing furnace fan energy consumption.

Manufacturers were opposed to listing inverter-driven PSCs as a viable technology option. Manufacturers commented that there are alternate, more cost-effective solutions to reduce energy consumption for air-moving systems, such as airflow path design or ECM (referred to herein by DOE as a ''constant-airflow BPM motor'') technology. 78 FR 64084.

For the NOPR analysis, DOE recognized manufacturers' concerns with the cost-effectiveness of inverter-driven PSC fan motors. However, DOE decided to include inverter-driven PSC motors as a technology option to be evaluated further in the screening analysis due to their potential to reduce furnace fan energy consumption. 78 FR 64084.

DOE did not receive comment or additional information on including inverter controls for PSC motors as a technology option, thus, DOE is including this technology option in the Final Rule. DOE evaluates in the engineering analysis the cost-effectiveness of all energy-saving technology options that are not screened out. Chapter 3 of the Final Rule TSD provides a more detailed discussion of inverter-driven PSC furnace fan motors.

High-Efficiency Motors

In the preliminary analysis, DOE identified four motor types that are typically used in furnace fan assemblies: (1) PSC motors; (2) PSC motors that have more than 3 airflow-control settings and sometimes improved materials (hereinafter referred to as ''improved PSC'' motors); (3) constant-torque BPM motors (often referred to as ''X13 motors''); and (4) constant-airflow BPM motors (often referred to as ''ECMs'').[21] DOE finds that furnace fans using high-efficiency motor technology options operate more efficiently than furnace fans using baseline PSC motors by:

- Functioning more efficiently at a given operating condition;
- Maintaining efficiency throughout the expected operating range; and
- Achieving a lower turndown ratio[22] (*i.e.,* ratio of airflow in lowest setting to airflow in highest setting).

Ingersoll Rand commented that a PSC motor will use less energy at higher static pressures, while an ECM increases energy use as static pressure rises. Ingersoll Rand stated that as a result, understanding the impact of switching to an ECM at higher static pressures may confuse the consumer. (Ingersoll Rand, PA Public Meeting Transcript, No. 43 at p. 67)

For the NOPR analysis, DOE stated that it is aware that consumers may be confused when BPM motors (referred to as ECMs by Ingersoll Rand above) consume more energy than PSC motors at higher static pressures, because consumers expect BPM motors to consume less energy than PSC motors under the same operating conditions. In general, input power to the fan motor increases as static pressure increases to provide a given airflow (*i.e.,* the fan motor has to work harder in the face of increased resistance to provide a desired amount of air).[23] DOE agreed with Ingersoll Rand that as static pressure increases, input power to a PSC-driven furnace fan will decrease, which is

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[19] Wiegman, Herman, Final Report for the Variable Speed Integrated Intelligent HVAC Blower (2003) (Available at: *http://www.osti.gov/bridge/servlets/purl/835010-GyvYDi/native/835010.pdf*).

[20] Walker, I.S, State-of-the-art in Residential and Small Commercial Air Handler Performance (2005) LBNL 57330 (Available at: *http://epb.lbl.gov/publications/pdf/lbnl-57330plus.pdf*).

[21] ''ECM'' and ''X13'' refer to the constant-airflow and constant torque (respectively) BPM offerings of a specific motor manufacturer. Throughout this notice, DOE will refer to these technologies using generic terms, which are introduced in the list above. However, DOE's summaries of interested-party submitted comments include the terminology used by the interested party when referring to motor technologies.

[22] A lower turndown ratio can significantly improve furnace fan efficiency because fan input power has a cubic relationship with airflow.

[23] See chapter 3 of the TSD for more details regarding fan operation.

seemingly contradictory to the principle described above. DOE found that input power to a PSC-driven furnace fan decreases because the airflow provided by the fan decreases as static pressure rises (*i.e.,* the fan does not have to work as hard in the face of increased resistance because the fan is not providing as much air). 78 FR 64084. Input power to a constant-airflow BPM motor-driven furnace fan, on the other hand, will increase as static pressure rises because the BPM motor-driven fan is designed to maintain the desired level of airflow. Recognizing that this behavior could complicate comparing the relative performance of these motor technologies, DOE's rating metric, FER, is normalized by airflow to result in ratings that are in units of watts/cfm. DOE believed that a comparison using a watts/cfm metric will mitigate confusion by accurately reflecting that even though a constant-airflow BPM motor is consuming more power at higher statics, it is also providing more airflow, which is useful to the consumer.

As detailed in the NOPR, interested parties recognized the benefits provided by constant-torque and constant-airflow BPM motors. Interested parties also agreed that the BPM motor variations (*i.e.,* constant-torque and constant-airflow) and inverter-driven PSC motors generally have lower turndown ratios than a three-speed PSC motor. 78 FR 64084. Table IV.3 contains the turndown ratio estimates supplied publicly by interested parties. Manufacturers generally provided similar feedback during interviews.

TABLE IV.3—INTERESTED PARTY ESTIMATED FAN MOTOR TURNDOWN RATIOS

Interested party	PSC	Wave chopper controller PSC	Constant-torque ECM	Constant-airflow ECM
NMC (NMC, No. 60 at p. 1)	0.45	0.36	0.45	0.20
Goodman (Goodman, No. 50 at p. 2)	0.70–0.75		0.40–0.50	0.25–0.35
Rheem (Rheem, No. 54 at p. 6)	0.60		0.30	0.20

Overall, comments regarding high-efficiency motor turndown ratio validated DOE's expectation that lower turndowns are associated with improved PSCs, inverter-driven PSCs, and BPM motor variations. These motors consume significantly less energy over a typical residential furnace fan operating range. DOE disagreed with Lennox that including constant circulation as part of FER would "artificially" inflate the performance of BPM motors compared to PSC motors, because DOE concluded that there is non-trivial use of this mode by consumers. 78 FR 64085. As part of the test procedure rulemaking, DOE estimated that on average, consumers operate furnace fans in constant-circulation mode 400 hours annually. This estimate is used to weight fan constant-circulation electrical energy consumption in FER. Excluding this mode from the rating metric would underestimate the potential efficiency improvements of technology options, such as BPM motors, that could reduce fan electrical consumption while performing this function. A detailed discussion of DOE's estimate for national average constant-circulation furnace fan operating hours can be found in the test procedure NOPR. 77 FR 28674, 28682 (May 15, 2012). DOE did not revise these estimates in the test procedure Final Rule published on January 3, 2014. 79 FR 499.

DOE did not receive comment or additional information on including high-efficiency motors as a technology option, thus, DOE is including this technology option in the Final Rule. DOE evaluates in the engineering analysis the cost-effectiveness of all energy-saving technology options that are not screened out. Chapter 3 of the Final Rule TSD provides a more detailed discussion of high-efficiency furnace fan motors.

Multi-Stage or Modulating Heating Controls

In the preliminary analysis (77 FR 40530 (July 10, 2012)), DOE identified two-stage and modulating heating controls (hereinafter collectively referred to as "multi-stage" controls) as a method of reducing residential furnace fan energy consumption. Multi-stage furnaces typically operate at lower heat input rates and, in turn, a lower airflow-control setting for extended periods of time compared to single-stage furnaces to heat a residence.[24] Due to the cubic relationship between fan input power and airflow, operating at the reduced airflow-control setting reduces overall fan electrical energy consumption for heating despite the extended hours. In the preliminary analysis, DOE analyzed multi-staging controls paired with use of a constant-airflow BPM fan motor as one technology option, because DOE found the two to be almost exclusively used together in commercially-available products.

Interested parties encouraged DOE to consider X13-level motors applied with multi-stage furnace controls as a technology option. 78 FR 64085. During interviews, manufacturers commented that multi-stage heating controls can be and are used regardless of motor type.

Based on comments from manufacturers, DOE recognized that multi-stage controls can be paired with other motor types, not just constant-airflow BPM motors. DOE agreed with interested parties that implementing multi-stage heating controls independent of motor type could result in residential furnace fan efficiency improvements. Consequently, DOE decided to de-couple multi-staging controls from the constant-airflow BPM motor technology option. Accordingly, DOE evaluated multi-staging controls as a separate technology option for the NOPR. 78 FR 64085.

DOE did not receive comment or additional information on multi-staging controls as a technology option, thus, DOE is including this technology option in the Final Rule.

Backward-Inclined Impellers

DOE determined in the preliminary analysis that using backward-inclined impellers could lead to possible residential furnace fan energy savings. Although limited commercial data regarding backward-inclined impeller performance were available, DOE cited research by General Electric (GE) that showed large improvements in efficiency were achievable under certain operating conditions.[25]

Interested parties disagreed with the DOE's findings, stating that literature indicates there are varying degrees of performance improvement when

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[24] A further discussion of multi-stage heating controls is found in chapter 3 of the preliminary analysis TSD, which can be found at the following web address: *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0011-0037.*

[25] Wiegman, Herman, Final Report for the Variable Speed Integrated Intelligent HVAC Blower (2003) (Available at: *http://www.osti.gov/bridge/servlets/purl/835010-GyvYDi/native/835010.pdf*).

backward-inclined impellers are used in place of forward-curved impellers. 78 FR 64085. Ebm-papst, a company that provides custom air-movement products, offered a diverging opinion from most manufacturers regarding the energy-saving potential of backward-inclined impellers. That company retrofitted several HVAC products with furnace fan assemblies that incorporated backward-inclined impellers without increasing cabinet size and tested them. Depending on the application and the external static pressure load (typically 0.5 in. w.c. to 1 in. w.c.), ebm-papst found that the backward-inclined impeller achieved input power reductions from 15–30 percent. (ebm-papst Inc., No. 52 at p. 1).

DOE recognized that backward-inclined impellers may not be more efficient than forward-curved impellers under all operating conditions and that there may be considerable constraints to implementation. However, the GE prototype and ebm-papst prototype both demonstrate that significant energy consumption reduction is achievable at some points within the range of residential furnace fan operation. For this reason, DOE included backward-inclined impellers as a technology option in the NOPR. 78 FR 64086.

DOE did not receive additional comment or information on including backward-inclined impellers as a technology option. Thus, DOE included backward-inclined impellers as a technology to be evaluated further in the screening analysis for the Final Rule.

B. Screening Analysis

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

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

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

3. *Impacts on product utility or product availability.* If it is determined that a technology would have significant adverse impact on the utility of the product to significant subgroups of consumers or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

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

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

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

1. Screened-Out Technologies

DOE screened out fan housing and airflow path design improvements in the preliminary analysis. DOE had little quantitative data to correlate specific fan housing alterations with efficiency improvements. Additionally, DOE anticipated that any improvements to airflow path design that would result in fan efficiency improvement would require an increase in furnace fan cabinet size or negatively impact heat exchanger performance, thereby compromising the practicability to manufacture or reducing utility to consumers.

In response to the preliminary analysis, interested parties stated many concerns associated with modifying airflow path designs to reduce residential furnace fan electrical energy consumption, namely, that airflow path design modifications would likely require increasing HVAC product size. Manufacturers explained that increasing HVAC products size would have adverse impacts on practicability to install and consumer utility, because the furnace fan market is predominantly a replacement market. 78 FR 64086.

For the NOPR, DOE did not receive or find additional quantitative data that shows a measurable increase in fan efficiency as a result of a specific fan housing or airflow path design modification. Even after individual discussion with manufacturers, DOE was not able to identify a case in which fan housing or airflow path design modifications could lead to potential fan energy savings without increasing the size of the HVAC product or compromising thermal performance or safety. DOE is aware of the impacts on thermal efficiency and furnace fan performance of the additional heat exchanger in condensing furnaces. As discussed in section III.B, DOE accounted for these impacts in its criteria for differentiating product classes. In addition, DOE concurs with manufacturers' observations that an increase in envelope size would adversely impact practicability to manufacture and install, as well as product utility. Accordingly, DOE decided to screen out fan housing and airflow path design modifications in the NOPR. 78 FR 64086.

DOE did not receive additional comment or information regarding fan housing and airflow path design modifications in response to the NOPR. Thus, DOE determined to screen out fan housing and airflow path design modifications in the Final Rule.

2. Remaining Technologies

Through a review of each technology, DOE found that all of the other identified technologies met all four screening criteria to be examined further in DOE's analysis. 78 FR 64087. In summary, DOE did not screen out the following technology options: (1) Inverter-driven PSC fan motors; (2) high-efficiency fan motors; (3) multi-stage heating controls; and (4) backward-inclined impellers. DOE understands that all of these technology options are technologically feasible, given that the evaluated technologies are being used (or have been used) in commercially-available products or working prototypes. These technologies all incorporate materials and components that are commercially available in today's supply markets for the residential furnace fans that are the subject of this Final Rule. Therefore, DOE believes all of the efficiency levels evaluated in this notice are technologically feasible. For additional details, please see chapter 4 of the Final Rule TSD.

Interested parties, however, voiced concerns regarding these screening criteria as they apply to BPM fan motors and backward-inclined impellers in previous phases of this rulemaking. DOE summarizes and addresses these concerns in the sections immediately below. DOE did not receive public comments relevant to the screening analysis criteria for the other remaining technology options.

High-Efficiency Motors

In response to the preliminary analysis, manufacturers stated that there are a limited number of ECM motor suppliers to furnace fan manufacturers, and that it is a proprietary technology. Manufacturers also stated that no alternative ECM exists at the scale of Regal Beloit ECMs and that limiting PSC applicability would reduce product flexibility.

Motor manufacturers disagreed with residential furnace fan manufacturers, claiming that there is more than just a single motor manufacturer offering ECM technology. Motor manufacturers also supported DOE's assumption that after implementation of furnace fan efficiency standards, brushless permanent magnet motor technologies will become increasingly available over time. DOE discovered during interviews with manufacturers that there are multiple suppliers of BPM motors. DOE also found further evidence that some manufacturers purchase BPM motors from multiple suppliers. EEI stated that the expiration of Regal Beloit ECM patents around 2020 may increase the availability of this motor type while decreasing cost. (EEI, PA Public Meeting Transcript, No. 43 at p. 127)

In the preliminary analysis, DOE requested comment as to whether manufacturers could alternatively develop BPM motor controls in-house when using high-efficiency motors from other, non-Regal Beloit, suppliers. Most furnace fan manufacturers claimed that development of in-house controls for BPM motors is not an option. 78 FR 64087.

While DOE recognizes that Regal Beloit possesses a number of patents in the BPM motor space, other motor manufacturers (*e.g.,* Broad Ocean, ebm-papbst, and NMC) also offer BPM models. Additionally, DOE is aware that in years past, residential furnace fans paired with constant-airflow BPM motors accounted for 30 percent of the market. While DOE estimates that constant-airflow BPM motors represent only 10–15 percent of the current furnace fan market, the manufacturing capability to meet BPM motor demand exists. Thus, DOE continues to expect that BPM motor technology is currently available from more than one source and will become increasingly available to residential furnace fan manufacturers. 78 FR 64087.

Also in response to the preliminary analysis, some fan manufacturers expressed concern that high-efficiency motor reliance on rare earth metals would impact supply. However, DOE is aware of high-efficiency motors that do not contain rare earth materials. DOE is also confident, after discussions with manufacturers, that if BPM motors are adopted as a means to meet a future residential furnace fan energy conservation standard, manufacturers would have a number of cost- and performance-competitive suppliers from which to choose who have available, or could rapidly develop, control systems independently of the motor manufacturer. 78 FR 64087.

DOE did not receive additional comment or information in response to the NOPR about high-efficiency motors related to the screening criteria. Thus DOE included high-efficiency motors as a technology option in the engineering analysis.

Backward-Inclined Impellers

In response to the preliminary analysis, furnace fan manufacturers stated that backward-inclined impellers must have larger diameter and operate at higher speed than forward-curve impellors in order to attain equivalent performance (*i.e.,* flow and pressure rise). However, ebm-papst stated that they retrofitted existing equipment with backward-inclined impellers, which only required making minor changes to the airflow path within the equipment. 78 FR 64088.

Manufacturers were also concerned with the potential impacts that backward-inclined impellers could have on heat exchanger temperatures. Some commenters also argued that backward-inclined impellers may affect furnace fan utility, because the noise produced by this impeller type may limit product application. Utilities claimed that a backward-inclined impeller, in combination with increased fan motor speeds to achieve higher efficiency, leads to amplified noise levels. 78 FR 64088.

For the NOPR, DOE found that there are multiple approaches to implementing backward-inclined impellers to reduce furnace fan energy consumption. DOE recognized that one approach is to use a backward-inclined impeller that is larger than a standard forward-curved impeller, which may lead to larger HVAC products. Another approach is to pair the backward-inclined impeller with a motor that operates at increased RPM. Ebm-papst tests show a significant potential to reduce fan electrical energy consumption for a backward-inclined impeller assembly that uses existing motor technology at higher RPMs and is implemented in existing HVAC products (i.e., no increase in product size required). Ebm-papst does not believe that achieving higher RPMs with existing motor technology is an obstacle for implementing this technology. DOE believed that this prototype represented a backward-inclined implementation approach that could achieve fan energy savings while avoiding the negative impacts listed by manufacturers. Consequently, DOE decided not to screen out the backward-inclined impeller technology option in the NOPR. 78 FR 64088.

DOE did not receive additional comment or information about backward-inclined impellers related to the screening criteria. Thus, DOE decided not to screen out backward-inclined impellers in the Final Rule.

C. Engineering Analysis

In the engineering analysis (corresponding to chapter 5 of the Final Rule TSD), DOE establishes the relationship between the manufacturer selling price (MSP) and improved residential furnace fan efficiency. This relationship serves as the basis for cost-benefit calculations for individual consumers, manufacturers, and the Nation. DOE typically structures the engineering analysis using one of three approaches: (1) Design option; (2) efficiency level; or (3) reverse engineering (or cost-assessment). The design-option approach involves adding the estimated cost and efficiency of various efficiency-improving design changes to the baseline to model different levels of efficiency. The efficiency-level approach uses estimates of cost and efficiency at discrete levels of efficiency from publicly-available information, and information gathered in manufacturer interviews that is supplemented and verified through technology reviews. The reverse engineering approach involves testing products for efficiency and determining cost from a detailed bill of materials derived from reverse engineering representative products. The efficiency values range from that of a least-efficient furnace fan sold today (*i.e.,* the baseline) to the maximum technologically feasible efficiency level. For each efficiency level examined, DOE determines the MSP; this relationship is referred to as a cost-efficiency curve.

1. Efficiency Levels

In this rulemaking, DOE used an efficiency-level approach in conjunction with a design-option approach to identify incremental improvements in efficiency for each product class. An efficiency-level approach enabled DOE to identify incremental improvements in efficiency for efficiency-improving technologies that furnace fan manufacturers already incorporate in commercially-available models. A design-option approach enabled DOE to model incremental improvements in efficiency for technologies that are not commercially available in residential furnace fan applications. In combination with these approaches, DOE used a cost-assessment approach to determine the manufacturing production cost (MPC) at each efficiency level identified for analysis. This methodology estimates the incremental cost of increasing product efficiency. When analyzing the cost of each efficiency level, the MPC is not for the entire HVAC product, because furnace fans are a component of the HVAC product in which they are integrated. The MPC includes costs only for the components of the HVAC product that impact FER.

Baseline

During the preliminary analysis, DOE selected baseline units typical of the least-efficient furnace fans used in commercially-available, residential HVAC models that have a large number of annual shipments. This sets the starting point for analyzing potential technologies that provide energy efficiency improvements. Additional details on the selection of baseline units may be found in chapter 5 of the Final Rule TSD. DOE compared the FER at higher energy efficiency levels to the FER of the baseline unit and compared baseline MPCs to the MPCs at higher efficiency levels.

DOE reviewed FER values that it calculated using test data and performance information from publicly-available product literature to determine baseline FER ratings. Table IV.4 presents the baseline FER values identified in the preliminary analysis for each product class.

TABLE IV.4—PRELIMINARY ANALYSIS BASELINE FER

Product class	FER (W/1,000 cfm)
Non-Weatherized, Non-Condensing Gas Furnace Fan	380
Non-Weatherized, Condensing Gas Furnace Fan	393
Weatherized, Non-Condensing Gas Furnace Fan	333
Non-Weatherized, Non-Condensing Oil Furnace Fan	333
Electric Furnace/Modular Blower Fan	312
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	295
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	319
Mobile Home Electric Furnace/Modular Blower Fan	243

In response to the preliminary analysis, manufacturers asserted that the baseline FER values presented were not representative of the furnace fans in the least-efficient residential HVAC models offered for sale today. Some manufacturers also requested that DOE alter FER to better reflect unit capacity. Specifically, some manufacturers stated that residential furnace fans having a larger capacity also have higher FERs and recommended that DOE adjust baseline FER values to include the largest-capacity fan within a product class. 78 FR 64089.

In the NOPR, DOE evaluated the feedback it received and used the data provided by interested parties to generate new FER values and to revise its baseline, intermediate efficiency levels, and max-tech FER estimates. DOE's revisions included FER results for furnace fan models that span the capacity range of residential products. After reviewing all of the available FER values based on new data, DOE concluded that FER can best be represented as a linear function of airflow capacity (*i.e.,* a first constant added to airflow multiplied by a second constant). The slope of the linear fit characterizes the change in FER for each unit of airflow capacity increase, and the y-intercept represents where the FER line intersects the y-axis (where airflow capacity is theoretically zero). For the NOPR, DOE proposed to use such linear functions to represent FER for the different efficiency levels of the different product classes. 78 FR 64089.

Table IV.5 shows the revised FER baseline efficiency levels estimates that DOE used for the NOPR.

TABLE IV.5—NOPR BASELINE FER ESTIMATES

Product class	FER* (W/1,000 cfm)
Non-Weatherized, Non-Condensing Gas Furnace Fan	FER = $0.057 \times Q_{Max} + 362$.
Non-Weatherized, Condensing Gas Furnace Fan	FER = $0.057 \times Q_{Max} + 395$.
Weatherized Non-Condensing Gas Furnace Fan	FER = $0.057 \times Q_{Max} + 271$.
Non-Weatherized, Non-Condensing Oil Furnace Fan	FER = $0.057 \times Q_{Max} + 336$.
Electric Furnace/Modular Blower Fan	FER = $0.057 \times Q_{Max} + 331$.
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	FER = $0.057 \times Q_{Max} + 271$.
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	FER = $0.057 \times Q_{Max} + 293$.
Mobile Home Electric Furnace/Modular Blower Fan	FER = $0.057 \times Q_{Max} + 211$.
Mobile Home Weatherized Gas Furnace Fan	Reserved.
Mobile Home Non-Weatherized Oil Furnace Fan	Reserved.

*Q_{Max} is the airflow, in cfm, at the maximum airflow-control setting measured using the proposed DOE test procedure at the time of the ECS NOPR publication. 78 FR 19606, 19627 (April 2, 2013).

Manufacturers stated that the baseline FER values presented in the NOPR need to be re-evaluated to determine the appropriate baseline. Because the test procedure was not finalized at the time of the ECS NOPR publication, Lennox believes that assumptions were made by DOE to determine the baseline from other sources, leading to overstated energy savings and misleading conclusions. (Lennox, No. 100 at p. 3) Goodman believes that the NOPR baseline values are too high. Goodman initially commented that baseline values were too low for the preliminary analysis. Based on the product testing per the April 2013 test procedure SNOPR, Goodman feels the increased values for baseline FER are too high, and should be closer (but still higher than) the original TSD estimated values. (Goodman, No. 102 at p. 8) Morrison, NEEA, and NPPC also commented that because there was no finalized test procedure at the time the ECS NOPR was published, DOE should not be using test data from public literature to generate FER values. (Morrison, No. 91 at p. 124; NEEA, NPCC, No. 96 at p. 2) Ingersoll-Rand echoed Lennox's and Morrison's comments, stating that it is difficult to get furnace fan power data from public literature, and that DOE's baseline FER values are over-estimated. (Ingersoll-Rand, No. 91 at pp. 110–111) Rheem and Lennox questioned whether the efficiency levels are based off of FER or the average annual auxiliary electrical energy consumption (E_{ae}). (Rheem, No. 83 at p. 4; Lennox, No. 100 at p. 3) Lennox and Ingersoll-Rand also commented specifically about the baseline FER for weatherized gas furnaces, citing a dramatic difference in DOE's baseline performance level as compared to their product offerings. Additionally, when the performance improvement factors are applied to DOE's baseline, the result is a very aggressive mandated increase in performance. (Lennox, No. 100 at p. 3; Ingersoll-Rand, No. 107 at p. 4) AHRI also commented on the FER for weatherized gas furnaces, stating that the FER values for weatherized gas furnace fans and non-weatherized condensing gas furnace fans should be the same because the test procedure is the same for both products, except for a difference in ESP. AHRI explained the difference in ESP accounts for the cooling coil within the weatherized gas furnace, therefore, in effect, the furnace fan assemblies for weatherized and non-weatherized gas furnaces are subject to the same ESP. (AHRI, No. 91 at pp. 127–129) Goodman agreed with AHRI that weatherized gas furnace fans should have the save efficiency levels as non-weatherized gas, non-condensing furnace fans. (Goodman, No. 102 at p. 3)

DOE did not use E_{ae} as an input for the engineering analysis. All efficiency levels considered by DOE throughout this rulemaking, including the baseline, are based on FER data, not E_{ae}. DOE used E_{ae} as a proxy for FER to evaluate market-wide energy performance of furnace fans in the market and technology assessment only. Further description of this characterization is found in chapter 3 of the Final Rule TSD. DOE disagrees with Lennox, Morrison, NEEA, and NPPC that FER values that DOE generated prior to the final test procedure or based on public literature should not be considered in this Final Rule. DOE outlines in detail in section III.A the reasons that FER data from previous stages of the rulemaking and public literature are relevant. Section III.A also explains how DOE's changes to the test procedure between the test procedure SNOPR and final rule should not result in significant differences in FER values for many covered products. Thus, DOE disagrees with Ingersoll Rand, Lennox, Goodman, and Morrison's claims that, in the absence of a final test procedure or because of changes in the final test procedure, DOE used unreliable information to calculate FER and model efficiency levels for the NOPR. Regardless, DOE agrees with interested parties that DOE should re-update its NOPR baseline equations based on new data. DOE received some baseline FER data from interested parties in response to the NOPR. As discussed in section III.A, DOE also conducted testing prior to and during the development of the test procedure final rule that generated a broad enough set of results to enable DOE to derive FER values that are consistent with the requirements of the final test procedure. DOE used this new baseline FER data to revise its baseline equations.

DOE investigated interested party claims that DOE's proposed baseline equation for weatherized gas furnace fans did not match manufacturer performance estimates. DOE did not receive additional baseline FER data for weatherized gas furnace fans. However, DOE did derive additional FER values from data from specification sheets and testing of weatherized gas furnaces at higher efficiency levels (i.e., weatherized gas furnaces that use constant-torque and constant-airflow BPM motors). DOE was able to collect more reliable FER data for more efficient weatherized gas furnace fans than for baseline weatherized gas furnace fans. Consequently, DOE estimated the weatherized gas furnace fan baseline FER by multiplying the market and capacity weighted FER value for weatherized gas furnace fans with constant-airflow BPM motor and multi-staging by the expected percent increase in FER (i.e., the inverse of the expected percent reduction in FER for constant-airflow BPM and multi-staging). DOE then developed a conversion factor from the non-weatherized, non-condensing gas furnace fan baseline FER to generate a y-intercept for the weatherized non-condensing gas furnace fan baseline FER equation. This approach significantly increased DOE's estimated baseline FER for weatherized non-condensing gas furnace fans to a level consistent with the revised baseline for non-weatherized, condensing gas furnace fans. Even though they are not identical, DOE concludes that the approach described is appropriate based on interested party feedback. The airflow path design of weatherized non-condensing gas and non-weatherized, condensing gas furnaces are very different, which impacts furnace fan performance, accounting for the slightly different FER equations.

DOE also received comments from interested parties regarding the slopes in the NOPR FER equations. Rheem and Lennox commented that the slope characterizing the relationship between FER and airflow capacity is too flat, adding that higher-capacity models are space constrained, and their FER values do not meet the proposed FER levels in the NOPR. (Rheem, No. 83 at p. 8; Lennox, No. 100 at p. 6) Ingersoll-Rand commented that for condensing furnaces and furnaces using improved PSC motors and multi-staging controls, FER tends to decrease as capacity increases, creating a negative slope. (Ingersoll-Rand, No. 91 at pp. 110–111; Ingersoll-Rand, No. 107 at pp. 3–4) Ingersoll-Rand also commented that even though FER values for furnace fans with PSC motors follow a linear trend, FER values for furnace fans that use BPM motor technologies do not because they react differently to changes in static pressure (Ingersoll-Rand, No. 107 at p. 5) ACEEE, Goodman, and Mortex questioned whether a linear slope is the best way to characterize the relationship between FER and airflow capacity. AHRI and Goodman added that there is a cubic relationship between fan input power and airflow, thus, a non-linear slope may be more appropriate. (ACEEE, No. 94 at p. 3; Goodman, No. 102 at p. 13; Mortex, No. 104 at p. 3; AHRI, No. 98 at p. 3)

In response to interested party comments, DOE recalculated FER versus airflow capacity slopes using new data from baseline series for both non-weatherized, non-condensing gas furnace fans and non-weatherized, condensing gas furnace fans. DOE found that the average baseline slope increased dramatically from 0.057 to 0.081. DOE is aware that some instances of furnace series models will not match DOE's slope analysis results. The data, that DOE has, shows a positive slope when characterizing the relationship between

FER and airflow capacity. Furthermore, DOE did not determine that a linear fit was the best fit statistically. DOE believes a linear fit is the best representation of furnace fan performance given the level of data available. DOE finds that linear fits result in a distribution of efficiency levels that match the distribution of furnace fan performance by technology option used. Additionally, a cubic trend-line does not account for changes in furnace envelope size, heat exchanger size, furnace fan outlet size, and other factors the affect furnace fan performance. Using a cubic trend-line would only be appropriate if these other factors were held constant. DOE finds that input power to a PSC-driven furnace fan decreases because the airflow provided by the fan decreases as static pressure rises (*i.e.,* the fan does not have to work as hard in the face of increased resistance because the fan is not providing as much air). Input power to a constant-airflow BPM motor-driven furnace fan, on the other hand, will increase as static pressure rises because the BPM motor-driven fan is designed to maintain the desired level of airflow. Recognizing that this behavior could complicate comparing the relative performance of these motor technologies, DOE's rating metric, FER, is normalized by airflow to result in ratings that are in units of watts/cfm.

Table IV.5 shows the revised FER baseline efficiency levels estimates that DOE used for the Final Rule.

