DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2022–BT–STD–0002]

RIN 1904–AF40

Energy Conservation Program: Energy Conservation Standards for Fans and Blowers

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

ACTION: Notice of proposed rulemaking and announcement of public meeting.

SUMMARY: The Energy Policy and Conservation Act, as amended (''EPCA''), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including fans and blowers. EPCA also requires the U.S. Department of Energy (''DOE'') to periodically determine whether more stringent standards would be technologically feasible and economically justified and would result in significant energy savings. In this notice of proposed rulemaking (''NOPR''), DOE proposes energy conservation standards for two categories of fans and blowers: air circulating fans (''ACFs''), and fans and blowers that are not ACFs, referred to as general fans and blowers (''GFBs'') throughout this document. DOE also announces a public meeting to receive comment on these proposed standards and associated analyses and results.

DATES: *Comments:* DOE will accept comments, data, and information regarding this NOPR no later than March 19, 2024.

Meeting: DOE will hold a public meeting on Wednesday, February 21, 2024, from 10 a.m. to 4 p.m., in Washington, DC. This meeting will also be broadcast as a webinar.

Comments regarding the likely competitive impact of the proposed standard should be sent to the Department of Justice contact listed in the **ADDRESSES** section on or before February 20, 2024.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 6E–069, 1000 Independence Avenue SW, Washington, DC 20585. See section VII of this document, ''Public Participation,'' for further details, including procedures for attending the in-person meeting, webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2022–BT–STD–0002. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2022–BT–STD–0002, by any of the following methods:

Email: FansAndBlowers2022STD0002@ee.doe.gov. Include docket number EERE–2022–BT–STD–0002 in the subject line of the message.

No telefacsimiles (''faxes'') will be accepted. For detailed instructions on submitting comments and additional information on this process, see section VII of this document.

Docket: The docket for this activity, which includes **Federal Register** notices, comments, and other supporting documents/materials, is available for review at *www.regulations.gov.* All documents in the docket are listed in the *www.regulations.gov* index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

The docket web page can be found at *www.regulations.gov/docket/EERE–2022–BT–STD–0002.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. *See* section VII of this document for information on how to submit comments through *www.regulations.gov.*

EPCA requires the Attorney General to provide DOE a written determination of whether the proposed standard is likely to lessen competition. The U.S. Department of Justice Antitrust Division invites input from market participants and other interested persons with views on the likely competitive impact of the proposed standard. Interested persons may contact the Division at *energy.standards@usdoj.gov* on or before the date specified in the **DATES** section. Please indicate in the ''Subject'' line of your email the title and Docket Number of this proposed rulemaking.

FOR FURTHER INFORMATION CONTACT: Mr. Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–9870. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Amelia Whiting, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–2588. Email: *Amelia.Whiting@hq.doe.gov.*

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

SUPPLEMENTARY INFORMATION: DOE maintains previously approved incorporations by reference (AMCA 210–16, AMCA 214–21, and ISO 5801:2017) and incorporates by reference the following material into part 431:

IEC 61800–9–2:2023, *Adjustable speed electrical power drive systems (PDS)—Part 9–2: Ecodesign for motor systems—Energy efficiency determination and classification,* Edition 2.0, 2023–10.

IEC TS 60034–30–2:2016, *Rotating electrical machines—Part 30–2: Efficiency classes of variable speed AC motors (IE-code),* Edition 1.0, 2016–12.

IEC TS 60034–31:2021, *Rotating electrical machines—Part 31: Selection of energy-efficient motors including variable speed applications—Application guidelines,* Edition 2.0, 2021–03.

Copies of IEC 61800–9–2:2023, IEC TS 60034–30–2:2016 and IEC TS 60034–31:2021 are available from the International Electrotechnical Committee (IEC), Central Office, 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland; + 41 22 919 02 11; *webstore.iec.ch.*

For a further discussion of these standards, see section VI.M of this document.

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I. Synopsis of the Proposed Rule

The Energy Policy and Conservation Act, Public Law 94–163, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C[2] of EPCA established the Energy Conservation Program for Certain Industrial Equipment. (42 U.S.C. 6311–6317) Such equipment includes fans and blowers. This proposed rule concerns two categories of fans and blowers: air circulating fans (''ACFs''), and fans and blowers that are not ACFs, which are referred to as general fans and blowers (''GFBs'') throughout this document.

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6316(a); 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.

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[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

6316(a); 42 U.S.C. 6295(o)(3)(B)) EPCA also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6316(a); 42 U.S.C. 6295(m))

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of six trial standard levels (''TSLs'') for two categories of fans and blowers: GFBs and ACFs. The TSLs and their associated benefits and burdens are discussed in detail in sections V.A through V.C of this document. As discussed in section V.C, DOE has tentatively determined that TSL 4 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. The proposed standards, which are expressed in terms of a fan energy index (''FEI'') for GFBs, are shown in Table I–1 through Table I–3. The proposed standards, which are expressed in terms of efficacy in cubic feet per minute per watt (''CFM/W'') at maximum speed for ACFs, are shown in Table I–3. These proposed standards, if adopted, would apply to all GFBs listed in Table I–1 and Table I–2 and ACFs listed in Table I–3 manufactured in, or imported into, the United States starting on the date 5 years after the publication of the final rule for this rulemaking. For GFBs, DOE proposes that every duty point at which the basic model is offered for sale would need to meet the proposed energy conservation standards. (*See* section III.C.1 of this document).

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Table I-1 Proposed Energy Conservation Standards for GFBs

Equipment Class	**With or Without Motor Controller**	**Fan Energy Index (FEI)***
Axial Inline	Without	1.18 * A
Axial Panel	Without	1.48 * A
Axial Power Roof Ventilator	Without	0.85 * A
Centrifugal Housed	Without	1.31 * A
Centrifugal Unhoused	Without	1.35 * A
Centrifugal Inline	Without	1.28 * A
Radial Housed	Without	1.17 * A
Centrifugal Power Roof Ventilator - Exhaust	Without	1.00 * A
Centrifugal Power Roof Ventilator - Supply	Without	1.19 * A
Axial Inline	With	1.18 * A* B
Axial Panel	With	1.48 * A* B
Axial Power Roof Ventilator	With	0.85 * A* B
Centrifugal Housed	With	1.31 * A* B
Centrifugal Unhoused	With	1.35 * A* B
Centrifugal Inline	With	1.28 * A* B
Radial Housed	With	1.17 * A* B
Centrifugal Power Roof Ventilator - Exhaust	With	1.00 * A* B
Centrifugal Power Roof Ventilator - Supply	With	1.19 * A* B

*A is a constant representing an adjustment in FEI for motor hp, which can be found in Table I-2. B is a constant representing an adjustment in FEI for motor controllers, which can be found in Table I-2

Table I-2 Constants for GFB Proposed Energy Conservation Standards

Constant	Condition		Value
A	Motor hp < 100 hp		$A = 1.00$
	Motor hp ≥ 100 hp and ≤ 250 hp		$A = \frac{\eta_{mtr,2023act}}{\eta_{mtr,2014ref}}$
B	With Motor Controller	FEPact of < 20 kW (26.8 hp)	$B = \frac{FEP_{act}-Credit}{FEP_{act}}$; where: $Credit = 0.03 \times FEP_{act} + 0.08$ **[SI]** $Credit = 0.03 \times FEP_{act} + 0.08 \times 1.341$ **[IP]**
		FEPact of ≥ 20 kW (26.8 hp)	$B = 0.966$

$\eta_{mtr,2023}$ is the motor efficiency in accordance with table 8 at 10 CFR 431.25, $\eta_{mtr,2014}$ is the motor efficiency in accordance with table 5 at 10 CFR 431.25, which DOE is proposing to adopt into 10 CFR 431.175, and FEP_{act} is determined according to the DOE test procedure in appendix A to subpart J of part 431.

Table I-3 Proposed Energy Conservation Standards for ACFs

Equipment Class*	Efficacy at Maximum Speed (CFM/W)
Axial ACFs; 12 inches ≤ D < 36 inches	12.2
Axial ACFs; 36 inches ≤ D < 48 inches	17.3
Axial ACFs; 48 inches ≤ D	21.5
Housed Centrifugal ACFs	N/A

*D: Diameter in inches

N/A: Not applicable; DOE is not proposing to set a standard for this equipment class.

A. Benefits and Costs to Consumers

Table I–4 and Table I–5 present DOE's evaluation of the economic impacts of the proposed standards on consumers of GFBs and ACFs, as measured by the average life-cycle cost ("LCC") savings and the simple payback period ("PBP").[3] The average LCC savings are positive for all equipment classes, and the PBP is less than the average lifetime of the considered equipment, which is estimated to be 16.0 years for GFBs and 6.3 years for ACFs (see section IV.F.6 of this document).

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[3] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended standards (*see* section IV.E.9 of this document). The simple PBP, which is designed to compare specific efficiency levels, is also measured relative to the no-new-standards case (*see* section IV.C of this document).

Table I-4 Impacts of Proposed Energy Conservation Standards on Consumers of GFBs

Equipment Class	Average LCC Savings *2022$*	Simple Payback Period *Years*
Axial Inline	550	9.6
Axial Panel	1,702	1.7
Centrifugal Housed	2,423	0.6
Centrifugal Inline	955	6.1
Centrifugal Unhoused	1,170	1.2
Axial Power Roof Ventilator	945	7.0
Centrifugal Power Roof Ventilator - Exhaust	154	8.9
Centrifugal Power Roof Ventilator - Supply	973	1.7
Radial Housed	3,714	1.7

Table I-5 Impacts of Proposed Energy Conservation Standards on Consumers of ACFs

Equipment Class*	Average LCC Savings *2022$*	Simple Payback Period *Years*
Axial ACFs; 12 inches ≤ D < 36 inches	327	0.5
Axial ACFs; 36 inches ≤ D < 48 inches	478	0.2
Axial ACFs; 48 inches ≤ D	668	0.1
Housed Centrifugal ACFs	N/A	N/A

*D: diameter in inches

N/A: Not applicable; DOE is not proposing to set a standard for this equipment class.

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

B. Impact on Manufacturers

The industry net present value (''INPV'') is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2024–2059). Using a real discount rate of 11.4 percent, DOE estimates that the INPV for manufacturers of fans and blowers in the case without new standards is $649 million in 2022 dollars for ACFs and $4,935 million in 2022 dollars for GFBs. Under the proposed standards, the change in INPV is estimated to range from −10.9 percent to less than 0.1 percent for ACFs, which represents a change in INPV of approximately −$71 million to less than $0.1 million, and from −9.2 percent to less than 0.1 percent for GFBs, which represents a change in INPV of approximately −$455 million to $1 million. In order to bring products into compliance with new standards, it is estimated that the industry would incur total conversion costs of $118 million for ACFs and $770 million for GFBs.

DOE's analysis of the impacts of the proposed standards on manufacturers is described in section IV.J of this document. The analytic results of the manufacturer impact analysis (''MIA'') are presented in section V.B.2 of this document.

C. National Benefits and Costs[4]

This section presents the combined results for GFBs and ACFs. Specific results for GFBs and ACFs are also discussed in sections I.C.1 and I.C.2 of this document, respectively.

DOE's analyses indicate that the proposed energy conservation standards for GFBs and ACFs would save a significant amount of energy. Relative to the case without new standards, the lifetime energy savings for GFBs and ACFs purchased in the 30-year period that begins in the anticipated first full year of compliance with the new standards (2030–2059) amount to 18.3 quadrillion British thermal units (''Btu''), or quads.[5]

The cumulative net present value (''NPV'') of total consumer benefits of the proposed standards for GFBs and ACFs ranges from $19.0 billion (at a 7 percent discount rate) to $49.5 billion (at a 3 percent discount rate). This NPV expresses the estimated total value of future operating cost savings minus the estimated increased equipment and installation costs for GFBs and ACFs purchased in 2030–2059.

In addition, the proposed standards for GFBs and ACFs are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 317.9

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

[5] The quantity refers to full-fuel-cycle (''FFC'') energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, *see* section IV.G.1 of this document.

million metric tons (''Mt'')[6] of carbon dioxide (''CO_2''), 92.7 thousand tons of sulfur dioxide (''SO_2''), 598.9 thousand tons of nitrogen oxides (''NO_X''), 2,760.5 thousand tons of methane (''CH_4''), 2.9 thousand tons of nitrous oxide (''N_2O''), and 0.6 tons of mercury (''Hg'').[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases (''GHG'') using four different estimates of the social cost of CO_2 (''SC–CO_2''), the social cost of methane (''SC–CH_4''), and the social cost of nitrous oxide (''SC–N_2O''). Together these represent the social cost of GHG (''SC–GHG''). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (''IWG'').[8] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are estimated to be $16.3 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit per ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE did not monetize the reduction in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be $11.4 billion using a 7 percent discount rate, and $31.6 billion using a 3 percent discount rate.[9] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I–6 summarizes the monetized benefits and costs expected to result from the proposed standards for GFBs and ACFs. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

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[6] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.

[7] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2023 (''AEO2023''). AEO2023* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.J of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

[8] To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990,* published in February 2021 by the IWG (''February 2021 SC–GHG TSD''). *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.*

[9] DOE estimates the economic value of these emissions reductions resulting from the considered trial standards levels (''TSLs'') for the purpose of complying with the requirements of Executive Order 12866.

Table I-6 Present Value of Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs and ACFs (TSL 4)

	Billion $2022
3% discount rate	
Consumer Operating Cost Savings	55.8
Climate Benefits*	16.3
Health Benefits**	31.6
Total Monetized Benefits†	103.7
Consumer Incremental Equipment Costs‡	6.3
Net Monetized Benefits	97.4
Change in Producer Cashflow (INPV‡‡)	(0.5) - 0
7% discount rate	
Consumer Operating Cost Savings	22.2
Climate Benefits* (3% discount rate)	16.3
Health Benefits**	11.4
Total Monetized Benefits†	49.8
Consumer Incremental Equipment Costs‡	3.2
Net Monetized Benefits	46.6
Change in Producer Cashflow (INPV‡‡)	(0.5) - 0

Note: This table presents the costs and benefits associated with GFBs and ACFs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) (*see* section IV.L of this document). Together these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

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

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

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

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all

impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB & ACF, those values are -$526 million and $1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this proposed rule, the net benefits would range from $96.9 billion to $97.4 billion at 3-percent discount rate and would range from $46.1 billion to $46.6 billion at 7-percent discount rate. Parentheses indicate negative values.

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the monetized value of climate and health benefits of emission reductions, all annualized.[10]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of GFBs and ACFs shipped in 2030–2059. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of GFBs and ACFs shipped in 2030–2059. Total benefits for both the 3 percent and 7 percent cases are presented using the average GHG social costs with a 3-percent discount rate.[11] Estimates of total benefits are presented for all four SC–GHG discount rates in section V.B.6 of this document.

Table I–7 presents the total estimated monetized benefits and costs associated with the proposed standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7 percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3 percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $360 million per year in increased equipment costs, while the estimated annual benefits are $2,506 million in reduced equipment operating costs, $963 million in monetized climate benefits, and $1,285 million in monetized health benefits. In this case, the monetized net benefit would amount to $4,394 million per year.

Using a 3 percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $374 million per year in increased equipment costs, while the estimated annual benefits are $3,302 million in reduced operating costs, $963 million in monetized climate benefits, and $1,869 million in monetized health benefits. In this case, the monetized net benefit would amount to $5,760 million per year.

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[10] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2024, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2030), and then discounted the present value from each year to 2024. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

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

Table I-7 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs and ACFs (TSL 4)

	Million 2022$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	3,302	3,074	3,521
Climate Benefits*	963	926	1,002
Health Benefits**	1,869	1,796	1,945
Total Benefits†	6,134	5,796	6,469
Consumer Incremental Equipment Costs‡	374	478	276
Net Benefits	5,760	5,317	6,192
Change in Producer Cashflow (INPV‡‡)	(62) - 0	(62) - 0	(62) - 0
7% discount rate			
Consumer Operating Cost Savings	2,506	2,346	2,658
Climate Benefits* (3% discount rate)	963	926	1,002
Health Benefits**	1,285	1,240	1,330
Total Benefits†	4,754	4,513	4,991
Consumer Incremental Equipment Costs‡	360	441	280
Net Benefits	4,394	4,072	4,710
Change in Producer Cashflow (INPV‡‡)	(62) - 0	(62) - 0	(62) - 0

Note: This table presents the costs and benefits associated with GFBs and ACFs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a declining rate in the High Net Benefits Estimate for GFBs, and a low declining rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a high declining rate in the High Net Benefits Estimate for ACFs. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

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

† Total benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate, but DOE does not have a single central SC-GHG point estimate.