TABLE IV.6—FINAL RULE BASELINE FER ESTIMATES

Product class	FER * (W/1,000 cfm)
Non-Weatherized, Non-Condensing Gas Furnace Fan	FER = 0.081 × Q_{Max} + 335.
Non-Weatherized, Condensing Gas Furnace Fan	FER = 0.081 × Q_{Max} + 358.
Weatherized Non-Condensing Gas Furnace Fan	FER = 0.081 × Q_{Max} + 365.
Non-Weatherized, Non-Condensing Oil Furnace Fan	FER = 0.081 × Q_{Max} + 433.
Electric Furnace/Modular Blower Fan	FER = 0.081 × Q_{Max} + 304.
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	FER = 0.081 × Q_{Max} + 252.
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	FER = 0.081 × Q_{Max} + 273.
Mobile Home Electric Furnace/Modular Blower Fan	FER = 0.081 × Q_{Max} + 186.
Mobile Home Weatherized Gas Furnace Fan	Reserved.
Mobile Home Non-Weatherized Oil Furnace Fan	Reserved.

* Q_{Max} is the airflow, in cfm, at the maximum airflow-control setting measured using the final DOE test procedure. 79 FR 499, 524 (January 3, 2014).

Percent Reduction in FER

For the preliminary analysis, DOE determined average FER reductions for each efficiency level for a subset of key product classes and applied these reductions to all product classes. DOE found from manufacturer feedback and its review of publically-available product literature that manufacturers use similar furnace fan components and follow a similar technology path to improving efficiency across all product classes. DOE does not expect the percent reduction in FER associated with each design option, whether commercially available or prototype, to differ across product classes as a result. Table IV.7 includes DOE's preliminary analysis estimates for the percent reduction in FER from baseline for each efficiency level.

TABLE IV.7—PRELIMINARY ANALYSIS ESTIMATES FOR PERCENT REDUCTION IN FER FROM BASELINE FOR EACH EFFICIENCY LEVEL

Efficiency level (EL)	Design option	Percent reduction in FER from baseline
1	Improved PSC	2
2	Inverter-Driven PSC	10
3	Constant-Torque BPM Motor	45
4	Constant-Airflow BPM Motor + Multi-Staging	59
5	Premium Constant-Airflow BPM Motor + Multi-Staging + Backward-Inclined Impeller	* 63

* DOE estimates that implementing a backward-inclined impeller at EL 5 results in a 10% reduction in FER from EL 4. This is equivalent to a reduction of 4% percent of the baseline FER. The total percent reduction in FER from baseline for EL 5 includes the 59% reduction from EL 4 and the 4% net reduction of the backward-inclined impeller for a total percent reduction of 63% from baseline.

Interested parties questioned DOE's estimates for the FER reduction for high-efficiency motors. Specifically, interested parties noted that DOE underestimated the efficiency gain of improved PSC motors over standard PSC motors, and overestimated the efficiency improvement of BPM motor technology options. 78 FR 64090.

For the NOPR, DOE reviewed its estimates of percent reduction in FER from baseline for each efficiency level based on interested party feedback. In addition to the comments summarized above, interested parties also provided FER values for higher-efficiency products in manufacturer interviews. DOE used these data to revise its percent reduction estimates. Table IV.8 shows DOE's revised estimates for the percent reduction in FER for each efficiency level that DOE used in the NOPR. For a given product class, DOE applied the percent reductions below to both the slope and y-intercept of the baseline FER equation to generate FER equations to represent each efficiency level above baseline.

TABLE IV.8—NOPR ESTIMATES FOR PERCENT REDUCTION IN FER FROM BASELINE FOR EACH EFFICIENCY LEVEL

Efficiency level (EL)	Design option	Percent reduction in FER from baseline
1	Improved PSC	10
2	Inverter-Driven PSC	25
3	Constant-Torque BPM Motor	42
4	Constant-Torque BPM Motor and Multi-Staging	50
5	Constant-Airflow BPM Motor and Multi-Staging	53
6	Premium Constant-Airflow BPM Motor and Multi-Staging + Backward-Inclined Impeller	* 57

* DOE estimates that implementing a backward-inclined impeller at EL 6 results in a 10% reduction in FER from EL 5. This is equivalent to a 4% percent reduction in FER from baseline. The total percent reduction in FER from baseline for EL 6 includes the 53% reduction from EL 5 and the 4% net reduction from the backward-inclined impeller for a total percent reduction of 57% from baseline.

Note that EL 4 in the table above was a newly proposed efficiency level in the NOPR. As discussed in section IV.A.3, DOE analyzed multi-staging as a separate technology option. For the NOPR, DOE also evaluated a separate efficiency level representing applying multi-staging to a furnace fan with a constant-torque BPM motor. 78 FR 64091.

In response to the NOPR, AHRI asked if DOE considered pairing PSC motors with multi-stage furnace controls in its analysis. (AHRI, No. 91 at p. 310) While DOE did gather data for and investigated PSC-driven furnace fans in multi-stage products, DOE did not include this combination as an efficiency level for the Final Rule. In the engineering analysis, DOE assesses technology options in order of cost-effectiveness. DOE finds that constant-torque BPM motors are more cost-effective than PSC motors with multi-staging. While the cost of multi-staging for each motor type is approximately the same, multi-staging results in significantly less energy savings when used with a PSC motor. DOE expects this is the result of a limited turndown ratio as discussed in section III.A.4.

Interested parties commented on the NOPR percent reductions in FER from the baseline and resulting efficiency level equations. Nidec stated that the percent reductions do not reflect furnace fan performance improvements when using higher-efficiency PSC motors. (Nidec, No. 91 at p. 147) Many manufacturers stated that the proposed efficiency levels are not consistent with product performance using the varying design options. Rheem, Allied Air, Daikin, Lennox, and Ingersoll-Rand stated that only their multi-staging furnace lines that use constant-airflow BPM motors would meet the proposed standard level. (Rheem, No, 83 at pp. 1–2; Allied Air, No. 91 at p. 105; Daikin, No. 91 at p. 105; Lennox, No. 100 at p. 5; Ingersoll-Rand, No. 91 at pp. 102–103) Goodman and AHRI submitted similar comments stating that there are existing products that use the design options specified within TSL 5 that will not even meet the proposed energy conservation standards. (AHRI, No. 98 at p. 3; and Goodman, No 102 at pp. 4 and 7) In a joint comment submitted by Appliance Standards Awareness Project (ASAP), Alliance to Save Energy (ASE), National Consumer Law Center (NCLC), and National Resources Defense Council (NRDC) and in a separate comment submitted by California Investor-Owned Utilities (CA IOUs), interested parties recommended that DOE conduct additional testing of furnace fans with constant-torque BPM motors with multi-staging controls to verify the accuracy of the proposed FER standard level equations, and to ensure that the majority of products containing constant-torque BPM motors with multi-staging controls meet the standard. (ASAP, *et al.,* No. 105 at p. 2; CA IOU, No. 106 at p. 3)

DOE carefully considered the feedback received from interested parties on the percent reductions in FER from baseline that the Department proposed in the NOPR. DOE shares manufacturers' concerns that their products are not meeting the levels proposed in the NOPR despite those models using the technologies (or more efficient technologies) on which those levels are based. DOE used data provided by interested parties, conducted additional testing using the final DOE test procedure, and gathered data from additional product specification sheets to generate new FER values. DOE used this new FER data to revise its estimates of percent reduction in FER from baseline for each efficiency level. In response to Nidec, DOE did analyze an efficiency level associated with improved PSC motors. However, DOE did not receive and could not gather any new FER data with which to revise its estimated percent reduction in FER from baseline for this technology. Using the revised estimates of percent reduction in FER from baseline, DOE revised its FER equations. Then, for the product classes with the highest shipments, DOE assessed how many models for which DOE has an FER value met the revised EL 4. DOE finds that over 90% of the non-weatherized, non-condensing gas, non-weatherized, condensing gas and weatherized non-condensing gas furnace fans for which DOE has FER values that use constant-torque BPM motors and multi-staging meet the revised EL 4. DOE finds that many models in those product classes for which DOE has FER data that use constant-torque BPM motors without multi-staging would also meet the revised EL 4. DOE feels that the percentage of models that meet the revised EL 4 show that the Final Rule efficiency levels are reflective of the performance of the technologies on which they are based.

Ingersoll Rand stated that percent reduction in FER from the baseline should not be constant across all capacities for products using constant-torque BPM motor technologies. Specifically, Ingersoll-Rand noted that efficiency improvements with this technology decrease with increasing furnace capacity, and that at high airflow capacities, there is little or no difference in FER values between furnace fans using improved PSC motors and those using constant-torque BPM motors. (Ingersoll-Rand, No. 107 at p. 5) Additionally, Ingersoll-Rand stated that wider cabinets for furnaces with more cooling capacity but the same heating input will have lower FERs. (Ingersoll-Rand, NOPR Public Meeting Transcript, No. 91 at p. 94) Ingersoll-Rand and Mortex disagree with DOE using the same slope for FER equations for both mobile home furnaces as well as non-mobile home furnaces. These parties cite that there are space constraints associated with mobile home applications, and that it is more difficult to meet the proposed standard at higher capacities because the cabinet size must remain the same. (Ingersoll-Rand, No. 91 at pp. 116–117; Mortex, No. 91 at pp. 129–131)

DOE recognizes that percent reduction in FER from baseline for a given technology option varies with capacity. DOE's estimates of percent reduction in FER from baseline are based on market-weighted averages of FER values from across the entire range of furnace fan airflow capacities to account for this variation. As discussed above, DOE finds that constant percent reductions in FER from baseline result in a distribution of efficiency levels that match the distribution of furnace fan performance by technology option used across the entire range of furnace fan airflow capacities. Thus, DOE believes that a constant percent reduction in FER from baseline across all airflow capacities is appropriate. DOE is also aware that in some instances FER may decrease for furnaces with higher cooling capacities but the same heating input. DOE's analysis includes FER data for furnace fans that have differing heating capacity to cooling capacity ratios. DOE recognizes that these ratios indicate design differences that impact fan performance. However, a significant majority of the models for which DOE has FER data are meeting the ELs associated with the technologies that they use. Of the few models that do not, DOE observes no pattern related to the ratio of heating capacity to cooling capacity. DOE recognizes that mobile home products are more space-constrained than the other products covered by this standard. DOE did not receive mobile home FER data in response to the NOPR. Despite DOE using the same slope for mobile home product classes to characterize the relationship between FER and airflow capacity for all product classes, the resulting ELs for mobile home furnace fans are less stringent than those for non-mobile home furnaces at higher capacities. EL 4 for MH–NWG–NC and NWG–NC both have slopes of 44 FER per 1000 cfm, for example. Thus, for an increase in airflow capacity of 1000 cfm, EL 4 allows for an increase of 44 in FER for both classes. At 1,200 cfm, EL 4 is represented by and FER of 235 for NWG–NC and 190 for MH–NWG–NC. An increase of 44 in FER would represent an increase in FER of approximately 18 percent for the NWG–NC furnace fan, but an increase in FER of approximately 23% for the MH–NWG–NC furnace fan. Consequently, the allowable increase in FER as capacity increases is more lenient for mobile home furnaces. DOE believes this leniency is appropriate considering the more rigid space constraints mobile home furnaces must meet. DOE recognizes that the same variation in stringency occurs as a result of DOE's method for establishing baseline FER equations using conversion factors as described in more detail in chapter 5 of the Final Rule TSD. However, the difference in FER values between mobile home and non-mobile home furnace fans is much greater than the difference between FER values amongst non-mobile home furnace fans. The variation in stringency for non-mobile home products is minimal as a result.

Table IV.9 shows DOE's revised estimates for the percent reduction in FER for each efficiency level that DOE used in the Final Rule analyses.

TABLE IV.9—FINAL RULE ESTIMATES FOR PERCENT REDUCTION IN FER FROM BASELINE FOR EACH EFFICIENCY LEVEL

Efficiency level (EL)	Design option	Percent reduction in FER from baseline
1	Improved PSC	12
2	Inverter-Driven PSC	25
3	Constant-Torque BPM Motor	41
4	Constant-Torque BPM Motor and Multi-Staging	46
5	Constant-Airflow BPM Motor and Multi-Staging	51
6	Premium Constant-Airflow BPM Motor and Multi-Staging + Backward-Inclined Impeller	*56

* DOE estimates that implementing a backward-inclined impeller at EL 6 results in a 10% reduction in FER from EL 5. This is equivalent to a 5% percent reduction in FER from baseline. The total percent reduction in FER from baseline for EL 6 includes the 51% reduction from EL 5 and the 5% net reduction from the backward-inclined impeller for a total percent reduction of 56% from baseline.

Ingersoll Rand provided a significant amount of FER data in its written comment to support its statements. (Ingersoll Rand, No. 107 at pp. 3, 12–16) DOE appreciates this information and included these FER values in its revision of the engineering analysis to account for the furnace fan performance behaviors described by Ingersoll Rand.

2. Manufacturer Production Cost (MPC)

In the preliminary analysis, DOE estimated the manufacturer production cost associated with each efficiency level to characterize the cost-efficiency relationship of improving furnace fan performance. The MPC estimates are not for the entire HVAC product because furnace fans are a component of the HVAC product in which they are integrated. The MPC estimates includes costs only for the components of the HVAC product that impact FER, which DOE considered to be the:

- Fan motor and integrated controls;
- Primary control board (PCB);
- Multi-staging components;
- Impeller;
- Fan housing; and
- Components used to direct or guide airflow.

DOE separated the proposed product classes into high-volume and low-volume product classes and generated high-volume and low-volume MPC estimates to account for the increased purchasing power of high-volume manufacturers.[26]

Production Volume Impacts on MPC

In response to the preliminary analysis, manufacturers commented that they use different manufacturing processes for high and low-volume products. In the NOPR analysis, DOE found that 94 percent of the MPC for furnace fans is attributed to materials (included purchased parts like fan motors), which are not impacted by process differences. DOE's estimates also already accounted for process differences between manufacturers for high-volume and low-volume products. The products that DOE evaluated to support calculation of MPC included furnace fans from various manufacturers, including both high-volume and low-volume models. Observed process differences are reflected in the bills of materials for

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[26] High-volume and low-volume product classes are discussed further in chapter 5 of the Final Rule TSD.

those products. DOE believed that its approach to distinguish between high-volume and low-volume product classes accounts for the expected difference in MPC between high-volume and low-volume product classes. 78 FR 64091.

DOE did not receive comment or additional information on production volume impacts on MPC, thus, DOE is taking the same approach to distinguish between high-volume and low-volume product classes in the Final Rule.

Inverter-Driven PSC Costs

In the preliminary analysis, DOE estimated that the MPC of inverter control for a PSC motor is $10–$12, depending on production volume. Interested parties commented that DOE was underestimating the cost of adding an inverter to a PSC motor, and questioned if DOE's cost estimate was for wave chopper technology and not inverters. In the NOPR, DOE stated that the preliminary analysis estimate for the MPC of an inverter-driven PSC was indeed based on a wave chopper drive. DOE found that more sophisticated and costly inverters are required to achieve the efficiencies reflected in DOE's analysis. Consequently, DOE adjusted its cost estimate for PSC inverter technology. DOE gathered more information about the cost of inverters that are suited for improving furnace fan efficiency. In addition to receiving cost estimates during manufacturer interviews, DOE also reviewed its cost estimates for inverter drives used in other residential applications, such as clothes washers. DOE found that $30 for high-volume products and $42.29 for low-volume products are better estimates of the MPC for inverters used to drive PSC furnace fan motors. Accordingly, DOE updated those values for the NOPR. 78 FR 64091–64092.

DOE did not receive comment or additional information on cost estimates for inverter-driven PSC motors, thus, DOE is not making changes to the MPC estimates for inverters used to drive PSC furnace fan motors in the Final Rule.

Furnace Fan Motor MPC

In response to the preliminary analysis, manufacturers stated that DOE underestimated the incremental MPC to implement high-efficiency motors in HVAC products, other than oil furnaces. Most manufacturers stated that the cost increase to switch from PSCs to more-efficient motor technologies was at least twice that of the DOE's estimate. Based upon the input received from interested parties, DOE adjusted its motor cost estimates in the NOPR analysis. In general, DOE increased its estimates by approximately 10 to 15 percent, which is consistent with the feedback DOE received. 78 FR 64092.

Goodman stated that DOE significantly underestimated the costs of the increasing levels of fan motor cost. (Goodman, No. 102 at p. 9) Lennox stated that DOE underestimated the total cost of furnace fans with BPM motor technology by 10 to 30 percent, therefore, the incremental costs are underestimated by 20 to 120 percent. (Lennox, No. 100 at p. 6) Conversely, ACEEE commented that DOE has a well-established record of over-estimating the cost of complying with standards, thus, DOE's cost estimates should be discounted to further improve the economics of advanced technology options. (ACEEE, No. 94 at p. 3) Rheem questioned if the DOE motor cost estimates included power factor correction filters for BPM motors, as those can cost $10 to $20. (Rheem, No. 91 at p. 165)

DOE recognizes that BPM motor use contributes to concerns regarding total harmonic distortion. However, the use of power factor correction filters for BPM motor technologies is currently not required under federal regulations. The DOE cost estimates reflect what is currently available on the market, thus, the added cost of filters for BPM motor technologies is not included in DOE's MPC estimates for BPM motors. DOE believes the motor MPC estimates presented in the NOPR are representative of current motor costs. Thus, DOE is keeping the same furnace fan motor cost estimates presented in the NOPR for the Final Rule analysis. Details regarding DOE's MPC estimates are provided in chapter 5 of the Final Rule TSD.

Motor Control Costs

In the preliminary analysis, DOE estimated that the MPC of the primary control board (PCB) increases with each conversion to a more-efficient motor type (*i.e.,* from PSC to constant-torque BPM motor and from constant-torque to constant-airflow BPM motor). Manufacturers confirmed that higher-efficiency motors and modulating motors require more sophisticated and costly controls. DOE also received feedback regarding the cost of the PCBs associated with each motor type during manufacturer interviews. In general, manufacturers commented that the PCBs used with constant-torque BPM motors are more costly. However, other manufacturer interview participants stated that the MPC of the PCB used with these motors should be equivalent or even less expensive than the PCBs used with PSC motors. 78 FR 64092.

In the NOPR, DOE agreed with interested parties that the MPC of the PCB needed for a constant-airflow BPM motor is higher than for the PCB paired with a PSC motor. DOE estimated that the MPC of a PCB paired with a constant-airflow BPM motor is roughly twice as much as for a PCB paired with a constant-torque BPM motor or PSC. DOE also agreed with the interested parties that stated that the MPC for a PCB paired with a constant-torque BPM motor is equivalent to that of a PCB needed for a PSC motor. DOE revised its analysis to reflect this assumption in the NOPR as a result.

DOE did not receive comment or additional information on motor control costs, thus, DOE is not making changes to this in the Final Rule.

Backward-Inclined Impeller MPC

Interested parties commented that DOE's preliminary analysis estimate for the incremental MPC associated with implementing a backward-inclined impeller, in combination with a premium constant-airflow BPM motor and multi-staging, is too low. Manufacturers also commented that tighter tolerances and increased impeller diameter lead to increased material costs, as well as increased costs associated with motor mount structure and reverse forming fabrication processes.

During the NOPR, DOE reviewed its manufacturer production cost estimates for the backward-inclined impeller technology option based on interested party comments. During manufacturer interviews, some manufacturers reiterated or echoed that DOE's estimated MPC for backward-inclined impellers is too low, but they did not provide quantification of the total MPC of backward-inclined impellers or the incremental MPC associated with the changes needed to implement them. Other manufacturers did quantify the MPC of backward-inclined impeller solutions and their estimates were consistent with DOE's preliminary analysis estimate. Consequently, DOE did not modify its preliminary analysis estimated MPC for backward-inclined impellers in the NOPR. 78 FR 64092.

In response to the NOPR, Mortex questioned whether the price differential between backward-inclined impellers manufactured at high volume and those manufactured at low volume should be greater than DOE's estimate of 32 cents. (Mortex, No. 91 at p. 163)

DOE reviewed its manufacturer production cost estimates for the backward-inclined impeller technology option based on interested party comments. DOE did not receive any quantification of the total MPC of backward-inclined impellers or the incremental MPC associated with the changes needed to implement them. Consequently, DOE did not modify its NOPR estimated MPC for backward-inclined impellers in the Final Rule. Regardless, DOE finds that EL 6, which represents use of a backward-inclined impeller, is not economically justified. Modifying the MPC estimate for this technology would not impact the standard set by this Final Rule as a result.

Other Components

In response to the MPCs presented in the NOPR, Goodman commented that there are likely additional components for the furnace that may need to be added if significant changes to the blower system are implemented. For example, improving air moving efficiency may require an increase in cabinet size, or the addition of internal baffling to direct airflow over the heat exchanger. None of these additional components or modifications were accounted for in the furnace fan MPC. (Goodman, No. 102 at p. 13)

As discussed in section III.B.1 and chapter 4 of the Final Rule TSD, DOE did not include housing design modifications in the engineering analysis. Thus, DOE did not develop cost estimates for housing design modifications. DOE recognizes that the airflow path design of the HVAC product in which the furnace fan is integrated impacts efficiency. DOE anticipates that modifying the size of the cabinet and the geometry of the heat exchanger(s) would be the primary considerations for improving airflow path design. Alterations to the design and configuration of internal components, such as the heat exchanger, could impact the thermal performance of the HVAC product, potentially reducing or eliminating product availability for certain applications. While DOE did not consider airflow path design as a technology option, as described in section III.B.1, DOE did account for the components used to direct or guide airflow in the MPC estimates.

D. Markups Analysis

DOE uses manufacturer-to-consumer markups to convert the manufacturer selling price estimates from the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis and in the manufacturer impact analysis. Before developing markups, DOE defines key market participants and identifies distribution channels. Generally, the furnace distribution chain (which is relevant to the residential furnace fan distribution chain) includes distributors, dealers, general contractors, mechanical contractors, installers, and builders. For the markups analysis, DOE combined mechanical contractors, dealers, and installers in a single category labeled ''mechanical contractors,'' because these terms are used interchangeably by the industry. Because builders serve the same function in the HVAC market as general contractors, DOE included builders in the ''general contractors'' category.

DOE used the same distribution channels for furnace fans as it used for furnaces in the recent energy conservation standards rulemaking for those products. DOE believes that this is an appropriate approach, because the vast majority of the furnace fans covered in this rulemaking is a component of a furnace. Manufactured housing furnace fans in new construction have a separate distribution channel in which the furnace and fan go directly from the furnace manufacturer to the producer of mobile homes. DOE has concluded that there is insufficient evidence of a replacement market for furnace fans to establish a separate distribution channel on that basis.

DOE develops baseline and incremental markups to transform the manufacturer selling price into a consumer product price. DOE uses the baseline markups, which cover all of a distributor's or contractor's costs, to determine the sales price of baseline models. Incremental markups are separate coefficients that DOE applies to reflect the incremental cost of higher-efficiency models.

Ingersoll Rand stated that the incremental markup percentages do not represent real life practices and are too low. It commented that once the new rule goes into effect, the more expensive furnaces will become the baseline and will need to be marked up appropriately for manufacturers, distributors, and dealers to remain viable. (Ingersoll Rand, No. 107 at p. 8) However, the commenter provided no data to support its expectation of how the actors respond in terms of pricing when confronted with more-stringent energy conservation standards.

DOE acknowledges that detailed information on actual distributor and contractor practices would be helpful in evaluating their markups on furnaces. In the absence of such information, DOE has concluded that its approach, which is consistent with expected business behavior in competitive markets, is reasonable to apply. If the cost of goods sold increases due to efficiency standards, DOE continues to assume that markups would decline slightly, leaving profit unchanged, and, thus, it uses lower markups on the incremental costs of higher-efficiency products.

Goodman stated that lower markups on incremental costs of higher-efficiency products is an invalid practice because manufacturers will attempt to have higher margin dollars to offset overall lower volumes. (Goodman, No. 102 at p. 9) For the LCC and NIA analyses, DOE does not use a lower markup on the incremental manufacturer selling price of higher-efficiency products. Instead, it assumes that manufacturers are able to maintain existing average markups in response to new standards. The MIA considers different markup scenarios for manufacturers (see section IV.J.2.b).

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of residential furnace fans in representative U.S. homes and to assess the energy savings potential of increased furnace fan efficiency. In general, DOE estimated the annual energy consumption of furnace fans at specified energy efficiency levels across a range of climate zones. The annual energy consumption includes the electricity use by the fan, as well as the change in natural gas, liquid petroleum gas (LPG), electricity, or oil use for heat production as result of the change in the amount of useful heat provided to the conditioned space as a result of the furnace fan. The annual energy consumption of furnace fans is used in subsequent analyses, including the LCC and PBP analysis and the national impact analysis.

DOE used the existing DOE test procedures for furnaces and air conditioners to estimate heating and cooling mode operating hours for the furnace fan. The power consumption of the furnace fan is determined using the individual sample housing unit operating conditions (the pressure and airflow) at which a particular furnace fan will operate when performing heating, cooling, and constant-circulation functions. The methodology and the data are fully described in chapter 7 of the final rule TSD.

DOE used the Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS) [27] to establish a sample of households using furnace fans for each furnace fan

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[27] Energy Information Administration, 2009 Residential Energy Consumption Survey (Available at: *http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption*).

product class. RECS data provide information on the age of furnaces with furnace fans, as well as heating and cooling energy use in each household. The survey also includes household characteristics such as the physical characteristics of housing units, household demographics, information about other heating and cooling products, fuels used, energy consumption and expenditures, and other relevant data. DOE uses the household samples not only to determine furnace fan annual energy consumption, but also as the basis for conducting the LCC and PBP analysis.

DOE used RECS 2009 [28] heating and cooling energy use data to determine heating and cooling operating hours. DOE used data from RECS 2009, American Housing Survey (AHS) 2011,[29] and the Census Bureau [30] to project household weights in 2019, which is the anticipated compliance date of any new energy efficiency standard for residential furnace fans. These adjustments account for housing market changes since 2009, as well as for projected product and demographic changes.

The power consumption (and overall efficiency) of a furnace fan depends on the speed at which the motor operates, the external static pressure difference across the fan, and the airflow through the fan. To calculate furnace fan electricity consumption, DOE determined the operating conditions (the pressure and airflow) at which a particular furnace fan will operate in each RECS housing unit when performing heating, cooling, and constant-circulation functions. For the final rule, DOE adjusted the furnace fan energy use estimated from RECS 2009 data to account for projected changes in heating and cooling loads due to climate change (as projected by EIA in *AEO 2013*).

DOE gathered field data from available studies and research reports to determine an appropriate distribution of external static pressure (ESP) values. DOE compiled over 1,300 field ESP measurements from several studies that included furnace fans in single-family and mobile homes in different regions of the country. The average ESP value in the cooling operating mode from these studies results in an average 0.65 in. w.c. for single-family households and 0.30 in. w.c. for mobile homes.

Rheem stated that substitution of a BPM motor can increase the conditioned air that is leaked to the atmosphere. (Rheem, No. 83 at p. 13) However, the commenter provided no data to support its view on increased air leakage associated with BPM motors.

DOE agrees that if a BPM motor maintains flow in a high-resistance duct system that has leakage, it may lead to higher duct leakage compared to a PSC motor. However, in cases where the heating load can be met with low air flow, the BPM motor may have lower air leakage. Given that the magnitude of these effects is uncertain and may offset, DOE did not include it in its analysis. DOE notes that the constant-torque BPM motor, which meets the standards in today's final rule, may not maintain the flow in leaky and overly-restrictive ducts, and, thus, would be expected to have similar losses as a PSC motor.

NEEA stated that their field measurements of ESP for the past 40 years are consistent with DOE's analysis. (NEEA, No. 91 at p. 222) Daikin stated that, from experience over the past 30 plus years, mobile homes have higher external static pressure than the typical site-built home in the preponderance of cases. (Daikin, No. 91 at p. 222)

The data that DOE has seen (described in appendix 7B of the final rule TSD) do not indicate that mobile homes have higher external static pressure. Furthermore, the HUD static pressure criteria for mobile homes [31] are supportive of DOE's assumptions regarding ESP. Consequently, DOE has maintained its approach regarding ESP for this final rule.

DOE determined furnace fan operating hours in heating mode by calculating the furnace burner operating hours and adjusting them for delay times between burner and fan operation. Burner operating hours are a function of annual house heating load, furnace efficiency, and furnace input capacity.

For the NOPR, to estimate use of constant circulation in the sample homes, DOE evaluated the available studies, which include a 2010 survey in Minnesota [32] and a 2003 Wisconsin field monitoring of residential furnaces.[33] DOE did not use these data directly, however, because it believes they are not representative of consumer practices for the U.S. as a whole. In these northern States, many homes have low air infiltration, and there is a high awareness of indoor air quality issues, which could lead to significant use of constant circulation. To develop appropriate assumptions for other regions, DOE modified the data from these States using information from manufacturer product literature (which suggests very little use in humid climates) and consideration of climate conditions in other regions. For the NOPR, DOE used the same assumptions for use of constant circulation as were used in the proposed DOE test procedure for furnace fans. 77 FR 28674 (May 15, 2012). The average value that emerges is approximately 400 hours per year. The shares of homes using the various constant-circulation modes are presented in Table IV.10.

NEEA and NPCC commented that DOE's estimate of 400 hours per year of continuous-circulation mode may be overly conservative, and they disagree with stakeholders who suggest that 400 hours per year is too high. (NEEA, NPCC, No. 32 at p. 5)

For the final rule, DOE examined a newly-released proprietary survey that broadly evaluates the use of continuous circulation across the U.S.[34] This survey shows a higher number of continuous-circulation hours than DOE used for the NOPR. DOE has concerns about the representativeness of the data, however, because the survey only included homeowners who had been involved in the purchase of central HVAC equipment in the past two years. The practices of these consumers may not accurately portray the use of continuous circulation across the entire stock of homes with central HVAC equipment. Given the uncertainty regarding the survey data, DOE decided that it would not be appropriate to change the continuous-circulation hours for the final rule.

Southern Company stated that if DOE is assuming a greater percentage of variable speed fans in the future, the need for constant circulation will be reduced. (Southern Company, No. 91 at p. 233) DOE accounted for the reduced hours of operation during constant-circulation mode when variable speed motors are applied (see appendix 7–C). Variable speed fans tend to increase the operating hours in heating and cooling modes, which would result in a smaller fraction of time in continuous-fan mode.

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[28] *See http://www.eia.gov/consumption/residential/data/2009/.*

[29] *See http://www.census.gov/housing/ahs/data/national.html.*

[30] *See http://www.census.gov/popest/.*

[31] HUD for Mobile Home with comfort cooling certificate −0.3 inches WC at cooling airflow setting [Title 24 of the HUD code PART 3280—Mobile Home Construction and Safety Standards, Part 3280.715(a)(3)(ll)].

[32] Provided in CEE, No. 22 at pp. 1–2.

[33] Pigg, S., ‘‘Electricity Use by New Furnaces: A Wisconsin Field Study’’ (October 2003) (Available at *http://www.ecw.org/sites/default/files/230-1.pdf*)

[34] Decision Analysts, 2013 American Home Comfort Study (2013) (Available at: *http://www.decisionanalyst.com/Syndicated/HomeComfort.dai*).

DOE also performed a sensitivity analysis to estimate the effect on the LCC results if it assumed half as much use of constant circulation. These results are discussed in section V.B.1 of this document.