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

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB & ACF, those values are -$62 million and less than $0.1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $5,698 million to $5,760 million at 3-percent discount rate and would range from $4,332 million to $4,394 million at 7-percent discount rate. Parentheses indicate negative values.

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

1. General Fans and Blowers

DOE's analyses indicate that the proposed energy conservation standards for GFBs would save a significant amount of energy. Relative to the case without new standards, the lifetime energy savings for GFBs purchased in the 30-year period that begins in the anticipated first full year of compliance with the new standards (2030–2059) amount to 13.8 quadrillion British thermal units ("Btu"), or quads.[12] This represents a savings of 11.4 percent relative to the energy use of these products in the case without standards (referred to as the "no-new-standards case").

The cumulative net present value ("NPV") of total consumer benefits of the proposed standards for GFBs ranges from $13.7 billion (at a 7 percent discount rate) to $36.9 billion (at a 3 percent discount rate). This NPV expresses the estimated total value of future operating cost savings minus the estimated increased equipment and installation costs for GFBs purchased in 2030–2059.

In addition, the proposed standards for GFBs are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 239.4 Mt of CO_2, 73.1 thousand tons of SO_2, 450.9 thousand tons of NO_X, 2,073.9 thousand tons of CH_4, 2.3 thousand tons of N_2O, and 0.5 tons of Hg".[13]

DOE estimates the value of climate benefits from a reduction in greenhouse gases ("GHG") using four different estimates of the social cost of CO_2 ("SC–CO_2"), the social cost of methane ("SC–CH_4"), and the social cost of nitrous oxide ("SC–N_2O"). Together these represent the social cost of GHG ("SC–GHG"). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases ("IWG").[14] The derivation of these values is discussed in section IV.K of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are estimated to be $11.9 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit per ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE did not monetize the reduction in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be $8.2 billion using a 7 percent discount rate, and $23.4 billion

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[12] The quantity refers to full-fuel-cycle ("FFC") energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, *see* section IV.G.1 of this document.

[13] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in *AEO 2023. AEO2023* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.J of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

[14] To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990,* published in February 2021 by the IWG ("February 2021 SC–GHG TSD"). *www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.*

using a 3 percent discount rate.[15] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I–8 summarizes the monetized benefits and costs expected to result from the proposed standards for GFBs. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

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[15] DOE estimates the economic value of these emissions reductions resulting from the considered trial standards levels (''TSLs'') for the purpose of complying with the requirements of Executive Order 12866.

Table I-8 Present Value of Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs (TSL 4)

	Billion $2022
3% discount rate	
Consumer Operating Cost Savings	42.7
Climate Benefits*	11.9
Health Benefits**	23.4
Total Monetized Benefits†	78.0
Consumer Incremental Equipment Costs‡	5.7
Net Monetized Benefits	72.2
Change in Producer Cashflow (INPV‡‡)	(0.5) – 0.0
7% discount rate	
Consumer Operating Cost Savings	16.6
Climate Benefits* (3% discount rate)	11.9
Health Benefits**	8.2
Total Monetized Benefits†	36.8
Consumer Incremental Equipment Costs‡	2.9
Net Monetized Benefits	33.8
Change in Producer Cashflow (INPV‡‡)	(0.5) – 0.0

Note: This table presents the costs and benefits associated with GFBs shipped in 2030–2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030–2059.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC-CO$_2$), methane (SC-CH$_4$), and nitrous oxide (SC-N$_2$O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) (*see* section IV.L of this document). Together these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

** Health benefits are calculated using benefit-per-ton values for NO$_X$ and SO$_2$. DOE is currently only monetizing (for SO$_2$ and NO$_X$) PM$_{2.5}$ precursor health benefits and (for NO$_X$) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct PM$_{2.5}$ emissions. *See* section IV.L_of this document for more details.

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

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

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the

manufacturer to manufacture the GFB and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For GFB, those values are -$455 million and $1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this proposed rule, the net benefits would range from $71.7 billion to $72.2 billion at 3-percent discount rate and would range from $33.3 billion to $33.8 billion at 7-percent discount rate. Parentheses indicate negative values.

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the monetized value of climate and health benefits of emission reductions, all annualized.[16]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of GFBs shipped in 2030–2059. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of GFBs shipped in 2030–2059. Total benefits for both the 3 percent and 7 percent cases are presented using the average GHG social costs with a 3-percent discount rate.[17] Estimates of total benefits are presented for all four SC–GHG discount rates in section V.B.6 of this document.

Table I–9 presents the total estimated monetized benefits and costs associated with the proposed standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7 percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3 percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $329 million per year in increased equipment costs, while the estimated annual benefits are $1,880 million in reduced equipment operating costs, $703 million in monetized climate benefits, and $932 million in monetized health benefits. In this case, the monetized net benefit would amount to $3,185 million per year.

Using a 3 percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $340 million per year in increased equipment costs, while the estimated annual benefits are $2,524 million in reduced operating costs, $703 million in monetized climate benefits, and $1,384 million in monetized health benefits. In this case, the monetized net benefit would amount to $4,271 million per year.

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[16] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2024, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2030), and then discounted the present value from each year to 2024. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

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

Table I-9 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs (TSL 4)

	Million 2022$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	2,524	2,321	2,724
Climate Benefits*	703	666	742
Health Benefits**	1,384	1,311	1,461
Total Benefits†	4,611	4,297	4,927
Consumer Incremental Equipment Costs‡	340	442	243
Net Benefits	4,271	3,855	4,684
Change in Producer Cashflow (INPV‡‡)	(53) - 0	(53) - 0	(53) - 0
7% discount rate			
Consumer Operating Cost Savings	1,880	1,739	2,017
Climate Benefits* (3% discount rate)	703	666	742
Health Benefits**	932	888	978
Total Benefits†	3,515	3,293	3,736
Consumer Incremental Equipment Costs‡	329	409	251
Net Benefits	3,185	2,884	3,486
Change in Producer Cashflow (INPV‡‡)	(53) - 0	(53) - 0	(53) - 0

Note: This table presents the costs and benefits associated with GFBs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a declining rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

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

† Total benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate, but DOE does not have a single central SC-GHG point estimate.
‡ Costs include incremental equipment costs as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB, those values are -$53 million and less than $0.1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $4,218 million to $4,271 million at 3-percent discount rate and would range from $3,132 million to $3,185 million at 7-percent discount rate. Parentheses indicate negative values.

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

2. Air Circulating Fans

DOE's analyses indicate that the proposed energy conservation standards for ACFs would save a significant amount of energy. Relative to the case without new standards, the lifetime energy savings for ACFs purchased in the 30-year period that begins in the anticipated first full year of compliance with the new standards (2030–2059) amount to 4.5 quadrillion British thermal units (''Btu''), or quads.[18] This represents a savings of 37.3 percent relative to the energy use of these products in the case without standards (referred to as the ''no-new-standards case'').

The cumulative net present value (''NPV'') of total consumer benefits of the proposed standards for ACFs ranges from $5.3 billion (at a 7 percent discount rate) to $12.6 billion (at a 3 percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment costs for ACFs purchased in 2030–2059.

In addition, the proposed standards for ACFs are projected to yield significant environmental benefits. DOE estimates that the proposed standards would result in cumulative emission reductions (over the same period as for energy savings) of 78.5 Mt[19] of CO_2, 19.7 thousand tons of SO_2, 148.0 thousand tons of NO_X, 686.7 thousand tons of CH_4, 0.6 thousand tons of N_2O, and 0.1 tons of mercury Hg.[20]

DOE estimates the value of climate benefits from a reduction in greenhouse gases (GHG) using four different estimates of the social cost of CO_2 (''SC–CO_2''), the social cost of methane (''SC–CH_4''), and the social cost of nitrous oxide (''SC–N_2O''). Together these represent the social cost of GHG (SC–GHG). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).[21] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3 percent discount rate are estimated to be $4.4 billion. DOE does not have a single central SC–GHG point estimate and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit per ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE did not monetize the reduction in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be $3.1 billion using a 7-percent discount rate, and $8.2 billion using a 3-percent discount rate.[22] DOE

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[18] The quantity refers to full-fuel-cycle (''FFC'') energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.2 of this document.

[19] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.

[20] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in *AEO2023. AEO2023* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.K of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

[21] To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive order 13990,* published in February 2021 by the IWG.

[22] DOE estimates the economic value of these emissions reductions resulting from the considered

is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I–10 summarizes the monetized benefits and costs expected to result from the proposed standards for ACFs. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

TSLs for the purpose of complying with the requirements of Executive Order 12866.

Table I-10 Present Value of Monetized Benefits and Costs of Proposed Energy Conservation Standards for ACFs (TSL 4)

	Billion $2022
3% discount rate	
Consumer Operating Cost Savings	13.2
Climate Benefits*	4.4
Health Benefits**	8.2
Total Monetized Benefits†	25.8
Consumer Incremental Equipment Costs‡	0.6
Net Monetized Benefits	25.2
Change in Producer Cashflow (INPV††)	(0.1) - 0
7% discount rate	
Consumer Operating Cost Savings	5.5
Climate Benefits* (3% discount rate)	4.4
Health Benefits**	3.1
Total Monetized Benefits†	13.1
Consumer Incremental Equipment Costs‡	0.3
Net Monetized Benefits	12.8
Change in Producer Cashflow (INPV††)	(0.1) - 0

Note: This table presents the costs and benefits associated with ACFs shipped in 2030– 2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030–2059.

* Climate benefits are calculated using four different estimates of the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) (*see* section IV.L of this document). Together these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

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

† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate.

‡ Costs include incremental equipment costs.

†† Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the

manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For ACF, those values are -$71 million and no change in INPV. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this proposed rule, the net benefits would range from $25.1 billion to $25.2 billion at 3-percent discount rate and would range from $12.7 billion to $12.8 billion at 7-percent discount rate. Parentheses indicate negative values.

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the monetized value of climate and health benefits of emission reductions, all annualized.[23]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of GFBs shipped in 2030–2059. The benefits associated with reduced emissions achieved as a result of the proposed standards are also calculated based on the lifetime of GFBs shipped in 2030–2059. Total benefits for both the 3 percent and 7 percent cases are presented using the average GHG social costs with 3 percent discount rate.[24] Estimates of total benefits are presented for all four SC–GHG discount rates in section V.B.6 of this document.

Table I–11 presents the total estimated monetized benefits and costs associated with the proposed standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $31 million per year in increased equipment costs, while the estimated annual benefits are $626 million in reduced equipment operating costs, $261 million in monetized climate benefits, and $353 million in monetized health benefits. In this case. The net monetized benefit would amount to $1,209 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $34 million per year in increased equipment costs, while the estimated annual benefits are $778 million in reduced operating costs, $261 million in monetized climate benefits, and $485 million in monetized health benefits. In this case, the monetized net benefit would amount to $1,489 million per year.

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[23] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2022, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2030), and then discounted the present value from each year to 2022. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

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

Table I-11 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for ACFs (TSL 4)

	Million 2022$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
	3% discount rate		
Consumer Operating Cost Savings	778	753	796
Climate Benefits*	261	261	261
Health Benefits**	485	485	485
Total Benefits†	1,523	1,498	1,542
Consumer Incremental Equipment Costs‡	34	36	33
Net Benefits	1,489	1,462	1,509
Change in Producer Cashflow (INPV‡‡)	(8) - 0	(8) - 0	(8) - 0
	7% discount rate		
Consumer Operating Cost Savings	626	607	641
Climate Benefits* (3% discount rate)	261	261	261
Health Benefits**	353	353	353
Total Benefits†	1,239	1,221	1,254
Consumer Incremental Equipment Costs‡	31	32	30
Net Benefits	1,209	1,188	1,225
Change in Producer Cashflow (INPV‡‡)	(8) - 0	(8) - 0	(8) - 0

Note: This table presents the costs and benefits associated with ACFs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a low declining rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a high declining rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

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

† Total benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate.

‡ Costs include incremental equipment costs.

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For ACF, those values are -$8 million and no annualized change in INPV. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $1,481 million to $1,489 million at 3-percent discount rate and would range from $1,201 million to $1,209 million at 7-percent discount rate. Parentheses indicate negative values.

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

D. Conclusion

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

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for GFBs is $329 million per year in increased GFB costs, while the estimated annual benefits are $1,880 million in reduced GFB operating costs, $703 million in monetized climate benefits and $932 million in monetized health benefits. The net monetized benefit amounts to $3,185 million per year. DOE notes that the net benefits are substantial even in the absence of the climate benefits,[25] and DOE would adopt the same standards in the absence of such benefits.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for ACFs is $31 million per year in increased ACF costs, while the estimated annual benefits are $626 million in reduced ACF operating costs, $261 million in monetized climate benefits and $353 million in monetized health benefits. The net monetized benefit amounts to $1,209 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[26] For example, some covered products and equipment have substantial energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the proposed standards are projected to result in estimated national energy savings of 13.8 quad FFC for GFBs and 4.5 quads FFC for ACFs, the equivalent of the primary annual energy use of 148 and 48 million homes, respectively. In addition, they are projected to reduce CO_2 emissions by 239.4 Mt and 78.5 Mt, for GFBs and ACFs, respectively. Based on these findings, DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these tentative conclusions is contained in the remainder of this document and the NOPR TSD.

DOE also considered more-stringent energy efficiency levels as potential standards, and is still considering them in this rulemaking. However, DOE has tentatively concluded that the potential burdens of the more stringent energy

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

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

efficiency levels would outweigh the projected benefits.

Based on consideration of the public comments DOE receives in response to this document and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy efficiency levels presented in this document that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

The following section briefly discusses the statutory authority underlying this proposed rule, as well as some of the relevant historical background related to the establishment of standards for fans and blowers.

A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency.

EPCA specifies a list of equipment that constitutes covered equipment (hereafter referred to as ''covered equipment'').[27] EPCA also provides that ''covered equipment'' includes any other type of industrial equipment for which the Secretary of Energy (''the Secretary'') determines inclusion is necessary to carry out the purpose of Part A–1. (42 U.S.C. 6311(1)(L); 42 U.S.C. 6312(b)) EPCA specifies the types of industrial equipment that can be classified as covered in addition to the equipment enumerated in 42 U.S.C. 6311(1). This industrial equipment includes fans and blowers, the subjects of this document. (42 U.S.C. 6311(2)(B)(ii) and (iii)) Additionally, industrial equipment must be of a type that consumes, or is designed to consume, energy in operation; is distributed in commerce for industrial or commercial use; and is not a covered product as defined in 42 U.S.C. 6291(a)(2) other than a component of a covered product with respect to which there is in effect a determination under 42 U.S.C. 6312(c). (42 U.S.C. 6311(2)(A)) On August 19, 2021, DOE published a final determination concluding that the inclusion of fans and blowers as covered equipment was necessary to carry out the purpose of Part A–1 and classifying fans and blowers as covered equipment. 86 FR 46579, 46588.

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316; 42 U.S.C. 6296).

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) There are currently no Federal energy conservation standards for fans and blowers. However, as noted in the Existing Efficiency Standards subsection of section IV.C.1.b of this document, the California Energy Commission (''CEC'') has finalized a rulemaking that requires manufacturers to report fan operating boundaries that result in operation at a FEI of greater than or equal to 1.00 for all fans within the scope of that rulemaking.[28] The scope of the CEC rulemaking includes some, but not all, GFBs that are considered in the scope of this energy conservation rulemaking. The CEC rulemaking goes into effect on November 1, 2023. However, if the Federal standards in this NOPR are finalized and made effective, they will supersede the CEC standard requirements. The CEC standards with respect to fans and blowers covered by a standard set in a final rule would be superseded once the Federal standard takes effect, meaning on the compliance date applicable to GFBs, which is expected to be 5 years after the publication of any final rule. 42 U.S.C. 6316(a)(10).

Furthermore, EPCA prescribes that all representations of energy efficiency and energy use, including those made on marketing materials and product labels, for certain equipment, including fans and blowers, must be made in accordance with an amended test procedure, beginning 180 days after publication of the final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1)) DOE notes that Federal test procedures generally supersede any State regulation insofar as such State regulation provides for the disclosure of information with respect to any measure of energy consumption or water use of any covered product (42 U.S.C 6297(a)(1)) The Federal test procedure for fans and blowers was published on May 1, 2023, and all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with this test procedure beginning October 30, 2023. 88 FR 27312. Therefore, DOE notes that any disclosure of information regarding any measure of energy consumption for fans required by the CEC must be tested in accordance with the Federal test procedure beginning October 30, 2023.