TABLE IV.10—CONSTANT-CIRCULATION TEST PROCEDURE ASSUMPTIONS USED FOR FURNACE FANS STANDARDS ANALYSIS

Constant-circulation fan use	Assumed average number of hours	Estimated share of homes in north and south-hot dry regions (percent)	Estimated share of homes in south-hot humid region (percent)
No constant fan	0	84	97
Year-round	7290	7	1
During heating season	1097	2	0.4
During cooling season	541	2	0.4
Other (some constant fan)	365	5	1
Total	....	100	100

Morrison stated that not all the energy used in circulation is wasted heat because the energy consumed for circulation during the heating season is useful energy. Morrison recommended that for a more accurate analysis of energy use in circulation mode, DOE should split heating and cooling hours. (Morrison, No. 108 at p. 2) DOE adjusted its analysis so that heat generated by constant-circulation fan operation reduces furnace heating energy use in the heating season, and in the cooling season, it adds to the operating hours of the air conditioner.

In the NOPR, DOE recognized that the energy savings in cooling mode from higher-efficiency furnace fans used in some higher-efficiency CAC and heat pumps was already accounted for in the analysis related to the energy conservation standards for those products. To avoid double-counting, the analysis for furnace fans did not include furnace fan electricity savings that were counted in DOE's rulemaking for CAC and heat pump products.[35]

Several stakeholders stated that DOE may be double-counting energy savings in cooling mode in this rulemaking by accounting for the central air conditioner blower output used for calculating SEER. (JCI, No. 95 at pp. 4–5; Morrison, No. 108 at p. 2; AHRI, No. 98 at p.6; Goodman, No. 102 at p. 5) EEI stated that a large share of the estimated furnace fan energy savings are a result of the air conditioner and heat pump energy efficiency standards, so some or all of these estimated energy savings should be removed from the furnace fan analyses. (EEI, No. 87 at p. 5)

DOE's rulemaking analysis for CAC and heat pump products included savings from those households purchasing a CAC or heat pump at SEER 15 or above that would need to have a BPM motor-driven fan in the furnace to achieve that efficiency level. The base-case efficiency distribution of fans used in the current analysis includes the presence of those BPM motor-driven fans in homes with the higher-efficiency CAC or heat pumps. Because the energy savings from the considered fan efficiency levels are measured relative to the base-case efficiencies, any savings reported here for furnace fans are over and above those counted in the CAC and heat pump rulemaking.

Morrison stated that any reduction in energy use by the fan from this rulemaking would be a *de facto* improvement in SEER and an unlawful change to the current SEER regulations. It noted that if there is no change to SEER, then there will be no energy savings when operated in the cooling mode. (Morrison, No. 108 at p. 2)

A reduction in energy use by the furnace fan resulting from this rulemaking would improve the CAC operating efficiency (for homes with both furnace and CAC), but DOE is not increasing the energy conservation standard for CAC or requiring a change to the reported current SEER ratings for CAC. DOE has clear and explicit statutory authority to regulate furnace fans under 42 U.S.C. 6295(f)(4)(D), and any related improvements to CAC efficiency would simply be an added benefit.

Recognizing the possibility of consumers using higher-efficiency furnace fans more than baseline furnace fans, DOE included a rebound effect in its preliminary analysis. DOE used a 2009 program evaluation report from Wisconsin[36] to estimate the extent to which increased use of constant circulation under a standard requiring BPM furnace fans is likely to cancel out some of the savings from such a fan. The specific assumptions are described in chapter 7 of the final rule TSD.

Commenting on the average energy use estimates reported in the final rule TSD, EEI stated that the baseline energy use values seem to be overstated, because baseline values reported in the market and technology assessment are lower than what was used in following analyses. Consequently, the estimated energy savings and energy cost savings are overstated as well, because they are shown in the NOPR as percentage savings based on the design options. (EEI, No. 87 at pp. 4–5) Goodman believes that the calculated baseline values, and thus the projected energy savings, are too high based on product testing for the April 2013 test procedure SNOPR. (Goodman, No. 102 at p. 8)

The baseline values reported in the market and technology assessment are based on the test procedure. The energy use analysis is not based on test procedure conditions, but instead reflects actual usage in the field, which is more appropriate for estimating the impacts of higher furnace fan efficiency on consumers. Therefore, the estimated energy savings and energy cost savings are not overstated.

JCI and AHRI stated that DOE needs to ensure that it avoids double-counting energy consumption associated with standby mode, noting that there is no standby mode and off mode energy use associated with furnace fans that would

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[35] U.S. Department of Energy—Energy Efficiency & Renewable Energy, Final Rule Technical Support Document: Energy Efficiency Standards for Consumer Products: Central Air Conditioners, Heat Pumps, and Furnaces (2011) (Available at: *http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012*).

[36] State of Wisconsin, Public Service Commission of Wisconsin, Focus on Energy Evaluation Semiannual Report, Final (April 8, 2009) (Available at: *https://focusonenergy.com/sites/default/files/semiannualreport18monthcontractperiodfinalrevisedoctober192009_evaluationreport.pdf*).

not already be measured by the established test procedures, because they are integrated in the electrical systems of the HVAC products in which they are used. (JCI, No. 95 at p. 5; AHRI, No. 98 at p. 6)

The proposed furnace fan energy rating metric would not account for the electrical energy consumption in standby mode and off mode, because energy consumption in those modes is already accounted for in the energy conservation standards for residential furnaces and residential CAC and HP. Accordingly, DOE did not include standby mode and off mode energy use associated with furnace fans in the present analysis. Consequently, there should not be any problems associated with double-counting of standby mode and off mode energy consumption.

F. Life-Cycle Cost and Payback Period Analysis

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

- *Life-cycle cost* (LCC) is the total consumer cost of an appliance or product, generally over the life of the appliance or product. The LCC calculation includes total installed cost (equipment manufacturer selling price, distribution chain markups, sales tax and installation cost), operating costs (energy, repair, and maintenance costs), equipment lifetime, and discount rate. Future operating costs are discounted to the time of purchase and summed over the lifetime of the product.
- *Payback period* (PBP) measures the amount of time it takes consumers to recover the assumed higher purchase price of a more energy-efficient product through reduced operating costs. Inputs to the payback period calculation include the installed cost to the consumer and first-year operating costs.

DOE analyzed the net effect of potential residential furnace fan standards on consumers by calculating the LCC and PBP for each efficiency level for each sample household. DOE performed the LCC and PBP analyses using a spreadsheet model combined with Crystal Ball (a commercially-available software program used to conduct stochastic analysis using Monte Carlo simulation and probability distributions) to account for uncertainty and variability among the input variables (*e.g.,* energy prices, installation costs, and repair and maintenance costs). It uses weighting factors to account for distributions of shipments to different building types and States to generate LCC savings by efficiency level. Each Monte Carlo simulation consists of 10,000 LCC and PBP calculations. The model performs each calculation using input values that are either sampled from probability distributions and household samples or characterized with single-point values. The analytical results include a distribution of points showing the range of LCC savings and PBPs for a given efficiency level relative to the base-case efficiency forecast. The results of DOE's LCC and PBP analysis are summarized in section IV.F and described in detail in chapter 8 of the final rule TSD.

1. Installed Cost

The installed cost at each efficiency level is based on the product price, distribution chain markups, sales tax, and installation cost.

The current product price comes from the engineering analysis. DOE believes that price trends for integral horsepower electric motors are a reasonable proxy for trends in prices of furnace fans, and for the NOPR DOE evaluated the historic real (*i.e.,* adjusted for inflation) producer price index (PPI) of such motors. DOE found that this index has been decreasing except for the last few years, when it started to increase (see appendix 10–C of the final rule TSD). Given the uncertainty about whether the recent trend will continue or instead revert to the historical mean, DOE elected to use constant prices at the most recent level as the default price assumption to project future prices of furnace fans. 78 FR 64068, 64096 (Oct. 25, 2013).

Morrison stated that motor prices have remained flat in the last decade because production of motors moved offshore and foreign competitors entered the marketplace. It stated that in the coming decades, motor prices will increase at the rate of long run prices for commodities (e.g. copper, steel, aluminum). (Morrison, No. 108 at p. 2) Goodman believes that it is incorrect to use constant prices at the most recent level of motor cost, which has shown a recent increasing trend, as the default price assumption to project future prices of furnace fans. (Goodman, No. 102 at p. 9)

DOE continues to believe that it is unclear whether the increasing trend in motor prices since 2004 will continue in the future. Part of the recent growth in prices of commodities used in motors was due to strong demand from China. Current projections envision slower growth in China, which would likely dampen commodity prices. Given the uncertainty, DOE continued to use constant prices at the most recent level as the default price assumption for the final rule. For the NIA, DOE also conducted sensitivity analysis using alternative price growth assumptions.

Because furnace fans are installed in furnaces in the factory, there is generally no additional installation cost at the home. However, furnace fans that employ a constant-airflow BPM design may require additional installation costs. DOE assumed that all constant-airflow BPM furnace fan installations will require extra labor at startup to check and adjust airflow.

Goodman stated that it is acceptable for relative product cost comparison to include costs only for the components of the HVAC product that impact FER in the manufacturing cost, but it disagrees with using the cost of only the furnace fan portion of the furnace in the LCC, GRIM, and other aspects of the financial analysis. The real upfront costs for the consumer will be significantly higher (likely two to four times more) than DOE has included in the analysis using only the furnace fan portion. (Goodman, No. 102 at p. 9) DOE believes that the commenter is claiming that the consumer will face higher costs when buying a furnace because the proposed furnace fan standards would require changes in furnace design. As discussed in section IV.B.1, DOE screened out fan housing and airflow path design modifications from further analysis. Accordingly, it is unlikely that significant changes in furnace design would be required to accommodate furnace fans that meet today's standards. Therefore, DOE concludes that using the incremental costs of the furnace fan portion is reasonable.

2. Operating Costs

To estimate the annual energy costs for operating furnace fans at different efficiency levels, DOE used the annual energy use results from the energy use analysis and projections of residential energy prices. DOE derived average monthly energy prices for a number of geographic areas in the United States using the latest data from EIA[37] and monthly energy price factors that it

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[37] U.S. Department of Energy—Energy Information Administration, Form EIA–826 Database Monthly Electric Utility Sales and Revenue Data, 2013. *http://www.eia.doe.gov/cneaf/electricity/page/eia826.html*; U.S. Department of Energy—Energy Information Administration, Natural Gas Navigator. 2013. *http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm.*

developed. Electricity and natural gas prices were adjusted using seasonal marginal price factors to come up with monthly marginal electricity and natural gas prices. DOE assigned an appropriate price to each household in the sample, depending on its location.

Laclede stated that using average utility rates leads to significantly overstating consumer savings. DOE should use marginal energy rates in its consumer energy savings calculations. (Laclede, No. 86 at p. 4) As described above, DOE did derive marginal electricity and natural gas prices based on recent data. (For a discussion of the development of marginal energy price factors, see appendix 8–C of the final rule TSD). To arrive at marginal prices in future years, DOE multiplied the current marginal prices by values in the Reference case projection of annual average residential electricity and natural gas price changes in EIA's *AEO 2013.* The price trends projected in the *AEO 2013* Reference case are shown in chapter 8 of the final rule TSD. For electricity prices, which are primarily of interest in this rulemaking, the *AEO 2013 projection* shows the average residential price growing from 0.119 $/kWh in 2020 to 0.122 $/kWh in 2030 and 0.131 $/kWh in 2040 (constant dollars).

To estimate annual maintenance costs, DOE derived labor hours and costs for annual maintenance from RS Means data.[38] The frequency with which the maintenance occurs was derived from a consumer survey [39] on the frequency with which owners of different types of furnaces perform maintenance.

For the NOPR, DOE used the same maintenance costs for furnace fans at different efficiency levels. 78 FR 64096. Goodman stated that it is invalid to assume that the maintenance costs for all efficiency levels are the same regardless of technology, as higher technology products will take a higher skill level of technician, and will require more costly equipment for service than baseline products. (Goodman, No. 102 at p. 9) Allied Air stated that in shifting from a primarily single-stage PSC market to multistage constant torque, the maintenance cost could be two to three times current costs. (Allied Air, No. 43 at pp. 252–253)

DOE understands that furnace fans require very little maintenance, and it did not find any evidence that there is any additional maintenance cost associated with higher efficiency equipment. It seems likely that the commenters are including repair costs under the term ''maintenance.'' DOE's treatment of repair costs is discussed below.

The most important element of repair costs for furnace fans is replacement of the fan motor. For the NOPR, to estimate rates of fan motor failure, DOE developed a distribution of fan motor lifetime (expressed in operating hours) by motor size using data developed for DOE's small electric motors final rule. 75 FR 10874 (March 9, 2010). DOE then paired these data with the calculated number of annual operating hours for each sample furnace, including constant circulation as appropriate. DOE did not have a firm basis for quantifying whether constant-torque BPM motors and constant-airflow BPM motors have different failure rates than PSC motors. Thus, it used the same motor lifetime for each fan efficiency level in terms of total operating hours (the lifetime in terms of years is lower for constant-torque BPM and constant-airflow BPM motors because they are more frequently used in multi-stage heating mode). 78 FR 64097.

Rheem stated that DOE did not justify the assumption that furnace fan motor lifetimes are equal to furnace lifetimes. (Rheem, No. 83 at p. 4) DOE modeled overall furnace fan lifetime based on furnace lifetimes (see discussion below), but it used the approach described above for furnace fan motor lifetime.

Morrison stated that multi-staged BPM assemblies will have longer operating times within a given period (to account for lower fire rates and heat output) and therefore, all else being equal, will have a shorter life expectancy. (Morrison, No. 108 at p. 5) DOE's approach is consistent with the comment; a multi-staged BPM motor has a shorter lifetime measured in years.

A number of stakeholders stated that failure rates are higher for BPM motors than for PSC motors, leading to shorter lifetime. Rheem stated that the PSC motor life, which it estimated to be 15 years, is much longer than the BPM motor life. (Rheem, No. 83 at pp. 2 and 13) Mortex stated that, based on their experience, BPM lifetime is half that of PSC motors. (Mortex, No. 104 at p. 2) Lennox estimated that constant-airflow BPM motors have failure rates that are 50% higher than PSC motors at 5 and 10 years, and furnaces with constant-torque BPM motors have failure rates that are 385% higher than PSC motors at 5 and 10 years. (Lennox, No. 100 at p. 8) Ingersoll Rand stated that its data indicate that BPM motors fail at 2.3 times the rate of PSC motors in the 5 to 10 year time frame. (Ingersoll Rand, No. 107 at pp. 6–7) AHRI stated that the failure rate for a high efficiency motor is typically higher than that of a PSC motor because the electronics added to a high efficiency motor introduce additional failure modes associated with the life of electronic controls in damp, very cold and very hot conditions. AHRI has collected data from manufacturers that show that the failure rates associated with constant-torque BPM and constant-airflow BPM technologies are higher than PSC motors over an extended time period. (AHRI, No. 98 at p. 7) Morrison and Ingersoll Rand cited recent data from an AHRI survey of manufacturers that indicate failure rates at 1, 5 and 10 years are 24%, 87% and 165% greater for BPM motors than PSC ones. (Morrison, No. 108 at p. 5, Ingersoll Rand, No. 107 at p. 6) JCI stated that, based on an analysis of JCI's residential warranty data, failure rates associated with constant-torque BPM and constant-airflow BPM technologies are significantly higher than those experienced by standard PSC motors due to the added electronic controls that are required as part of the BPM motor designs, which are more susceptible to failure due to power fluctuations and other factors. (JCI, No. 95 at p. 7) Ingersoll Rand stated that repair of the electronics is not possible for the constant-torque BPM motors available today, so an electronics failure will result in a complete motor replacement. (Ingersoll Rand, No. 107 at pp. 7–8)

In contrast, NEEA and NPCC believe that the NOPR analysis assumptions may unfairly penalize BPM motors, as the Department has insufficient data to properly estimate the frequency and nature of BPM motor repair. (NEEA, NPCC, No. 96 at p. 5)

DOE notes that BPM motors had higher level of failure in the late 1990s and early 2000s when the electronics technologies went through major renovations. The comments from furnace manufacturers may reflect this past experience. For example, the cited data from an AHRI survey of manufacturers would reflect BPM technology in the early 2000s. For the final rule, DOE searched for more information on the lifetime of BPM and PSC motors. This information (discussed in appendix 8–E) suggests that BPM and PSC motors have similar lifetimes, as BPM designs have improved over the years. While BPM motor designs could have additional failures due to the additional controls or

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[38] RS Means Company Inc., Means Facilities Maintenance & Repair Cost Data. 2012. Kingston, MA.

[39] Decision Analysts, 2008 American Home Comfort Study: Online Database Tool, 2009. Arlington, Texas. *http://www.decisionanalyst.com/Syndicated/HomeComfort.dai.*

electronics, furnace fan motor manufacturers claim longer mechanical life for BPM designs due to better bearings and less heat generated by inefficiency. Between now and the compliance date, future BPM motor enhancements could further strengthen product reliability and reduce failures. In this analysis, DOE assumes higher failures for BPM designs due to longer operating hours (because of multi-stage operating at more hours and more constant circulation operation of BPM motors), as well as additional control failures. For example, DOE estimates that 43% for BPM constant torque multi-stage designs experience failure during the lifetime of the furnace, compared to 35% of PSC designs.

Recognizing that there exists some uncertainty regarding the lifetime of BPM motors, DOE conducted a sensitivity analysis using alternative assumptions, as requested in a comment by Mortex. (Mortex, No. 43 at pp. 264–265) This analysis is described in appendix 8–E of the final rule TSD.

For the NOPR, the replacement motor costs were based on costs developed in the engineering analysis for each motor type, and the labor time and unit costs were based on RS Means data.[40] 78 FR 64097. DOE included additional labor hours to repair constant-torque BPM and constant-airflow BPM motors, as well as higher equipment cost for the BPM motors. DOE assumed that when replacement is necessary, consumers replace the failed motor with the same type of motor.

A number of stakeholders stated that the replacement cost of BPM motors is higher than the cost DOE used in its analysis. (Morrison, No. 108 at p. 2; Goodman, No 102 at p. 8; APGA, No. 110 at p. 3) Mortex stated that DOE substantially underestimated BPM replacement costs, which in its experience are 2–3 times that of a PSC. (Mortex, No. 104 at p. 2) Ingersoll Rand stated that replacement costs are significantly underestimated for constant-torque BPM and constant-airflow BPM motors. It added that the difference between PSC motor replacement and constant-torque BPM motor replacement should be at least $225, and the PSC to constant-airflow BPM difference should be at least $295. (Ingersoll Rand, No. 107 at pp. 7–8) JCI stated that outside the warranty periods (typically 10 years for parts), ECM motors can cost 3 to 5 times the replacement costs of PSC motors due to the complexity of those motors and the electronic controls required to use them. (JCI, No. 95 at p. 6)

The replacement equipment cost of BPM and PSC motors used in DOE's LCC analysis is based on costs derived in the engineering analysis, which DOE believes are accurate. It is possible that the stakeholders believe that the higher BPM replacement costs are largely due to extra labor charges by contractors. DOE determined that for a constant torque BPM motor any such extra charges would be minimal. In the analysis for today's final rule, on average the replacement cost is $407 for a constant torque multi-stage BPM (EL 4) and $356 for the PSC design (EL 0).

Several stakeholders stated that the replacement cost of an aftermarket furnace fan is 2–3 times higher than DOE's estimated manufacturer production costs for low-volume product classes. They added that DOE's material cost estimate of $0.00 for furnace fan replacements is incorrect. (JCI, No. 95 at p. 6; Morrison, No. 108 at p. 5; AHRI, No. 98 at p. 8; Lennox, No. 100 at p. 8; Unico, No. 93 at p. 5)

DOE believes that the first comment above refers to a replacement motor. DOE applies markups to the motor MPC, such that the cost to the consumer is two to three times higher than the MPC. The material cost is listed as $0.00 in the cited tables because these tables refer to labor costs only (as stated in the table captions).

Ingersoll Rand stated that motors that fail in-warranty are not free, as standard product warranties in the HVAC industry cover parts only, and do not typically include labor charges, which the homeowner must pay. (Ingersoll Rand, No. 107 at p. 7) DOE excluded labor charges only if the consumer has a service contract or if the motor fails the first year (which is rare).

Southern Company stated that DOE unrealistically considered component failures as independent events rather than interdependent ones. It stated that in actual consumer settings, rather than a lab, it is likely that a capacitor failure will not be detected until it results in a motor failure. (Southern Company, No. 85 at p. 3) Undetected capacitor failure that leads to motor failure (as may occur for PSC motors) is reflected in DOE's distribution of motor lifetimes.

3. Furnace Fan Lifetime

DOE used the same modeling for furnace fan lifetime (meaning the life of the overall equipment not including the motor) as in the NOPR.78 FR 64097. Chapter 8 of the final rule TSD describes the approach. DOE used the same lifetime for furnace fans at different efficiency levels because there are no data that indicate variation of lifetime with efficiency. For the NOPR analysis, DOE assumed that the lifetime for the fans installed in electric furnaces and gas furnaces is the same.

Rheem stated that the lifetime of a residential furnace fan is limited by the lifetime of the electronic control, and advanced controls may shorten the lifetime of the product. (Rheem, No. 83 at pp. 6, 13) JCI stated that the repair costs for furnace fans are generally the cost of replacing the motors used, as there are very few failures of fan components other than the motor. (JCI, No. 95 at p. 6)

DOE believes that with current technology there are few failures of the electronic control, as stated by JCI. DOE also expects that the reliability of the electronic controls is likely to increase as the technology matures. Nonetheless, DOE accounts for failure of capacitors and motor electronic controls in its repair cost analysis.

APGA stated that 23.6 years lifetime for gas-fired furnace fans in the LCC analysis is unrealistic, and DOE should employ more realistic furnace fan lives based on documented motor lives. (APGA, No. 110 at p. 3) It would appear that APGA misinterpreted DOE's approach. Motor failure, which occurs on average at around 15 years, is counted as a repair cost. However, DOE believes that the rest of the furnace fan would last as long as the furnace itself.

Southern Company stated that because the analysis shows at least 50% greater shipments of furnace fans than furnaces, the data seems to indicate a shorter lifetime for furnace fans than furnaces. (Southern Company, No. 85 at p. 3) DOE did not calculate the shipments of furnace fans. Since furnace fans are a component of furnaces, the shipments in the NIA analysis are limited to furnace shipments only.

4. Discount Rates

For the NOPR, DOE used distributions of discount rates based on a variety of financial data. 78 FR 64097. For replacement furnaces, the average rate was 5.0 percent.

Miller stated that, based on a literature review of consumer discount rates for energy-using durables, the 3-percent and 7-percent discount rates used in the analysis only represent high-income households; other consumers may use much higher discount rates. Consumers with higher discount rates—including median-income Americans, low-income Americans, and the elderly—are much less likely to benefit from higher efficiency furnace fans. (Miller, No. 79 at pp. 10–13)

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[40] RS Means Company Inc., *RS Means Residential Cost Data* (2012); RS Means Company Inc., *Facilities Maintenance & Repair Cost Data* (2012).

DOE uses 3-percent and 7-percent discount rates to measure net consumer benefits from energy efficiency standards from a national perspective (see section IV.H). DOE recognizes that a wide range of discount rates may be appropriate for consumers, and thus it uses distributions of discount rates when it evaluates consumer impacts in the LCC analysis. For the final rule, DOE developed specific distributions of discount rates for each of six consumer income groups. Chapter 8 of the final rule TSD describes the approach. The estimated impacts of today's standards on low-income households are discussed in section V.B.1.[41]

5. Compliance Date

In the NOPR, DOE proposed a 5-year compliance date for residential furnace fan standards. 78 FR 64103. A number of stakeholders encouraged DOE to adopt a three-year period between the final rule publication and the compliance date rather than the five years proposed in the NOPR. (ACEEE, No. 94 p. 6; NEEP, No. 109 at p. 2; Earthjustice, No. 101 at p. 3; CA IOU, No. 106 at p. 3; Joint Advocates, No. 105 at p. 4; NEEA, NPCC, No. 96 at p. 3) ACEEE, CA IOU, the Joint Advocates, and NEEA and NPCC stated that the technologies assumed to be required to meet TSL 4 are well-established in the market and commercially available. (ACEEE, No. 94 at p. 6; CA IOU, No. 106 at p. 3; Joint Advocates, No. 105 at p. 4; NEEA, NPCC, No. 96 at p. 3) NEEP stated that three years should provide adequate time for manufacturers to adjust product lines. (NEEP, No. 109 at p. 2) The Joint Advocates stated that constant-torque BPM motors are essentially drop-in replacements for PSC motors, and capital conversion costs are not required. (Joint Advocates, No. 105 at p. 4) NEEA and NPCC believe that three years of lead time should be sufficient to allow a ramping up of motor manufacturing capacity and a gradual shift of air handler manufacturing lines to incorporate them. The technology required to meet the TSL 4 standards requires little more than expansion of current production capacity for these models, which mostly means buying different furnace fan motors and the associated controls. (NEEA, NPCC, No. 96 at p. 3) Earthjustice stated that DOE must choose a compliance date based on an assessment that includes a consideration of factors beyond the impact on manufacturers. (Earthjustice, No. 101 at p. 3)

JCI, Morrison, AHRI, Lennox, and HARDI support the five-year period between the final rule publication and the compliance date as proposed in the NOPR. (JCI, No. 95 at p. 2; Morrison, No. 108 at p. 2; AHRI, No. 98 at p. 2; Lennox, No. 100 at p. 4; HARDI, No. 103 at p. 2) JCI, AHRI, and Lennox stated that to comply with the proposed standard, manufacturers would not only have to alter the designs and fabrication processes for the furnace fan assembly but also modify the broader product design of the furnaces, air handlers, modular blowers, and residential single package units that include those furnace fans. (JCI, No. 95 at p. 2; AHRI, No. 98 at p. 2; Lennox, No. 100 at pp. 4–5) AHRI stated that similar products that require similar actions for compliance typically have lead times of five years. (AHRI, No. 98 at p 2) Ingersoll Rand agrees with AHRI's comments. (Ingersoll Rand, No. 107 at p. 11)

DOE continues to believe a 5-year lead time is appropriate. Since EPCA does not mandate a specific lead time for furnace fan standards, DOE considered the actions required by manufacturers to comply with today's standards. As discussed in the NOPR, during manufacturer interviews, DOE found that standards would result in manufacturers' extending R&D beyond the furnace fan assembly to understand the impacts on the design and performance of the furnace or modular blower in which the furnace fan is integrated. 78 FR 64103. To comply with the standards, manufacturers may have to alter not only the designs and fabrication processes for the furnace fan assembly, but also for the furnace or modular blower into which the furnace fan is integrated. Similar products that require similar actions for compliance typically have lead times of five years. For these reasons, DOE selected a 5-year lead time, which would place the compliance date in 2019. For the purposes of the LCC and PBP analysis, DOE assumed that all relevant consumers purchase a furnace fan in 2019.

6. Base-Case Efficiency Distribution

To estimate the share of consumers that would be affected by an energy conservation standard at a particular efficiency level, DOE's LCC and PBP analysis considers the projected distribution (*i.e.,* market shares) of product efficiencies in the first compliance year under the base case (*i.e.,* the case without new or amended energy conservation standards).

For the NOPR, DOE reviewed the information provided by the manufacturers and estimated that the combined market share of constant-torque BPM fans and constant-airflow BPM fans will be 35 percent in 2019. The shares are 13 percent for constant-torque BPM fans and 22 percent for constant-airflow BPM fans. DOE estimated separate shares for replacement and new home applications.78 FR 64097.

The market shares of efficiency levels within the constant-torque BPM motor and constant-airflow BPM motor categories were derived from AHRI data on number of models.[42] No such data were available for the PSC fan efficiency levels, so DOE used the number of models it tested or could measure using product literature to estimate that 40 percent of shipments are at the baseline level and 60 percent are improved PSC fans. There are currently no models of PSC with a controls design, so DOE assumed zero market share for such units. *Id*

No comments were received on the base case efficiency distribution, and DOE retained the NOPR assumptions for the final rule. The details of DOE's approach are described in chapter 8 of the final rule TSD.

7. Payback Period

To calculate PBPs for the considered efficiency levels, DOE uses the same inputs as for LCC analysis, except that discount rates are not required.

Goodman stated that not including repair costs from later years in the PBP does not provide a realistic picture of what most consumers will face. It noted that while repair costs later in the product life cycle may allow the initial investment to balance out faster, the overall life-cycle costs can be very negatively impacted by such repairs. (Goodman, No 102 at p. 10)

DOE recognizes that the PBP metric does not provide a complete assessment of all costs that consumers may face, but it has found that the results are of interest in standards rulemakings. The LCC analysis does include all costs, and in part for this reason, DOE expresses the share of consumers who benefit

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[41] The comment refers to high discount rates based on studies of implicit consumer discount rates using the purchase of energy-using durables (such as air conditioners, dishwashers, and refrigerators) to measure consumer time preferences. While these studies of implicit consumer discount rates provide a way of characterizing consumer behavior, they do not necessarily measure consumer time preferences. What appears to be low valuation of future energy cost savings from higher-efficiency appliances instead may be partially a result of lack of information on the magnitude of savings or inability to evaluate the available information.

[42] DOE used the AHRI Directory of Certified Furnace Equipment (Available at: *http://www.ahridirectory.org/ahridirectory/pages/home.aspx*) as well as manufacturer product literature.

from standards in terms of the change in LCC.

As discussed in section III.E.2, EPCA provides that a rebuttable presumption is established 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. (42 U.S.C. 6295(o)(2)(B)(i)) The calculation of this so-called rebuttable presumption payback period uses the same inputs as the calculation of the regular PBP for each sample household, but it uses average values instead of distributions, and the derivation of energy consumption and savings only uses the parameters specified by the proposed DOE test procedure for furnace fans rather than the method applied in the energy use analysis (described in section IV.E), which considers the characteristics of each sample household.

DOE's LCC and PBP analyses generate values that calculate the payback period for consumers of potential energy conservation standards, which includes, but is not limited to, the three-year payback period contemplated under the rebuttable presumption test discussed above. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this 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).

G. Shipments Analysis

DOE uses forecasts of product shipments to calculate the national impacts of standards on energy use, NPV, and future manufacturer cash flows. DOE develops shipment projections based on historical data and an analysis of key market drivers for each product.

The vast majority of furnace fans are shipped installed in furnaces, so DOE estimated furnace fan shipments by projecting furnace shipments in three market segments: (1) Replacements; (2) new housing; and (3) new owners in buildings that did not previously have a central furnace.

To project furnace replacement shipments, DOE developed retirement functions for furnaces from the lifetime estimates and applied them to the existing products in the housing stock. The existing stock of products is tracked by vintage and developed from historical shipments data. The shipments analysis uses a distribution of furnace lifetimes to estimate furnace replacement shipments.

To project shipments to the new housing market, DOE utilized projected new housing construction and historic saturation rates of various furnace and cooling product types in new housing. For the final rule, DOE used *AEO 2013* for projections of new housing. Furnace saturation rates in new housing are provided by the U.S. Census Bureau's *Characteristics of New Housing.*[43]

DOE also included a small market segment consisting of households that become ''new owners'' of a gas furnace. This segment consists of households that have central air conditioning and non-central heating or central air conditioning and electric heating and choose to install a gas furnace.

Lennox stated that the shipment projections do not appear to be supported by the record or recent sales figures, as historical shipments data from AHRI for gas and oil warm air furnaces show a downward trend in shipments. (Lennox, No. 100 at pp. 6–7) AHRI stated that DOE's shipment projections are inaccurate and the projected numbers significantly skew the national energy savings estimates. (AHRI, No. 98 at pp. 4–5)

DOE's shipments projections are based on replacement of furnaces installed over the past few decades and furnaces installed in future new homes. Most of the recent downward trend in shipments is due to lower new construction in the wake of the financial crisis. DOE updated historical shipments with 2013 data, which shows a growth in gas furnace shipments. DOE also updated the new construction forecast based on *AEO 2013* projections, which reflect improving economic conditions and a future increase of the new construction market. In addition, the replacements reflect an updated furnace retirement function based on the latest furnace lifetime data. Oil furnace shipments are projected to continue to drop in the future.

JCI and AHRI stated that the projected shipments should account for an echo effect loss in replacement sales for the furnaces that were not sold in the years 2008–2012. (JCI, No. 95 at p. 10; AHRI, No. 98 at pp. 4–5) The projection for today's final rule shows a lower level of replacement shipments in the 2025–2030 period, which is a consequence (*i.e.,* an echo) of the decline in historical shipments in 2006–2009.

JCI believes that the shipment projections for furnaces are too optimistic. It noted that during the years prior to 2006, demand for large homes with multiple furnace systems was more common than it is today. (JCI, No. 95 at pp. 9–10) Mortex stated that forecasts of future shipments are unrealistically high because new homes are smaller and less likely to have two furnaces. (Mortex, No. 104 at p. 3) In DOE's final rule analysis, DOE assumed that new homes would not have multiple furnaces.

It is reasonable to expect that energy conservation standards for residential furnace fans that result in higher furnace prices would have some dampening effect on sales. Some consumers might choose to repair their existing furnace rather than purchase a new one, or perhaps install an alternative space heating product. To estimate the impact on shipments of the price increase for the considered efficiency levels, DOE used a relative price elasticity approach. This approach also gives some weight to the operating cost savings from higher-efficiency products.

Ingersoll Rand stated that the shipment projections do not account for a drop off in sales due to higher furnace prices that will result from using more expensive components. (Ingersoll Rand, No. 107 at p. 9) The comment is incorrect; the relative price elasticity approach does estimate the impact on shipments of the price increase for the considered efficiency levels for the NOPR and the final rule.

Several stakeholders raised issues with DOE's relative price elasticity approach. They stated that the household income data and data used to derive the elasticity are outdated and do not reflect current trends, and the household appliances used to derive the relative price elasticity (refrigerators, clothes washers and dishwashers) are inappropriate for this rulemaking. (JCI, No. 95 at p. 10; Morrison, No. 108 at p. 8; AHRI, No. 98 at pp. 12–13; Goodman, No. 102 at p. 13) Rheem expressed similar concerns. (Rheem, No. 83 at p. 12)

In response, DOE notes that there are very few estimates of consumer demand elasticity for durable goods. Although the data that DOE used to estimate relative price elasticity are not current, and the analysis focused on products that differ from furnaces, DOE believes that consumer behavior with respect to the impact of higher appliance price on

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[43] Available at: *http://www.census.gov/construction/chars/.*

demand is not likely to have changed significantly. One recent paper suggests that demand elasticity for air conditioners is inelastic—holding efficiency constant, a 10% rise in price leads to a 1.4% decline in sales.[44] This is a lower elasticity than DOE uses in its analysis. Therefore, DOE believes that it is reasonable to use the relative price elasticity approach for today's final rule. See chapter 9 in the final rule TSD for a description of the method.

Mortex stated that a big increase in the installed cost of a new furnace under the proposed energy conservation standards will lead many consumers to repair rather than replace with a new furnace. (Mortex, No. 104 at p. 3) In terms of the overall cost of a new furnace, the increase attributable to using a more energy-efficient furnace fan is relatively small—less than 10 percent—for fans meeting today's standards. In any case, the price elasticity approach described above captures the potential consumer response to higher furnace prices, which often would consist of choosing to repair an existing furnace rather than replace it with a new furnace.

AGA urged the Department to include a robust fuel switching analysis, including the competing economics of natural gas furnaces versus both electric furnaces and heat pumps. (AGA, No. 110 at p. 3) There is a possibility that for some consumers considering replacement of a non-condensing gas furnace, the higher price of a gas furnace due to today's standards could lead to some switching to heat pumps. However, this switching would only occur if the CAC is replaced at the same time as the furnace. Furthermore, switching to a heat pump would require additional cost to install backup electric resistance heating elements. Based on the above considerations, DOE believes that any switching to heat pumps due to today's standards would be minimal. The standards would not create any incentive to switch to electric furnaces because electric furnaces are subject to the furnace fan standard and would see a similar incremental cost as a gas furnace.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings expected to result from new or amended energy conservation standards at specific efficiency levels. DOE determined the NPV and NES for the potential standard levels considered for the furnace fan product classes analyzed. To make the analysis more accessible and transparent to all interested parties, DOE prepared a computer spreadsheet that uses typical values (as opposed to probability distributions) as inputs. To assess the effect of input uncertainty on NES and NPV results, DOE has developed its spreadsheet model to conduct sensitivity analyses by running scenarios on specific input variables.

Analyzing impacts of potential energy conservation standards for residential furnace fans requires comparing projections of U.S. energy consumption with new or amended energy conservation standards against projections of energy consumption without the standards. The forecasts include projections of annual appliance shipments, the annual energy consumption of new appliances, and the purchase price of new appliances.

A key component of DOE's NIA analysis is the energy efficiencies projected over time for the base case (without new standards) and each of the standards cases. The projected efficiencies represent the annual shipment-weighted energy efficiency of the products under consideration during the shipments projection period (*i.e.,* from the assumed compliance date of a new standard to 30 years after compliance is required).

For the NOPR, DOE reviewed the information provided by the manufacturers and modified its estimate of the long-run trend in market shares of constant-torque BPM and constant-airflow BPM motor furnace fans. The NOPR analysis assumes a long-run trend that results in market share of the constant-torque BPM and constant-airflow BPM furnace fans reaching 45 percent in 2048. 78 FR 64099. No comments were received on this issue and DOE retained the same approach for the final rule.

For the NOPR, DOE used a roll-up scenario for estimating the impacts of the potential energy conservation standards for residential furnace fans. Under the roll-up scenario, DOE assumes: (1) Products with efficiencies in the base case that do not meet the standard level under consideration would roll up to meet the new standard level; and (2) products with efficiencies above the standard level under consideration would not be affected. *Id.*

Rheem stated that DOE's assumption that the sale of premium products above the standard level will be unaffected is unreasonable. (Rheem, No. 83 at p. 3) DOE acknowledges that the market shares of fans with efficiency levels above a given standard level could change after compliance with the new standards is required. Estimating how manufacturers will respond to new standards with regard to their marketing strategy for ''above-standard'' products is very difficult, however. Rather than speculate, DOE believes that it is preferable to retain a roll-up scenario for today's final rule.

For the standards cases, the assumed efficiency trend after the compliance year varies depending on the particular standard. For the case with today's standards, the overall BPM motor market share goes to 100 percent in 2019 and remains at that level. The shares of the specific BPM motor designs (i.e., constant-torque BPM, constant-torque BPM motor + multi-stage, constant-airflow BPM motor + multi-stage, and constant-airflow BPM motor + multi-stage + backward-inclined impeller) remain at the levels of 2019. The details are provided in chapter 10 of the final rule TSD.

1. National Energy Savings Analysis

The national energy savings analysis involves a comparison of national energy consumption of the considered products in each potential standards case (TSL) with consumption in the base 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). Vintage represents the age of the product. DOE calculated annual NES based on the difference in national energy consumption for the base case (without new efficiency standards) and for each higher efficiency standard. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

DOE calculates primary energy savings (power plant consumption) from site electricity savings by applying a factor to account for losses associated with the generation, transmission, and distribution of electricity. For the NOPR, DOE derived marginal site-to-power plant factors based on the version of the National Energy Modeling System (NEMS) that corresponds to *AEO 2012.* 78 FR 64099. The factors change over time in response to projected changes in the types of power plants projected to provide electricity to the country.

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[44] David Rapson. Durable Goods and Long-Run Electricity Demand: Evidence from Air Conditioner Purchase Behavior. Department of Economics, University of California, Davis. Available at: *www.econ.ucdavis.edu/faculty/dsrapson/Rapson_LR_electricity.pdf.*

Commenting on DOE's approach, AGA stated that it is highly unlikely and unrealistic that all of the projected changes in types of power plant used to generate electricity in this country will occur between 2019 and 2021 and that essentially no change will occur from 2031 through 2048. AGA stated that realistic trend lines to 2048 including a linear forecast of declining site-to-power plant energy use should be provided. (AGA, No. 110 at p. 3)

For the final rule, DOE derived site-to-power plant factors based on the version of NEMS that corresponds to *AEO 2013.* As shown in Figure 10.3.1 in the final rule TSD, the factor (expressed as primary energy per site kWh) declines through 2030 as more efficient power plants gain share in power generation. After 2035, there is an increase due to lower projected share of highly-efficient combined-cycle power plants. DOE acknowledges that projections after 2035 are uncertain, but it believes that NEMS provides a reasonable projection.

DOE has historically presented NES in terms of primary energy savings. 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 Science, DOE announced its intention to use full-fuel-cycle (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 notice, DOE published a statement of amended policy in the **Federal Register** in which DOE explained its determination that 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). The approach used for today's final rule is described in appendix 10–C of the final rule TSD.

JCI and AHRI stated that, for cooling mode, the NIA spreadsheet model does not indicate how DOE used the average annual electricity use values from the energy use analysis to determine national energy savings. (JCI, No. 95 at pp. 4–5; AHRI, No. 98 at p. 6) In the NIA spreadsheet, the LCC Inputs worksheet shows how the average annual electricity use values are used over the analysis period.

Several stakeholders questioned the accuracy of the doubling in FFC energy savings from TSL 3 to TSL 4 from an incremental efficiency level improvement of 8 percent for five of the product classes from adding the multi-staging option. (JCI, No. 95 at p 4; EEI, No. 91 at pp. 307, 309; Morrison, No. 108 at p. 4; AHRI, No. 98 at pp. 4–5; Lennox, No. 100 at p. 2; Ingersoll Rand, No. 107 at p. 9) Similarly, AHRI stated that if the effect of multi-staging was indeed prominent enough to nearly double the estimated FFC energy savings between TSLs 3 and 4, DOE should have evaluated this effect for PSC motors as well. (AHRI, No. 98 at p. 5) Morrison stated that for non-weatherized gas furnace fans, it is inconsistent that TSL 4 could produce a very large increase in FFC energy savings over TSL 3 while TSL 2 and 3 have the same national energy savings; compared to the difference in energy use between TSL 2 and TSL 3, TSL 4 has a much lower incremental average electricity savings and higher additional fuel use compared to TSL 3. (Morrison, No. 108 at p. 4)

For the final rule, DOE incorporated new test data on the fan efficiency levels that were included in TSL 3 (constant torque BPM motors) and TSL 4 (constant torque BPM motors (multi-stage)). These data contributed to a decrease in efficiency for TSL 4 (see section IV.C.1) With this change, the increase in savings from TSL 3 to TSL 4 is now smaller than in the NOPR. The NIA results are presented in section V.B.3.

Several stakeholders stated that it is implausible that the furnace fan standard will save about as much energy as the 2006 13 SEER rulemaking (76 FR 7185) or the 2013/2015 90% AFUE furnace and 14 SEER rulemaking (76 FR 37412). (AHRI, No. 98 at p. 6; Ingersoll Rand, No. 107 at p. 9; Lennox, No. 100 at p. 2; Goodman, No. 102 at p. 6) Ingersoll Rand stated that the energy savings from the proposed rule claim to be greater than savings from the 13 SEER rule, but the energy savings of a furnace switching from a PSC motor to a constant torque BPM is nearly an order of magnitude less than the energy use of the furnace or heat pump. (Ingersoll Rand, No. 107 at p. 9)

DOE reviewed the methodology used to assess the energy savings estimated for the proposed standards, as discussed in previous parts of this notice, and believes that the energy savings estimated for the considered TSLs are reasonable. Comparison with other rules must be done with caution, as the savings in those rules depends on both the stringency of the standards and the base case that was chosen in the analysis. The fact that the energy savings of a furnace switching from a PSC motor to a constant torque BPM is much less than the energy use of the furnace or heat pump is not relevant to the energy savings associated with standards for furnaces or heat pumps.

2. Net Present Value Analysis

The inputs for determining NPV are: (1) Total annual installed cost; (2) total annual savings in operating costs; (3) a discount factor to calculate the present value of costs and savings; (4) present value of costs; and (5) present value of savings. DOE calculated net savings each year as the difference between the base case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculated savings over the lifetime of products shipped in the forecast period. DOE calculated NPV as the difference between the present value of operating cost savings and the present value of total installed costs. DOE used a discount factor based on real discount rates of 3 and 7 percent to discount future costs and savings to present values.

For the NPV analysis, DOE calculates increases in total installed costs as the difference in total installed cost between the base case and standards case (*i.e.,* once the standards take effect).

DOE assumed no change in residential furnace fan prices over the 2019–2048 period. In addition, DOE conducted a sensitivity analysis using alternative price trends, specifically one in which prices decline over time, and another in which prices rise. These price trends are described in appendix 10–C of the final rule TSD.

DOE expresses savings in operating costs as decreases associated with the lower energy consumption of products bought in the standards case compared to the base efficiency case. Total savings in operating costs are the product of savings per unit and the number of units of each vintage that survive in a given year.

DOE estimates 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.[45] The NPV results for the residential furnace fan TSLs are presented in section V.B.3 of this document.

I. Consumer Subgroup Analysis

A consumer subgroup comprises a subset of the population that may be affected disproportionately by new or revised energy conservation standards (*e.g.,* low-income consumers, seniors).

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[45] OMB Circular A–4 (Sept. 17, 2003), section E, ''Identifying and Measuring Benefits and Costs.''

The purpose of a consumer subgroup analysis is to determine the extent of any such disproportional impacts.

For today's final rule, DOE evaluated impacts of potential standards on two subgroups: (1) Senior-only households and (2) low-income households. DOE identified these households in the RECS sample and used the LCC spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. The consumer subgroup results for the residential furnace fan TSLs are presented in section V.B.1 of this document.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impact of new energy conservation standards on manufacturers of residential furnace fans and to calculate the potential impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model with inputs specific to this rulemaking. The key GRIM inputs are data on the industry cost structure, product costs, shipments, and assumptions about markups and conversion expenditures. The key output is the industry net present value (INPV). Different sets of assumptions (markup scenarios) will produce different results. The qualitative part of the MIA addresses factors such as product characteristics, impacts on particular subgroups of firms, and important market and product trends. The complete MIA is outlined in chapter 12 of the final rule TSD.

For this rulemaking, DOE considers the ''furnace fan industry'' to consist of manufacturers who assemble furnace fans as a component of the HVAC products addressed in this rulemaking.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the residential furnace fans industry that includes a top-down cost analysis of manufacturers used to derive preliminary financial inputs for the GRIM (*e.g.,* sales, general, and administration (SG&A) expenses; research and development (R&D) expenses; and tax rates). DOE used public sources of information, including company SEC 10–K filings,[46] corporate annual reports, the U.S. Census Bureau's Economic Census,[47] and Hoover's reports.[48]

In Phase 2 of the MIA, DOE prepared an industry cash-flow analysis to quantify the potential impacts of a new energy conservation standard. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) Create a need for increased investment; (2) raise production costs per unit; and (3) alter revenue due to higher per-unit prices and possible changes in sales volumes.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with a representative cross-section of manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. Section IV.J.4 of the NOPR contains a description of the key issues manufacturers raised during the interviews. 78 FR 64068, 64104–05 (Oct. 25, 2013).

Additionally, in Phase 3, DOE evaluated subgroups of manufacturers that may be disproportionately impacted by new standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash-flow analysis. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected. DOE identified one subgroup (*i.e.,* small manufacturers) for a separate impact analysis.

DOE applied the small business size standards published by the Small Business Administration (SBA) to determine whether a company is considered a small business. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. To be categorized as a small business under North American Industry Classification System (NAICS) code 333415, ''Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing,'' a residential furnace fan manufacturer and its affiliates may employ a maximum of 750 employees. The 750-employee threshold includes all employees in a business's parent company and any other subsidiaries. Based on this classification, DOE identified 15 residential furnace fan manufacturers that qualify as small businesses. The residential furnace fan small manufacturer subgroup is discussed in chapter 12 of the final rule TSD and in section V.B.2.d of this document.

2. Government Regulatory Impact Model

DOE uses the GRIM to quantify the changes in cash flow due to new standards that result in a higher or lower industry value. The GRIM analysis uses a standard, annual cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM model changes in costs, distribution of shipments, investments, and manufacturer margins that could result from new energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2014 and continuing to 2048. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For residential furnace fan manufacturers, DOE used a real discount rate of 7.8 percent, which was derived from industry financials and then modified according to feedback received during manufacturer interviews.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between a base case and each standards case. The difference in INPV between the base case and a standards case represents the financial impact of the new energy conservation standard on manufacturers. As discussed previously, DOE collected this information on the critical GRIM inputs from a number of sources, including publicly-available data and interviews with a number of manufacturers (described in the next section). The GRIM results are shown in section V.B.2.a. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Government Regulatory Impact Model Key Inputs

Manufacturer Production Costs

Manufacturing a higher-efficiency product is typically more expensive than manufacturing a baseline product due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of the analyzed products can affect the revenues, gross

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[46] U.S. Securities and Exchange Commission, Annual 10–K Reports (Various Years) (Available at: *http://sec.gov*).

[47] U.S. Census Bureau, Annual Survey of Manufacturers: General Statistics: Statistics for Industry Groups and Industries (Available at: *http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*).

[48] Hoovers Inc. Company Profiles (Various Companies) (Available at: *http://www.hoovers.com*).

margins, and cash flow of the industry, making these product cost data key GRIM inputs for DOE's analysis.

In the MIA, DOE used the MPCs for each considered efficiency level calculated in the engineering analysis, as described in section IV.C and further detailed in chapter 5 of the final rule TSD. In addition, DOE used information from its teardown analysis, described in chapter 5 of the TSD, to disaggregate the MPCs into material, labor, and overhead costs. To calculate the MPCs for equipment above the baseline, DOE added the incremental material, labor, and overhead costs from the engineering cost-efficiency curves to the baseline MPCs. These cost breakdowns and product markups were validated and revised with manufacturers during manufacturer interviews.

Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of these values by efficiency level. 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 forecasts derived from the shipments analysis from 2014 (the base year) to 2048 (the end year of the analysis period). See chapter 9 of the final rule TSD for additional details.

Product and Capital Conversion Costs

New energy conservation standards would 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) Product conversion costs; and (2) capital conversion costs. Product conversion costs are one-time investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with the new energy conservation standard. Capital conversion costs are one-time investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new product designs can be fabricated and assembled.

To evaluate the level of capital conversion expenditures manufacturers would likely incur to comply with new 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. DOE validated manufacturer comments through estimates of capital expenditure requirements derived from the product teardown analysis and engineering analysis described in chapter 5 of the TSD.

DOE assessed the product conversion costs at each considered efficiency level by integrating data from quantitative and qualitative sources. DOE considered market-share-weighted feedback regarding the potential costs of each efficiency level from multiple manufacturers to determine conversion costs such as R&D expenditures and certification costs. Manufacturer data were aggregated to better reflect the industry as a whole and to protect confidential information.

In general, DOE assumes that 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 investment figures used in the GRIM can be found in section IV.J.2 of this notice. For additional information on the estimated product and capital conversion costs, see chapter 12 of the final rule TSD.

b. Government Regulatory Impact Model Scenarios

Shipment Scenarios

In the NIA, DOE modeled shipments with a roll-up scenario to represent possible standards-case efficiency distributions for the years beginning 2019 (the year that compliance with new standards would be required) through 2048 (the end of the analysis period). The roll-up scenario represents the case in which all shipments in the base case that do not meet the new standard would roll up to meet the new standard level, with the efficiency of products already at the new standard level remaining unchanged. Consumers in the base case who purchase products above the standard level are not affected as they are assumed to continue to purchase the same product in the standards case. See chapter 9 of the final rule TSD for more information.

Markup Scenarios

As discussed above, MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent the uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of new energy conservation standards: (1) A preservation of gross margin percentage markup scenario; and (2) a preservation of per unit operating profit markup scenario. These scenarios lead to different markups values that, when applied to the inputted MPCs, result in varying revenue and cash flow 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 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 absolute dollar markup will increase as well. Based on publicly-available financial information for manufacturers of residential furnace fans and comments from manufacturer interviews, DOE assumed the non-production cost markup—which includes SG&A expenses, R&D expenses, interest, and profit—to be the following for each residential furnace fan product class:

TABLE IV.11—MANUFACTURER MARKUP BY RESIDENTIAL FURNACE FAN PRODUCT CLASS

Product class	Markup
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC)	1.30
Non-Weatherized, Condensing Gas Furnace Fan (NWG–C)	1.31
Weatherized, Non-condensing Gas Furnace Fan (WG–NC)	1.27
Non-Weatherized, Non-condensing Oil Furnace Fan (NWO–NC)	1.35
Electric Furnace/Modular Blower Fan (EF/MB)	1.19

TABLE IV.11—MANUFACTURER MARKUP BY RESIDENTIAL FURNACE FAN PRODUCT CLASS—Continued

Product class	Markup
Mobile Home Non-Weatherized, Non-condensing Gas Furnace Fan (MH–NWG–NC)	1.25
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C)	1.25
Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB)	1.15

Because this markup scenario assumes that manufacturers would be able to maintain their gross margin percentage markups as production costs increase in response to a new energy conservation standard, it represents a high bound to industry profitability.

In the preservation of per unit operating profit scenario, manufacturer markups are set so that operating profit one year after the compliance date of the new energy conservation standard is the same as in the base case on a per unit basis. Under this scenario, as the costs of production increase under a standards case, manufacturers are generally required to reduce their markups to a level that maintains base-case operating profit per unit. The implicit assumption behind this markup scenario is that the industry can only maintain its operating profit in absolute dollars per unit after compliance with the new standard is required. Therefore, operating margin in percentage terms is squeezed (reduced) between the base case and standards case. DOE adjusted the manufacturer markups in the GRIM at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the base case. This markup scenario represents a low bound to industry profitability under a new energy conservation standard.

3. Discussion of Comments

During the NOPR public meeting, interested parties commented on the assumptions and results of the NOPR analysis TSD. Oral and written comments addressed several topics, including conversion costs, cumulative regulatory burdens, scope of MIA coverage, markups analysis, employment impacts, consumer utility impacts, and impacts on small businesses.

a. Conversion Costs

Several manufacturers expressed concern regarding the DOE's estimates of the capital and product conversion costs, including costs relating to testing and certification.

Regarding capital conversion costs associated with a furnace fans standard, Goodman commented that DOE's estimate of zero capital conversion costs at TSL 4 does not properly reflect feedback from manufacturer interviews. (Goodman, No. 102 at p. 10) AHRI stated that the technology option associated with TSL 4 would necessitate changes in manufacturers' assembly and subassembly production lines, including the modification and/or elimination of current fan housings, heat exchanger types, and furnace cabinet sizes, at a cost of $103 million for the industry. (AHRI, No. 98 at p. 10) Johnson Controls commented that compliance with the proposed standard would likely require them to make a capital investment ranging from $2.8 million to $4 million. (JCI, No. 95 at p. 2)

In the engineering analysis, most of the technology options being considered require only a change in the type of motor used. At the NOPR stage, DOE tentatively concluded that TSLs 1 through 5 would not require manufacturers to incur capital expenditures for new tooling or equipment. However, in response to the above-mentioned public comments received during the NOPR period, DOE has revised its methodology for estimating capital conversion costs at all TSLs for the final rule. DOE incorporated all capital conversion cost values submitted by manufacturers during the course of MIA interviews and used a product listing weighted-average of feedback (based on basic model listings in the AHRI directory) to determine conversion costs for the industry. As a result, capital conversion costs were revised upward at all TSLs, as shown in Table IV.12.

TABLE IV.12—FINAL RULE CAPITAL CONVERSION COSTS (CCC)

	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Total Industry CCCs ($ millions)	8.8	11.1	11.8	15.1	15.7	134.7

DOE notes that the conversion costs submitted by AHRI and Johnson Controls are generally consistent with DOE's estimates of conversion costs at TSL 6 in the final rule. However, without a more detailed breakdown of the conversion costs by TSL from those stakeholders, it was not feasible for DOE to determine the discrepancies in capital conversion cost values or to incorporate their feedback into the GRIM model.

With regards to product conversion costs, including costs associated with compliance, certification, and enforcement (CC&E), both Trane and Johnson Controls provided their own estimates in support of the notion that there will be significant testing burden associated with standards compliance. (Trane, No. 107 at pp. 2, 6, and JCI, No. 95 at p. 8) Goodman also stated that investments in additional testing equipment may be required in order to keep pace with current and future testing requirements. (Goodman, No. 102 at p. 11) AHRI and multiple manufacturers commented that the performance standard associated with TSL 4 would require total industry product conversion costs of $6.2 million. (AHRI, No. 98 at p. 10)

DOE acknowledges manufacturers' concerns regarding product conversion cost estimates, including those relating to testing and certification. Similar to the capital conversion cost analysis, DOE refined its final rule modeling of product conversion costs to better reflect information received during manufacturer interviews. DOE used a product listing weighted-average (based on basic model listings in the AHRI directory) to extrapolate individual manufacturer feedback to an industry value for each efficiency level and for each product class. Additionally, for the final rule, DOE explicitly incorporated certification costs into the product conversion cost estimates used in the GRIM. These certification costs occur in the base case and apply in the standards cases. DOE modeled testing and certification costs under the assumption that larger manufacturers have would conduct all FER testing in-house, while small manufacturers would outsource all certification testing. DOE assumed a cost of $175 per test per basic model for large manufacturers (derived from the test procedure estimate of a maximum of 4 hours per test) (79 FR 500 (Jan. 3, 2014)) and a cost of $2,000 per test per basic model for small manufacturers (77 FR 28674 (May 15, 2012)). See Table IV.13 and Table IV.14 below for a summary of testing and certification cost calculations and overall product conversion costs. Conversion costs are discussed in detail in section V.B.2.a of today's document and in chapter 12 of the final rule TSD.

TABLE IV.13—TESTING AND CERTIFICATION COSTS

	Value
General assumptions:	
[a] Number of FER tests required per Basic Model	2
[b] Total Industry Number of Basic Models [1]	2,254
[c] Number of Basic Models for Large Manufacturers	1,943
[d] Number of Basic Models for Small Manufacturers	311
Large manufacturer assumptions:	
[e] Labor rate ($/hr) [2]	43.73
[f] Time required per test (hours) [3]	4
Small manufacturer assumptions:	
[g] Cost per FER test (outsource) ($) [4] =	$2,000
[h] FER costs per model for Large Manufacturer ($) = [a]*[e]*[f]	$350
[i] FER costs per model for Small Manufacturer ($) = [a]*[g]	$4,000
Total Industry FER costs ($ millions) = [h]*[c] + [i]*[d]	$1.9
Total Industry FER costs rescaled to account for EF/MB and MH–EF/MB product classes ($ millions) [5]	$2.2

[1] AHRI Directory: Residential Furnaces.

[2] Bureau of Labor Statistics, 2012 mean hourly wage for all engineers.

[3] 2012–05–15 Test Procedures for Residential Furnace Fans; Notice of proposed rulemaking, section IV, part B.

[4] 2012–05–15 Test Procedures for Residential Furnace Fans; Notice of proposed rulemaking, section IV, part B.

[5] The AHRI residential furnaces database does not contain electric furnaces/modular blowers. In order to account for CC&E costs relates to these products (standard and MH), DOE rescaled the $1.9 value by 12%, which is the estimated proportion of shipments for these two categories combined. $2.2 is the value used in the GRIM.

TABLE IV.14—PRODUCT CONVERSION COSTS

	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Total Number of Basic Models [1]	2,254						
Average Testing and Certification Costs + R&D Costs per Basic Model ($)	853	8,449	10,577	11,356	11,434	12,157	13,182
Total Industry PCCs ($ millions)	2.2	18.8	23.6	25.3	25.5	27.1	29.4

[1] AHRI Directory: Residential Furnaces.

b. Cumulative Regulatory Burden

Interested parties expressed concern over the cumulative regulatory burden that would result from a residential furnace fan energy conservation standard. AHRI, Morrison, and Lennox commented that DOE did not account for the cumulative impacts of additional DOE regulations, including energy conservation standards or potential standards for commercial and industrial fans and blowers, commercial package air conditioners and heat pumps, and commercial warm air furnaces. The three stakeholders also asserted that DOE did not address testing burdens associated with the recently finalized test procedures for two-stage and modulating condensing furnaces and boilers, and potential updates to test procedures for residential furnaces and boilers. (AHRI, No. 98 at p. 8–9; Morrison, No. 108 at p. 6; Lennox, No. 100 at p. 8) Rheem argued that DOE failed to address cumulative burdens relating to regulations for water heaters, boilers, pool heaters, and commercial refrigeration equipment. (Rheem, No. 83 at p. 14)

DOE notes that the energy conservation standard rulemakings for commercial and industrial fans and blowers, commercial package air conditioners and heat pumps, commercial warm air furnaces, water heaters, residential boilers, commercial boilers, and pool heaters are all regulation currently in progress. No standards have been proposed, and no final regulations have been issued for these rulemakings. It is DOE's policy not to include the impacts of regulatory proposals until the analyses are complete and the standards are finalized. Until such rulemaking is complete, it is unclear what, if any, requirements will be adopted for the products in question. Consequently, it would be speculative to try to include incomplete regulatory actions in an assessment of cumulative regulatory burden. With regard to the test procedure final rule for residential furnaces and boilers published on July 10, 2013, the changes have a compliance date of January 6, 2014. 78 FR 41265. Because the regulation goes into effect before 2016, it is outside of the 3-year window set for consideration in the cumulative regulatory burden analysis. With regard to the commercial refrigeration equipment (CRE) energy conservation standard rulemaking, at the time of the residential furnace fan rulemaking NOPR publication, the final rule for CRE standards had not yet been published. The final rule for CRE standards was published on March 28, 2014 and is now included in the final rule cumulative regulatory burden review in section V.B.2.e. 79 FR 17725.