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 EPCA. (*See* 42 U.S.C. 6316(a) (applying the preemption waiver provisions of 42 U.S.C. 6297).)

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered equipment. (42 U.S.C. 6295(o)(3)(A) and 42 U.S.C. 6295I) Manufacturers of covered equipment must use the Federal test procedures as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)), and (2) making representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)) The DOE test procedures for fans and blowers appear at title 10 of the Code of Federal Regulations (''CFR'') part 431, subpart J, appendices A and B.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including fans and blowers. Any new or

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[27] ''Covered equipment'' means one of the following types of industrial equipment: electric motors and pumps; small commercial package air conditioning and heating equipment; large commercial package air conditioning and heating equipment; very large commercial package air conditioning and heating equipment; commercial refrigerators, freezers, and refrigerator-freezers; automatic commercial ice makers; walk-in coolers and walk-in freezers; commercial clothes washers; packaged terminal air-conditioners and packaged terminal heat pumps; warm air furnaces and packaged boilers; and storage water heaters, instantaneous water heaters, and unfired hot water storage tanks. (42 U.S.C. 6311(1)(A)–(K))

[28] California Energy Commission. Commercial and Industrial Fans and Blowers. Docket No. 22–AAER–01. Available at *efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=22-AAER-01.*

amended standard for covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6316(a); (42 U.S.C. 6295(o)(3))

Moreover, DOE may not prescribe a standard: (1) for certain equipment, including fans and blowers, if no test procedure has been established for the equipment, or (2) if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

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

(2) The savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered equipment 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 equipment 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing equipment complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(iii))

EPCA also contains what is known as an ''anti-backsliding'' provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of covered equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered equipment 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. 6316(a); 42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for covered equipment that has two or more subcategories. DOE must specify a different standard level for a type or class of equipment that has the same function or intended use, if DOE determines that equipment within such group: (A) consume a different kind of energy from that consumed by other covered equipment within such type (or class); or (B) have a capacity or other performance-related feature which other equipment within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of equipment, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. *Id.* Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)(2))

B. Background

1. Current Standards

DOE does not currently have energy conservation standards for fans and blowers. The following section summarizes relevant background information regarding DOE's consideration of energy conservation standards for fans and blowers.

On May 10, 2021, DOE published a request for information requesting comments on a potential fan or blower definition. 86 FR 24752. DOE followed this with a publication of a final determination on August 19, 2021, classifying fans and blowers as covered equipment (''August 2021 Final Coverage Determination''). 86 FR 46579. At this time, DOE determined that the term ''blower'' is used interchangeably in the U.S. market with the term ''fan.'' 86 FR 46579, 46583. DOE defines a fan (or blower) as a rotary bladed machine used to convert electrical or mechanical power to air power, with an energy output limited to 25 kilojoule (''kJ'') per kilogram (''kg'') of air. It consists of an impeller, a shaft and bearings and/or driver to support the impeller, as well as a structure or housing. A fan (or blower) may include a transmission, driver, and/or motor controller. 10 CFR 431.172.

2. History of Standards Rulemaking for Fans and Blowers

In considering whether to establish standards, on June 28, 2011 DOE published a notice of proposed determination of coverage to initiate an energy conservation standards rulemaking for fans, blowers, and fume hoods. 76 FR 37678. Subsequently, DOE published a notice of public meeting and availability of the Framework document for GFBs in the **Federal Register**. 78 FR 7306 (February 1, 2013). In the Framework document (''2013 Framework Document''), DOE requested feedback from interested parties on many issues, including the engineering analysis, the MIA, the LCC and PBP analyses, and the national impact analysis (''NIA'').

On December 10, 2014, DOE published a notice of data availability (''December 2014 NODA'') that estimated the potential economic impacts and energy savings that could result from promulgating energy conservation standards for fans. 79 FR 73246. The December 2014 NODA analysis used FEI, a ''wire-to-air'' fan electrical input power metric, to characterize fan performance.

In October 2014, several representatives of fan manufacturers and energy efficiency advocates[29] (''Joint Stakeholders'') presented DOE with an alternative metric approach, the ''Fan Efficiency Ratio,'' which included a fan efficiency-only metric approach (''FER_H'') and a wire-to-air metric approach (''FER_W'').[30] On May 1, 2015,

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[29] The Air Movement and Control Association (AMCA), New York Blower Company, Natural Resources Defense Council (NRDC), the Appliance Standards Awareness Project (ASAP), and the Northwest Energy Efficiency Alliance (NEEA).

[30] Supporting documents from this meeting, including presentation slides are available at

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based on the additional information received and comments to the December 2014 NODA, DOE published a second NODA (''May 2015 NODA'') that announced data availability from DOE analyses conducted using a modified FEI metric, similar to the FER_W metric presented by the Joint Stakeholders. 80 FR 24841, 24843.

Concurrent with these efforts, DOE established an Appliance Standards Rulemaking Federal Advisory Committee (''ASRAC'') Working Group (''Working Group'') to discuss negotiated energy conservation standards and test procedures for fans.[31]

The Working Group concluded its negotiations on September 3, 2015, and, by consensus vote,[32] approved a term sheet containing 27 recommendations related to scope, test procedure, and energy conservation standards (''term sheet''). (*See* Docket No. EERE–2013–BT–STD–0006, No. 179.) ASRAC approved the term sheet on September 24, 2015. (Docket No. EERE–2013–BT–NOC–0005; Public Meeting Transcript, No. 58, at p. 29)

On November 1, 2016, DOE published a third notification of data availability (''November 2016 NODA'') that presented a revised analysis for GFBs consistent with the scope and metric recommendations in the term sheet. 81 FR 75742, 75743. As recommended by the working group, the November 2016 NODA used the fan electrical input power metric (FEP)[33] in conjunction with FEI to characterize fan performance. DOE made several additional updates to the November 2016 NODA to address the term sheet recommendations developed by the Working Group as well as stakeholder feedback submitted via public comment. Specifically, the analysis presented in the November 2016 NODA was updated to include (1) augmentation of the Air Movement and Control Association International (''AMCA'') sales data used in the May 2015 NODA to better account for fans made by companies that incorporate those fans for sale in their own equipment, (2) augmentation of the AMCA sales data to represent additional sales of forward-curved fans, and (3) inclusion of original equipment manufacturer (''OEM'') conversion costs. *Id.* The November 2016 NODA evaluated only fans with a fan shaft input power equal to, or greater than, 1 horsepower (''hp'') and a fan airpower equal to or less than 150 hp. 81 FR 75742, 75746.

On October 1, 2021, DOE published a request for information pertaining to test procedures for fans and blowers (''October 2021 TP RFI''). 86 FR 54412. As part of the October 2021 TP RFI, DOE discussed definitions and potential scope for ACFs. 86 FR 54412, 54414–54415. DOE published a separate request for information on February 8, 2022 (''February 2022 RFI''), to seek input to aid in its development of the technical and economic analyses regarding whether standards for ACFs may be warranted. 87 FR 7048. On October 13, 2022, DOE published a notice of data availability (''October 2022 NODA'') to present its preliminary engineering analysis for ACFs and to seek input to support DOE in completing a notice of proposed rulemaking analysis for all fans and blowers. 87 FR 62038.

DOE received comments in response to the October 2022 NODA from the interested parties listed in Table II–1.

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www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0029.

[31] Information on the ASRAC, the commercial and industrial fans Working Group, and meeting dates is available at: *energy.gov/eere/buildings/appliance-standards-and-rulemaking-federal-advisory-committee.*

[32] At the beginning of the negotiated rulemaking process, the Working Group defined that before any vote could occur, the Working Group must establish a quorum of at least 20 of the 25 members and defined consensus as an agreement with less than 4 negative votes. Twenty voting members of the Working Group were present for this vote. Two members (Air-Conditioning, Heating, and Refrigeration Institute and Ingersoll Rand/Trane) voted no on the term sheet.

[33] The FEP metric represents the electrical input power of the fan and includes the performance of the motor, and any transmission and/or control if integrated, assembled, or packaged with the fan. In the November 2016 NODA, DOE developed standards based on FEI values evaluated relative to the EL 3 standard FEP.

Table II-1 October 2022 NODA Written Comments

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
Association of Home Appliance Manufacturers	AHAM	123	Trade Association
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	130	Trade Association
Air Movement and Control Association International	AMCA	132	Trade Association
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, National Consumer Law Center, Natural Resources Defense Council	Efficiency Advocates	126	Efficiency Organizations
Ava Rohleder*	Rohleder	13	Individual
Brandon Damas, P.E. and Jeff Boldt, P.E.	Damas and Boldt	131	Individuals
California Investor-Owned Utilities: Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison	CA IOUs	127	Utilities
Ethan Dwyer*	Dwyer	119	Individual
Greenheck Group	Greenheck	122	Manufacturer
Madison Indoor Air Quality	MIAQ	124	Manufacturer
Morrison Products Inc.	Morrison	128	Manufacturer
National Electrical Manufacturers Association	NEMA	125	Trade Association
Northwest Energy Efficiency Alliance	NEEA	129	Efficiency Organization

* DOE reviewed the comments from Rohleder, who supports adopting energy conservation standards for ACFs. However, Rohleder's comments otherwise do not provide information or feedback that could be used for this NOPR analysis and instead encouraged DOE to conduct ASRAC negotiations. Similarly, DOE reviewed the comments from Dwyer and determined that Dwyer's comments summarize the October 2022 NODA and otherwise generally note their support of DOE regulating fans and blowers, are out of scope of this rulemaking, or do not provide concrete recommendations that DOE could use in the development of this NOPR analysis. Therefore, comments from these stakeholders are not summarized in the document.

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DOE also acknowledges that it received numerous identical comments via a mass email campaign stating that standards for fans and blowers is an important issue and requesting that DOE pursue an approach that is fair and equitable to both businesses and consumers. [34]

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[35]

C. Deviation From Process Rule

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''Process Rule''), DOE notes that it is deviating from the provision in the Process Rule regarding the pre-NOPR and NOPR stages for an energy conservation standards rulemaking.

1. Framework Document

Section 6(a)(2) of the Process Rule states that if DOE determines it is appropriate to proceed with a rulemaking, the preliminary stages of a rulemaking to issue or amend an energy conservation standard that DOE will undertake will be a framework document and preliminary analysis, or an advance notice of proposed rulemaking.

As described in section II.B.2 of this document, DOE published the 2013 Framework Document, the December 2014 NODA, the May 2015 NODA, and the November 2016 NODA for GFBs. 78 FR 7306; 79 FR 73246; 80 FR 24841; 81 FR 75742. The three NODAs presented DOE's analysis at various points, provided stakeholders opportunity to review and provide comment. Furthermore, while DOE published the February 2022 RFI and October 2022 NODA for ACFs, DOE did not publish a framework document in conjunction with the NODA for ACFs. 87 FR 62038. DOE notes that ACFs and GFBs are analyzed separately, however, the general analytical framework that DOE uses in evaluating and developing potential new energy conservation standards for both GFBs and ACFs is similar. As such, publication of a separate framework document for ACFs would be largely redundant of previously published documents.

2. Public Comment Period

Section 6(f)(2) of the Process Rule specifies that the length of the public comment period for a NOPR will be not less than 75 calendar days. For this NOPR, DOE is instead providing a 60-day comment period, consistent with EPCA requirements. 42 U.S.C. 6316(a); 42 U.S.C. 6295(p). DOE is opting to deviate from the 75-day comment period because of the robust opportunities already afforded to stakeholders to provide comments on this proposed rulemaking.

DOE is providing a 60-day comment period, which DOE believes is appropriate given the substantial stakeholder engagement for general fans and blowers to date, as discussed in section II.B.2 of this document. Furthermore, the request for information on air circulating fans that was published on February 8, 2022, provided early notice to interested parties that DOE was interested in evaluating potential energy conservation standards for air circulating fans. DOE also provided a 45-day comment period for the notice of data availability that was published on October 13, 2022. Therefore, DOE believes a 60-day comment period is appropriate and will provide interested parties with a meaningful opportunity to comment on the proposed rule.

III. General Discussion

DOE developed this proposal after considering oral and written comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters.

A. General Comments

This section summarizes general comments received from interested parties in response to the October 2022 NODA regarding rulemaking timing, process, and impact.

In response to many of DOE's requests for comment, AMCA recommended that DOE obtain the requested information through confidential interviews with fan manufacturers. (AMCA, No. 132 at pp. 6–14) DOE notes that it used information collected during manufacturer interviews to inform its engineering, market, and manufacturer analyses.

NEMA commented that its interpretation of DOE's analysis in the October 2022 NODA was that DOE was proposing energy efficiency requirements for motors that are used in ACFs, which would be confusing and problematic for the motor industry, since there is a separate rulemaking for motors. (NEMA, No. 125 at pp. 2, 4). Additionally, NEMA stated that DOE's inclusion of higher efficiency small, non-''small electric motor'' electric motors (''SNEMs'') as a technology option for increasing the efficiency of ACFs could be an issue because of an ongoing rulemaking for SNEMs. (NEMA, No. 125 at p. 2) DOE notes that in a NOPR for expanded scope electric motors (''ESEMs'') published on December 15, 2023 (''December 2023 ESEM NOPR''), motors that were previously referred to as SNEMs were redefined to be ESEMs. 88 FR 87062 DOE will use the term ''ESEM'' throughout the remainder of this document to refer to these motors. Morrison commented that it is concerned about the small motors rulemaking being in progress at the same time as this fans and blowers rulemaking. (Morrison, No. 128 at p. 1)

DOE notes that it is proposing energy conservation standards for fans and blowers, including ACFs and GFBs, and that it is not proposing energy conservation standards for motors in this rulemaking. DOE typically defines a likely design path to structure its engineering analysis; however, DOE notes that this design path is not prescriptive. DOE heard from ACF manufacturers that replacing a less efficient motor with a more efficient motor would be one of the first options they would evaluate. Therefore, DOE considered more efficient motors as an option that a manufacturer might apply to reach a given ACF efficiency level. DOE acknowledges that the electric motors rulemaking involving ESEMs is ongoing (*see* EERE–2020–BT–STD–0007) and that stakeholders made a joint recommendation for the efficiencies at which they believe the standards for ESEMs should be set. (Docket No. EERE–2020–BT–STD–0007, Joint Stakeholders, No. 38 at p. 6, Table 2) As discussed in section IV.C.2.c, DOE defined an efficiency level (EL 2) in its ACF engineering analysis based on the efficiencies recommended for ESEMs by the Joint Stakeholders. DOE may consider adjusting the baseline efficiency level for ACFs if it sets a standard in the ESEM rulemaking at the recommended ESEM levels.

AMCA commented that it generally supports NEMA's comments. (AMCA, No. 132 at pp. 2, 21) DOE therefore notes that throughout this document, reference to comments made by NEMA are understood to be representative of the viewpoints of AMCA as well.

Greenheck stated that it would be beneficial for the ACF rulemaking to be delayed until after AMCA 230–2023 is

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[34] Comment numbers 14–118 in the docket (Docket No. EERE–2022–BT–STD–0002, maintained at *www.regulations.gov*).

[35] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for fans and blowers. (Docket No. EERE–2022–BT–STD–0002, maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

published. (Greenheck, No. 122 at p. 1) AMCA commented that DOE should finalize a test procedure before proceeding with its fans and blowers energy conservation standards rulemaking so that stakeholders can make informed comments on the energy conservation standards rulemaking. (AMCA, No. 132 at p. 10) DOE notes that ACMA 230–23 was published on February 10, 2023, and that DOE has since published its test procedure final rule for fans and blowers, on May 1, 2023. 88 FR 27312.

MIAQ commented that it disagrees with DOE's decision to provide a 45-day comment period instead of the usual 75-day comment period for the October 2022 NODA. (MIAQ, No. 124 at p. 2) In the October 2022 NODA, DOE discussed its decision to deviate from section 3(a) of appendix A to subpart C of 10 CFR part 430 and reduce the comment period. 87 FR 62038, 62039. DOE provided a 45-day comment period given the substantial stakeholder engagement prior to the publication of the NODA and to provide DOE with ample time to review comments to inform this NOPR analysis. *Id.*

The CA IOUs commented that they are concerned that the energy conservation standards may supersede the fan input power limits currently in place for building codes, such as the California Building Energy Code (Title 24), American Society of Heating, Refrigerating, and Air-Conditioning Engineers (''ASHRAE'') Standard 90.1, ''Energy Standard for Buildings Except Low-Rise Residential Buildings,'' and the International Energy Conservation Code (''IECC'') 2021, which would reduce the influence of these building codes and ultimately result in an increase in the energy consumption of the equipment in which fans are embedded because the fan power limits in those codes are significantly more stringent than the FEI requirements and ensure the overall fan system in a building is designed efficiently. (CA IOUs, No. 127 at p. 6) Damas and Boldt also expressed their concern that energy conservation standards may preempt the limits on fan system power in building energy codes such as ASHRAE 90.1 and therefore could potentially increase energy use in new construction. (Damas and Boldt, No. 131 at p. 5) AHRI commented that an energy conservation standard is not needed for fans because all States are obligated to comply with ASHRAE 90.1. (AHRI, No. 130 at pp. 16–17)

DOE notes that neither ASHRAE 90.1 nor IECC 2021 are federally mandated standards. Although ASHRAE 90.1 and IECC 2021 may be incorporated into municipal and/or building codes, this is not required and is performed on a State and local level. Furthermore, their incorporation does not always mandate standard efficiency requirements. DOE also acknowledges that as stated in section II.A, Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) Therefore, if energy conservation standards for fans and blowers were to be adopted, they would supersede State laws and regulations for the efficiency of individual fans and blowers at the product or equipment level. DOE considered the fan efficiency requirements in ASHRAE 90.1 and IECC 2021 in its analysis, as discussed in section IV.C.1.b of this document. With regard to CA IOUs concern that DOE's regulation would supersede current regulations for fan input power limits, DOE notes that the standards proposed in this NOPR apply only to individual fans, whether embedded or standalone, that are within the proposed scope of this rulemaking. DOE is not proposing minimum input power requirements for fan systems that may be incorporated into buildings. Therefore, although the individual fans used in fan systems would be required to comply with DOE's minimum FEI requirements if the fan is within the proposed scope of this rulemaking, DOE's proposed regulations would not supersede input power requirements for fan systems.

B. Scope of Coverage

This NOPR covers those commercial and industrial equipment that meet the definition of ''fan'' or ''blower,'' as codified at 10 CFR 431.172 and for which DOE has finalized test procedures in subpart J of 10 CFR part 431.

As discussed, DOE defines a ''fan'' or ''blower'' as a rotary bladed machine used to convert electrical or mechanical power to air power, with an energy output limited to 25 kJ/kg of air. It consists of an impeller, a shaft and bearings and/or driver to support the impeller, as well as a structure or housing. A fan or blower may include a transmission, driver, and/or motor controller. 10 CFR 431.172. DOE separates fans and blowers into general fans and blowers and air circulating fans.

An ''air circulating fan'' means a fan that has no provision for connection to ducting or separation of the fan inlet from its outlet using a pressure boundary, operates against zero external static pressure loss, and is not a jet fan. 10 CFR 431.172. Fans and blowers that are not ACFs are referred to as general fans and blowers (''GFBs'') throughout this document.

In response to the October 2022 NODA, DOE received comments on the fans considered within the scope of its analysis.

Greenheck, AMCA, and Morrison commented that ACFs should be considered in a separate rule from GFBs since ACFs and GFBs are utilized in different applications and use different industry test procedures (*i.e.,* AMCA 230 for ACFs and AMCA 214 for GFBs). (Greenheck, No. 122 at p. 1; AMCA, No. 132 at pp. 1, 20–21; Morrison, No. 128 at p. 2)

DOE acknowledges that ACFs and GFBs have separate utilities and test procedures. In the test procedure final rule that was published on May 1, 2023 (''May 2023 TP Final Rule''), DOE adopted separate test procedures for GFBs and ACFs (*see* appendix A and appendix B, respectively, to subpart J of 10 CFR part 431). 88 FR 27312. Similarly, in this NOPR, separate analyses were conducted for ACFs and GFBs to account for the difference in test procedures, metrics, and utility. DOE is proposing separate standards for GFBs and ACFs, expressed in different metrics, as discussed in later sections.

1. General Fans and Blowers

In the May 2023 TP Final Rule, DOE established the scope of the test procedure. 88 FR 27312. In this NOPR, DOE is proposing energy conservation standards for GFBs consistent with the scope of coverage defined in the May 2023 TP Final Rule.

Specifically, in this NOPR, DOE proposes energy conservation standards for the following GFB categories, as defined in the DOE test procedure: (1) axial inline fan; (2) axial panel fan; (3) centrifugal housed fan; (4) centrifugal unhoused fan; (5) centrifugal inline fan; (6) radial housed fan; and (7) power roof/wall ventilator (''PRV''). Furthermore, consistent with the DOE test procedure, DOE proposes that the scope of this energy conservation standards rulemaking for GFBs would apply to fans with duty points with a fan shaft input power equal to or greater than 1 hp and a fan static or total air power equal to or less than 150 hp.

Additionally, DOE did not evaluate or consider potential energy conservation standards for GFBs that were not included in the scope of its test procedure. *See* 10 CFR 431.174. DOE notes that its test procedure excludes fans that create a vacuum of 30 inches water gauge or greater. 10 CFR

431.174(a)(2)(vii) In this NOPR, DOE proposes to further clarify that this provision excludes fans that are manufactured and marketed exclusively to create a vacuum of 30 inches water gauge or greater.

DOE requests comment on its proposed clarification for fans that create a vacuum. Specifically, DOE requests comment on whether fans that are manufactured and marketed exclusively to create a vacuum of 30 inches water gauge or greater could also be used in positive pressure applications. Additionally, DOE requests information on the applications in which a fan not manufactured or marketed exclusively for creating a vacuum would be used to create a vacuum of 30 inches water gauge or greater.

Consistent with the test procedure, DOE has excluded certain embedded fans, listed in Table III–1, from its analysis. *See* the May 2023 TP Final Rule for a detailed discussion of these exclusions. 88 FR 27312, 27322–27331.

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Table III-1 Embedded Fans Proposed for Exclusion from the Scope of the Energy Conservation Standards Rulemaking

Fans embedded in:
Direct-expansion dedicated outdoor air systems (“DX-DOASes”) subject to any DOE test procedures in appendix B to subpart F of part 431
Single-phase central air conditioners and heat pumps rated with a certified cooling capacity less than 65,000 British thermal units per hour (“Btu/h”), that are subject to DOE’s energy conservation standard at 10 CFR 430.32(e)
Three-phase, air-cooled, small commercial packaged air-conditioning and heating equipment rated with a certified cooling capacity less than 65,000 Btu/h, that are subject to DOE’s energy conservation standard at 10 CFR 431.97(b)
Transport refrigeration (*i.e.*, Trailer refrigeration, Self-powered truck refrigeration, Vehicle-powered truck refrigeration, Marine/Rail container refrigerant), and fans exclusively powered by combustion engines
Vacuum cleaners
Heat Rejection Equipment: • Packaged evaporative open circuit cooling towers • Evaporative field-erected open circuit cooling towers • Packaged evaporative closed-circuit cooling towers • Evaporative field-erected closed-circuit cooling towers • Packaged evaporative condensers • Field-erected evaporative condensers • Packaged air-cooled (dry) coolers • Field-erected air-cooled (dry) coolers • Air-cooled steam condensers • Hybrid (water saving) versions of all of the previously listed equipment that contain both evaporative and air-cooled heat exchange sections
Air curtains
*Air-cooled commercial package air conditioners and heat pumps (CUAC, CUHP) with a certified cooling capacity between 5.5 tons (65,000 Btu/h) and 63.5 tons (760,000 Btu/h) that are subject to DOE’s energy conservation standard at 10 CFR 431.97(b)
*Water-cooled and evaporatively cooled commercial air conditioners and water-source commercial heat pumps that are subject to DOE’s energy conservation standard at 10 CFR 431.97(b)
*Single package vertical air conditioners and heat pumps that are subject to DOE’s energy conservation standard at 10 CFR 431.97(d)
*Packaged terminal air conditioners (PTAC) and packaged terminal heat pumps (PTHP) that are subject to DOE’s energy conservation standard at 10 CFR 431.97(e)
*Computer room air conditioners that are subject to DOE’s energy conservation standard at 10 CFR 431.97(e)
*Variable refrigerant flow multi-split air conditioners and heat pumps that are subject to DOE’s energy conservation standard at 10 CFR 431.97(f)

* The exclusion only applies to supply and condenser fans embedded in this equipment.

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In response to the October 2022 NODA, DOE received comments regarding the scope of the energy conservation standards for GFBs.

AHAM agreed with DOE’s proposal to only cover GFBs that were rated at 1 hp or higher because it effectively excluded most fans used in consumer product applications. (AHAM, No. 123 at p. 5) AHRI commented that regulating GFBs with an input power of less than 1 hp would include residential fans. (AHRI, No. 130 at p. 3) Morrison expressed concern with the minimum power limit for GFBs being 0.1 hp instead of 1 hp since most GFBs with input powers less than 1 hp are not commercial or industrial. (Morrison, No. 128 at p. 1). DOE interprets Morrison's reference to a 0.1 hp limit to be a reference to the 0.1 hp representative unit for ACFs in the October 2022 NODA. DOE notes that a minimum power limit of 0.1 hp for GFBs was not proposed in the October 2022 NODA. As discussed, GFBs with an input power of less than 1 hp are excluded from the scope of this rulemaking, which is consistent with the scope of coverage in the DOE test procedure. *See* 10 CFR 431.174(a)(4)(i).

In response to both the October 2022 NODA and the July 2022 TP NOPR, AHRI and Morrison commented that they were concerned about how energy conservation standards would apply to replacement fans. (Morrison, No. 128 at p. 2; AHRI, No. 130 at pp. 2, 5, 12) Morrison and AHRI stated that replacement fans should be exempt from the standards rulemaking because a fan with the same specific performance and safety devices needs to be used for replacement in order to achieve the same system performance and to comply with safety requirements. *Id.* DOE notes that the comments from AHRI and Morrison submitted in response to the October 2022 NODA are identical in content to the comments submitted from these and other stakeholders to the July 2022 NOPR. These comments are fully summarized in the May 2023 TP Final Rule. 88 FR 27312, 27334.

CA IOUs stated that consumers seeking to replace low-pressure fans in constrained spaces may not be able to find replacement fans that meet a higher FEI. Since a more efficient fan may require a larger diameter, it might not fit in the constrained space. Therefore, either the constrained space will need to be enlarged to fit the larger fan (which is likely to be costly for the consumer) or the consumer would select a replacement fan of the same size but with higher pressure (resulting in more power use to achieve the same airflow). (CA IOUs, No. 127 at p. 6) CA IOUs therefore proposed a narrow exception for [non-embedded] centrifugal fans with a rated pressure not greater than 1.5 inches water gauge. (CA IOUs, No. 127 at p. 7)

Consistent with DOE's response to these comments in the April 2023 Final Rule, DOE is proposing to exclude certain embedded fans from potential energy conservation standards in this rulemaking, whether sold for incorporation into the equipment or already incorporated in the equipment, if embedded in equipment listed in Table III–1. This approach would exclude replacement fans for the equipment listed in Table III–1. For equipment not listed in Table III–1, DOE notes that it is not excluding replacement fans from the scope of the rulemaking, consistent with the scope of the DOE test procedure. In its analysis, which is discussed in further detail in section IV.C.1 of this document, DOE evaluated improved efficiency options while maintaining constant diameter and duty point (*i.e.,* air flow and operating pressures remained constant as efficiency increased); therefore, DOE has tentatively concluded that a compliant fan of the same size and performance would be available for use as an embedded fan or replacement for an embedded fan. Additionally, DOE does not expect that manufacturers of equipment that contain embedded fans would need to redesign their equipment. Furthermore, DOE is not excluding centrifugal fans based on its rated pressure. In its analysis, DOE specifically examined centrifugal housed fans designed at both lower- and higher-pressure duty points. Based on that analysis, DOE did not find a significant difference in the achievable FEI values between the higher- and lower-pressure duty points. Accordingly, DOE has tentatively determined that centrifugal housed fans do not require an exclusion based on rated pressure. Additional details on DOE's analysis are presented in chapter 3 of the accompanying TSD.

DOE also received multiple comments from stakeholders about fans that should be excluded from the scope of the rulemaking; these comments were similar to the comments received in response to the July 2022 TP NOPR. Morrison and AHRI commented that they are concerned over double regulation of products. (Morrison, No. 128 at pp. 2–3; AHRI, No. 130 at p. 2) AHRI commented that fans embedded in boilers and commercial water heaters should be excluded. (AHRI, No. 130 at pp. 10–11) DOE notes that these comments were summarized and responded to in the May 2023 TP Final Rule. 88 FR 27312, 27329–27330. Additionally, AHRI commented that the regulation of fans within air-cooled water chillers would not improve the efficiency of the entire equipment, nor would it lead to net energy savings because ASHRAE 90.1 already sets efficiency standards for the equipment and the entire system is designed to meet the ASHRAE 90.1 efficiency standards. (AHRI, No. 130 at pp. 9–10) MIAQ commented that energy conservation standards for embedded fans would not necessarily improve the performance of the products in which the fans are embedded if the products are already regulated. (MIAQ, No. 124 at p. 4)

As previously discussed, DOE is exempting fans embedded in the equipment listed in Table III–1, consistent with the DOE test procedure, and continues to exclude fans in covered equipment in which the fan energy use is already captured in the equipment-specific test procedures. Furthermore, as discussed in section III.A of this document, ASHRAE 90.1 is not a federally mandated standard, though it may be adopted by State and local governments, and therefore DOE is not specifically exempting fans that are in equipment that are regulated by IECC and ASHRAE 90.1.

More details regarding the scope of GFBs that are included in this NOPR can be found in the May 2023 TP Final Rule. 88 FR 27312, 27317–27336.

2. Air Circulating Fans

In the October 2022 NODA, DOE stated that it was considering all air circulating fans in its analysis of potential energy conservation standards for fans and blowers, including unhoused air circulating fan heads and housed air circulating fan heads. 87 FR 62038, 62041. DOE received comments from stakeholders in response to the scope discussion in the October 2022 NODA.

AHAM commented there is a lack of clarity about which products are included and excluded in DOE's proposed scope and that DOE was improperly expanding the scope of products included in the fans and blowers category by including residential products. AHAM stated that it did not believe that the metric, technology options, assumptions, and test procedure discussed in the October 2022 NODA are relevant to residential fans. (AHAM, No. 123 at pp. 1–2) Specifically, AHAM commented that the proposed test procedure from the July 2022 TP NOPR and AMCA 214–21 are not applicable to residential fans and that no energy conservation standards should be set for residential fans until a test procedure for residential fans is established. (AHAM, No. 123 at pp. 5, 9) AHAM, Greenheck, and AMCA also commented that ACFs with an input power less than 125 W should be excluded from scope to coincide with the scope limit in AMCA 230–23 and IEC 60879. (AHAM, No. 123

at pp. 5–6; Greenheck, No. 122 at p. 2; AMCA, No. 132 at pp. 1–2, 19–20) AHAM noted that this would effectively differentiate between residential and consumer products, so long as the 125 W threshold applies to the fan rating alone and not to the entire product or the fan and motor. (AHAM, No. 123 at p. 5) DOE notes that ACFs are tested in a configuration that measures electrical input power to the fan, inclusive of the motor, and that the existing test procedures (*i.e.,* AMCA 230–23 or IEC 60879:2019) do not allow measuring the mechanical shaft power to the fan, exclusive of the motor. Therefore, DOE has determined that a limit in terms of electrical input power (applicable to the fan and motor) is more appropriate. DOE notes that AHAM submitted additional comments recommending exclusion of residential fans and fans embedded in residential products that were also submitted in response to the July 2022 TP NOPR. (AHAM, No. 123 at pp. 2–5) DOE addressed those comments in the May 2023 TP Final Rule. 88 FR 27312, 27326. In the May 2023 TP Final Rule, DOE established the scope of the test procedure for ACFs and excluded ACFs with an input power of less than 125 W at maximum speed. 88 FR 27312, 27331. In this NOPR, DOE is proposing energy conservation standards for ACFs consistent with the scope of coverage defined in the May 2023 TP Final Rule. (*see* 10 CFR 431.174(b)). Therefore, DOE proposes that ACFs with an input power of less than 125 W at maximum speed are excluded from the scope of this standards rulemaking. DOE is aware, however, that ACFs with an input power less than 125 W at maximum speed could be distributed in commerce for industrial and commercial use, and that ACFs with an input power greater than 125 W at maximum speed could be distributed in commerce for residential use. However, any equipment that meets the definition of air circulating fan, has an input power greater than or equal to 125 W at maximum speed, as measured by the test procedure at high speed, and is of a type that is not a covered consumer product and is, to any significant extent, distributed in commerce for industrial or commercial purposes would be subject to these proposed energy conservation standards, regardless of whether it is sold for use in commercial, industrial, or residential settings.