Johnson Controls commented that DOE should consider the cumulative impacts of State or local weatherization programs that may be restrictive on HVAC equipment selections, as well as building code standards at State, national, and international levels. In addition, JCI believes DOE should include the impact of commercial product energy efficiency standards, alternate refrigeration requirements, and modifications to existing or the generation of new building performance standards, such as ASHRAE standards. (JCI, No. 95 at p. 7).

DOE considers cumulative regulatory burden pursuant to the directions in the Process Rule (10 CFR part 430, subpart C, appendix A). DOE notes that States and localities are generally preempted from requiring HVAC standards beyond the Federal minimum through building codes or other regulatory requirements. Once finalized, Federal commercial energy efficiency standards, alternative refrigeration requirements, and ASHRAE 90.1 standards that go into effect within 3 years of the effective date of today's standard are considered in the cumulative regulatory burden analysis.

AHRI and Morrison commented that DOE failed to provide quantitative estimates of the incremental burden imposed by the additional DOE standards impacting furnace fan manufacturers. As a result, both parties do not feel that such impacts were adequately reflected in the GRIM. (AHRI, No. 98 at p. 9, and Morrison, No. 108 at p. 7).

In the final rule cumulative regulatory burden section, DOE has provided an explicit review of the conversion costs associated with DOE energy conservation standards that impact the manufacturers covered under the residential furnace fan rulemaking. For more information, please see section V.B.2.e of this document.

c. Scope of MIA Coverage

AHRI and Rheem commented that impacts on motor manufacturers should be included in the manufacturing impact analysis. (AHRI, No. 43 at p. 151, and Rheem, No. 83 at p. 6)

DOE's manufacturer impact analysis focuses on the manufacturers that have the direct burden of complying with the energy conservation standard. In this rulemaking, the manufacturer of the residential furnace has the burden of certifying and labeling the furnace fan performance. Motors manufacturers are a component supplier but do not have a direct compliance burden associated with this rule.

d. Markups Analysis

AHRI provided comments relating to both markup scenarios used in the GRIM. With regards to the preservation of gross margin percentage markup scenario, AHRI commented that it is unreasonable for DOE to assume that, as manufacturer production costs increase in response to an energy conservation standard, manufacturers would be able to maintain the same gross margin percentage markup as the base case. (AHRI, No. 98 at p. 10) AHRI continued by commenting that the preservation of operating profit scenario is also inaccurate since it implies that manufacturer markups are set so that operating profit one year after the compliance date of the new energy conservation standards is the same as in the base case. AHRI believes that the one year time period is an extremely optimistic assumption and that a five-year time period would be a more realistic average for the industry. (AHRI, No. 98 at p. 10)

DOE intends for the preservation of gross margin percentage and preservation of per-unit operating profit markup scenarios to represent the upper and lower bounds for the performance of the industry as a result of new standards. The preservation of gross margin percentage scenario assumes that manufacturers are able to pass on all increases in MPC that result from standards to their first customers. Additionally, the scenario assumes manufacturers are able to maintain the existing markup on the incremental manufacturer production costs that result from the standard, thereby allowing manufacturers to recover portions of their conversion cost investments. The preservation of per-unit operating profit scenario assumes that manufacturers are not able to generate greater operating profit per unit sold in the standards case. Additionally, the scenario assumes that manufacturers are not able to recover any of their conversion cost investments. By applying these two scenarios, DOE models examine the range of potential industry impacts that reflect manufacturers' varying ability to pass costs on to customers and recover conversion costs. The scenario described by AHRI appears to relate to manufacturers' ability to recover conversion costs, which is likely not possible by one year following the standard year. However, the preservation of operating profit per-unit markup scenario assumes only that manufacturers will maintain the same annual operating profit as in the base case in the year after the standards go into effect. DOE believes that manufacturers' annual operating profit will be relatively constant in the years following the standard, and, accordingly, the choice between a one-year and five-year time horizon for this scenario is arbitrary.

e. Employment Impacts

AHRI and EEI commented that it is unrealistic to assume there would be no reductions in domestic production employment at TSLs 1 through 5. This is because labor costs will increase with higher design options, and, subsequently, manufacturers will try to compensate by reducing labor. (AHRI, No. 98 at p. 10 and EEI, No. 43 at p. 349) Additionally, AHRI commented that subsection 12.7.1 in the NOPR TSD accounts for line-supervisors as production workers who contribute towards the manufacture of furnace fans, but should also account for engineers and managers in supervisory roles who may not be involved in the day-to-day assembly line operations. (AHRI, No. 98 at p. 11)

At the NOPR stage, DOE's employment analysis only provided an upper bound to employment changes. These upper bound impacts were directly correlated to changes in shipments and changes in per-unit labor inputs. For the final rule, DOE uses the same employment model to determine the upper bound of employment impacts. At the lower bound, DOE models the scenario in which all production moves to lower production cost countries. In reference to AHRI's second comment, DOE does account for non-production workers in the GRIM and presents these results along with revised estimates of domestic production employment in chapter 12 of the final rule TSD.

f. Consumer Utility

Morrison commented in support of DOE's previously-stated concern relating to the use of multiple rating systems on a given product. Morrison emphasized that this would indeed lead to consumer confusion. (Morrison, No. 108 at p. 2)

DOE understands manufacturer concern relating to multiple ratings. However, DOE is required by legislation to set a separate standard and an associated metric for the covered product, furnace fans.

g. Small Businesses

In reference to the Regulatory Flexibility Analysis contained in the NOPR, Mortex expressed concern that DOE significantly underestimated capital and product conversion costs. According to Mortex, even at the underestimated level, the calculated impact to small businesses (conversion costs of 5.1 percent of annual revenues) would be highly detrimental. (Mortex, No. 104 at pp. 2–3)

DOE has revised its analysis of conversion costs for the final rule. The increase in conversion costs is reflected in the Final Regulatory Flexibility Analysis (FRFA), in section VI.B of this notice. To help portray the magnitude of the conversion costs relative to the size of the average small business, the conversion costs (which are invested over a five-year period) are compared to the financial metric of a single year's operation.

K. Emissions Analysis

In the emissions analysis, DOE estimated the reduction in power sector emissions of carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2), and mercury (Hg) from potential energy conservation standards for the considered products (here, furnace fans). In addition to estimating impacts of standards on power sector emissions, DOE estimated emissions impacts in production activities (extracting, processing, and transporting fuels) that provide the energy inputs to power plants. These are referred to as ''upstream'' emissions. Together, these emissions account for the full-fuel-cycle (FFC). In accordance with DOE's FFC Statement of Policy (76 FR 51281 (August 18, 2011) as amended at 77 FR 49701 (August 17, 2012)), this FFC analysis also includes impacts on emissions of methane (CH_4) and nitrous oxide (N_2O), both of which are recognized as greenhouse gases.

DOE primarily conducted the emissions analysis using emissions factors for CO_2 and most of the other gases derived from data in *AEO 2013,* supplemented by data from other sources. DOE developed separate emissions factors for power sector emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 13 of the final rule TSD.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of the greenhouse gas by the gas's global warming potential (GWP) over a 100-year time horizon. Based on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,[49] DOE used GWP values of 25 for CH_4 and 298 for N_2O.

EIA prepares the *Annual Energy Outlook* using the National Energy Modeling System (NEMS). Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2013* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2012.

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 (42 U.S.C. 7651 *et seq.*) and the District of Columbia (DC). SO_2 emissions from 28 eastern States and DC were also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia, but it remained in effect.[50] See *North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008); *North Carolina* v. *EPA,* 531 F.3d 896 (D.C. Cir. 2008). In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (August 8, 2011). On August 21, 2012, the DC Circuit issued a decision to vacate CSAPR.[51] The court ordered EPA to continue administering CAIR. The *AEO 2013* emissions factors used for today's final rule assume that CAIR remains a binding regulation through 2040.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of a new or amended efficiency standard could be used to allow offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2015, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO2013* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2015. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, NEMS shows a reduction in SO_2 emissions when electricity demand decreases (*e.g.,* as a result of energy efficiency standards). Emissions will be far below the cap that would be established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to allow offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that energy efficiency standards will reduce SO_2 emissions in 2015 and beyond.

CAIR established a cap on NO_X emissions in 28 eastern States and the District of Columbia. Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CAIR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to allow offsetting increases in NO_X emissions. However, standards would be expected to reduce NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions reductions from the standards considered in today's final rule for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps, and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO 2013,* which incorporates the MATS.

JCI and EEI stated that DOE did not consider the impact of the EPA rulemakings on new and existing power plants, which likely will materially affect the projections of CO_2 emissions reductions on which the DOE's SCC benefit calculations are based. (JCI, No. 95 at p. 10–11; EEI, No. 87 at p. 9) Consistent with past practice, DOE has

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[49] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, Editors (2007) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 212.

[50] See *North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008); *North Carolina* v. *EPA,* 531 F.3d 896 (D.C. Cir. 2008).

[51] See *EME Homer City Generation, LP* v. *EPA,* 696 F.3d 7, 38 (D.C. Cir. 2012), *cert. granted,* 81 U.S.L.W. 3567, 81 U.S.L.W. 3696, 81 U.S.L.W. 3702 (U.S. June 24, 2013) (No. 12–1182).

concluded that it would not be appropriate for its analysis to assume implementation of regulations that are not in effect at this time. The shape of any final EPA regulations is uncertain, as is the outcome of potential legal challenges to those regulations.

EEI stated that, to be consistent with other rulemakings, DOE should use modeling that calculates no emissions reductions as a result of efficiency standards where such emissions are capped by State, regional, or Federal regulations. In particular, DOE should eliminate any estimated CO_2 reductions in California and in the Northeastern/Mid-Atlantic states that participate in the Regional Greenhouse Gas Initiative (RGGI). (EEI, No. 87 at p. 10) Morrison stated that different agencies simultaneously addressing similar sources of CO_2 emissions should not double-count emissions reductions. (Morrison, No. 108 at p. 10)

As stated above, DOE based its emissions analysis on *AEO 2013,* which represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2012. *AEO 2013* accounts for the implementation of regional and State air emissions regulations, including those cited by EEI.[52] Its analysis also considers the impact of caps set by Federal regulations, as discussed above. Consequently, the emissions reductions estimated to result from today's standards are over and above any reductions attributable to other State, regional, or Federal regulations.

EEI stated that DOE's analysis significantly overestimates the future emissions from power plants, as coal-fired power plants are being retired and large amounts of wind and solar capacity are being added. It stated that due to these factors, along with EPA regulations, there will be a significant reduction in the baseline emissions from power plants and a reduced emissions impact from any efficiency standard. (EEI, No. 87 at p. 9)

DOE bases its emissions analysis on the latest projections from the *AEO,* which consider retirement of coal-fired power plants, addition of wind and solar capacity, and current EPA regulations. Decline in baseline emissions from power plants does not mean that there would be reduced impact from any efficiency standard, however. The impact of standards on electricity demand takes place at the margin, and DOE's analysis endeavors to reflect this marginal impact.

EEI stated that it is not clear how or why the power plant emissions factors would increase for any regulated emission (SO_2, NO_X, Hg, and CO_2) after 2025 or 2030, based on current trends and Federal and State regulations. (EEI, No. 87 at p. 10) DOE agrees that average power plant emissions factors for the Nation as a whole would likely not increase after 2025 or 2030. DOE's analysis uses marginal emissions factors, however, which depend on changes to the mix of generation capacity by fuel type induced by a marginal reduction in electricity demand for a particular end use (*e.g.,* residential heating). The behavior of marginal emissions factors can be significantly different from the behavior of average emissions factors. Marginal emissions factors are very sensitive to shifts in the capacity mix relative to the *AEO* reference case, whereas average emissions factors are not affected by these small shifts.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of the standards in this final rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. 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 equipment shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this final rule.

For today's final rule, DOE is relying on a set of values for the SCC that was developed by a Federal interagency process. The basis for these values is summarized below, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the final rule TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of carbon dioxide. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b) of Executive Order 12866, agencies must, to the extent permitted by law, ''assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.'' The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed these SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of challenges. A report from the National Research Council[53] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) Future emissions of GHGs; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

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[52] See Assumptions to *AEO 2013* (Available at: *http://www.eia.gov/forecasts/aeo/assumptions/*).

[53] National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use* (2009) National Academies Press: Washington, DC.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across Federal agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: Global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules.

Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specially, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models, while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three IAMs, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, was included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[54] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.15 presents the values in the 2010 interagency group report,[55] which is reproduced in appendix 14A of the DOE final rule TSD.

TABLE IV.15—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050

[2007$ per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

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[54] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no *a priori* reason why domestic benefits should be a constant fraction of net global damages over time.

[55] *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* Interagency Working Group on Social Cost of Carbon, United States Government (February 2010) (Available at: *www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf*).

The SCC values used for today's notice were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[56]

Table IV.16 shows the updated sets of SCC estimates in 5-year increments from 2010 to 2050. The full set of annual SCC estimates between 2010 and 2050 is reported in appendix 14B of the DOE final rule TSD. The central value that emerges is the average SCC across models at the 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE IV.16—ANNUAL SCC VALUES FROM 2013 INTERAGENCY REPORT, 2010–2050

[2007$ per metric ton CO_2]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	11	32	51	89
2015	11	37	57	109
2020	12	43	64	128
2025	14	47	69	143
2030	16	52	75	159
2035	19	56	80	175
2040	21	61	86	191
2045	24	66	92	206
2050	26	71	97	220

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The 2009 National Research Council report mentioned above points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report adjusted to 2013$ using the GDP price deflator. For each of the four sets of SCC values, the values for emissions in 2015 were $12.0, $40.5, $62.4, and $119 per metric ton avoided (values expressed in 2013$). DOE derived values after 2050 using the relevant growth rates for the 2040–2050 period in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

In responding to the NOPR, many commenters questioned the scientific and economic basis of the SCC values.

A number of stakeholders stated that DOE should not use SCC values to establish monetary figures for emissions reductions until the SCC undergoes a more rigorous notice, review, and comment process. (Morrison, No. 108 at p. 9; JCI, No. 95 at p. 10; AHRI, No. 98 at pp. 12–13; The Associations, No. 99 at p. 2; NAM, No. 84 at p. 1–2; Cato Institute, No. 81 at p. 2) Ingersoll Rand agrees with AHRI's comments. (Ingersoll Rand, No. 107 at p. 11) Rheem stated that the Federal Interagency Working Group has failed to disclose and quantify key uncertainties to inform decision makers and the public about the effects and uncertainties of alternative regulatory actions, as required by OMB. (Rheem, No. 83 at p. 9) NAM stated that the SCC estimates were developed without sufficient transparency, inadequate supporting information related to assumptions and other data, and a failure to peer-review critical model inputs. (NAM, No. 84 at pp. 1–2) Morrison stated that the SCC estimates are the product of an opaque process and that any pretensions to their supposed accuracy are unsupportable. (Morrison, No. 108 at p. 9) JCI stated that the SCC has not been adequately noticed and reviewed before being used in this NOPR or any other rulemaking. JCI added that it is aware that the SCC process is undergoing a current review and comment process, which has the potential for significant changes in how those SCC calculations are used in any rulemakings. (JCI, No. 95 at p. 10) Rheem stated that even if the SCC estimate development process were transparent, rigorous, and peer-reviewed, the modeling conducted in this effort does not offer a reasonably acceptable range of accuracy for use in policymaking. (Rheem, No. 83 at p. 9)

In conducting the interagency process that developed the SCC values, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. Key uncertainties and model differences transparently and consistently inform the range of SCC estimates. These uncertainties and model differences are discussed in the interagency working group's reports, which are reproduced in appendix 14A and 14B of the final rule TSD, as are the major assumptions. The 2010 SCC

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[56] *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, United States Government (May 2013; revised November 2013) (Available at: *http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf*).

values have been used in a number of Federal rulemakings in which the public had opportunity to comment. In November 2013, the OMB announced a new opportunity for public comment on the TSD underlying the revised SCC estimates. See 78 FR 70586 (Nov. 26, 2013). OMB is currently reviewing comments and considering whether further revisions to the 2013 SCC estimates are warranted. DOE stands ready to work with OMB and the other members of the interagency working group on further review and revision of the SCC estimates as appropriate.

NAM stated that in using the SCC estimates, DOE fails to adhere to its own guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by the DOE. (NAM, No. 84 at pp. 1–2) DOE has sought to ensure that the data and research used to support its policy decisions—including the SCC values—are of high scientific and technical quality and objectivity, as called for by the Secretarial Policy Statement on Scientific Integrity.[57] See section VI.J for DOE's evaluation of today's final rule and supporting analyses under the DOE and OMB information quality guidelines.

Rheem stated that the modeling systems used for the SCC estimates and the subsequent analyses were not subject to peer review as appropriate. (Rheem, No. 83 at p. 9) The Cato Institute stated that the determination of the SCC is discordant with the best scientific literature on the equilibrium climate sensitivity and the fertilization effect of carbon dioxide—two critically important parameters for establishing the net externality of carbon dioxide emissions. (Cato Institute, No. 81 at p. 2)

The three integrated assessment models used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used in 2013 to estimate revised SCC values were published in the peer-reviewed literature (see appendix 14B of the final rule TSD). The revised estimates that were issued in November 2013 are based on the best available scientific information on the impacts of climate change. The issue of equilibrium climate sensitivity is addressed in section 14A.4 of appendix 14A in the final rule TSD. The EPA, in collaboration with other Federal agencies, continues to investigate potential improvements to the way in which economic damages associated with changes in CO_2 emissions are quantified.

Morrison stated that the CO_2 emissions reductions benefits are overestimated, because the SCC values do not account for any prior changes that impact the baseline emissions trends in previous years. According to the commenter, DOE fails to take into consideration EPA regulations of greenhouse gas emissions from power plants, which would affect the SCC values. (Morrison, No. 108 at p. 10)

The SCC values are based on projections of global GHG emissions over many decades. Such projections are influenced by many factors, particularly economic growth rates and prices of different energy sources. In the context of these projections, the proposed EPA regulations of greenhouse gas emissions from new power plants are a minor factor. In any case, it would not be appropriate for DOE to account for regulations that are not currently in effect, because whether such regulations will be adopted and their final form are matters of speculation at this time.

Miller stated that the Department appears to violate the directive in OMB Circular A–4, which states: ''The analysis should focus on benefits and costs that accrue to citizens and residents of the United States. Where the agency chooses to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects should be reported separately.'' Miller stated that instead of focusing on domestic benefits and separately reporting any international effects, the Department focused on much-larger global benefits in the text of the proposed rule and separately reported the (much smaller) domestic effects in a chapter of the TSD. (Miller, No. 79 at pp. 6–7) Similarly, Rheem stated that by presenting only global SCC estimates and downplaying domestic SCC estimates in 2013, the IWG has severely limited the utility of the SCC for use in benefit-cost analysis and policymaking. (Rheem, No. 83 at p. 9) Mercatus stated that OMB guidelines specifically require that benefit-cost analysis of Federal regulations be reported for domestic estimates, with global estimates being optional. Mercatus argued that by using the global estimate at a three-percent discount rate, DOE inflated the benefits of reducing carbon emissions by almost double compared to using a domestic SCC at five percent. (Mercatus, No. 82 at pp. 7–8) EEI stated that the use of global SCC values, which are estimates that are based on many global assumptions and are subject to a great deal of uncertainty, may be important in assessing the overall costs and benefits of particular regulations, but using these values in the context of setting energy conservation standards is problematic, as the geographic and temporal scales of the LCC and SCC values are very different. (EEI, No. 87 at p. 10–11)

Although the relevant analyses address both domestic and global impacts, the interagency group has determined that it is appropriate to focus on a global measure of SCC because of the distinctive nature of the climate change problem, which is highly unusual in at least two respects. First, it involves a global externality: Emissions of most greenhouse gases contribute to damages around the world when they are emitted in the United States. Second, climate change presents a problem that the United States alone cannot solve. The issue of global versus domestic measures of the SCC is further discussed in appendix 14A of the final rule TSD.

NAM stated that under DOE's analysis, the cost-benefit results and the proposed rule are legally sufficient without the inclusion of the SCC estimate. (NAM, No. 84 at p. 3) In contrast, JCI stated that the monetary value of the CO_2 emissions reduction plays a significant role in DOE's justification to set the TSL 4 levels as the national standards. (JCI, No. 95 at p. 10)

DOE disagrees with NAM's assessment, which suggests that consideration of the SCC in the context of this rulemaking is somehow unnecessary or unimportant. When selecting a proposed standard level or adopting a final standard level, DOE considers and carefully weighs all relevant factors. Thus, the monetary value of the CO_2 emissions reduction did play a role in DOE's decision to propose TSL 4 (and to adopt TSL 4 in today's notice), as appropriate. DOE has determined that today's standards are expected to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, with or without consideration of the economic benefits associated with reduced CO_2 emissions.

Morrison stated that DOE does not conduct the cost-benefit analysis for NPV and SCC values over the same time frame and within the same scope, an important principle of cost-benefit analysis. (Morrison, No. 108 at p. 9)

For the analysis of national impacts of standards, DOE considers the lifetime impacts of equipment shipped in a 30-year period. With respect to energy and energy cost savings, impacts continue past 30 years until all of the equipment

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[57] See *https://www.directives.doe.gov/directives-documents/0411.2-APolicy.*

shipped in the 30-year period is retired. With respect to the valuation of CO_2 emissions reductions, the SCC estimates developed by the interagency working group are meant to represent the full discounted value (using an appropriate range of discount rates) of emissions reductions occurring in a given year. DOE is thus comparing the costs of achieving the emissions reductions in each year of the analysis, with the carbon reduction value of the emissions reductions in those same years. Neither the costs nor the benefits of emissions reductions outside the analytic time frame are included in the analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the power generation industry that would result from the adoption of new or amended energy conservation standards. In the utility impact analysis, DOE analyzes the changes in electric installed capacity and generation that result for each trial standard level. The utility impact analysis uses a variant of NEMS, which is a public domain, multi-sectored, partial equilibrium model of the U.S. energy sector. DOE uses a variant of this model, referred to as NEMS–BT,[58] to account for selected utility impacts of new or amended energy conservation standards. DOE's analysis consists of a comparison between model results for the most recent *AEO* Reference Case and for cases in which energy use is decremented to reflect the impact of potential standards. The energy savings inputs associated with each TSL come from the NIA. Chapter 15 of the final rule TSD describes the utility impact analysis in further detail.

EEI stated that it is not possible under most operational scenarios to increase electric capacity and decrease the amount of electric generation, as is indicated by DOE's analysis. (EEI, No. 87 at p. 8) In response, it would appear that the commenter has misinterpreted Table 15.3.1 in the NOPR TSD. The figure shows the capacity reduction as a positive value; it is not an increase as it might appear at first glance.

EEI stated that it is ironic that DOE is showing that an estimated reduction of renewable power plants provides an economic benefit to the United States. (EEI, No. 87 at p. 9) DOE reports the projected changes in the installed capacity of different types of power plants resulting from potential standards. Since the change in demand occurs at the margin, it is not surprising that plant types with relatively high first cost (such as solar and wind power) would be affected by standards. When assessing the energy savings associated with energy conservation standards, DOE does not claim that any particular changes in installed capacity of different types of power plants provide an economic benefit to the Nation relative to other types of power plant facilities.

EEI stated that the analysis appears to ignore the impacts of renewable portfolio standards in 29 States and the District of Columbia (as well as the renewable power goals in 8 other States). (EEI, No. 87 at p. 9) DOE disagrees with EEI's assertion regarding DOE's consideration of renewable portfolio standards. In the utility impact analysis, DOE used the projections of electricity generation by plant type in *AEO 2013.* These projections account for the estimated impacts of all renewable portfolio standards that were in place at the end of 2012.

Several stakeholders stated that DOE did not adequately consider power quality issues, specifically that DOE did not account for the effect of such a large number of non-linear power supplies (constant-torque BPM motors and multi-staging controls) without power factor correction on the grid. Several of them stated that the non-linear loads produced by constant-torque and constant-airflow BPM motors tend to cause harmonic distortions in both voltage and current, and could potentially cause voltage control problems within a power grid system. (JCI, No. 95 at p. 9; Morrison, No. 108 at p. 7; AHRI, No. 98 at p. 11) JCI stated that the Electric Power Research Institute suggests that while harmonic emissions from a single system may not have a major impact on the grid, the cumulative impact of millions of furnaces could be significant on the grid systems within the U.S. (JCI, No. 95 at p. 9) Southern Company stated that the BPM motors considered in this rulemaking typically have poor power factors and emit strong 3rd and 5th order harmonics, which is likely to cause problems with utility systems at a future date when most of the older equipment has been retired and replaced by BPM motors. (Southern Company, No. 85 at p. 4) JCI, Morrison, and AHRI stated that the mitigation costs associated with harmonic distortions would have a significant impact on consumers, especially related to failure rates, maintenance and repair costs, and the overall economic analysis for life-cycle costs. (JCI, No. 95 at p. 9; Morrison, No. 108 at p. 7; AHRI, No. 98 at p. 11) Southern Company stated that, for furnace fans with BPM motors, DOE could assume a percentage of households would require wiring upgrades and some additional costs to either the utility or the homeowner for filtering of harmonics or power factor correction. (Southern Company, No. 85 at p. 4) APGA stated that DOE should include the cost of installation of harmonic filters in the LCC analysis and recalculate the economic justification of design options incorporating ECM motors. (APGA, No. 110 at p. 3)

Regarding these comments, DOE notes that a number of studies assume that output from BPM motors is constant at full load at time of use, similar to operation of PSC motors. However, BPM motors are specifically designed to accommodate reduced-load operation, and, therefore, most of the time, they will operate at part load (*i.e.,* at lower speeds and higher efficiency). The current of a BPM motor at lower-speed operation is significantly lower than a PSC motor at normal operation; therefore, total current contribution will not exceed the existing system grid capacity. In addition, the harmonic contribution is a small part of total circuit loading, at the lower current levels. For example, motor performance data from GE[59] shows an increase in power of 133 volt-amperes (VA) from a ⅓ HP PSC to BPM at full output. On average, 5 to 20 residential customers are served per distribution transformer, which are normally rated between 15 and 50 kVA.[60][61] An increase of this current would result in an increase in loading less than 3 percent at the extreme case. (The extreme case is all HVAC at full load concurrently, served by the same distribution transformer.) The transformers are normally rated approximately 30 percent to 50 percent above predicted peak load.[62] In this case, the increased current draw (VA) would have negligible impact. Measured

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[58] DOE/EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on DOE/EIA assumptions, DOE refers to it by the name ''NEMS–BT'' (''BT'' is DOE's Building Technologies Program, under whose aegis this work has been performed).

[59] GE Industrial Systems, GE ECM 2.3 Series motors datasheet (Available at: *http://www.columbiaheating.com/page_images/file/GET-8068.pdf*).

[60] Farmer, C., Hines, P., Dowds, J., Blumsack, S., *Modeling the Impact of Increasing PHEV Loads on the Distribution Infrastructure,* Proceedings of the 43rd International Conference on System Sciences (2010).

[61] NEMA. NEMA TP 1–2002: Guide for Determining Energy Efficiency for Distribution Transformers.

[62] NEMA Standards Publication TP 1–2002: Guide for Determining Energy Efficiency for Distribution Transformers (Available at: *https://www.nema.org/Standards/Pages/Guide-for-Determining-Energy-Efficiency-for-Distribution-Transformers.aspx?#download*).

performance data[63] show a decrease in current drawn for cooling functionality (152 VA) and an increase for heating functionality (32 VA) from PSC to equivalent BPM, confirming the small BPM loading impact. In addition, an evaluation of increased penetration of BPM motors in commercial buildings was presented at the ASHRAE 6 ECM Motor Workshop at the CEC, which reviewed California Utility Codes with regards to the BPM-specific issue.[64] It was stated in this study that while the power factor could be reduced to 50 percent, a BPM motor will have a lower current draw than a PSC motor at 100 percent power factor due to efficiency gains.

Regarding the EPRI study[65] referenced in the JCI comment, DOE noticed that the power factor impacts are associated with several types of loads becoming common in the modern household: Low power factor lighting, modern entertainment systems, and electric vehicle chargers, as well as HVAC with BPM motors. This reference indicates that the power quality issues caused by the BPM motors are a small contributor to the total harmonic distortion experienced at the utility level compared to all contributing loads. The study indicated that for devices with an existing 3rd harmonic resonance, the contribution of all new devices would require filtering; however, this correction is not attributed to the high penetration of EC motors alone. The BPM's third harmonic distortion contributed a 1.5-percent current increase to the circuit. The study showed the overall impact on the 3rd, 5th, 7th order and included in total harmonic distortion (THD) was within 0.1 percent of the original harmonic profile applied to the studied feeder. In summary, the impact of introducing BPM motors for HVAC under a high penetration scenario on a residential line was negligible.

With regards to household power quality, furnaces have a minimum basic electrical requirement for THD of 5 percent, and individual harmonic distortion of 3 percent.[66] [67] Furnaces supplied with voltages with harmonic distortion greater than 8 percent THD may not be operated.[68] The EPRI study, which simulates a harmonic spectrum of a large number of BPM-based HVAC, shows that the BPM-related harmonic distortions are within the 5 percent THD limit, and within the 3 percent individual harmonic limit. Therefore, DOE concludes the BPM-related harmonic distortions would not cause the problems cited by the commenters.

In addition to the analysis described above, DOE used NEMS–BT, along with EIA data on the capital cost of various power plant types, to estimate the reduction in national expenditures for electricity generating capacity due to potential residential furnace fan standards. The method used and the results are described in chapter 15 of the final rule TSD.

N. Employment Impact Analysis

Employment impacts from new or amended energy conservation standards include 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 jobs created or eliminated in the national economy due to: (1) Reduced spending by end users on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased consumer spending on the purchase of new products; 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.[69] 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, based on the BLS data alone, DOE believes net national employment may increase because of shifts in economic activity resulting from energy conservation standards for residential furnace fans.

For the standard levels considered in today's document, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 3.1.1 (ImSET).[70] 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 the 187 sectors. ImSET's national economic I–O structure is based on a 2002 U.S. benchmark table, specially aggregated to the 187 sectors most relevant to industrial, commercial, and residential building energy use. DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET

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[63] Gusdorf, J., M. Swinton, C. Simpson, E. Enchev, S. Hayden, D. Furdas, and B. Castellan, *Saving Electricity and Reducing GHG Emissions with ECM Furnace Motors: Results from the CCHT and Projections to Various Houses and Locations (*2004) ACEEE Proceedings (Available at: *http://aceee.org/files/proceedings/2004/data/papers/SS04_Panel1_Paper12.pdf*).

[64] Taylor Engineering LLC, *ASHRAE 6 ECM Motors, August 17th CEC Workshop* (2011) California Statewide Utility Code and Standard Program (Available at: *http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/2011-08-17_workshop/presentations/08%20EC%20Motors.pdf*).