AHAM commented that the terminology used in the October 2022 NODA for fan head diameter, rather than fan blade diameter, is inconsistent with how residential ACFs are typically analyzed. (AHAM, No. 123 at p. 8) DOE notes that while it works to use terminology that is consistent with industry terminology, it is not always possible given the size and maturity of test standards development in a given industry. DOE clarifies that its usage of the term ''fan head diameter'' in the October 2022 NODA was intended to be analogous to ''fan blade diameter.'' Additionally, DOE notes that it is proposing a definition for ''diameter'' for fans and blowers that is consistent with the term ''fan blade diameter'' in this NOPR, which is discussed in section IV.A.1.b of this document.

AHAM also commented that it did not believe that DOE has enough data on residential fans to analyze them. AHAM stated that DOE's analysis in the October 2022 NODA had an ACF with a 24-inch (''in.'') blade and a 0.5 hp motor, which is not representative of residential ACFs. (AHAM, No. 123 at p. 8) DOE notes that in the October 2022 NODA, it analyzed ACFs at multiple representative sizes and motor horsepowers, including a 12 in. diameter, 0.1 motor hp unit; a 20 in. diameter, 0.33 motor hp unit; a 24 in. diameter, 0.5 motor hp unit; a 36 in. diameter, 0.5 motor hp unit; and 50 in. diameter, 1 motor hp unit. 87 FR 62038, 62046. DOE had determined that these diameters and motor horsepowers were representative of the full scope of ACFs considered in the October 2022 NODA. *Id.*

AHAM stated that the size of motors that are typically used in residential ACFs are excluded from the scope of the ongoing electric motors rulemaking; therefore, residential ACFs should be excluded from this rulemaking since DOE would not see potential savings. (AHAM, No. 123 at p. 9) DOE notes that this is a rulemaking for fans and blowers. For ACFs, DOE considers higher-efficiency motors as a design option as well as other design options but emphasizes that the approach that DOE uses to evaluate potential efficiency standards is not prescriptive (*see* section IV.A.3 of this document). Furthermore, DOE considers both potential economic and energy savings in its analysis, which is discussed in section IV.G of this document.

Additionally, AHAM commented that it was their understanding that the proposed definitions for ACFs in the July 2022 TP NOPR did not include bladeless fans and agreed with the exclusion of bladeless ACFs from scope. (AHAM, No. 123 at p. 5) The definition of air circulating fan, ''a fan that has no provision for connection to ducting or separation of the fan inlet from its outlet using a pressure boundary, operates against zero external static pressure loss, and is not a jet fan,'' does not exclude bladeless fans. *See* 10 CFR 431.172. However, as discussed above, ACFs with input powers less than 125 W at maximum speed are excluded from the scope of this rulemaking. Therefore, bladeless fans, which have input power less than 125 W are excluded from the scope of this NOPR.

NEMA expressed concern that the July 2022 TP NOPR proposed only including fans with a shaft input power between 1 hp and 150 hp, but that the October 2022 NODA proposed including fans with a shaft input power of less than 1 hp. (NEMA, No. 125 at p. 2). DOE notes that, as specified in the test procedure, the 1 hp and 150 hp limits are applicable to GFBs, and that GFBs with an input power of less than 1 hp are excluded from scope. *See* 10 CFR 431.174(a)(4)(i). Additionally, DOE clarifies that the 150-hp limit applies to the fan air power. 10 CFR 431.174(a)(4)(ii) DOE notes that the ACF scope evaluated in this NOPR is consistent with the scope DOE adopted in the May 2023 TP Final Rule, which excludes ACFs with an input power of less than 125 W. 88 FR 27312, 27333.

a. Ceiling Fan Distinction

DOE explained in the coverage determination that fans and blowers, the subjects of this rulemaking, do not include ceiling fans, as defined at 10 CFR 430.2. See 86 FR 46579, 46586 and 10 CFR 431.171. Therefore, as stated in the May 2023 TP Final Rule, equipment that meets the definition of a ceiling fan would be excluded from the scope of equipment included under ''fan and blower''. 88 FR 27312, 27365. A ceiling fan means a nonportable device that is suspended from a ceiling for circulating air via the rotation of fan blades. 10 CFR 430.2. In the ceiling fan test procedure final rule published on August 16, 2022, DOE finalized an amendment to the ceiling fan definition at 10 CFR 430.2 to specify that a ceiling fan provides ''circulating air,'' which means ''the discharge of air in an upward or downward direction. A ceiling fan that has a ratio of fan blade span (in inches) to maximum rotation rate (in revolutions per minute) greater than 0.06 provides circulating air.'' 87 FR 50396, 50402. Specifically, the 0.06 in/RPM ratio was added in the ceiling fans definition to distinguish fans with directional airflow from circulating airflow. *Id.*

DOE also finalized a definition for ''high-speed belt-driven ceiling fan'' (''HSBD'') and added language to clarify that high-speed belt-driven ceiling fans were to be subject to the AMCA 230–15 test procedure and subject to a similar efficiency metric as large-diameter ceiling fans (namely the ceiling fan energy index ''CFEI''). *Id.* at 87 FR 50424, 50426, 50431.

In the May 2023 TP Final Rule, DOE established the definitions of ACF and related terms. DOE defined the term air circulating fan as ''a fan that has no provision for connection to ducting or separation of the fan inlet from its outlet using a pressure boundary, operates against zero external static pressure loss, and is not a jet fan''. In addition, DOE defined an unhoused circulating fan as ''an air circulating fan without housing, having an axial impeller with a ratio of fan blade span (in inches) to maximum rate of rotation (in revolutions per minute) less than or equal to 0.06. The impeller may or may not be guarded.'' 88 FR 27312, 27389–27390. DOE relied on the blade span to maximum rpm ratio to distinguish these ACFs from ceiling fans. 87 FR 44194, 44216. For housed ACFs however, DOE defined a housed ACF as an air circulating fan with an axial or centrifugal impeller, and a housing. 88 FR 27312, 27390. This definition aligns with the housed ACF definition in AMCA 230–23 and does not specify a diameter to speed ratio limit because housed ACFs can have blade span to maximum rpm ratios that are in the same range as ceiling fans (*i.e.,* greater than 0.06).

In the Ceiling Fan ECS NOPR published on June 22, 2023, DOE noted that that a ceiling fan must be ''distributed in commerce with components that enable it to be suspended from a ceiling.'' 88 FR 40932, 40943. Belt-driven fans are often distributed in commerce without components that enable the fan to be suspended from a ceiling. For example, some belt-driven fans are sold connected to wheels or to a pedestal base. In this case, such a fan would not meet the definition of a ceiling fan because it has not been manufactured to be suspended from the ceiling, and therefore would not be subject to the HSBD test procedure or any potential energy conservation standards for HSBDs even though a consumer could independently purchase their own straps or chains and elect to hang this fan from the ceiling. 88 FR 40932, 40943.

DOE stated that HSBD ceiling fans, in contrast to belt-driven fans connected to wheel or a pedestal base, are distributed in commerce with specific straps, chains, or other similar components that are designed and tested by the manufacturer to safely support the weight of the ceiling fan in an overhead configuration. Further, they circulate air since they meet the 0.06 blade span to maximum rpm ratio. 88 FR 40932, 40943.

Many belt-driven fans are housed (*i.e.,* the fan blades are contained within a cylindrical enclosure, often with solid metal sides and a cage on the front and back). However, the presence of a housing is not relevant in determining whether a product meets the definition of ceiling fan. While a housing is generally included to better direct air, a housing could be added to a ceiling fan, including those that are clearly intended to circulate air. As such, DOE emphasizes that the definition of a ceiling fan requires that fan to be ''suspended from a ceiling'' and to ''circulate air'', rather than the presence or absence of a fan housing. 88 FR 40932, 40943.

In response to the June 2023 Ceiling Fan ECS NOPR (88 FR 40932), CA IOUs commented that CFEI is not intended for small-diameter ceiling fans.[36] (CA IOUs, No. EERE–2021–BT–STD–0011–0049 at p. 3). All HSBD ceiling fans identified by DOE would be small-diameter ceiling fans. Therefore, DOE interprets CA IOU's comment to mean that the CFEI metric is not intended for HSBD ceiling fans. VES also pointed out in response to the September 2019 Ceiling Fan TP NOPR (84 FR 51440) that they sell shrouded fans that currently are not subject to ceiling fan energy conservation standards because they are belt-driven. VES added that if they transition to a direct-drive motor they would be subject to high-speed small-diameter ceiling fan standards, which are not appropriate as the airflow of their products is significantly higher than high-speed small-diameter ceiling fans given the intended directional application. (VES, No. EERE–2013–BT–TP–0050–0026 at pp. 1–2)

DOE notes that VES did not make a statement as to whether or not the 0.06 blade span to rpm ratio would appropriately distinguish between their circulating fans and traditional ceiling fans. However, as the air circulating fan definitions have pointed out, the 0.06 blade span to rpm ratio is most appropriate for distinguishing between unhoused air circulating fans. Housed air circulating fans may exceed the 0.06 blade span to rpm ratio and commonly do, despite the fact that they are typically thought of in industry as air circulating fans and not ceiling fans, even if they are ceiling mounted.

Based on the interpretation of the ceiling fan definition in the June 2023 Ceiling Fan ECS NOPR, an identical fan product could switch between being regulated as a high-speed belt-driven ceiling fan and a housed air circulating fan based only on if the equipment is sold with straps or chains for mounting overhead. Similarly, an identical direct drive fan product could switch between being regulated as a high-speed small-diameter ceiling fan and a housed air circulating fan based only on the if the product is sold with straps or chains for mounting overhead. Further complicating the analysis is the fact that high-speed belt-driven ceiling fans, air circulating fans and high-speed small-diameter ceiling fans are subject to different test procedures and different efficiency standards. DOE believes this confusion necessitates further refinement.

To avoid this confusion, DOE is reinterpreting the scope of the ceiling fan definition based on the potential overlap of products with housed air circulating fans. As DOE noted in the September 2019 Ceiling Fan TP NOPR, the intent of the ceiling fan definition is to be limited to ''nonportable'' devices that ''circulate air''. 84 FR 51440, 51444. Specifically, to clarify the distinction between air circulating fans and ceiling fans, DOE is interpreting the elements of the ceiling fan definition in the following way:

- Portable—means: (1) that a fan is offered for mounting on surfaces other than or in addition to the ceiling; and (2) that a consumer can vary the location of the product/equipment throughout the product/equipment lifetime. A ceiling fan is only mounted to the ceiling and is not intended to be installed in any other mounting configuration or change location after it's been installed. This is in contrast to housed air circulating fans sold with straps and chains, where the products are intended to be regularly modified to direct air in different directions or move airflow around different obstacles or in different areas. DOE also notes that once a ceiling fan is mounted to the ceiling, it is often hard-wired in place;
- Not for the purpose of circulating air—While DOE has traditionally emphasized the 0.06 fan blade span to maximum rotation rate ratio as the distinction between circulating air and direction airflow, DOE notes that the definition of ''circulating air'' in the ceiling fan definition is provided in contrast to directional airflow. DOE is interpreting the presence of a housing as evidence of airflow that is intended to be directional. In addition, DOE is interpreting the ability for the consumer

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[36] According to the DOE test procedure for ceiling fans at appendix U to subpart B of 10 CFR part 430, a small diameter ceiling fan means ''a ceiling fan that has a represented value of blade span, as determined in 10 CFR 429.32(a)(3)(i), less than or equal to seven feet.''

to easily modify the direction of the airflow via mounting by ceiling mounted chains, straps or via a ceiling bracket wherein the fan is able to be pointed in different directions as evidence that the fan is providing directional airflow.[37]

Based on the interpretation, the scope of the ceiling fan definition would be limited to only traditional ceiling fan products that are connected to the ceiling via a downrod, flush mounting, or similar, non-portable device. All other portable ceiling mounted fans that provide directional airflow would be regulated under the air circulating fan regulation. While the June 2023 Ceiling Fan ECS NOPR included proposed efficiency standards for high-speed belt-driven ceiling fans, under the proposed interpretation of the ceiling fan definition, all high-speed belt-driven ceiling fan products identified by DOE would not be within the scope of the ceiling fan definition and would instead meet the definition of housed air-circulating fans. Further, any direct-drive ceiling-mounted fan that is portable and provides directional airflow (*i.e.,* with a housing) would meet the housed air circulating fan definition and be subject to the air circulating fan test procedure and standards. In line with this interpretation of the ceiling fan definition, all housed air-circulating fans have been included within this NOPR analysis regardless of whether they are sold with a straps or chains to hang them from the ceiling or with wheels or other mounting configurations.

C. Test Procedure and Metric

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314(a)) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product.

As previously discussed, DOE published its test procedure final rule on May 1, 2023, which established separate uniform test procedures for GFBs and ACFs. 88 FR 27312. The test procedure for GFBs is based on American National Standards Institute (''ANSI'')/AMCA Standard 214–21 ''Test Procedure for Calculating Fan Energy Index (FEI) for Commercial and Industrial Fans and Blowers'' (''AMCA 214–21'') with some modification and prescribes test methods for measuring the fan electrical input power and determining the FEI of GFBs. The test procedure for ACFs is based on ANSI/AMCA Standard 230–23 ''Laboratory Methods of Testing Air Circulating Fans for Rating and Certification'' (''AMCA 230–23'') with some modification and prescribes test methods for measuring the fan airflow in cubic feet per minute per watt (''CFM/W'') of electric input power to an ACF. (*See* 10 CFR part 431, subpart J, appendices A and B, respectively.) 88 FR 27312, 27315.

In response to the October 2022 NODA, AHAM commented that the test procedure proposed in the July 2022 TP NOPR was inconsistent with agreements made in the 2015 ASRAC negotiations, which diminishes the value of participating in ASRAC negotiations. (AHAM, No. 123 at pp. 10–11) DOE notes that the context of this comment is the same as an AHAM comment submitted by AHAM to the July 2022 TP NOPR that DOE summarized and responded to in the May 2023 TP Final Rule. 88 FR 27312, 27377.

1. General Fans and Blowers

a. General

DOE is proposing energy conservation standards for GFBs in terms of FEI, which is calculated in accordance with the DOE test procedure. *See* 10 CFR part 431, subpart J, appendix A. In accordance with the DOE test procedure, the FEI metric would be evaluated at each duty point as specified by the manufacturer and, if adopted, DOE proposes that each duty point at which the fan is offered for sale would need to meet the proposed energy conservation standards.

FEI provides for evaluation of the efficiency of a GFB across a range of operating conditions, captures the performance of the motor, transmission, or motor controllers (if any), and allows for the differentiation of fans with motors, transmissions, and motor controllers with differing efficiency levels. FEI is a wire-to-air metric, which means that it considers the efficiency from the input power to the output power of a fan, including the efficiencies of the motor, motor controller (if included), transmission, and fan itself. The inclusion of all of these components encourages the improvement of motor, motor controller, and transmission efficiencies, in addition to the improvement of a fan's aerodynamic efficiency. In addition, FEI aligns with the industry test standard (AMCA 214–21) and can help drive better fan selections by making it easier to compare performance of different fans. AMCA 214–21 defines FEI as the ratio of the electrical input power (''FEP'') of a reference fan to the FEP of the fan for which the FEI is calculated, both established at the same duty point. The DOE test procedure provides methods to calculate both FEP and FEI of a fan at a given duty point.

In response to the October 2022 NODA, DOE received comment on the metric used for GFBs. Morrison and AHRI commented that they disagreed with using the weighted FEI (''WFEI'') metric that was discussed in the July 2022 TP NOPR. (Morrison, No. 128 at pp. 1, 3; AHRI, No. 130 at p. 2–3). DOE notes that these comments are similar to the comments submitted to the July 2022 TP NOPR that DOE summarized in the May 2023 TP Final Rule. MIAQ commented in support of using FEI as the metric used for regulation and disagreed with the use of WFEI because it has not been evaluated by fan manufacturers or their customers (MIAQ, No. 124 at p. 2). In the May 2023 TP Final Rule, DOE responded to similar comments and ultimately defined FEI as the metric for general fans and blowers. 88 FR 27312, 27367–27369.