[65] Sharma, H. M. Rylander, and D. Dorr, *Grid Impacts due to Increased Penetration of Newer Harmonic Sources,* Proceedings of IEEE Rural Electric Power Conference (April 2013) pp. B5–1—B5–5 (Available at: *http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6681854*).

[66] IEEE Standard 519–1992—IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems (April 9 1993) pp. 1–112 (Available at: *http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=210894*).

[67] Fluke Corporation, *Generator power quality and furnaces: The effects of harmonic distortion (*2009) (Available at: *http://support.fluke.com/find-sales/Download/Asset/3497420_6112_ENG_A_W.PDF*).

[68] *Id.*

[69] *See* Bureau of Economic Analysis, ''Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II),'' U.S. Department of Commerce (1992).

[70] J. M. Roop, M. J. Scott, and R. W. Schultz, *ImSET 3.1: Impact of Sector Energy Technologies,* PNNL–18412, Pacific Northwest National Laboratory (2009) (Available at: *www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf*).

may over-estimate actual job impacts over the long run. For the final rule, DOE used ImSET only to estimate short-term (2019 and 2024) employment impacts.

For more details on the employment impact analysis, see chapter 16 of the final rule TSD.

O. Comments on Proposed Standards

NEEP, CA IOUs, and the Joint Advocates support the selection of DOE's proposed trial standard level, given the limited impact on furnace fan manufacturers, positive benefits to consumers, and substantial energy savings. (NEEP, No. 109 at p. 2; CA IOUs, No. 106 at p. 2; Joint Advocates, No. 105 at p. 1)

A number of stakeholders disagreed with the proposed selection of TSL 4. Rheem argued that TSL 4 is not economically justified. (Rheem, No. 83 at p. 7) Lennox stated that because TSL 4 likely has costs that are understated, and overly optimistic efficiency projections, DOE should not pursue TSL 4, and instead adopt standards based on a less-stringent, less-costly technology. (Lennox, No. 100 at p. 2) EEI suggested the adoption of TSL 1 or TSL 2 to conserve energy, minimize economic harm to consumers, and minimize the possible negative impacts on the electric grid from the motors that would be able to meet the proposed standard. (EEI, No. 87 at p. 2)

DOE has addressed specific issues regarding costs, efficiency projections, and possible negative impacts on the electric grid in previous parts of section IV of this document. DOE addresses the economic justification for today's standards in section V.C of this document.

Southern Company believes that under TSL 4, too large a proportion of consumers have net costs. Southern Company would prefer that a substantial majority of consumers derive benefits from a proposed rule. (Southern Company, No. 85 at p. 3) EEI also stated that a much higher percentages of consumers will experience a net cost than is the case with many other DOE energy conservation standards. (EEI, No. 87 at p. 2) The Mercatus Center stated that the proposed rule will confer net benefits on a majority of the consumers for only one product class (*i.e.,* non-weatherized, non-condensing gas furnace fans). It added that the aggregate financial benefits to consumers are not spread uniformly over the population, but instead are mostly concentrated in a minority of households. (Mercatus Center, No. 82 at p. 7)

As shown in Table V.31 of today's final rule, more consumers would have a net benefit from standards at TSL 4 than would have a net cost for all of the considered product classes. For the two largest product classes (non-weatherized non-condensing gas furnace fans and non-weatherized condensing gas furnace fans), nearly twice as many consumers would have a net benefit from standards at TSL 4 as would have a net cost.

The Mercatus Center stated that seven out of eight proposed standards at TSL 4 fail the rebuttable payback period benchmark, thereby making it difficult for DOE to demonstrate economic justification for the proposed rule. (Mercatus Center, No. 82 at p. 6) In response, the commenter has misinterpreted the role of the rebuttable payback period presumption. As discussed in section III.E.2, EPCA provides that a rebuttable presumption is established 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. (42 U.S.C. 6295(o)(2)(B)(iii)) To determine economic justification, DOE routinely conducts an analysis that considers the full range of impacts, including those 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 to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Rheem and Miller stated that the proposed standard may act as a transfer payment from lower-income households, who are more likely to bear net costs as a result of this rule, to higher-income households; and that higher-priced furnace fans resulting from this rule will be out of reach for some consumers. They stated that these distributive impacts necessitate close scrutiny from the Department in order to determine whether the proposed standards will actually improve social welfare. (Rheem, No. 83 at p. 14; Miller, No. 79 at p. 14)

DOE's consumer subgroup analysis indicates that, for non-weatherized gas furnace fans, lower-income households would have positive average LCC savings and median PBPs less than five years (see section V.B.1). Furthermore, many lower-income households rent rather than own their dwelling, and are responsible for utility bills but not for purchase of a furnace. To the extent that there is delay in the landlords' passing of extra costs into the rent, consumers that rent will benefit more those who own, all else being equal.

Ingersoll Rand stated that promulgating a rule at TSL4 would force the future generation of furnaces sold in the U.S. to be less reliable than many of those on the market today as a result of eliminating PSC motors from the market. (Ingersoll Rand, No. 107 at p. 7) DOE notes that furnace fans meeting today's standards are already widely available as a substitute for units with baseline motors. DOE evaluated issues related to reliability, as discussed in section IV.F.2, and concluded that the benefits to consumers outweigh any costs related to reliability that may be associated with products meeting the standards.

V. Analytical Results and Conclusions

This section addresses the results from DOE's analyses with respect to potential energy conservation standards for residential furnace fans. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for furnace fans, and the standard levels ultimately adopted by DOE in today's final rule. Additional details regarding DOE's analyses are contained in the TSD supporting this document.

A. Trial Standard Levels

DOE developed trial standard levels (TSLs) that combine efficiency levels for each product class of residential furnace fans. Table V.1 presents the efficiency levels for each product class in each TSL. TSL 6 consists of the max-tech efficiency levels. TSL 5 consists of those efficiency levels that provide the maximum NPV using a 7-percent discount rate (see section V.B.3 for NPV results). TSL 4 consists of those efficiency levels that provide the highest NPV using a 7-percent discount rate, and that also result in a higher percentage of consumers that receive an LCC benefit than experience an LCC loss (see section V.B.1 for LCC results). TSL 3 uses efficiency level 3 for all product classes. TSL 2 consists of efficiency levels that are the same as TSL 3 for non-weatherized gas furnace fans, weatherized gas furnace fans, and electric furnace fans, but are at efficiency level 1 for oil-fired furnace fans and mobile home furnace fans. TSL 1 consists of the most common efficiency levels in the current market. In summary, Table V.1 presents the six TSLs which DOE has identified for residential furnace fans, including the efficiency level associated with each

TSL, the technology options anticipated to achieve those levels, and the expected resulting percentage reduction in FER from the baseline corresponding to each efficiency level.

TABLE V.1—TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS

Product class	Trial standard levels (Efficiency level) *					
	1	2	3	4	5	6
Non-Weatherized, Non-Condensing Gas Furnace Fan	1	3	3	4	4	6
Non-Weatherized, Condensing Gas Furnace Fan	1	3	3	4	4	6
Weatherized Non-Condensing Gas Furnace Fan	1	3	3	4	4	6
Non-Weatherized, Non-Condensing Oil Furnace Fan	1	1	3	1	3	6
Non-Weatherized Electric Furnace/Modular Blower Fan	1	3	3	4	4	6
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	1	1	3	1	3	6
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	1	1	3	1	3	6
Mobile Home Electric Furnace/Modular Blower Fan	1	1	3	4	4	6

* Efficiency level (EL) 1 = Improved PSC (12 percent). (For each EL, the percentages given refer to percent reduction in FER from the baseline level.) EL 2 = Inverter-driven PSC (25 percent). EL 3 = Constant-torque BPM motor (38 percent). EL 4 = Constant-torque BPM motor + Multi-Staging (51 percent). EL 5 = Constant-airflow BPM motor (57 percent). EL 6 = Constant-airflow BPM motor + Multi-Staging (61 percent).

B. Economic Justification and Energy Savings

1. Economic Impacts on Consumers

Life-Cycle Cost and Payback Period

To evaluate the economic impact of the considered efficiency levels on consumers, DOE conducted an LCC analysis for each efficiency level. More-efficient residential furnace fans would affect these consumers in two ways: (1) Annual operating expense would decrease; and (2) purchase price would increase. Inputs used for calculating the LCC include total installed costs (*i.e.,* equipment price plus installation costs), operating expenses (*i.e.,* energy costs, repair costs, and maintenance costs), product lifetime, and discount rates.

The output of the LCC model is a mean LCC savings (or cost) for each product class, relative to the base-case efficiency distribution for residential furnace fans. The LCC analysis also provides information on the percentage of consumers for whom an increase in the minimum efficiency standard would have a positive impact (net benefit), a negative impact (net cost), or no impact.

DOE also performed a PBP analysis as part of the LCC analysis. The PBP is the number of years it would take for the consumer to recover the increased costs of higher-efficiency products as a result of energy savings based on the operating cost savings. The PBP is an economic benefit-cost measure that uses benefits and costs without discounting. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

DOE's LCC and PBP analyses provide five key outputs for each efficiency level above the baseline, as reported in Table V.2 through Table V.9 for the considered TSLs. (Results for all efficiency levels are reported in chapter 8 of the final rule TSD.) These outputs include the proportion of residential furnace fan purchases in which the purchase of a furnace fan compliant with the new energy conservation standard creates a net LCC increase, no impact, or a net LCC savings for the consumer. Another output is the average LCC savings from standards-compliant products, as well as the median PBP for the consumer investment in standards-compliant products. Savings are measured relative to the base-case efficiency distribution (see section IV.F.4), not the baseline efficiency level.

TABLE V.2—LCC AND PBP RESULTS FOR NON-WEATHERIZED, NON-CONDENSING GAS FURNACE FANS

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$347	$2,194	$2,541	$0	0	100	0	
1	1	359	1,933	2,292	85	1	68	30	1.1
2		408	1,655	2,063	263	25	25	50	3.8
3	2, 3	423	1,367	1,791	471	17	25	58	2.6
4	4, 5	501	1,249	1,750	506	30	14	56	5.4
5		658	1,244	1,902	373	47	12	41	10.6
6	6	694	1,150	1,844	431	50	0	50	10.2

Table V.3—LCC and PBP Results for Non-Weatherized, Condensing Gas Furnace Fans

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$343	$2,134	$2,478	$0	0	100	0	
1	1	355	1,909	2,264	58	1	75	24	1.2
2		403	1,666	2,070	182	21	41	38	4.2
3	2, 3	416	1,402	1,818	335	11	41	48	2.9
4	4, 5	493	1,319	1,812	341	23	34	43	5.8
5		652	1,334	1,987	219	42	29	30	12.0
6	6	687	1,250	1,937	268	51	0	49	11.0

Table V.4—LCC and PBP Results for Weatherized, Non-Condensing Gas Furnace Fans

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No Impact	Net benefit	
Baseline		$333	$2,667	$3,000	$0	0	100	0	
1	1	345	2,329	2,674	67	0	81	19	0.7
2		393	2,025	2,418	189	8	56	36	3.2
3	2, 3	406	1,609	2,015	378	3	56	41	1.8
4	4, 5	481	1,434	1,914	447	16	33	51	4.4
5		633	1,476	2,109	304	38	27	35	10.3
6	6	668	1,354	2,022	391	41	0	59	8.2

Table V.5—LCC and PBP Results for Non-Weatherized, Non-Condensing Oil Furnace Fans

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$417	$2,510	$2,927	$0	0	100	0	
1	1, 2, 4	427	2,356	2,783	46	13	71	17	1.7
2		501	2,090	2,592	181	46	28	26	10.3
3	3, 5	507	1,979	2,486	259	44	28	28	4.6
4		589	1,920	2,509	244	48	28	24	8.1
5		813	1,922	2,736	80	56	28	16	18.3
6	6	863	1,873	2,736	80	78	0	22	18.6

Table V.6—LCC and PBP Results for Non-Weatherized Electric Furnace/Modular Blower Fans

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$244	$1,211	$1,455	$0	0	100	0	
1	1	255	1,079	1,335	29	4	73	22	1.9
2		299	941	1,241	88	27	37	36	6.2
3	2, 3	292	797	1,089	181	17	37	45	2.6
4	4, 5	309	747	1,055	204	23	25	51	3.2
5		444	796	1,240	66	48	25	27	12.0
6	6	477	748	1,225	81	60	0	39	11.5

TABLE V.7—LCC AND PBP RESULTS FOR MOBILE HOME NON-WEATHERIZED, NON-CONDENSING GAS FURNACE FANS

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$256	$1,118	$1,374	$0	0	100	0	
1	1, 2, 4	268	1,026	1,293	36	10	56	34	2.7
2		313	930	1,243	87	62	0	38	10.2
3	3, 5	318	867	1,185	144	55	0	45	6.8
4		390	831	1,222	108	67	0	33	12.7
5		530	853	1,383	(54)	81	0	19	24.3
6	6	563	824	1,388	(58)	80	0	20	24.4

* Parentheses indicate negative values.

TABLE V.8—LCC AND PBP RESULTS FOR MOBILE HOME NON-WEATHERIZED, CONDENSING GAS FURNACE FANS

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$274	$1,283	$1,556	$0	0	100	0	
1	1, 2, 4	285	1,170	1,454	35	5	68	27	2.3
2		330	1,061	1,391	79	43	29	28	9.7
3	3, 5	339	977	1,316	133	37	29	33	6.6
4		411	936	1,347	103	66	4	29	15.8
5		558	953	1,510	(53)	80	4	16	33.3
6	6	591	917	1,508	(51)	82	0	18	31.3

* Parentheses indicate negative values.

TABLE V.9—LCC AND PBP RESULTS FOR MOBILE HOME ELECTRIC FURNACE/MODULAR BLOWER FAN

Efficiency level	TSL	Life-cycle cost 2013$			Life-cycle cost savings				Median payback period years
		Installed cost	Discounted operating cost	LCC	Average savings 2013$	Percent of consumers that experience			
						Net cost	No impact	Net benefit	
Baseline		$194	$643	$837	$0	0	100	0	
1	1, 2	204	575	778	19	7	71	22	2.1
2		245	531	777	20	36	38	26	8.9
3	3	237	466	702	70	26	38	37	3.6
4	4, 5	251	433	685	85	32	26	43	4.1
5		375	487	862	(48)	57	26	18	15.0
6	6	406	462	868	(54)	75	0	25	14.9

* Parentheses indicate negative values.

Consumer Subgroup Analysis

DOE estimated the impacts of the considered efficiency levels (TSLs) on the following consumer subgroups: (1) Senior-only households; and (2) low-income households. The results of the consumer subgroup analysis indicate that for residential furnace fans, senior-only households and low-income households experience lower average LCC savings and longer payback periods than consumers overall, with the difference being larger for low-income households. The difference between the two subgroups and all consumers is larger for non-weatherized, non-condensing gas furnace fans (see Table V.10) than for non-weatherized, condensing gas furnace fans (see Table V.11). Chapter 11 of the final rule TSD provides more detailed discussion on the consumer subgroup analysis and results for the other product classes.

TABLE V.10—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, NON-WEATHERIZED, NON-CONDENSING GAS FURNACE FANS

Efficiency level	Average life-cycle cost savings (2013$)				Median payback period (years)		
	TSL	Senior-only	Low-income	All consumers	Senior-only	Low-income	All consumers
1	1	$65	$48	$85	1.6	1.7	1.1
2		209	133	263	5.2	6.3	3.8
3	2, 3	366	251	471	3.7	3.6	2.6
4	4, 5	373	234	506	7.6	7.8	5.4
5		226	77	373	14.5	15.9	10.6
6	6	264	96	431	13.7	15.3	10.2

TABLE V.11—COMPARISON OF IMPACTS FOR CONSUMER SUBGROUPS WITH ALL CONSUMERS, NON-WEATHERIZED, CONDENSING GAS FURNACE FANS

Efficiency level	Average life-cycle cost savings (2013$)				Median payback period (years)		
	TSL	Senior-only	Low-income	All consumers	Senior-only	Low-income	All consumers
1	1	$49	$38	$58	1.5	2.0	1.2
2		155	121	182	5.5	7.1	4.2
3	2, 3	288	230	335	3.7	4.4	2.9
4	4, 5	275	202	341	7.5	9.7	5.8
5		141	66	219	15.4	19.5	12.0
6	6	178	90	268	12.2	17.0	11.0

Rebuttable Presumption Payback

As discussed in section III.E.2, EPCA provides a rebuttable presumption that, in essence, 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. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this 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. For comparison with the more detailed analytical results, DOE calculated a rebuttable presumption payback period for each TSL. Table V.12 shows the rebuttable presumption payback results to determine whether any of them meet the rebuttable presumption conditions for the residential furnace fans product classes.

TABLE V.12—REBUTTABLE PRESUMPTION PAYBACK PERIODS FOR RESIDENTIAL FURNACE FAN PRODUCT CLASSES

Product class	Rebuttable presumption payback (years)					
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Non-Weatherized, Non-Condensing Gas Furnace Fan	3.3	5.3	5.3	10.3	10.3	19.4
Non-Weatherized, Condensing Gas Furnace Fan	3.1	4.9	4.9	9.6	9.6	18.2
Weatherized Non-Condensing Gas Furnace Fan	3.0	4.8	4.8	9.4	9.4	17.6
Non-Weatherized, Non-Condensing Oil Furnace Fan	2.3	2.3	5.9	2.3	5.9	19.8
Non-Weatherized Electric Furnace/Modular Blower Fan	3.2	5.1	5.1	5.8	5.8	15.4
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	3.8	3.8	6.1	3.8	6.1	22.1
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	3.5	3.5	5.7	3.5	5.7	20.9
Mobile Home Electric Furnace/Modular Blower Fan	4.3	4.3	6.8	7.7	7.7	20.2

2. Economic Impact on Manufacturers

As noted above, DOE performed an MIA to estimate the impact of new energy conservation standards on manufacturers of residential furnace fans. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

Industry Cash-Flow Analysis Results

Table V.13 and Table V.14 depict the financial impacts (represented by changes in INPV) of new energy standards on manufacturers of residential furnace fans, as well as the conversion costs that DOE expects manufacturers would incur for all product classes at each TSL. To evaluate the range of cash flow impacts on the residential furnace fans industry, DOE modeled two different mark-up scenarios using different assumptions that correspond to the range of anticipated market responses to potential new energy conservation standards: (1) The preservation of gross margin percentage; and (2) the preservation of per-unit operating profit. Each of these scenarios is discussed immediately below.

To assess the lower (less severe) end of the range of potential impacts, DOE modeled a preservation of gross margin percentage markup scenario, in which a uniform ''gross margin percentage'' markup is applied across all potential efficiency levels. In this scenario, DOE assumed that a manufacturer's absolute dollar markup would increase as production costs increase in the standards case.

To assess the higher (more severe) end of the range of potential impacts, DOE modeled the preservation of per-unit operating profit markup scenario, which assumes that manufacturers would be able to earn the same operating margin in absolute dollars per-unit in the standards case as in the base case. In this scenario, while manufacturers make the necessary investments required to convert their facilities to produce new standards-compliant products, operating profit does not change in absolute dollars per unit and decreases as a percentage of revenue.

The set of results below shows potential INPV impacts for residential furnace fan manufacturers; Table V.13 reflects the lower bound of impacts, and Table V.14 represents the upper bound.

Each of the modeled scenarios 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 industry value between the base case and each standards case that results from the sum of discounted cash flows from the base year 2014 through 2048, the end of the analysis period. To provide perspective on the short-run cash flow impact, DOE includes in the discussion of the results below a comparison of free cash flow between the base case and the standards case at each TSL in the year before new standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry in the base case.

TABLE V.13—MANUFACTURER IMPACT ANALYSIS FOR RESIDENTIAL FURNACE FANS—PRESERVATION OF GROSS MARGIN PERCENTAGE MARKUP SCENARIO *

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	$M	349.6	336.6	360.0	359.1	397.8	397.6	422.4
Change in INPV	$M		(13.0)	10.4	9.4	48.2	48.0	72.8
	(%)		(3.7)	3.0	2.7	13.8	13.7	20.8
Product Conversion Costs	$M	2.2	18.8	23.6	25.3	25.5	27.1	29.4
Capital Conversion Costs	$M		8.8	11.1	11.8	15.1	15.7	134.7
Total Conversion Costs	$M	2.2	27.7	34.7	37.1	40.6	42.8	164.2
Free Cash Flow (2018)	$M	20.3	11.3	8.8	8.0	6.4	5.6	(48.6)
Free Cash Flow (change from Base Case) (2018).	%	0.0	(44.5)	(56.7)	(60.8)	(68.3)	(72.2)	(339.8)

* Values in parentheses are negative values. All values have been rounded to the nearest tenth.
M = millions.

TABLE V.14—MANUFACTURER IMPACT ANALYSIS FOR RESIDENTIAL FURNACE FANS—PRESERVATION OF OPERATING PROFIT MARKUP SCENARIO *

	Units	Base case	Trial standard level					
			1	2	3	4	5	6
INPV	$M	349.6	332.3	313.2	311.0	290.6	288.8	147.2
Change in INPV	$M		(17.3)	(36.4)	(38.6)	(59.0)	(60.8)	(202.5)
	(%)		(5.0)	(10.4)	(11.0)	(16.9)	(17.4)	(57.9)
Product Conversion Costs	$M	2.2	18.8	23.6	25.3	25.5	27.1	29.4
Capital Conversion Costs	$M		8.8	11.1	11.8	15.1	15.7	134.7
Total Conversion Costs	$M	2.2	27.7	34.7	37.1	40.6	42.8	164.2
Free Cash Flow	$M	20.3	11.3	8.8	8.0	6.4	5.6	(48.6)
Free Cash Flow (change from Base Case)	%	0.0	(44.5)	(56.7)	(60.8)	(68.3)	(72.2)	(339.8)

* Values in parentheses are negative values. All values have been rounded to the nearest tenth.
M = millions.

TSL 1 represents the most common efficiency levels in the current market for all product classes. At TSL 1, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$17.3 million to −$13.0 million, or a change in INPV of −5.0 percent to −3.7 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 44.5 percent to $11.3 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs totaling $27.7 million at TSL 1.

TSL 2 represents EL 1 for the oil and mobile home product classes, and EL 3 for all other product classes. At TSL 2, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$36.4 million to $10.4 million, or a change in INPV of −10.4 percent to 3.0 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 56.7 percent to $8.8 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs of $34.7 million at TSL 2.

TSL 3 represents EL 3 for all product classes. At TSL 3, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$38.6 million to $9.4 million, or a change in INPV of −11.0 percent to 2.7 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 60.8 percent to $8.0 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs of $37.1 million at TSL 3.

TSL 4 represents the efficiency levels that provide the highest NPV using a 7-percent discount rate, and that also result in a higher percentage of consumers receiving an LCC benefit rather than an LCC loss. At TSL 4, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$59.0 million to $48.2 million, or a change in INPV of −16.9 percent to 13.8 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 68.3 percent to $6.4 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs totaling $40.6 million at TSL 4.

TSL 5 represents the efficiency levels that provide the maximum NPV using a 7-percent discount rate. At TSL 5, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$60.8 million to $48.0 million, or a change in INPV of −17.4 percent to 13.7 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 72.2 percent to $5.6 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs of $42.8 million at TSL 5.

TSL 6 represents the max-tech efficiency level for all product classes. At TSL 6, DOE estimates impacts on INPV for residential furnace fan manufacturers to range from −$202.5 million to $72.8 million, or a change in INPV of −57.9 percent to 20.8 percent. At this potential standard level, industry free cash flow is estimated to decrease by as much as 339.8 percent to −$48.6 million, compared to the base-case value of $20.3 million in the year before the compliance date (2018). DOE anticipates industry conversion costs totaling $164.2 million at TSL 6.

DOE anticipates very high capital conversion costs at TSL 6 because manufacturers would need to make significant changes to their manufacturing equipment and production processes in order to accommodate the use of backward-inclined impellers. This design option would require modifying, or potentially eliminating, current fan housings. DOE also anticipates high product conversion costs to develop new designs with backward-inclined impellers for all their products. Some manufacturers may also have stranded assets from specialized machines for building fan housing that can no longer be used.

Impacts on Employment

To quantitatively assess the impacts of energy conservation standards on direct employment in the residential furnace fan industry, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the base case and at each TSL from 2014 through 2048. DOE used statistical data from the U.S. Census Bureau's 2011 Annual Survey of Manufacturers (ASM),[71] the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to manufacturing of the product are a function of the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of MPCs.

The total labor expenditures in the GRIM were then converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the U.S. Census Bureau's 2011 ASM). The estimates of production workers in this section cover workers, including line-supervisors who are directly involved in fabricating and assembling a product within the manufacturing facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific products covered by this rulemaking.

The total direct employment impacts calculated in the GRIM are the sum of the changes in the number of production workers resulting from the new energy conservation standards for residential furnace fans, as compared to the base case.

TABLE V.15—POTENTIAL CHANGES IN THE NUMBER OF FURNACE FAN INDUSTRY EMPLOYMENT IN 2019

	Trial standard level *						
	Base case	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2019 (assuming no changes in production locations).	303	303	303	303	301	301	349.
Total Number of Domestic Non-Production Workers in 2019.	107	107	107	107	106	106	123.
Range of Potential Changes in Domestic Workers in 2019 **.		(410) to 0	(410) to 0	(410) to 0	(410) to (3)	(410) to (3)	(410) to 62.

* Numbers in parentheses represent negative values.

** DOE presents a range of potential employment impacts, where the lower range represents the scenario in which all domestic manufacturers move production to other countries.

The employment impacts shown in Table V.15 represent the potential production and non-production employment changes that could result following the compliance date of a new energy conservation standard for residential furnace fans. The upper end of the results in the table estimates the maximum increase in the number of production and non-production workers after the implementation of new energy conservation standards, and it assumes

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[71] "Annual Survey of Manufactures (ASM)," U.S. Census Bureau (2011) (Available at: *http://www.census.gov/manufacturing/asm/*).

that manufacturers would continue to produce the same scope of covered products within the United States. The lower end of the range indicates the total number of U.S. production and non-production workers in the industry who could lose their jobs if all existing production were moved outside of the United States or if companies exited the market. This scenario is highly conservative. Even if all production was relocated overseas, manufacturers would likely maintain large portions of domestic non-production staff (*e.g.,* sales, marketing, technical, and management employees). The industry did not provide sufficient information for DOE fully quantify the percentage of the non-production workers that would leave the country or be eliminated at each evaluated standard level.

For residential furnace fans, DOE does not expect significant changes in domestic employment levels from baseline to TSL 5. Based on the engineering analysis, DOE has concluded that most product lines could be converted to meet the standard with changes in motor technology and the application of multi-staging designs. While such designs require more controls and have more complex assembly, DOE does not believe the per-unit labor requirements for the furnace fan assembly would change significantly.

The only standard level at which significant changes in employment would be expected is at TSL 6, the max-tech level. At TSL 6, DOE estimates increases in labor costs because backwards-inclined impeller assemblies are heavier and require more robust mounting approaches than are currently used for forward-curved impeller assemblies. Backward-inclined impeller assemblies could require manufacturers to adjust their assembly processes, with the potential for increases in per-unit labor requirements. However, DOE received limited feedback from manufacturers regarding the labor required to produce furnace fans with backward-curved impellers, because they generally do not have any experience in working with this design option.

DOE notes that the employment impacts discussed here are independent of the indirect employment impacts to the broader U.S. economy, which are documented in chapter 15 of the final rule TSD.

Impacts on Manufacturing Capacity

According to the residential furnace fan manufacturers interviewed, the new energy conservation standards being adopted in today's final rule would not significantly affect manufacturers' production capacity, or throughput levels. Some manufacturers noted in interviews that testing resources could potentially be a bottleneck to the conversion process and cited the potential need for adding in-house testing capacity. However, in written comments, stakeholders generally agreed that a five-year lead time between the publication date and compliance date is appropriate for this rulemaking.

Impacts on Subgroups of Manufacturers

Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. As discussed in section IV.J, using average cost assumptions developed for an industry cash-flow estimate is inadequate to assess differential impacts among manufacturer subgroups.

For the residential furnace fans industry, DOE identified and evaluated the impact of new energy conservation standards on one subgroup, specifically small manufacturers. The SBA defines a "small business" as having 750 employees or less for NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." Based on this definition, DOE identified 15 manufacturers in the residential furnace fans industry that qualify as small businesses. For a discussion of the impacts on the small manufacturer subgroup, see the regulatory flexibility analysis in section VI.B of this notice and chapter 12 of the final rule TSD.

Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of 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. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

During previous stages of this rulemaking, DOE identified a number of requirements in addition to new energy conservation standards for residential furnace fans. The following section briefly summarizes those identified regulatory requirements and addresses comments DOE received with respect to cumulative regulatory burden, as well as other key related concerns that manufacturers raised during interviews.

While the cumulative regulatory burden analysis contained in the NOPR reflects manufacturers' concerns regarding CC&E costs, DOE has decided to exclude CC&E costs from the cumulative burden analysis for the final rule. The furnace fan test procedure changed from the NOPR to the final rule. Much of the concern relating to CC&E costs expressed by stakeholders, and summarized in the NOPR, had to do with the old test procedure. The new test procedure reduces burden substantially. Also, for the final rule, CC&E costs have been explicitly incorporated into product conversion costs inputted into the GRIM, so they are no longer considered separately in the cumulative regulatory burdens section.

DOE Energy Conservation Standards

Companies that produce a wide range of regulated products and equipment may face more capital and product development expenditures than competitors with a narrower scope of products and equipment. Many furnace fan manufacturers also produce other residential and commercial equipment. In addition to the amended energy conservation standards for furnace fans, these manufacturers contend with several other Federal regulations and pending regulations that apply to other products and equipment. DOE recognizes that each regulation can significantly affect a manufacturer's financial operations. Multiple regulations affecting the same manufacturer can quickly strain manufacturers' profits and possibly cause an exit from the market. Table V.16 lists the other DOE energy conservation standards that could also affect manufacturers of furnace fans in the 3 years leading up to and after the compliance date of the new energy conservation standards for this equipment. Additionally, at the request of stakeholders, DOE has listed several DOE rulemakings in the table below that are currently in process but that have not been finalized.

TABLE V.16—OTHER DOE REGULATIONS IMPACTING FURNACE FAN MANUFACTURERS

Regulation	Compliance year	Number of impacted companies	Estimated total industry conversion costs
Commercial Refrigeration Equipment	2017	4	$184.0 million (2012$).
Commercial Packaged Air-Conditioning and Heating Equipment	*2018	24	N/A.**
Commercial/Industrial Fans and Blowers	*2019	29	N/A.**
Residential Boilers	*2019	9	N/A.**
Residential Non-Weatherized Gas Furnaces	n/a	38	N/A.**

* The dates listed are an approximation. The exact dates are pending final DOE action.

** For energy conservation standards that have not been issued, DOE does not have finalized industry conversion cost data available.

EPA ENERGY STAR

During interviews, some manufacturers stated that ENERGY STAR specifications for residential furnaces, central air conditioners, and heat pumps would be a source of cumulative regulatory burden. ENERGY STAR specifications are as follows:

TABLE V.17—ENERGY STAR SPECIFICATIONS FOR HVAC PRODUCTS THAT USE FURNACE FANS

Gas Furnaces	Rating of 90% AFUE or greater for U.S. South gas furnaces. Rating of 95% AFUE or greater for U.S. North gas furnaces. Less than or equal to 2.0% furnace fan efficiency.*
Oil Furnaces	Rating of 85% AFUE or greater. Less than or equal to 2.0% furnace fan efficiency.*
Air-Source Heat Pumps	>= 8.2 HSPF/>= 14.5 SEER/>= 12 EER for split systems. >= 8.0 HSPF/>= 14 SEER/>=11 EER for single-package equipment.
Central Air Conditioners	>= 14.5 SEER/>= 12 EER for split systems. >= 14 SEER/>=11 EER for single-package equipment.

* Furnace fan efficiency in this context is furnace fan electrical consumption as a percentage of total furnace energy consumption in heating mode.

DOE realizes that the cumulative effect of several regulations on an industry may significantly increase the burden faced by manufacturers that need to comply with multiple regulations and certification programs from different organizations and levels of government. However, DOE notes that certain standards, such as ENERGY STAR, are optional for manufacturers. As they are voluntary standards, they are not considered by DOE to be part of manufacturers' cumulative regulatory burden.

DOE discusses these and other requirements (*e.g.,* Canadian Energy Efficiency Regulations, California Title 24, Low NO_X requirements), and includes the full details of the cumulative regulatory burden analysis, in chapter 12 of the final rule TSD. DOE also discusses the impacts on the small manufacturer subgroup in the regulatory flexibility analysis in section VI.B of this final rule.

3. National Impact Analysis

Significance of Energy Savings

For each TSL, DOE projected energy savings for residential furnace fans purchased in the 30-year period that begins in the first full year of compliance with amended standards (2019–2048). The savings are measured over the entire lifetime of products purchased in the 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. Table V.18 presents the estimated primary energy savings for each considered TSL, and Table V.19 presents the estimated FFC energy savings for each considered TSL. The energy savings in the tables below are net savings that reflect the subtraction of the additional gas or oil used by the furnace associated with higher-efficiency furnace fans. The approach for estimating national energy savings is further described in section IV.H.1.

The difference between primary energy savings and FFC energy savings for all TSLs is small (less than 1 percent), because the upstream energy savings associated with the electricity savings are partially or fully offset by the upstream energy use from the additional gas or oil used by the furnace due to higher-efficiency furnace fans.

TABLE V.18—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS SOLD IN 2019–2048

Product class	Trial standard level					
	1	2	3	4	5	6
	quads					
Non-Weatherized, Non-Condensing Gas Furnace Fan	0.296	1.341	1.341	1.796	1.796	2.426
Non-Weatherized, Condensing Gas Furnace Fan	0.278	1.188	1.188	1.614	1.614	2.324
Weatherized Non-Condensing Gas Furnace Fan	0.048	0.224	0.224	0.330	0.330	0.462
Non-Weatherized, Non-Condensing Oil Furnace Fan	0.006	0.006	0.022	0.006	0.022	0.046
Non-Weatherized Electric Furnace/Modular Blower Fan	0.032	0.143	0.143	0.193	0.193	0.264
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	0.009	0.009	0.023	0.009	0.023	0.053

Table V.18—Cumulative National Primary Energy Savings for Trial Standard Levels for Residential Furnace Fans Sold in 2019–2048—Continued

Product class	Trial standard level					
	1	2	3	4	5	6
	quads					
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	0.001	0.001	0.003	0.001	0.003	0.008
Mobile Home Electric Furnace/Modular Blower Fan	0.009	0.009	0.030	0.044	0.044	0.055
Total—All Classes	0.679	2.922	2.974	3.994	4.024	5.639

Note: Components may not sum to total due to rounding.

Table V.19—Cumulative National Full-Fuel-Cycle Energy Savings for Trial Standard Levels for Residential Furnace Fans Sold in 2019–2048

Product class	Trial standard level					
	1	2	3	4	5	6
	quads					
Non-Weatherized, Non-Condensing Gas Furnace Fan	0.297	1.338	1.338	1.793	1.793	2.428
Non-Weatherized, Condensing Gas Furnace Fan	0.278	1.176	1.176	1.604	1.604	2.314
Weatherized Non-Condensing Gas Furnace Fan	0.048	0.225	0.225	0.331	0.331	0.463
Non-Weatherized, Non-Condensing Oil Furnace Fan	0.006	0.006	0.020	0.006	0.020	0.044
Non-Weatherized Electric Furnace/Modular Blower Fan	0.032	0.145	0.145	0.196	0.196	0.268
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	0.009	0.009	0.022	0.009	0.022	0.052
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	0.001	0.001	0.003	0.001	0.003	0.008
Mobile Home Electric Furnace/Modular Blower Fan	0.010	0.010	0.030	0.045	0.045	0.056
Total—All Classes	0.680	2.909	2.958	3.986	4.014	5.635

Note: Components may not sum to total due to rounding.

OMB Circular A–4 [72] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine, rather than 30, years of product shipments. The choice of a nine-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[73] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to residential furnace fans. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES results based on a 9-year analytical period are presented in Table V.20. The impacts are counted over the lifetime of products purchased in 2019–2027.

Table V.20—Cumulative National Primary Energy Savings for Trial Standard Levels for Residential Furnace Fans Sold in 2019–2027

Product class	Trial standard level					
	1	2	3	4	5	6
	quads					
Non-Weatherized, Non-Condensing Gas Furnace Fan	0.099	0.454	0.454	0.611	0.611	0.838
Non-Weatherized, Condensing Gas Furnace Fan	0.075	0.316	0.316	0.429	0.429	0.612
Weatherized Non-Condensing Gas Furnace Fan	0.016	0.075	0.075	0.108	0.108	0.150
Non-Weatherized, Non-Condensing Oil Furnace Fan	0.002	0.002	0.009	0.002	0.009	0.020
Non-Weatherized Electric Furnace/Modular Blower Fan	0.009	0.043	0.043	0.058	0.058	0.080

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[72] U.S. Office of Management and Budget, ''Circular A–4: Regulatory Analysis'' (Sept. 17, 2003) (Last accessed September 17, 2013 from *http://www.whitehouse.gov/omb/circulars_a004_a-4/.)*

[73] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some consumer products, the compliance period is 5 years rather than 3 years.

TABLE V.20—CUMULATIVE NATIONAL PRIMARY ENERGY SAVINGS FOR TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS SOLD IN 2019–2027—Continued

Product class	Trial standard level					
	1	2	3	4	5	6
	quads					
Mobile Home Non-Weathered, Non-Condensing Gas Furnace Fan	0.003	0.003	0.007	0.003	0.007	0.018
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	0.000	0.000	0.001	0.000	0.001	0.002
Mobile Home Electric Furnace/Modular Blower Fan	0.003	0.003	0.009	0.013	0.013	0.017
Total—All Classes	0.207	0.897	0.914	1.225	1.236	1.737

Note: Components may not sum to total due to rounding.

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 residential furnace fans. In accordance with OMB's guidelines on regulatory analysis,[74] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.21 shows the consumer NPV results for each TSL considered for residential furnace fans. In each case, the impacts cover the lifetime of products purchased in 2019–2048.

TABLE V.21—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS SOLD IN 2019–2048

Product class	Discount rate %	Trial standard level					
		1	2	3	4	5	6
		*billion 2013$**					
Non-Weatherized, Non-Condensing Gas Furnace Fan	3	2.150	12.031	12.031	13.309	13.309	11.943
Non-Weatherized, Condensing Gas Furnace Fan		1.842	10.769	10.769	11.444	11.444	10.156
Weatherized Non-Condensing Gas Furnace Fan		0.335	1.849	1.849	2.288	2.288	2.082
Non-Weatherized, Non-Condensing Oil Furnace Fan		0.028	0.028	0.154	0.028	0.154	0.078
Non-Weatherized Electric Furnace/Modular Blower Fan		0.215	1.237	1.237	1.480	1.480	0.615
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan		0.045	0.045	0.171	0.045	0.171	(0.039)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan		0.007	0.007	0.025	0.007	0.025	(0.005)
Mobile Home Electric Furnace/Modular Blower Fan		0.047	0.047	0.168	0.209	0.209	(0.099)
Total—All Classes		4.668	26.013	26.403	28.810	29.079	24.731
Non-Weatherized, Non-Condensing Gas Furnace Fan	7	0.823	4.502	4.502	4.713	4.713	3.381
Non-Weatherized, Condensing Gas Furnace Fan		0.677	3.856	3.856	3.876	3.876	2.686
Weatherized Non-Condensing Gas Furnace Fan		0.129	0.702	0.702	0.825	0.825	0.604
Non-Weatherized, Non-Condensing Oil Furnace Fan		0.012	0.012	0.061	0.012	0.061	0.006
Non-Weatherized Electric Furnace/Modular Blower Fan		0.078	0.438	0.438	0.515	0.515	0.014
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan		0.017	0.017	0.058	0.017	0.058	(0.071)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan		0.003	0.003	0.008	0.003	0.008	(0.010)
Mobile Home Electric Furnace/Modular Blower Fan		0.017	0.017	0.054	0.065	0.065	(0.102)

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[74] OMB Circular A–4, section E (Sept. 17, 2003) (Available at: *http://www.whitehouse.gov/omb/circulars_a004_a-4*).

TABLE V.21—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS SOLD IN 2019–2048—Continued

Product class	Discount rate %	Trial standard level					
		1	2	3	4	5	6
		*billion 2013$**					
Total—All Classes		1.754	9.545	9.679	10.024	10.120	6.509

* Numbers in parentheses indicate negative NPV.

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.22. The impacts are counted over the lifetime of products purchased in 2019–2027. As mentioned previously, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.22—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFIT FOR TRIAL STANDARD LEVELS FOR RESIDENTIAL FURNACE FANS SOLD IN 2019–2027

Product class	Discount rate %	Trial standard level					
		1	2	3	4	5	6
		*billion 2013$**					
Non-Weatherized, Non-Condensing Gas Furnace Fan	3	0.893	5.028	5.028	5.527	5.527	4.908
Non-Weatherized, Condensing Gas Furnace Fan		0.652	3.784	3.784	4.005	4.005	3.550
Weatherized Non-Condensing Gas Furnace Fan		0.139	0.777	0.777	0.945	0.945	0.864
Non-Weatherized, Non-Condensing Oil Furnace Fan		0.015	0.015	0.082	0.015	0.082	0.064
Non-Weatherized Electric Furnace/Modular Blower Fan		0.080	0.463	0.463	0.549	0.549	0.217
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan		0.019	0.019	0.073	0.019	0.073	(0.012)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan		0.003	0.003	0.010	0.003	0.010	(0.001)
Mobile Home Electric Furnace/Modular Blower Fan		0.017	0.017	0.061	0.074	0.074	(0.052)
Total—All Classes		1.819	10.106	10.278	11.137	11.266	9.537
Non-Weatherized, Non-Condensing Gas Furnace Fan	7	0.444	2.433	2.433	2.531	2.531	1.799
Non-Weatherized, Condensing Gas Furnace Fan		0.325	1.840	1.840	1.845	1.845	1.290
Weatherized Non-Condensing Gas Furnace Fan		0.070	0.384	0.384	0.446	0.446	0.333
Non-Weatherized, Non-Condensing Oil Furnace Fan		0.008	0.008	0.040	0.008	0.040	0.015
Non-Weatherized Electric Furnace/Modular Blower Fan		0.039	0.220	0.220	0.257	0.257	0.001
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan		0.009	0.009	0.033	0.009	0.033	(0.037)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan		0.001	0.001	0.004	0.001	0.004	(0.005)
Mobile Home Electric Furnace/Modular Blower Fan		0.008	0.008	0.026	0.031	0.031	(0.059)
Total—All Classes		0.905	4.904	4.980	5.128	5.186	3.338

* Numbers in parentheses indicate negative NPV.

As noted in section IV.H.2, DOE assumed no change in residential furnace fan prices over the 2019–2048 period. In addition, DOE conducted a sensitivity analysis using alternative price trends: One in which prices decline over time, and one in which prices increase over time. These price trends, and the NPV results from the associated sensitivity cases, are described in appendix 10–C of the final rule TSD.

Indirect Impacts on Employment

DOE expects energy conservation standards for residential furnace fans to reduce energy costs for consumers, with the resulting net savings being redirected to other forms of economic activity. Those shifts in spending and economic activity could affect the demand for labor. As described in section IV.N, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered in this rulemaking. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term time frames (2019 and 2024), where these uncertainties are reduced.

The results suggest that today's standards would be likely to have 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 more detailed results about anticipated indirect employment impacts.

4. Impact on Product Utility or Performance

DOE has concluded that the standards it is adopting in this final rule would not lessen the utility or performance of residential furnace fans.

5. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition that is likely to result from standards. It also 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. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii))

To assist the Attorney General in making such a determination for today's standards, DOE provided the Department of Justice (DOJ) with copies of the NOPR and the TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for residential furnace fans are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

6. Need of the Nation To Conserve Energy

An improvement in the energy efficiency of the products subject to this rule is likely to improve the security of the nation's energy system by reducing overall demand for energy. Reduction in the growth of electricity demand resulting from energy conservation standards may also improve the reliability of the electricity system. Reductions in national electric generating capacity estimated for each considered TSL are reported in chapter 15 of the final rule TSD.

Energy savings from standards for the residential furnace fan products covered in today's final rule could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with electricity production. Table V.23 provides DOE's estimate of cumulative emissions reductions projected to result from the TSLs considered in this rulemaking. The table includes both power sector emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

As discussed in section IV.K, DOE did not include NO_X emissions reduction from power plants in States subject to CAIR, because an energy conservation standard would not affect the overall level of NO_X emissions in those States due to the emissions caps mandated by CAIR. For SO_2, under the MATS, projected emissions will be far below the cap established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that efficiency standards will reduce SO_2 emissions.

TABLE V.23—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR RESIDENTIAL FURNACE FANS

	TSL					
	1	2	3	4	5	6
Primary Energy Emissions *						
CO_2 (million metric tons)	29.3	124.5	126.3	171.1	172.0	241.5
SO_2 (thousand tons)	38.1	174.3	178.0	232.5	235.2	323.5
NO_X (thousand tons)	(5.2)	(32.4)	(33.8)	(38.7)	(40.2)	(51.1)
Hg (tons)	0.1	0.3	0.3	0.4	0.4	0.5
N_2O (thousand tons)	1.0	4.5	4.6	6.0	6.1	8.4
CH_4 (thousand tons)	5.2	23.4	23.9	31.3	31.6	43.7
Upstream Emissions						
CO_2 (million metric tons)	1.7	6.7	6.7	9.6	9.5	13.7
SO_2 (thousand tons)	0.5	2.4	2.4	3.2	3.2	4.4
NO_X (thousand tons)	22.5	84.9	85.0	122.8	122.0	177.5
Hg (tons)	0.0	0.0	0.0	0.0	0.0	0.0
N_2O (thousand tons)	0.0	0.1	0.1	0.1	0.1	0.2
CH_4 (thousand tons)	127.0	447.7	455.4	663.7	666.1	984.3
Total FFC Emissions						
CO_2 (million metric tons)	31.0	131.2	133.1	180.6	181.5	255.2
SO_2 (thousand tons)	38.6	176.7	180.4	235.7	238.4	327.9
NO_X (thousand tons)	17.2	52.6	51.2	84.0	81.8	126.4
Hg (tons)	0.1	0.3	0.3	0.4	0.4	0.5
N_2O (thousand tons)	1.0	4.6	4.7	6.2	6.2	8.6
N_2O *thousand tons CO_2eq* **	302.2	1378.9	1402.4	1843.7	1859.3	2569.2
CH_4 (thousand tons)	132.1	471.1	479.3	695.0	697.7	1028.0

TABLE V.23—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR RESIDENTIAL FURNACE FANS—Continued

	TSL					
	1	2	3	4	5	6
CH_4 *million tons CO_2eq* **	3303.3	11778	11982	17375	17442	25700

* Includes emissions from additional gas use associated with more-efficient furnace fans.
** CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
Note: Parentheses indicate negative values.

As part of the analysis for this final rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X estimated for each of the TSLs considered for residential furnace fans. As discussed in section IV.L, for CO_2, DOE used four sets of values for the SCC developed by an interagency process. Three sets of values are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate. The SCC values for CO_2 emissions reductions in 2015, expressed in 2013$, are $12.0/ton, $40.5/ton, $62.4/ton, and $119/ton. The values for later years are higher due to increasing damages as the magnitude of projected climate change increases. Table V.24 presents the global value of CO_2 emissions reductions at each TSL. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 14 of the final rule TSD.

TABLE V.24—GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR RESIDENTIAL FURNACE FANS

TSL	SCC Case*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	million 2013$			
Primary Energy Emissions **				
1	184	880	1,409	2,722
2	785	3,755	6,007	11,612
3	797	3,811	6,096	11,784
4	1,077	5,152	8,245	15,934
5	1,083	5,181	8,291	16,023
6	1,517	7,265	11,628	22,467
Upstream Emissions				
1	10.2	50.1	81	155
2	40.0	196	315	607
3	40.0	196	316	608
4	57.0	279	449	866
5	56.6	278	447	861
6	81.7	401	644	1,241
Total FFC Emissions				
1	194	930	1,489	2,878
2	825	3,951	6,323	12,219
3	837	4,007	6,412	12,392
4	1,134	5,432	8,694	16,799
5	1,140	5,459	8,737	16,884
6	1,599	7,666	12,272	23,709

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.0, $40.5, $62.4, and $119 per metric ton (2013$). The values are for CO_2 only (*i.e.,* not CO_2eq of other greenhouse gases).
** Includes site emissions from additional use of natural gas associated with more-efficient furnace fans.

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other greenhouse gas (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 in this rulemaking on reducing CO_2 emissions is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this final rule the most recent values and analyses resulting from the interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from standards for the residential furnace fan products that are the subject of this final rule. The dollar-per-ton values that DOE used are discussed in section IV.L. Table V.25 presents the present value of cumulative NO_X emissions reductions for each TSL calculated using the average dollar-per-ton values and 7-percent and 3-percent discount rates.

TABLE V.25—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR RESIDENTIAL FURNACE FANS

TSL	3% Discount rate	7% Discount rate
	million 2013$	
Power Sector and Site Emissions *		
1	(3.8)	0.0
2	(27.1)	(3.7)
3	(28.6)	(4.1)
4	(31.0)	(2.8)
5	(32.5)	(3.3)
6	(39.4)	(2.1)
Upstream Emissions		
1	25.9	10.2
2	98.1	38.7
3	98.3	38.8
4	141.8	55.9
5	140.9	55.6
6	205.5	81.4
Total FFC Emissions **		
1	22.1	10.2
2	71.0	35.1
3	69.7	34.7
4	110.8	53.1
5	108.4	52.3
6	166.1	79.3

* Includes site emissions from additional use of natural gas associated with more-efficient furnace fans.
** Components may not sum to total due to rounding.
Note: Parentheses indicate negative values.

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.26 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced full-fuel-cycle CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7-percent and a 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions discussed above.

TABLE V.26—POTENTIAL STANDARDS FOR RESIDENTIAL FURNACE FANS: NET PRESENT VALUE OF CONSUMER SAVINGS COMBINED WITH PRESENT VALUE OF MONETIZED BENEFITS FROM CO_2 AND NO_X EMISSIONS REDUCTIONS

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Case $12.0/metric ton CO_2* and low value for NO_X**	SCC Case $40.5/metric ton CO_2* and medium value for NO_X**	SCC Case $62.4/metric ton CO_2* and medium value for NO_X**	SCC Case $119/metric ton CO_2* and high value for NO_X**
	billion 2013$			
1	4.9	5.6	6.2	7.6
2	26.9	30.0	32.4	38.3
3	27.3	30.5	32.9	38.9
4	30.1	34.4	37.6	45.7
5	30.3	34.6	37.9	46.1
6	26.5	32.6	37.2	48.6

TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Case \$12.0/metric ton CO_2* and low value for NO_X**	SCC Case \$40.5/metric ton CO_2* and medium value for NO_X**	SCC Case \$62.4/metric ton CO_2* and medium value for NO_X**	SCC Case \$119/metric ton CO_2* and high value for NO_X**
	billion 2013$			
1	2.0	2.7	3.3	4.6
2	10.4	13.5	15.9	21.8
3	10.6	13.7	16.1	22.1
4	11.2	15.5	18.8	26.9
5	11.3	15.6	18.9	27.1
6	8.2	14.3	18.9	30.3

* These label values represent the global SCC in 2015, in 2013$.

** Low Value corresponds to \$476 per ton of NO_X emissions. Medium Value corresponds to \$2,684 per ton, and High Value corresponds to \$4,893 per ton.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and the SCC are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2019–2048. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year. Because of the long residence time of CO_2 in the atmosphere, these impacts continue well beyond 2100.

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)(VI)) No other factors were considered in this analysis.

C. Conclusions

When considering proposed standards, the new or amended energy conservation standard that DOE adopts for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

For today's final rule, DOE considered the impacts of standards 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 in understanding the benefits and/or burdens of each TSL, tables in this section summarize the quantitative analytical results for each TSL, based on the assumptions and methodology discussed herein. The efficiency levels contained in each TSL are described in section V.A. 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. Section V.B.1.b presents the estimated impacts of each TSL for these subgroups. DOE discusses the impacts on direct employment in residential furnace fan manufacturing in section V.B.2.b, and discusses the indirect employment impacts in section V.B.3.c.

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, renter versus owner or builder versus purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off at a higher than expected rate between current consumption and uncertain future energy cost savings. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution).

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego a purchase of a product in the standards case, this decreases sales for product manufacturers and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of changes in the volume of product purchases in chapter 9 of the final rule TSD. 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.[75]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[76] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis.

1. Benefits and Burdens of Trial Standard Levels Considered for Residential Furnace Fans

Table V.27 through Table V.29 summarize the quantitative impacts estimated for each TSL for residential furnace fans. The national impacts are measured over the lifetime of furnace fans purchased in the 30-year period that begins in the first full year of compliance with amended standards (2019–2048). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. Results that refer to primary energy savings are presented in chapter 10 of the final rule TSD.

TABLE V.27—SUMMARY OF ANALYTICAL RESULTS FOR RESIDENTIAL FURNACE FAN STANDARDS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
National Full-Fuel-Cycle Energy Savings *quads*						
	0.680	2.909	2.958	3.986	4.014	5.635
NPV of Consumer Benefits *2013$ billion*						
3% discount rate	4.668	26.013	26.403	28.810	29.079	24.731
7% discount rate	1.754	9.545	9.679	10.024	10.120	6.509
Cumulative Emissions Reduction (FFC Emissions)						
CO_2 *million metric tons*	31.0	131.2	133.1	180.6	181.5	255.2
SO_2 *thousand tons*	38.6	176.7	180.4	235.7	238.4	327.9
NO_X *thousand tons*	17.2	52.6	51.2	84.0	81.8	126.4
Hg *tons*	0.1	0.3	0.3	0.4	0.4	0.5
N_2O *thousand tons*	1.0	4.6	4.7	6.2	6.2	8.6
N_2O *thousand tons CO_2eq**	302.2	1378.9	1402.4	1843.7	1859.3	2569.2
CH_4 *thousand tons*	132.1	471.1	479.3	695.0	697.7	1028.0
CH_4 *million tons CO_2eq**	3303	11778	11982	17375	17442	25700
Value of Emissions Reduction (FFC Emissions) *2013$ billion*						
CO_2 **	0.194 to 2.878	0.825 to 12.219	0.837 to 12.392	1.134 to 16.799	1.140 to 16.884	1.599 to 23.709
NO_X—3% discount rate	0.0221	0.0710	0.0697	0.1108	0.1084	0.1661
NO_X—7% discount rate	0.0102	0.0351	0.0347	0.0531	0.0523	0.0793

* CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).
** Range of the economic value of CO_2 reductions is based on interagency estimates of the global benefit of reduced CO_2 emissions.

TABLE V.28—SUMMARY OF ANALYTICAL RESULTS FOR RESIDENTIAL FURNACE FAN STANDARDS: MANUFACTURER AND AVERAGE OR MEDIAN CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Manufacturer Impacts						
Industry NPV (baseline value is 349.6) (2013*$ in millions*)	332.3 to 336.6	313.2 to 360.0	311.0 to 359.1	290.6 to 397.8	288.8 to 397.6	147.2 to 422.4
Change in Industry NPV (*% change*)	(5.0) to (3.7)	(10.4) to 3.0	(11.0) to 2.7	(16.9) to 13.8	(17.4) to 13.7	(57.9) to 20.8
Consumer Average LCC Savings (*2013$*)						
Non-Weatherized, Non-condensing Gas Furnace Fan	$85	$471	$471	$506	$506	$431
Non-Weatherized, Condensing Gas Furnace Fan	$58	$335	$335	$341	$341	$268
Weatherized Non-Condensing Gas Furnace Fan	$67	$378	$378	$447	$447	$391
Non-Weatherized, Non-Condensing Oil Furnace Fan	$46	$46	$259	$46	$259	$80
Non-Weatherized Electric Furnace/Modular Blower Fan	$29	$181	$181	$204	$204	$81
Mobile Home Non-Weatherized, Non-condensing Gas Furnace Fan	$36	$36	$144	$36	$144	($58)
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	$35	$35	$133	$35	$133	($51)

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[75] P.C. Reiss and M.W. White, Household Electricity Demand, Revisited, *Review of Economic Studies* (2005) 72, 853–883.

[76] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory (2010) (Available at: *http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (Last accessed May 3, 2013).

TABLE V.28—SUMMARY OF ANALYTICAL RESULTS FOR RESIDENTIAL FURNACE FAN STANDARDS: MANUFACTURER AND AVERAGE OR MEDIAN CONSUMER IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Mobile Home Electric Furnace/Modular Blower Fan	$19	$19	$70	$85	$85	($54)
Consumer Median PBP (*years*)						
Non-Weatherized, Non-condensing Gas Furnace Fan	1.12	2.60	2.60	5.41	5.41	10.16
Non-Weatherized, Condensing Gas Furnace Fan	1.18	2.87	2.87	5.78	5.78	11.01
Weatherized Non-Condensing Gas Furnace Fan	0.73	1.79	1.79	4.42	4.42	8.19
Non-Weatherized, Non-Condensing Oil Furnace Fan	1.70	1.70	4.65	1.70	4.65	18.56
Non-Weatherized Electric Furnace/Modular Blower Fan	1.94	2.64	2.64	3.21	3.21	11.45
Mobile Home Non-Weatherized, Non-condensing Gas Furnace Fan	2.72	2.72	6.84	2.72	6.84	24.38
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	2.31	2.31	6.65	2.31	6.65	31.27
Mobile Home Electric Furnace/Modular Blower Fan	2.07	2.07	3.58	4.09	4.09	14.90

Note: Parentheses indicate negative values.

TABLE V.29—SUMMARY OF ANALYTICAL RESULTS FOR RESIDENTIAL FURNACE FAN STANDARDS: DISTRIBUTION OF CONSUMER LCC IMPACTS

Product Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Non-Weatherized, Non-Condensing Gas Furnace Fan:						
Net Cost	1%	17%	17%	30%	30%	50%
No Impact	68%	25%	25%	14%	14%	0%
Net Benefit	30%	58%	58%	56%	56%	50%
Non-Weatherized, Condensing Gas Furnace Fan:						
Net Cost	1%	11%	11%	23%	23%	51%
No Impact	75%	41%	41%	34%	34%	0%
Net Benefit	24%	48%	48%	43%	43%	49%
Weatherized Non-Condensing Gas Furnace Fan:						
Net Cost	0%	3%	3%	16%	16%	41%
No Impact	81%	56%	56%	33%	33%	0%
Net Benefit	19%	41%	41%	51%	51%	59%
Non-Weatherized, Non-Condensing Oil Furnace Fan:						
Net Cost	13%	13%	44%	13%	44%	78%
No Impact	71%	71%	28%	71%	28%	0%
Net Benefit	17%	17%	28%	17%	28%	22%
Non-Weatherized Electric Furnace/Modular Blower Fan:						
Net Cost	4%	17%	17%	23%	23%	60%
No Impact	73%	37%	37%	25%	25%	0%
Net Benefit	22%	45%	45%	51%	51%	39%
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan:						
Net Cost	10%	10%	55%	10%	55%	80%
No Impact	56%	56%	0%	56%	0%	0%
Net Benefit	34%	34%	45%	34%	45%	20%
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan:						
Net Cost	5%	5%	37%	5%	37%	82%
No Impact	68%	68%	29%	68%	29%	0%
Net Benefit	27%	27%	33%	27%	33%	18%
Mobile Home Electric Furnace/Modular Blower Fan:						
Net Cost	7%	7%	26%	32%	32%	75%
No Impact	71%	71%	38%	26%	26%	0%
Net Benefit	22%	22%	37%	43%	43%	25%

Note: Components may not sum to total due to rounding.

First, DOE considered TSL 6, which would save an estimated total of 5.63 quads of energy, an amount DOE considers significant. TSL 6 has an estimated NPV of consumer benefit of $6.51 billion using a 7-percent discount rate, and $24.7 billion using a 3-percent discount rate.

The cumulative CO_2 emissions reduction at TSL 6 is 255.2 million metric tons. The estimated monetary value of the CO_2 emissions reductions ranges from $1.60 billion to $23.71 billion. The other emissions reductions are 327.9 thousand tons of SO_2, 126.4 thousand tons of NO_X, 0.5 tons of Hg, 8.6 thousand tons of N_2O, and 1,028.0 thousand tons of CH_4.

At TSL 6, the average LCC savings are positive for: (1) Non-weatherized, non-condensing gas furnace fans; (2) non-weatherized, condensing gas furnace fans; (3) weatherized non-condensing gas furnace fans; (4) non-weatherized, non-condensing oil furnace fans; and (5) non-weatherized electric furnace/modular blower fans. The LCC savings are negative for: (1) Mobile home non-weatherized, non-condensing gas furnace fans; (2) mobile home non-weatherized, condensing gas furnace fans; and (3) mobile home electric furnace/modular blower fans. The median payback period is lower than the median product lifetime (which is 21.2 years for gas and electric furnace fans) for all of the product classes except for: (1) Mobile home non-weatherized, non-condensing gas furnace fans, and (2) mobile home non-weatherized, condensing. The share of consumers experiencing an LCC cost (increase in LCC) is higher than the share experiencing an LCC benefit (decrease in LCC) for all of the product classes except for weatherized non-condensing gas furnace fans.