Morrison commented that the FEI metric aligned well with the agreements made in the ASRAC Term Sheet and that FEI is now being used by numerous standards as the metric for efficiency. (Morrison, No. 128 at pp. 2–3) DOE interprets Morrison's comment as support for using the FEI metric.

Morrison commented that variable-frequency drive (''VFD'') control provides a good method to dynamically achieve part-load operation to promote energy savings. Morrison stated that since the FEP calculation metric penalizes the use of VFDs, DOE should consider providing an equivalent bonus factor, at a minimum, to gain back the losses in the calculation. Morrison commented that operating at part load saves significantly more energy than any other efficiency change. (Morrison, No. 128 at p. 3) As discussed in the May 2023 TP Final Rule, DOE is not adopting a control credit in the calculation of FEP for fans with a motor controller, such as a VFD; however, as shown in Table I–1, DOE is proposing lower standards for fans sold with motor controllers to account for the motor controller losses in the FEP metric associated with testing a fan with a controller.

As discussed in the May 2023 TP Final Rule, to the extent that manufacturers of general fans and blowers are making voluntary representations of FEI, then they would need to ensure that the product is tested in accordance with the DOE test

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[37] See example of ''ceiling mounted fans'' that are intended to provide directional, rather than circulating air at *www.trianglefans.com/type/ceiling-mounted-fans.*

procedure and that any voluntary representations of FEI (such as in marketing materials or on any label affixed to the product) disclosure the results of such testing. DOE recognizes that the ability to make an additional voluntary representation of the EU metric in marketing materials and on product labels may limit manufacturer burden. DOE is clarifying that manufacturers may represent the additional EU metric, but if doing so they must also represent the FEI metric in accordance with the existing DOE test procedure.

b. Combined Motor and Motor Controller Efficiency Calculation

For fans with a polyphase regulated motor and a controller, AMCA 214–21 allows testing these fans using a shaft-to-air test (*i.e.,* a test that does not include the motor and controller performance). When conducting a shaft-to-air test, the mechanical fan shaft input power is measured and the FEP is calculated by using a mathematical model to represent the performance of the combined motor and controller (*i.e.,* its part-load efficiency). The FEP is then used to calculate the FEI of the fan.

Section 6.4.2.4 of AMCA 214–21, which relies on Annex B, ''Motor Constants if Used With VFD (Normative),'' and Annex C, ''VFD Performance Constants (Normative),'' provides a method to estimate the combined motor and controller part-load efficiency for certain electric motors and controller combinations that meet the requirements in sections 6.4.1.3 and 6.4.1.4 of AMCA 214–21, which specify that the motor must be polyphase regulated motor (*i.e.,* an electric motor subject to energy conservation standards at 10 CFR 431.25).

In the July 2022 TP NOPR, DOE stated its concerns that the equations described in section 6.4.2.4 of AMCA 214–21 may not be appropriately representative, resulting in FEI ratings that would be higher than FEI ratings obtained using the wire-to-air test method described in section 6.1 of AMCA 214–21. Therefore, in the July 2022 TP NOPR, DOE did not propose to allow the use of section 6.4.2.4 of AMCA 214–21. Instead, DOE proposed that fans with a motor and controller be tested in accordance with section 6.1 of AMCA 214–21. DOE indicated that manufacturers would still be able to rely on a mathematical model (including the same mathematical model as described in section 6.4.2.4 of AMCA 214–21, if the mathematical model met the AEDM requirements) in lieu of testing to determine the FEI of a fan with a motor and controller. 87 FR 44194, 44223. In the July 2022 TP NOPR, DOE also reviewed the reference motor and controller (''power drive system'') efficiency provided in IEC 61800–9–2:2017 ''Adjustable speed electrical power drive systems Part 9–2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications—Energy efficiency indicators for power drive systems and motor starters,'' which also provides equations to represent the performance of a motor and controller used with fans, and found that the IEC model predicted values of efficiency that were significantly lower (more than 10 percent on average) than the model included in AMCA 214–21. *Id.*

In the May 2023 TP Final Rule, DOE further reviewed the model in AMCA 214–21 section 6.4.2.4 and stated that it continued to have concerns that applying the model in section 6.4.2.4 of AMCA 214–21 may result in fan FEI ratings that would be higher than FEI ratings obtained using the wire-to-air test method described in section 6.1 of AMCA 214–21. 88 FR 27312, 27347. Specifically, DOE reviewed information provided by AMCA analyzing the AHRI 1210 database of certified motor controllers and providing graphical representations comparing the AHRI data to the AMCA 207 model and found that there were several AHRI-certified motor and motor controller combinations that had a tested efficiency that is lower than the model in section 6.4.2.4 of AMCA 214–21. (Docket No. EERE–2021–BT–TP–0021–0046, AMCA, No. 41 at pp. 18–19) In their comments, AMCA stated that the model in AMCA 214–21, section 6.4.2.4, was not intended to be a conservative estimate of losses. Instead, according to AMCA, the model was intended to provide a level playing field between manufacturers that chose to test wire-to-air and those that chose to test fan shaft power and calculate wire-to-air losses. (Docket No. EERE–2021–BT–TP–0021–0046, AMCA, No. 41 at p. 18) 88 FR 27312, 27348.

Therefore, to minimize the possibility that using the calculation approach would result in better energy efficiency ratings than when testing the equipment inclusive of the motor and controller, in the May 2023 TP Final Rule, DOE did not allow the use of section 6.4.2.4 of AMCA 214–21. Instead, DOE required that fans with motor and controller be tested in accordance with section 6.1 of AMCA 214–21. DOE noted that manufacturers would still be able to rely on a mathematical model (including the same mathematical model as described in section 6.4.2.4 of AMCA 214–21) in lieu of testing to determine the FEI of a fan with a motor and controller, as long as the mathematical model meets the AEDM requirements. *Id.* In other words, manufacturers would not be able to generally apply the model in section 6.4.2.4 of AMCA 214–21. Manufacturers would have to first go through the AEDM validation process to demonstrate that the FEI as established by the AEDM (or a calculation method that would rely on the model in section 6.4.2.4 of AMCA 214–21) would be less than or equal to 105 percent of the FEI determined from the wire-to-air test of the basic models used to validate the AEDM. See 10 CFR 429.70(n).

Since the publication of the May 2023 Final Rule, the IEC published a new version of IEC 61800–9–2 (''IEC 61800–9–2: 2023''). Compared to IEC 61800–9–2:2017, which included a calculation method to directly establish typical losses of a reference motor and motor controller combination (or ''Power Drive System'', ''PDS''), this version provides the reference motor controller. It also points to a separate IEC publication (IEC TS 60034–30–2:2016 ''Rotating electrical machines—Part 30–2: Efficiency classes of variable speed AC motors (IE-code)'') for establishing the reference motor losses. The detailed calculations of losses for a reference motor and motor controller are also described in IEC TS 60034–31: 2021 (''Rotating electrical machines—Part 31: Selection of energy-efficient motors including variable speed applications—Application guidelines'').

IEC 61800–9–2:2023 also characterizes the reference motor controller or ''complete drive module'' (''CDM'') as corresponding to an IE1 efficiency class.[38] See section 6.2 of IEC 61800–9–2:2023. IEC 61800–9–2:2023 further establishes efficiency classes for PDS based on pairing different levels of efficiency motors to baseline efficiency CDMs at IE2 levels. See section 6.5 of IEC 61800–9–2:2023. DOE reviewed a report from the International Energy Agency, Electric Motor Systems Annex[39] which included test data from 179 tests on 57 motor controllers, as well as additional market data and showed that VFDs on the market today are all within the same efficiency class corresponding to ''IE2'', in line with the baseline levels used in IEC 61800–9–2

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[38] IEC 61900–9–2 Ed.2:2023 establishes three efficiency classes (IE0, IE1, and IE2) to characterize the different efficiency levels of CDMs on the market.

[39] International Energy Agency, Electric Motor Systems Annex, Report on Round Robin of Converter Losses, Final Report of Results. *www.iea-4e.org/wp-content/uploads/2022/11/rrc_report_final_2022dec.pdf.*

Ed. 2:2023. Therefore, DOE has tentatively determined that the IE2 level is appropriate to represent a baseline CDM or motor controller.

In order to support an alternative credit calculation (See discussion in section IV.C.1.b) and potentially reduce test burden, DOE evaluated the model in IEC 61800–9–2:2023 assuming a polyphase regulated motor that exactly meets the standards at 10 CFR 431.25, and a motor controller at IE2 level. In addition, DOE adjusted the IE3 levels[40] to exactly match the standards at 10 CFR 431.25 and be comparable to the motor losses in AMCA 214–21.[41] DOE found that compared to the AMCA model, the IEC 61800–9–2:2023 model resulted in generally lower combined motor and motor controller efficiencies.[42] Based on this analysis, DOE has tentatively determined that the IEC model provides a better representation of a baseline motor and VFD combination (*i.e.,* resulting in a conservative estimate of losses) as by definition it relies on a regulated polyphase motor that exactly meets the standards at 10 CFR 431.25 and on a baseline IE2 motor controller.

Therefore, DOE proposes to reduce test burden by adding a combined motor and controller efficiency calculation to allow establishing the FEI of fans sold with a regulated polyphase motor and a motor controller based on a shaft-to-air test and calculated motor and controller efficiency. DOE proposes that the performance of the motor and motor controller combination be allowed for certain electric motors and controller combinations that meet the requirements in sections 6.4.1.3 and 6.4.1.4 of AMCA 214–21, which specify that the motor must be polyphase regulated motor (*i.e.,* an electric motor subject to energy conservation standards at 10 CFR 431.25). To support this approach, DOE proposes that the performance of the motor and motor controller combination be calculated in accordance with the model described in IEC 61800–9–2:2023 and the calculation in IEC TS 60034–31: 2016, and assuming a regulated polyphase motor that exactly meets the standards at 10 CFR 431.25 and a baseline IE2 motor controller. For the final rule, DOE may also consider an approach where the calculation of AMCA 214–21 would be preserved but adjusted (*i.e.,* same equations but with different coefficients) to align with the results of the IEC 61800–9–2:2023 model as proposed.

DOE requests comments and feedback on the proposed methodology and calculation of motor and motor controller losses as well as potentially using an alternative calculation based on adjusted AMCA 214–21 equations.

2. Air Circulating Fans

In the October 2022 NODA, DOE used FEI as the metric for ACFs in its analysis. DOE requested feedback on the FEI values that it determined and its approach for estimating FEI values for ACFs. 87 FR 62038, 62050.

AHAM commented that FEI is not an appropriate metric to use for residential ACFs because the reference fan used for FEI is based on a commercial fan. (AHAM, No. 123 at p. 7) Furthermore, AHAM commented that the AMCA 214–21 test procedure, which DOE proposed to incorporate by reference in the July 2022 TP NOPR, is not applicable to residential ACFs. (AHAM, No. 123 at p. 6) DOE notes that, as discussed in section III.B.2 of this document, ACFs with an input power of less than 125 W are excluded from the scope of the rulemaking.

The CA IOUs and AMCA commented that the reason FEI values are much higher for ACFs at diameters less than 20 in. is because the airflow constant in the FEI calculation (3,210 CFM) is more impactful for ACFs with lower CFM. (CA IOUs, No. 127 at pp. 4–5; AMCA, No. 132 at pp. 10–11, 19) To support their comment, the CA IOUs provided data demonstrating how, at lower airflows, there is a ‘‘bonus’’ value added to reference shaft input power as a result of the airflow constant. (CA IOUs, No. 127 at pp. 4–5) Ultimately, the CA IOUs recommended that DOE consider using a different airflow constant for lower airflow fans to counter this effect. *Id.* Greenheck explained that the airflow constant in AMCA 214–21 is higher than the 12-in. representative unit can generate; therefore, Greenheck would expect that efficiencies of the 12-in. representative unit would be greater than the efficiencies of larger units, which is why AMCA 214–21 limits the application of FEI to fans with airpowers of at least 125 W. (Greenheck, No. 122 at p. 2) NEEA suggested that DOE review and confirm the increases in FEI for ACFs at diameters of 20 in. or less. (NEEA, No. 129 at p. 4) AMCA commented that there was a discrepancy between the airflow constant defined for ACFs in the July 2022 TP NOPR (3,210 CFM) and the airflow constant that DOE used in the October 2022 NODA (3,201 CFM). (AMCA, No. 132 at p. 10) In response, DOE confirms that the airflow constant used in the October 2022 NODA is consistent with that in the July 2022 TP NOPR (3,210 CFM) and that the value of 3,201 CFM was a typographical error in the October 2022 NODA. Greenheck commented that using the FEI metric for both GFBs and ACFs would cause confusion regarding which constants should be used for GFBs and which constants should be used for ACFs. (Greenheck, No. 122 at p. 1)

Based on additional evaluation and stakeholder feedback on the airflow constant in the FEI calculation, DOE has adopted the efficacy metric in terms of CFM/W at maximum speed for ACFs in appendix B to subpart J of 10 CFR part 431 (*see* section 2.2). In the May 2023 TP Final Rule, DOE explained that it has concerns over the readiness of an FEI metric for ACFs and acknowledged the uncertainty regarding the airflow and pressure constant values that should be used when calculating FEI for ACFs. Additionally, the efficacy metric is consistent with the metric used in the ACF industry. 88 FR 27312, 27371. Therefore, DOE conducted its analysis for this NOPR and is proposing standards in efficacy in terms of CFM/Wat maximum speed.

D. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the equipment that is 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 equipment or in working prototypes to be technologically feasible. 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, section 6I(3)(i) and 7(b)(1) (‘‘Process Rule’’).

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[40] The IEC defines motor efficiency classes. See IEC TS 60034–30–2:2016, Rotating electrical machines—Part 30–2: Efficiency classes of variable speed AC motors (IE-code).

[41] For the purposes of this analysis, DOE considered a 4-pole motor. DOE relied on the coefficients provided in the EXCEL sheet accompanying the IEC TS 60034–31 Ed.2:2021 to calculate the motor losses equivalent to an IE3 motor (See Table 4 of IEC TS 60034–30–2:2016) and multiplied each coefficient by $((100-\eta_r)\ \eta_{IE3})/((100-\eta_{IE3})\ \eta_r$ where η_r is the minimum value of full-load efficiency at 10 CFR 431.25 at a given horsepower across open and enclosed enclosure categories and η_{IE3} is the IE3 full load efficiency at the same horsepower and pole configuration.

[42] Two percent lower on average for 4 poles motors at 1, 10, 15, 25, 75, and 200 hp for loads between 0.25 and 1.

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety, and (4) unique-pathway proprietary technologies. 10 CFR 431.4; Sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5) of the Process Rule. Section IV.B of this document discusses the results of the screening analysis for fans and blowers, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, *see* chapter 4 of the NOPR technical support document (''TSD'').

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt a standard for a type or class of covered equipment, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. (42 U.S.C. 6316(a); 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 fans and blowers, 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 proposed rule and in chapter 5 of the NOPR TSD.

E. Energy Savings

1. Determination of Savings

For each trial standard level (''TSL''), DOE projected energy savings from application of the TSL to fans and blowers purchased in the 30-year period that begins in the first full year of compliance with the proposed standards (2030–2059).[43] The savings are measured over the entire lifetime of fans and blowers purchased in the previous 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for equipment would likely evolve in the absence of energy conservation standards.

DOE used its national impact analysis (''NIA'') spreadsheet model to estimate national energy savings (''NES'') from potential new standards for fans and blowers. The NIA spreadsheet model (described in section IV.I of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by equipment at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[44] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

To adopt any new or amended standards for covered equipment, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6316(a); (42 U.S.C. 6295(o)(3)(B))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[45] For example, some covered equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these equipment on the energy infrastructure can be more pronounced than equipment with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors. DOE has initially determined the energy savings from the proposed standard levels are ''significant'' within the meaning of 42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(B).

F. Economic Justification

1. Specific Criteria

As noted previously, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

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

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

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

[44] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012).

[45] The numeric threshold for determining the significance of energy savings established in a final rule published on February 14, 2020 (85 FR 8626, 8670), was subsequently eliminated in a final rule published on December 13, 2021 (86 FR 70892).