At TSL 6, manufacturers may expect diminished profitability due to increases in product costs, stranded assets, capital investments in equipment and tooling, decreases in unit shipments, and expenditures related to engineering and testing. The projected change in INPV ranges from a decrease of $202.5 million to an increase of $72.8 million based on DOE's manufacturer markup scenarios. The upper bound of $72.8 million is considered an optimistic scenario for manufacturers because it assumes manufacturers can fully pass on substantial increases in product costs and maintain existing mark ups. DOE recognizes the risk of large negative impacts on industry if manufacturers' expectations concerning reduced profit margins are realized. TSL 6 could reduce INPV in the residential furnace fan industry by up to 57.9 percent if impacts reach the lower bound of the range.

Accordingly, the Secretary concludes that at TSL 6 for residential furnace fans, the benefits of significant energy savings, positive NPV of consumer benefit, emission reductions and the estimated monetary value of the CO_2 emissions reductions, as well as positive average LCC savings for most product classes would be outweighed by the high percentage of consumers that would experience an LCC cost in all of the product classes, and the substantial reduction in INPV for manufacturers. Consequently, DOE has concluded that TSL 6 is not economically justified.

Next, DOE considered TSL 5, which would save an estimated total of 4.01 quads of energy, an amount DOE considers significant. TSL 5 has an estimated NPV of consumer benefit of $10.1 billion using a 7-percent discount rate, and $29.1 billion using a 3-percent discount rate.

The cumulative CO_2 emissions reduction at TSL 5 is 181.5 million metric tons. The estimated monetary value of the CO_2 emissions reductions ranges from $1.14 billion to $16.88 billion. The other emissions reductions are 238.4 thousand tons of SO_2, 81.8 thousand tons of NO_X, 0.4 tons of Hg, 6.2 thousand tons of N_2O, and 697.7 thousand tons of CH_4.

At TSL 5, the average LCC savings are positive for all of the product classes. The median payback period is lower than the average product lifetime for all of the product classes. The share of consumers experiencing an LCC benefit (decrease in LCC) is higher than the share experiencing an LCC cost (increase in LCC) for five of the product classes (non-weatherized, non-condensing gas furnace fans; non-weatherized, condensing gas furnace fans; weatherized non-condensing gas furnace fans; non-weatherized electric furnace/modular blower fans; and mobile home electric furnace/modular blower fans), but lower for the other three product classes.

At TSL 5, the projected change in INPV ranges from a decrease of $60.8 million to an increase of $48.0 million. At TSL 5, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the lower bound of the range of impacts is reached, as DOE expects, TSL 5 could result in a net loss of 17.4 percent in INPV for residential furnace fan manufacturers.

Accordingly, the Secretary concludes that at TSL 5 for residential furnace fans, the benefits of significant energy savings, positive NPV of consumer benefit, positive average LCC savings for all of the product classes, emission reductions and the estimated monetary value of the CO_2 emissions reductions, would be outweighed by the high percentage of consumers that would be negatively impacted for some of the product classes, and the substantial reduction in INPV for manufacturers. Consequently, DOE has concluded that TSL 5 is not economically justified.

Next, DOE considered TSL 4, which would save an estimated total of 3.99 quads of energy, an amount DOE considers significant. TSL 4 has an estimated NPV of consumer benefit of $10.0 billion using a 7-percent discount rate, and $28.8 billion using a 3-percent discount rate.

The cumulative CO_2 emissions reduction at TSL 4 is 180.6 million metric tons. The estimated monetary value of the CO_2 emissions reductions ranges from $1.13 billion to $16.8 billion. The other emissions reductions are 235.7 thousand tons of SO_2, 84.0 thousand tons of NO_X, 0.4 tons of Hg, 6.2 thousand tons of N_2O, and 695.0 thousand tons of CH_4.

At TSL 4, the average LCC savings are positive for all of the product classes. The median payback period is lower than the average product lifetime for all of the product classes. The share of consumers experiencing an LCC benefit (decrease in LCC) is higher than the share experiencing an LCC cost (increase in LCC) for all of the product classes.

At TSL 4, the projected change in INPV ranges from a decrease of $59.0 million to an increase of $48.2 million. At TSL 4, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the lower bound of the range of impacts is reached, as DOE expects, TSL 4 could result in a net loss of 16.9 percent in INPV for residential furnace fan manufacturers.

After considering the analysis and weighing the benefits and the burdens, the Secretary concludes that at TSL 4 for residential furnace fans, the benefits of significant energy savings, positive NPV of consumer benefit, positive average LCC savings for all of the product classes, emission reductions and the estimated monetary value of the CO_2 emissions reductions would outweigh the reduction in INPV for manufacturers. The Secretary has concluded that TSL 4 would save a significant amount of energy and is technologically feasible and economically justified. Therefore, DOE today is adopting the energy conservation standards for residential furnace fans at TSL 4. Table V.30 presents the energy conservation standards for residential furnace fans.

TABLE V.30—ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL FURNACE FANS

Product class	Standard: FER * (W/1000 cfm)
Non-Weatherized, Non-Condensing Gas Furnace Fan	$FER = 0.044 \times Q_{Max} + 182$
Non-Weatherized, Condensing Gas Furnace Fan	$FER = 0.044 \times Q_{Max} + 195$
Weatherized Non-Condensing Gas Furnace Fan	$FER = 0.044 \times Q_{Max} + 199$
Non-Weatherized, Non-Condensing Oil Furnace Fan	$FER = 0.071 \times Q_{Max} + 382$
Non-Weatherized Electric Furnace/Modular Blower Fan	$FER = 0.044 \times Q_{Max} + 165$
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan	$FER = 0.071 \times Q_{Max} + 222$
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan	$FER = 0.071 \times Q_{Max} + 240$

TABLE V.30—ENERGY CONSERVATION STANDARDS FOR RESIDENTIAL FURNACE FANS—Continued

Product class	Standard: FER * (W/1000 cfm)
Mobile Home Electric Furnace/Modular Blower Fan	FER = 0.044 × Q_{Max} + 101
Mobile Home Weatherized Non-Condensing Gas Furnace Fan	Reserved
Mobile Home Non-Weatherized Non-Condensing Oil Furnace Fan	Reserved

* Q_{Max} is the airflow, in cfm, at the maximum airflow-control setting measured using the final DOE test procedure. 79 FR 500, 524 (Jan. 3, 2014).

2. Summary of Benefits and Costs (Annualized) of Today's Standards

The benefits and costs of today's standards can also be expressed in terms of annualized values. The annualized monetary values are the sum of: (1) The annualized national economic value, expressed in 2013$, of the benefits from operating products that meet the standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV), and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.[77] The value of the CO_2 reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO_2 developed by a recent interagency process.

Although combining the values of operating savings and CO_2 reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and SCC are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2019–2048. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year over a very long period.

Table V.31 shows the annualized values for today's standards for residential furnace fans. The results under the primary estimate are as follows. (All monetary values below are expressed in 2013$.) Using a 7-percent discount rate for benefits and costs other than CO_2 reduction (for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $40.5/ton in 2015), the cost of the residential furnace fan standards in today's rule is $358 million per year in increased equipment costs, while the benefits are $1,416 million per year in reduced equipment operating costs, $312 million in CO_2 reductions, and $5.61 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,376 million per year.

Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $40.5/ton in 2015, Table V.31 shows the cost of the residential furnace fans standards in today's rule is $355 million per year in increased equipment costs, while the benefits are $2010 million per year in reduced operating costs, $312 million in CO_2 reductions, and $6.36 million in reduced NO_X emissions. In this case, the net benefit amounts to $1,973 million per year.

TABLE V.31—ANNUALIZED BENEFITS AND COSTS OF STANDARDS (TSL 4) FOR RESIDENTIAL FURNACE FANS

	Discount rate	Primary estimate *	Low net benefits estimate	High net benefits estimate
		million 2013$/year		
Benefits:				
Consumer Operating Cost Savings	7%	1416	1167	1718
	3%	2010	1626	2467
CO_2 Reduction Monetized Value ($12.0/t case) **	5%	90	77	108
CO_2 Reduction Monetized Value ($40.5/t case) **	3%	312	268	377
CO_2 Reduction Monetized Value ($62.4/t case) **	2.5%	459	393	555
CO_2 Reduction Monetized Value ($119/t case) **	3%	965	828	1166
NO_X Reduction Monetized Value (at $2,684/ton) **	7%	5.61	4.80	6.82
	3%	6.36	5.35	7.86
Total Benefits †	7% plus CO_2 range	1,512 to 2,387	1,249 to 2,000	1,833 to 2,891
	7%	1,734	1,439	2,102
	3% plus CO_2 range	2,106 to 2,981	1,708 to 2,459	2,583 to 3,641
	3%	2,328	1,899	2,852
Costs:				
Consumer Incremental Product Costs	7%	358	314	410
	3%	355	304	419
Net Benefits:				
Total †	7% plus CO_2 range	1,154 to 2,029	935 to 1,685	1,423 to 2,481
	7%	1,376	1,125	1,692

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[77] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2013, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates. From the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in 2013, that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined would be a steady stream of payments.

TABLE V.31—ANNUALIZED BENEFITS AND COSTS OF STANDARDS (TSL 4) FOR RESIDENTIAL FURNACE FANS—Continued

	Discount rate	Primary estimate *	Low net benefits estimate	High net benefits estimate
		million 2013$/year		
	3% plus CO_2 range 3%	1,750 to 2,625 1,973	1,404 to 2,155 1,595	2,164 to 3,222 2,433

* This table presents the annualized costs and benefits associated with residential furnace fans shipped in 2019–2048. These results include benefits to consumers which accrue after 2048 from the products purchased in 2019–2048. Costs incurred by manufacturers, some of which may be incurred in preparation for the rule, are not directly included, but are indirectly included as part of incremental equipment costs. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices and housing starts from the *AEO 2013* Reference case, Low Estimate, and High Estimate, respectively. Incremental product costs reflect a constant product price trend in the Primary Estimate, an increasing price trend in the Low Benefits Estimate, and a decreasing price trend in the High Benefits Estimate.

** The CO_2 values represent global values of the SCC, in 2013$, in 2015 under several scenarios. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC values increase over time. The value for NO_X (in 2013$) is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to the SCC value of $40.5/t in 2015. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that today's standards address, are as follows:

(1) There is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the home appliance market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of residential furnace fans that are not captured by the users of such equipment. These benefits include externalities related to environmental protection and energy security that are not reflected in energy prices, such as reduced emissions of greenhouse gases.

In addition, DOE has determined that today's regulatory action is an ''economically significant regulatory action'' under section 3(f) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order requires that DOE prepare a regulatory impact analysis (RIA) for this rule and that the Office of Information and Regulatory Affairs (OIRA) in the OMB review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011. 76 FR 3281 (Jan. 21, 2011). Executive Order 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) Propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

DOE emphasizes as well that Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE believes that today's final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of 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 Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's Web site (*http://energy.gov/gc/office-general-counsel*). DOE has prepared the following FRFA for the products that are the subject of this rulemaking.

1. Description and Estimated Number of Small Entities Regulated

Methodology for Estimating the Number of Small Entities

For the manufacturers of residential furnace fans, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. The size standards are listed by NAICS code and industry description and are available at: *http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.* Residential furnace fan manufacturing 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 750 employees or less for an entity to be considered as a small business for this category.

To estimate the number of companies that could be small business manufacturers of products covered by this rulemaking, DOE conducted a market survey using available public information to identify potential small manufacturers. DOE's research involved public databases (*e.g.,* AHRI Directory,[78] the SBA Database[79]), individual company Web sites, and market research tools (*e.g.,* Hoovers Web site[80]) to create a list of companies that manufacture or sell products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at DOE public meetings. DOE reviewed publicly-available data and contacted select companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered residential furnace fans. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a ''small business,'' or are foreign owned and operated.

DOE initially identified 38 manufacturers of residential furnace fan products sold in the U.S. DOE then determined that 23 were large manufacturers or manufacturers that are foreign owned and operated. DOE was able to determine that 15 domestic manufacturers meet the SBA's definition of a ''small business'' and manufacture products covered by this rulemaking.

Manufacturer Participation

Before issuing this Notice, DOE attempted to contact all the small business manufacturers of residential furnace fans it had identified. One of the small businesses consented to being interviewed during the MIA interviews. DOE also obtained information about small business impacts while interviewing large manufacturers.

Industry Structure

The 15 identified domestic manufacturers of residential furnace fans that qualify as small businesses under the SBA size standard account for a small fraction of industry shipments. Generally, manufacturers of furnaces are also manufacturers of furnace fan products. The market for residential gas furnaces is almost completely held by seven large manufacturers, and small manufacturers in total account for only 1 percent of unit sales in the market. These seven large manufacturers also control 97 percent of the market for central air conditioners. The market for mobile home furnaces is primarily held by one large manufacturer. In contrast, the market for domestic oil furnaces is almost entirely comprised of small manufacturers.

Comparison Between Large and Small Entities

Today's standards for residential furnace fans could cause small manufacturers to be at a disadvantage relative to large manufacturers. One way in which small manufacturers could be at a disadvantage is that they may be disproportionately affected by product conversion costs. Product redesign, testing, and certification costs tend to be fixed per basic model and do not scale with sales volume. For each model, small businesses must make investments in research and development to redesign their products, but because they have lower sales volumes, they must spread these costs across fewer units. In addition, because small manufacturers have fewer engineers than large manufacturers, they would need to allocate a greater portion of their available resources to meet a standard. Since engineers may need to spend more time redesigning and testing existing models as a result of the new standard, they may have less time to develop new products.

Furthermore, smaller manufacturers may lack the purchasing power of larger manufacturers. For example, since motor suppliers give discounts to manufacturers based on the number of motors they purchase, larger manufacturers may have a pricing advantage because they have higher volume purchases. This purchasing power differential between high-volume and low-volume orders applies to other furnace fan components as well, including the impeller fan blade, transformer, and capacitor.

2. Description and Estimate of Compliance Requirements

Since the standard in today's final rule for residential furnace fans could cause small manufacturers to be at a disadvantage relative to large manufacturers, DOE cannot certify that today's standards would not have a significant impact on a significant number of small businesses, and consequently, DOE has prepared this FRFA.

At TSL 4, the level adopted in today's document, DOE estimates capital conversion costs of $0.14 million and product conversion costs of $0.23 million over a five-year conversion period for a typical small manufacturer. This is compared to capital conversion costs of $0.59 and product conversion costs of $1.00 million over a five-year conversion period for a typical large manufacturer. These costs and their impacts are described in detail below.

To estimate how small manufacturers would be potentially impacted, DOE used the market share of small manufacturers to estimate the annual revenue, earnings before interest and tax (EBIT), and research and development (R&D) expense for a typical small manufacturer. DOE then compared these costs to the required product conversion costs at each TSL for both an average small manufacturer and an average large manufacturer. Table VI.1 and VI.2 show the capital and product conversion costs for a typical small manufacturer versus those of a typical large manufacturer. Tables VI.3 and VI.4 report the total conversion costs as a percentage of annual R&D expense, annual revenue, and EBIT for a typical small and large manufacturer, respectively. In the following tables, TSL 4 represents the adopted standard.

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[78] See *https://www.ahridirectory.org/ahriDirectory/pages/home.aspx.*

[79] See *http://dsbs.sba.gov/dsbs/search/dsp_dsbs.cfm.*

[80] See Hoovers: *http://www.hoovers.com/.*

TABLE VI.1—COMPARISON OF TYPICAL SMALL AND LARGE MANUFACTURER'S CAPITAL CONVERSION COSTS

	Capital conversion costs for typical small manufacturer (in 2013$ millions)	Capital conversion costs for typical large manufacturer (in 2013$ millions)
TSL 1	0.08	0.35
TSL 2	0.10	0.44
TSL 3	0.11	0.46
TSL 4	0.14	0.59
TSL 5	0.14	0.62
TSL 6	1.24	5.28

TABLE VI.2:—COMPARISON OF TYPICAL SMALL AND LARGE MANUFACTURER'S PRODUCT CONVERSION COSTS

	Product conversion costs for typical small manufacturer (in 2013$ millions)	Product conversion costs for typical large manufacturer (in 2013$ millions)
TSL 1	0.17	0.74
TSL 2	0.22	0.93
TSL 3	0.23	0.99
TSL 4	0.23	1.00
TSL 5	0.25	1.06
TSL 6	0.27	1.15

TABLE VI.3—IMPACTS OF CONVERSION COSTS ON A SMALL MANUFACTURER

	Capital conversion cost as a percentage of annual capital expenditures	Product conversion cost as a percentage of annual R&D expense	Total conversion cost as a percentage of annual revenue	Total conversion cost as a percentage of annual EBIT
TSL 1	69%	185%	5%	72%
TSL 2	86%	232%	6%	90%
TSL 3	92%	249%	7%	96%
TSL 4	117%	250%	8%	105%
TSL 5	122%	266%	8%	111%
TSL 6	1048%	289%	31%	427%

TABLE VI.4—IMPACTS OF CONVERSION COSTS ON A LARGE MANUFACTURER

	Capital conversion cost as a percentage of annual capital expenditures	Product conversion cost as a percentage of annual R&D expense	Total conversion cost as a percentage of annual revenue	Total conversion cost as a percentage of annual EBIT
TSL 1	3%	8%	0%	3%
TSL 2	4%	10%	0%	4%
TSL 3	4%	11%	0%	4%
TSL 4	5%	11%	0%	5%
TSL 5	5%	11%	0%	5%
TSL 6	45%	12%	1%	18%

Based on the results in Table VI.1 and Table VI.2, DOE understands that the potential conversions costs faced by small manufacturers may be proportionally greater than those faced by larger manufacturers. Small manufacturers have less engineering staff and lower R&D budgets. They also have lower capital expenditures annually. As a result, the conversion costs incurred by a small manufacturer would likely be a larger percentage of its annual capital expenditures, R&D expenses, revenue, and EBIT, than those for a large manufacturer.

3. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being adopted today.

4. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from the other TSLs DOE considered. Although TSLs lower than the proposed TSLs would be expected to reduce the impacts on small entities, DOE is required by EPCA to establish standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, and result in a significant conservation of energy. Thus, DOE rejected the lower TSLs.

In addition to the other TSLs being considered, the NOPR TSD includes a regulatory impact analysis in chapter 17. For residential furnace fans, this report discusses the following policy alternatives: (1) No standard, (2) consumer rebates, (3) consumer tax credits, (4) manufacturer tax credits, and (5) early replacement. DOE does not intend to consider these alternatives further because they are either not feasible to implement without authority and funding from Congress, or are expected to result in energy savings that are much smaller (ranging from less than 1 percent to less than 31 percent) than those that would be achieved by the considered energy conservation standards.

C. Review Under the Paperwork Reduction Act

Manufacturers of furnace fans, or their third party representatives, must certify to DOE that their products comply with any applicable energy conservation standard. In certifying compliance, manufacturers or their third-party representatives must test their equipment according to the DOE test procedure for furnace fans, including any amendments adopted for that test procedure. Manufacturers or their third-party representatives must then submit certification reports and compliance statements using DOE's electronic Web-based tool, the Compliance and Certification Management System (CCMS), regarding product characteristics and energy consumption information regarding basic models of furnace fans distributed in commerce in the U.S. CCMS uses product-specific templates that manufacturers are required to use when submitting certification data to DOE. See *http://www.regulations.doe.gov/ccms*.

The collection-of-information requirement for furnace fan certification is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been submitted to OMB for approval. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Note that the certification and recordkeeping requirements for certain consumer products in 10 CFR part 430 have previously been approved by OMB and assigned OMB control number 1910–1400; the certification requirement for furnace fans will be included in this collection once approved by OMB. DOE will notify the public of OMB approval through a **Federal Register** notice.

Public comment is sought regarding: whether this proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information shall have practical utility; the accuracy of the burden estimate; ways to enhance the quality, utility, and clarity of the information to be collected; and ways to minimize the burden of the collection of information, including through the use of automated collection techniques or other forms of information technology. Send comments on these or any other aspects of the collection of information to the DOE program official listed in the **ADDRESSES** section above, and email to *Chad_S._Whiteman@omb.eop.gov*.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that this rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR Part 1021, App. B, B5.1(b); 1021.410(b) and Appendix B, B(1)–(5). The rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this rule. DOE's CX determination for this rule is available at *http://cxnepa.energy.gov/*.

E. Review Under Executive Order 13132

Executive Order 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 final 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 today's 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) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that

Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a ‘‘significant intergovernmental mandate,’’ and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf*.

Although today's final rule, which adopts new energy conservation standards for residential furnace fans, does not contain a Federal intergovernmental mandate, it may require annual expenditures of $100 million or more by the private sector. Specifically, the final rule could require expenditures of $100 million or more, including: (1) Investment in research and development and in capital expenditures by residential furnace fans 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 residential furnace fans, 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 final rule and the ‘‘Regulatory Impact Analysis’’ section of the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. 2 U.S.C. 1535(a). DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(f) and (o), today's final rule establishes energy conservation standards for residential furnace fans that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the ‘‘Regulatory Impact Analysis’’ section 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 Executive Order 12630, ‘‘Governmental Actions and Interference with Constitutionally Protected Property Rights,’’ 53 FR 8859 (March 18, 1988), DOE has determined that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's 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

Executive Order 13211, ‘‘Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,’’ 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A ‘‘significant energy action’’ is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that today's regulatory action, which sets forth energy conservation standards for residential furnace fans, is not a significant energy action because the new 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 the 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.'' *Id.* at 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. 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. The ''Energy Conservation Standards Rulemaking Peer Review Report'' dated February 2007 has been disseminated and is available at the following Web site: *www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

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 is a ''major rule'' as defined by 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

10 CFR Part 429

Administrative practice and procedure, Commercial equipment, Confidential business information, Energy conservation, Household appliances, Imports, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Small businesses.

Issued in Washington, DC, on June 25, 2014.

David T. Danielson,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE amends parts 429 and 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

§ 429.12 [Amended]

■ 2. Section 429.12 is amended by:

■ a. Removing in paragraph (b)(13) ''429.54'' and adding in its place ''429.58'';

■ b. Removing in paragraph (d) table, first column, second row (*i.e.,* for products with a submission deadline of May 1st) the word ''and'' and adding ''and Residential furnace fans'' at the end of the listed products.

■ 3. Section 429.58 is amended by:

■ a. Adding in paragraph (a)(2) introductory text ''within the scope of appendix AA of subpart B of part 430'' after ''basic model of furnace fan''; and

■ b. Adding paragraph (b).

The addition reads as follows:

§ 429.58 Furnace fans.

* * * * *

(b) *Certification reports.* (1) The requirements of § 429.12 are applicable to residential furnace fans; and

(2) Pursuant to § 429.12(b)(13), a certification report shall include the following public product-specific information: The fan energy rating (FER) in watts per thousand cubic feet per minute (W/1000 cfm); the calculated maximum airflow at the reference system external static pressure (ESP) in cubic feet per minute (cfm); the control system configuration for achieving the heating and constant-circulation airflow-control settings required for determining FER as specified in the furnace fan test procedure (10 CFR part 430, subpart B, appendix AA); the measured steady-state gas, oil, or electric heat input rate (Q_{IN}) in the heating setting required for determining FER; and for modular blowers, the manufacturer and model number of the electric heat resistance kit with which it is equipped for certification testing.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 4. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 5. Section 430.2 is amended by adding definitions for ''small-duct high-velocity (SDHV) electric furnace'' and ''small-duct high-velocity (SDHV) modular blower'' in alphabetical order to read as follows:

§ 430.2 Definitions.

* * * * *

Small-duct high-velocity (SDHV) electric furnace means an electric furnace that:

(1) Is designed for, and produces, at least 1.2 inches of external static pressure when operated at the certified air volume rate of 220–350 CFM per rated ton of cooling in the highest default cooling airflow-control setting; and

(2) When applied in the field, uses high velocity room outlets generally greater than 1,000 fpm that have less than 6.0 square inches of free area.

Small-duct high-velocity (SDHV) modular blower means a modular blower that:

(1) Is designed for, and produces, at least 1.2 inches of external static pressure when operated at the certified air volume rate of 220–350 CFM per rated ton of cooling in the highest default cooling airflow-controls setting; and

(2) When applied in the field, uses high velocity room outlets generally greater than 1,000 fpm that have less than 6.0 square inches of free area.

* * * * *

■ 6. Section 430.32 is amended by adding paragraph (y) to read as follows:

§ 430.32 Energy and water conservation standards and their effective dates.

* * * * *

(y) *Residential furnace fans.* Residential furnace fans incorporated in the products listed in Table 1 of this paragraph and manufactured on and after July 3, 2019, shall have a fan energy rating (FER) value that meets or is less than the following values:

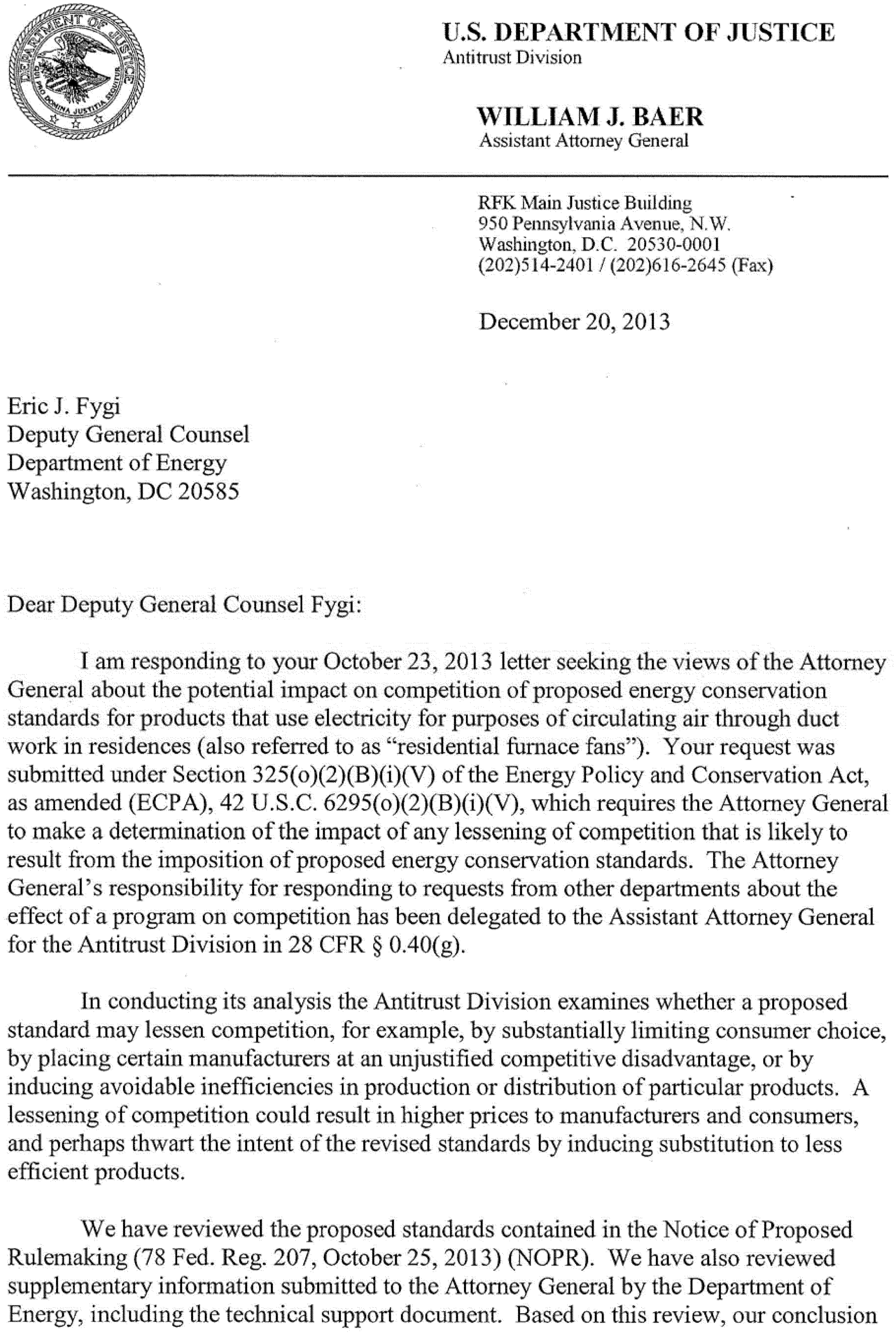
TABLE 1—ENERGY CONSERVATION STANDARDS FOR COVERED RESIDENTIAL FURNACE FANS*

Product class	FER ** (Watts/cfm)
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG–NC)	FER = $0.044 \times Q_{Max} + 182$
Non-Weatherized, Condensing Gas Furnace Fan (NWG–C)	FER = $0.044 \times Q_{Max} + 195$
Weatherized Non-Condensing Gas Furnace Fan (WG–NC)	FER = $0.044 \times Q_{Max} + 199$
Non-Weatherized, Non-Condensing Oil Furnace Fan (NWO–NC)	FER = $0.071 \times Q_{Max} + 382$
Non-Weatherized Electric Furnace/Modular Blower Fan (NWEF/NWMB)	FER = $0.044 \times Q_{Max} + 165$
Mobile Home Non-Weatherized, Non-Condensing Gas Furnace Fan (MH–NWG–NC)	FER = $0.071 \times Q_{Max} + 222$
Mobile Home Non-Weatherized, Condensing Gas Furnace Fan (MH–NWG–C)	FER = $0.071 \times Q_{Max} + 240$
Mobile Home Electric Furnace/Modular Blower Fan (MH–EF/MB)	FER = $0.044 \times Q_{Max} + 101$
Mobile Home Non-Weatherized Oil Furnace Fan (MH–NWO)	Reserved
Mobile Home Weatherized Gas Furnace Fan (MH–WG) **	Reserved

* Furnace fans incorporated into hydronic air handlers, SDHV modular blowers, SDHV electric furnaces, and CAC/HP indoor units are not subject to the standards listed in this table.

** Q_{Max} is the airflow, in cfm, at the maximum airflow-control setting measured using the final DOE test procedure at 10 CFR part 430, subpart B, appendix AA.

Note: The following will not appear in the Code of Federal Regulations.



U.S. DEPARTMENT OF JUSTICE
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December 20, 2013

Eric J. Fygi
Deputy General Counsel
Department of Energy
Washington, DC 20585

Dear Deputy General Counsel Fygi:

I am responding to your October 23, 2013 letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for products that use electricity for purposes of circulating air through duct work in residences (also referred to as "residential furnace fans"). Your request was submitted under Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (ECPA), 42 U.S.C. 6295(o)(2)(B)(i)(V), 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).

In conducting its analysis the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice, by placing certain manufacturers at an unjustified competitive disadvantage, or by inducing avoidable inefficiencies in production or distribution of particular products. A lessening of competition could result in higher prices to manufacturers and consumers, and perhaps thwart the intent of the revised standards by inducing substitution to less efficient products.

We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking (78 Fed. Reg. 207, October 25, 2013) (NOPR). We have also reviewed supplementary information submitted to the Attorney General by the Department of Energy, including the technical support document. Based on this review, our conclusion is that the proposed energy conservation standards for residential furnace fans are unlikely to have a significant adverse impact on competition.

Sincerely,

William J. Baer

Enclosure

[FR Doc. 2014–15387 Filed 7–2–14; 8:45 am]

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