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

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered equipment that are likely to result from a standard. (42 U.S.C. 6316(a); 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 equipment (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the equipment. The LCC analysis requires a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as equipment lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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

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

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section III.E, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing equipment classes and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards proposed in this document would not reduce the utility or performance of the equipment under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(ii)) DOE will transmit a copy of this proposed rule to the Attorney General with a request that the Department of Justice (''DOJ'') provide its determination on this issue. DOE will publish and respond to the Attorney General's determination in the final rule. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section for information to send comments to DOJ.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the proposed standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The proposed standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (''GHGs'') associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section V.C.1 of this document.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under ''other factors.''

2. Rebuttable Presumption

EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the equipment 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(iii)) DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section V.B.1.c of this proposed rule.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to fans and blowers. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards proposed in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (''GRIM''), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this proposed rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=51&action=viewlive.* Additionally, DOE used output from the latest version of the Energy Information Administration's (''EIA's'') *Annual Energy Outlook* (''*AEO*''), a widely known energy projection for the United States, for the emissions and utility impact analyses.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, manufacturers, market characteristics, and technologies used in the equipment. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include (1) determination of equipment classes, (2) scope of the analysis and data availability, and (3) technology and design options that could improve the energy efficiency of fans and blowers. The key findings of DOE's market assessment are summarized in the following sections. *See* chapter 3 of the NOPR TSD for further discussion of the market and technology assessment.

1. Equipment Classes

When evaluating and establishing energy conservation standards, DOE is required to establish separate standards for a group of covered equipment (*i.e.,* establish a separate equipment class) based on the type of energy used. DOE may also establish separate standards if DOE determines that an equipment's capacity or other performance-related feature that other equipment lacks justifies a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

a. General Fans and Blowers

As discussed, DOE develops equipment classes based on specific performance-related features that impact utility and may necessarily impact efficiency in serving that utility. For GFBs, DOE identified the direction of airflow through the fan, the outlet configuration of the fan, housing features, and impeller features as characteristics that may justify establishing separate equipment classes. DOE also considered the presence of motor controllers as an additional factor for developing equipment classes.

Based on the direction of airflow through a fan impeller, the classification of a fan may be either axial or centrifugal. Axial fans move air parallel to their axis of rotation and are suitable for applications requiring high airflow at relatively low pressures. Alternatively, centrifugal fans move air radially outward from the axis of rotation, resulting in a change in direction of the air from the inlet of the fan to the impeller edge occurring at or close to 90 degrees. This air is often redirected by a housing, which may concentrate the airflow into a perpendicular outlet, as in the case of a scroll housing, or again redirect the air to move parallel to the inlet flow, as in the case of an inline fan. Centrifugal fans can overcome much higher pressures than axial fans, but operate at lower airflow, resulting in a difference in utility where different airflows and pressures are required. DOE has tentatively determined that the differences between axial- and centrifugal-flow fans result in a difference in utility based on the pressure and airflow ranges under which they are able to operate. For example, an axial fan may be better suited for a general-purpose ventilation application, in which large volumes of air are required at low pressure, whereas a centrifugal fan may be more appropriate for an air conditioning application, which may require a greater operating pressure than could be achieved by an axial fan. Mixed-flow fans utilize a combination of axial and centrifugal flows to provide similar pressures at higher airflows compared to centrifugal fans where the outlet flow is parallel to the inlet flow. Based on a review of the market, DOE has tentatively determined that mixed-flow fans do not provide a unique utility from centrifugal fans in similar arrangements, due to their similar operating pressure and airflow ranges. Therefore, DOE separated GFBs into equipment classes based on whether they utilize an axial or centrifugal airflow in this NOPR.

The outlet configuration of a fan can also affect its efficiency. In the DOE test procedure, DOE established test configuration and measurement requirements based on whether the immediate outlet of a fan is ducted or not ducted.[46] *See* appendix A to subpart J of 10 CFR part 431. For GFBs, ducted fans may be utilized to move air directly from the outlet of the fan through HVAC ducting internal to a building, while not ducted fans discharge air into a plenum or open space. For example, not ducted fans may be utilized to exhaust large quantities of air from a building. Not ducted fans are also better suited for applications in which the fan discharge needs to split into multiple directions, such as ventilation systems which recirculate air from one room to other parts of a building via multiple branching outlets. When a fan outlet is ducted, the outlet air moves through the duct system, and the velocity pressure associated with that air can be regained as static pressure as it travels through the ducting. In this case, FEI is calculated based on a total pressure basis accounting for both the static pressure and the pressure associated with the speed of the outlet air of the fan.[47] When a fan outlet is not ducted,

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[46] For the purposes of DOE's test procedure, ducting refers to the immediate discharge of a fan and not the fan's application. For example, a centrifugal unhoused fan which exhausts air in all directions into a plenum or open space would be considered not ducted, and tested via the corresponding test configuration, even if that fan is ultimately installed in ducted ventilation system.

[47] Static pressure is defined as the pressure exerted by a fluid that is not in motion. Total pressure is defined as the sum of the static pressure and the pressure that arises from the movement of a fluid, or the velocity pressure. A fan's static pressure is the static pressure at the outlet of the fan minus the total pressure at the inlet of the fan. The total pressure of a fan is the total pressure at the outlet of the fan minus the total pressure at the inlet of the fan.

the outlet air is immediately released into the surroundings, and the velocity pressure of this air is lost to its surroundings. In this case, FEI is calculated only on a static pressure basis since the pressure associated with the outlet speed of the air is not aiding the system. Because these outlet configurations have different utilities, and in providing this utility the efficiency is calculated differently according to the DOE test procedure, DOE is proposing to separate GFBs into equipment classes based on their outlet configuration.

DOE has determined that a fan's housing may also impact utility. A fan housing is the structure that encloses and guides the airflow of a fan. Fans require certain housing features for specific utilities. For example, PRVs require a special housing to prevent precipitation from entering buildings. Further, different fan housings result in different outlet directions for airflow. For example, centrifugal fans with a scroll-shaped housing redirect airflow perpendicular to the fan inlet, while centrifugal fans with a cylindrical or inline housing have parallel inlet and outlet airflow. In applications that require continuous airflow in a single direction, such as in a long ventilation duct, a centrifugal fan with inline housing could be directly placed in the duct to push air along the single direction. Inserting a centrifugal fan with a scroll housing in the same application, however, would create unnecessary complexity because it would create multiple changes of direction of airflow, may require changes to the ducting work, and could lead to reduced performance in a space-constrained environment. Because the described housings have specific utilities and DOE has observed different FEI ranges for fans with the described housings, DOE is proposing to separate GFBs into separate equipment classes by whether they are housed or unhoused, and to further separate GFBs by the types of housings described.

DOE also considered impeller features for separating fans into equipment classes. DOE identified that radial impellers as defined in AMCA 214–21 offer unique self-cleaning characteristics that allow them to be utilized with significantly less maintenance in airstreams with a high density of particulate matter, such as fume exhaust from a mine.[48] However, these impellers are also less efficient than other centrifugal impellers. Therefore, DOE is proposing a separate equipment class for fans that use a radial impeller.

The last feature that DOE evaluated for separating GFBs into equipment classes was the use of motor controllers, which allow a fan to adapt to changing load requirements. This enables a fan to run at lower speed when the system requirements allow, thus saving energy. While this may result in energy savings during operation, the DOE test procedure for fans does not account for these possible changes in operation and energy savings. Furthermore, FEI is a wire-to-air metric, as discussed in section III.C.1 of this document, which means that the use of a motor controller would act to reduce the FEI of a fan at each of its individual operating points. Any efficiency standard set without consideration of the motor controller would be more stringent. DOE recognizes the energy savings benefits of using a motor controller with a fan to allow the energy consumption of fan to be adjusted based on the changing load requirements of the system; therefore, to avoid penalizing the use of such technology, DOE proposes to create equipment classes for GFBs sold with and without motor controllers.

In the DOE Test Procedure, DOE adopted definitions consistent with AMCA 214–21 for several categories of fans and blowers that are within the scope of this NOPR. *See* 10 CFR 431.172. DOE also established a modified definition for axial-panel fans to distinguish these fans from ACFs. *Id.* Table IV–1 presents the fan categories and corresponding definitions adopted by DOE.

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[48] AMCA 214–21 defines a radial impeller as a form of centrifugal impeller with several blades extending radially from a central hub. Airflow enters axially through a single inlet and exits radially at the impeller periphery into a housing with impeller blades; the blades are positioned so their outward direction is perpendicular within 25 degrees to the axis of rotation.

Table IV-1 Fan Category Definitions

Fan Category	**Definition from test procedure**
Axial Inline Fan	A fan with an axial impeller and a cylindrical housing with or without turning vanes.
Panel Fan	An axial fan, without cylindrical housing, that includes a panel, orifice plate, or ring with brackets for mounting through a wall, ceiling, or other structure that separates the fan's inlet from its outlet.
Centrifugal Housed Fan	A fan with a centrifugal or mixed flow impeller in which airflow exits into a housing that is generally scroll-shaped to direct the air through a single fan outlet. A centrifugal housed fan does not include a radial impeller.*
Centrifugal Unhoused Fan	A fan with a centrifugal or mixed flow impeller in which airflow enters through a panel and discharges into free space. Inlets and outlets are not ducted. This fan type also includes fans designed for use in fan arrays that have partition walls separating the fan from other fans in the array.**
Centrifugal Inline Fan	A fan with a centrifugal or mixed flow impeller in which airflow enters axially at the fan inlet and the housing redirects radial airflow from the impeller to exit the fan in an axial direction.
Radial Housed Fan	A fan with a radial impeller in which airflow exits into a housing that is generally scroll-shaped to direct the air through a single fan outlet. Inlets and outlets can optionally be ducted.
Power Roof Ventilators ("PRVs")	A fan with an internal driver and a housing to prevent precipitation from entering the building. It has a base designed to fit over a roof or wall opening, usually by means of a roof curb.

* The inclusion of "scroll-shaped" in this definition excludes inline fans.

**Radial fans are housed and therefore not included in this definition.

During its analysis, DOE tentatively determined that additional definitions would help to clarify certain fan equipment classes. DOE is proposing in this NOPR to adopt the definitions for "radial impeller", "mixed-flow impeller" and "housing" presented in Table IV–2. DOE notes that these proposed definitions are consistent with those in AMCA 214–21, with some minor modifications for clarity.

Table IV-2 Proposed Definitions for Fan Features

Characteristic	**Proposed Definition**
Radial Impeller	A form of centrifugal impeller with several blades extending radially from a central hub. Airflow enters axially through a single inlet and exits radially at the impeller periphery into a housing; the blades are positioned so their outward direction is perpendicular within 25 degrees to the axis of rotation. Impellers can have a back plate and/or shroud.
Mixed Flow Impeller	An impeller featuring construction characteristics between those of an axial and centrifugal impeller. A mixed-flow impeller has a fan flow angle[49] greater than 20 degrees and less than 70 degrees. Airflow enters axially through a single inlet and exits with combined axial and radial directions at a mean diameter greater than the inlet diameter.
Fan Housing	Any fan component(s) that direct airflow into or away from the impeller and/or provide(s) protection for the internal components of a fan or blower that is not an air circulating fan. A housing may serve as a fan's structure.

DOE found some fans are sold as radial fans but have impellers that incorporate both radial and non-radial features, such as blades with a slight backward-inclined design or blades with both straight and backward-curved portions. To ensure that these fans are properly and consistently classified as either radial or centrifugal housed, DOE

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[49] AMCA 214–21 defines fan flow angle as the angle of the centerline of the air-conducting surface of a fan blade measured at the midpoint of its trailing edge with the centerline of the rotation axis in a plane through the rotation axis and the midpoint of the trialing edge.

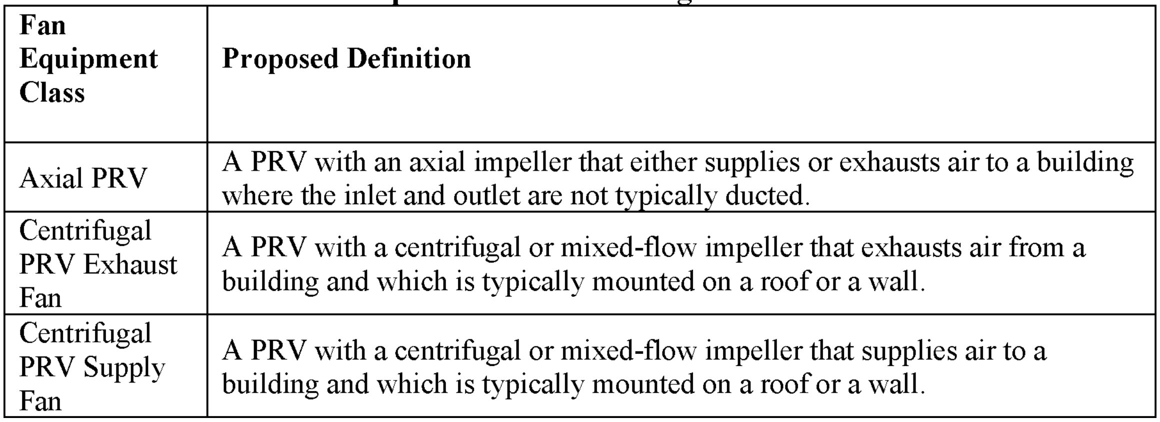
is proposing a definition for ‘‘radial impeller’’.

Additionally, DOE is proposing to define ‘‘mixed flow impeller’’ to distinguish mixed flow impellers from axial and centrifugal impellers and to ensure that fans sold with a mixed flow impeller are correctly classified. DOE notes that, as defined in Table IV–1, inline fans with mixed flow impellers are considered in the centrifugal inline equipment class.

Lastly, DOE is proposing to define ‘‘fan housing’’ since housing is a criterion used to separate equipment classes. In its evaluation of the market, DOE found some fans that may not be easily classified without a clear and consistent definition for housing. For example, cabinet fans are sold with an enclosure surrounding their internal moving components and an additional enclosure further directing airflow. DOE has observed that cabinet fans are commonly marketed as inline fans since the outermost enclosure directs the airflow to be inline; however, the internal enclosure, which directs airflow into and out of the impeller, directs airflow at a 90-degree angle, which would be consistent with a centrifugal housed fan. Based on DOE’s proposed definitions, cabinet fans would be part of the centrifugal housed equipment class.

DOE evaluated each of the fan categories defined in the DOE test procedure using the identified GFB performance features and proposes that each fan category defined in the test procedure will be evaluated as a separate equipment class. For PRVs, DOE has found that they can be either axial or centrifugal, and their outlets can either be ducted or not ducted. PRVs used for supply will have a ducted outlet, while PRVs used for exhaust will not have a ducted outlet. DOE notes that while centrifugal PRVs serve both supply and exhaust functions, DOE did not find a significant number of axial PRVs being used for supply in the market. Therefore, DOE is proposing to further divide PRVs into three distinct equipment classes: axial PRVs, centrifugal PRV exhaust fans, and centrifugal PRV supply fans. Table IV–3 presents the proposed definitions for each of the three PRV fan equipment classes, which align with the definitions in AMCA 214–21.

Table IV-3 Proposed PRV Fan Categories and Definitions



Fan Equipment Class	Proposed Definition
Axial PRV	A PRV with an axial impeller that either supplies or exhausts air to a building where the inlet and outlet are not typically ducted.
Centrifugal PRV Exhaust Fan	A PRV with a centrifugal or mixed-flow impeller that exhausts air from a building and which is typically mounted on a roof or a wall.
Centrifugal PRV Supply Fan	A PRV with a centrifugal or mixed-flow impeller that supplies air to a building and which is typically mounted on a roof or a wall.

Additionally, DOE is proposing that each GFB equipment class be split into a class of fans that are sold with motor controllers and a class of fans that are sold without motor controllers. For example, there would be two equipment classes for axial PRVs—one for axial PRVs sold with motor controllers and one for axial PRVs sold without motor controllers. This would be the same for all remaining proposed GFB equipment classes.

In summary, DOE is proposing to separate GFBs into 18 equipment classes in this NOPR. These equipment classes are shown in Table IV–4. As just discussed, DOE notes that each equipment class shown in the table has a variable-speed and a constant-speed variant. As mentioned previously, these equipment classes directly correspond to the GFB fan categories defined in the DOE test procedure, with the exception of PRVs.

Table IV-4 Proposed Equipment Classes for General Fans and Blowers

Equipment Class*	Airflow	Outlet Configuration	Housing	Impeller Feature
Axial Inline	Axial	Ducted	Inline	Standard
Panel	Axial	Not Ducted	none	Standard
Axial Power Roof Ventilator	Axial	Not Ducted	Precipitation protection	Standard
Centrifugal Inline**	Centrifugal	Ducted	Inline	Standard
Centrifugal Power Roof Ventilator – Supply	Centrifugal	Ducted	Precipitation protection	Standard
Centrifugal Housed	Centrifugal	Ducted	Scroll	Standard
Radial Housed	Centrifugal	Ducted	Scroll	Self-Cleaning
Centrifugal Unhoused	Centrifugal	Not Ducted	none	Standard
Centrifugal Power Roof Ventilator – Exhaust	Centrifugal	Not Ducted	Precipitation protection	Standard

* Each equipment class is further separated by whether the fan is sold with motor controllers as discussed below

** Includes mixed-flow fans

Although GFBs were not discussed in the October 2022 NODA, DOE received comment on GFB equipment classes. Specifically, AHRI commented that forward-curved fans, which are typically used in low-pressure applications, could be removed from the market by energy conservation standards. (AHRI, No. 130 at pp. 12–13) AHRI stated that forward-curved fans should have a separate equipment class because they provide code-required sound quality in low-pressure and low-speed ranges. *Id.* Morrison and AHRI also commented that return or relief fans, which are commonly used for energy-saving economizer functions in systems, could be removed from the market if they are regulated by a DOE energy conservation standard. (Morrison, No. 128 at p. 2; AHRI, No. 130 at p. 2, 13)

DOE notes that the FEI metric is a function of the operating pressure. As mentioned in section III.C.1 of this document, FEI is the ratio of the reference FEP to the actual FEP. The reference fan is used to normalize the FEI calculation by evaluating fan performance compared to a consistent reference fan at each duty point and configuration. Evaluating FEI in this manner allows for comparison of different fans independent of the wide variety of fan types and duty points. Consequently, a return or relief fan operating at a lower pressure than a supply fan at a given airflow would be compared to a reference FEP specific to that duty point, which accounts for the lower operating pressure and mitigates disproportionate impacts; therefore, DOE has tentatively concluded that return and relief fans do not need a separate equipment class.

To address AHRI's comment that forward-curved fans provide code-required sound quality in low-pressure and low-speed ranges, DOE evaluated data on inlet and outlet noise obtained from manufacturer fan selection software for centrifugal-housed fans at low-pressure duty points. Based on this analysis, DOE observed centrifugal-housed fans with both backward-inclined and airfoil impellers that provided equivalent or nearly equivalent noise levels, in A-weighted decibels, to forward-curved fans operating at the same duty point. Furthermore, DOE observed that noise levels significantly decreased as the FEI of the fan increased, indicating that energy conservation standards would not inhibit fans from complying with sound quality requirements. Therefore, DOE has tentatively determined that forward-curved fans do not require a separate equipment class. However, to ensure that forward-curved fans were adequately evaluated, DOE evaluated a parallel design path in which it assumed that all forward-curved fans would be redesigned to meet any proposed energy conservation standards, rather than replacing the forward-curved impeller with another impeller topology such as airfoil or backward-inclined. DOE evaluated this parallel design path to consider the costs required to preserve forward-curved fans in the market. Additional details on the parallel design path for forward-curved fans are provided in section IV.C.1.b of this document and chapter 5 of the NOPR TSD.

DOE received no further comments on GFB equipment classes and is therefore proposing the equipment classes in Table IV–4.

b. Air Circulating Fans

In response to the October 2022 NODA, AMCA recommended that DOE use the same ACF definitions as those used in AMCA 230–23. (AMCA, No. 132 at pp. 2, 18) As discussed in the May 2023 Test Procedure Final Rule, the definitions that DOE adopted for ACF, unhoused air circulating fan head (''ACFH''), housed ACFH, air circulating axial panel fan, box fan, cylindrical

ACF, and housed centrifugal ACF align with the definitions published in AMCA 230–23. 88 FR 27312, 27339. DOE additionally adopted definitions for air circulating axial panel fan, box fan, cylindrical ACF, and housed centrifugal ACF in the DOE test procedure, as defined in Annex B of AMCA 230–23. *See* 10 CFR 431.172. These definitions are reproduced Table IV–5.

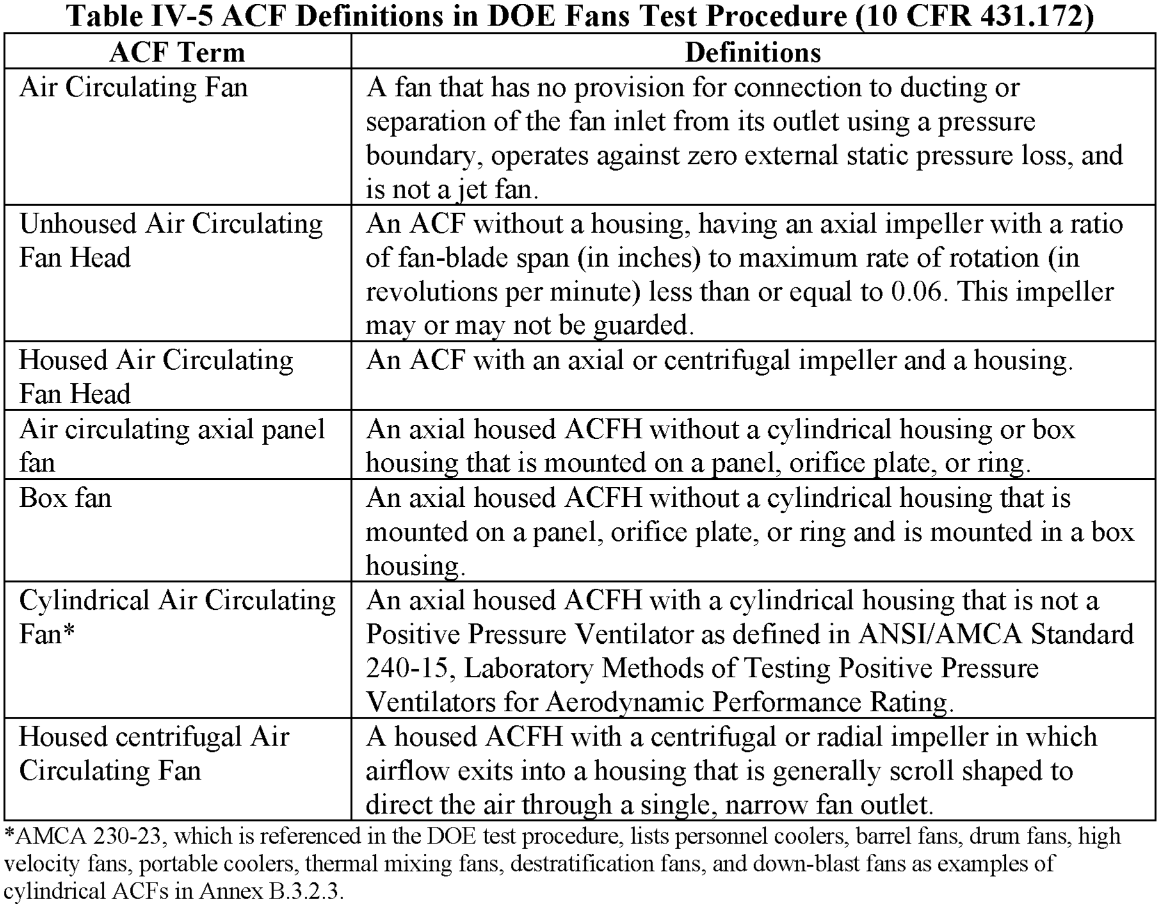


Table IV-5 ACF Definitions in DOE Fans Test Procedure (10 CFR 431.172)

ACF Term	Definitions
Air Circulating Fan	A fan that has no provision for connection to ducting or separation of the fan inlet from its outlet using a pressure boundary, operates against zero external static pressure loss, and is not a jet fan.
Unhoused Air Circulating Fan Head	An ACF without a housing, having an axial impeller with a ratio of fan-blade span (in inches) to maximum rate of rotation (in revolutions per minute) less than or equal to 0.06. This impeller may or may not be guarded.
Housed Air Circulating Fan Head	An ACF with an axial or centrifugal impeller and a housing.
Air circulating axial panel fan	An axial housed ACFH without a cylindrical housing or box housing that is mounted on a panel, orifice plate, or ring.
Box fan	An axial housed ACFH without a cylindrical housing that is mounted on a panel, orifice plate, or ring and is mounted in a box housing.
Cylindrical Air Circulating Fan*	An axial housed ACFH with a cylindrical housing that is not a Positive Pressure Ventilator as defined in ANSI/AMCA Standard 240-15, Laboratory Methods of Testing Positive Pressure Ventilators for Aerodynamic Performance Rating.
Housed centrifugal Air Circulating Fan	A housed ACFH with a centrifugal or radial impeller in which airflow exits into a housing that is generally scroll shaped to direct the air through a single, narrow fan outlet.

*AMCA 230-23, which is referenced in the DOE test procedure, lists personnel coolers, barrel fans, drum fans, high velocity fans, portable coolers, thermal mixing fans, destratification fans, and down-blast fans as examples of cylindrical ACFs in Annex B.3.2.3.

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In the October 2022 NODA, DOE did not evaluate separate equipment classes for housed and unhoused ACFs and requested comment and supporting data on whether housed and unhoused ACFs have significant differences in utility and/or efficiency. 87 FR 62038, 62045. NEEA stated that DOE should analyze unhoused and housed ACFs separately in its analysis because the efficiencies of housed and unhoused fans differ enough that an analysis of both together could result in non-representative EL values. To support this point, NEEA referenced a plot that was included in the supplementary spreadsheet for the October 2022 NODA that showed ACF efficiency distribution overlayed on the efficiency levels analyzed in the NODA [50] and stated that the efficiency distributions in the plot were wide for all diameters. (NEEA, No. 129 at p. 1–2) NEEA commented that, given the many performance-related features with unquantifiable impacts on the fan efficiency data DOE used for its analysis, DOE should separate housed and unhoused ACFs into separate equipment classes to ensure that housed and unhoused ACFs are fairly analyzed. NEEA added that the separation of housed and unhoused fans aligns with the approach taken for GFBs in NODA 3. (NEEA, No. 129 at p. 2–3)

The Efficiency Advocates commented that DOE should group ACFHs, box fans, panel fans, and personnel coolers together into a single axial ACF class since they are all axial fans that provide directional airflow and do not differ significantly in FEI. (Efficiency Advocates, No. 126 at p. 3) They noted that the ACF subcategories in AMCA 230 are delineated in AMCA 230 primarily for descriptive purposes and not for regulatory purposes. *Id.* DOE interprets ACFHs and personnel coolers, as referenced by the Efficiency Advocates, to align with the definitions given for unhoused ACFHs and cylindrical ACFs, respectively, in Table IV–5. DOE therefore interprets the Efficiency Advocates' comment as a recommendation to combine all axial ACFs into a single equipment class.

DOE's review of the ACF market generally indicated that air circulating axial panel fans, box fans, cylindrical ACFs, and unhoused ACFHs could all be used interchangeably for air circulation applications. DOE did observe that cylindrical ACFs are sometimes marketed toward high-velocity applications. To verify whether design in high-velocity applications would warrant separating cylindrical ACFs into their own equipment class, DOE reviewed available air velocity and thrust data for air circulating axial panel fans, box fans, cylindrical ACFs, and unhoused ACFHs. Based on this analysis, DOE did not find a consistent trend of one or more of these subcategories of ACFs producing more air velocity or thrust than another, further indicating that they may be used interchangeably. DOE therefore

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[50] *See* Docket No. EERE–2022–BT–STD–0002, No. 11 for the supplementary spreadsheet associated with the October 2022 NODA.

evaluated air circulating axial panel fans, box fans, cylindrical ACFs, and unhoused ACFHs as a single ''axial ACF'' equipment class in this NOPR. DOE is therefore proposing that an axial ACF be defined as ''an ACF with an axial impeller that is either housed or unhoused.'' DOE considers all fans that meet the axial ACF definition to be subject to the DOE test procedure, and these fans, unless specifically excluded, would be subject to any future energy conservation standards.

DOE requests comment on whether there are specific fans that meet the axial ACF definition that provide utility substantially different from the utility provided from other axial ACFs and that would impact energy use. If so, DOE requests information on how the utility of these fans differs from other axial ACFs and requests data showing the differences in energy use due to differences in utility between these fans and other axial ACFs.

In the October 2022 NODA, DOE also requested comment on whether each of the following design characteristics may impact the utility of air circulating fans: presence or absence of a safety guard, presence or absence of housing, housing design, blade type, power requirements, and air velocity or throw. 87 FR 62038, 62045. Additionally, DOE requested information on any additional design characteristics that may impact ACF utility. *Id.* In response, AMCA commented that all the design variables on which DOE requested comment are combined to influence an ACF's performance characteristics. (AMCA, No. 132 at p. 6–7). DOE reviewed the market and found that adjusting these design variables while keeping other design parameters constant did not produce a significant difference in efficiency, impact the operation, or impact the fan's application. Therefore, DOE has tentatively decided not to delineate separate equipment classes for axial ACFs based on safety guards, housing, blade type, power requirements, or air velocity and throw.

In the October 2022 NODA, DOE additionally requested comment and supporting data on whether belt-driven and direct-driven ACFs have significant differences in utility or efficiency. 87 FR 62038, 62045. The Efficiency Advocates commented that DOE should not consider belt-driven fans as a separate equipment class because those fans are merely a low-cost alternative to the more efficient direct-drive fans rather than a different performance or utility consideration, and that a separate equipment class for belt-driven ACFs could undermine the potential energy savings for larger diameter ACFs. (Efficiency Advocates, No. 126 at p. 3) DOE's review of belt-driven ACFs on the market indicated that, while belt drives do provide a utility for adjusting the rotational speed of the ACF, VFDs also allow users to adjust the rotational speed of the ACF. Therefore, DOE has tentatively determined that belt drives do not provide a unique utility and DOE did not treat belt-driven ACFs as an equipment class in its NOPR analysis. The shift from belt drive to direct drive is instead discussed as a design option in section IV.C.2.b of this document.

DOE further reviewed the ACF market to determine if additional equipment classes were appropriate for axial ACFs. DOE observed that axial ACFs with larger impeller diameters tended to be more efficient than axial ACFs with smaller impeller diameters. DOE also received feedback during manufacturer interviews that fans with larger diameters are generally more efficient. Therefore, DOE considered diameter as a class-setting variable for axial ACFs in this NOPR. DOE found multiple efficiency incentive programs that provide rebates to agricultural fan manufacturers if they meet certain efficiency targets.[51] For axial ACFs, these agricultural rebate programs typically define four diameter ranges to which the rebate efficiency levels applied: ''12-inch to less than 24-inch diameter range,'' ''24-inch to less than 36-inch diameter range,'' ''36-inch to less than 48-inch diameter range,'' and ''48-inch diameter or greater range.'' To align with these programs, DOE initially considered four different equipment classes for axial ACFs, one for each diameter range. However, after reviewing efficacy data for axial ACFs, DOE did not find a significant difference in efficacy between axial ACFs in the 12-inch to less than 24-inch diameter range and the 24-inch to less than 36-inch diameter range. Therefore, DOE combined these two diameter ranges into a single equipment class: the ''12-inch to less than 36-inch diameter axial ACF'' class. DOE assigned the 36-inch to less than 48-inch diameter range to a ''36-inch to less than 48-inch diameter axial ACF'' class and the 48-inch diameter or greater range to a ''48-inch diameter or greater axial ACF'' class.

The term ''diameter'' in the context of fans and blowers refers to the impeller diameter of a fan. Impeller diameter is typically determined by measuring the radial distance from the tip of one of the impeller blades to the center of the impeller hub and doubling that value. DOE is therefore proposing to define diameter for fans and blowers as ''the impeller diameter of a fan, which is twice the measured radial distance between the tip of one of the impeller blades of a fan to the center axis of its impeller hub.'' DOE notes that impeller diameter may often be different than nominal diameter.

Additionally, in the October 2022 NODA, DOE summarized a comment from the Efficiency Advocates stating that portable blowers may require an equipment class separate from other ACFs because they provide a unique application (*i.e.,* drying floors), have centrifugal rather than axial construction, and are relatively low in efficiency. 87 FR 62038, 62045. DOE understands the term ''portable blower'' to be a housed centrifugal ACF. As discussed in section IV.A.1.a of this document, DOE tentatively determined that axial and centrifugal fans generally have different utilities. DOE also reviewed the housed centrifugal ACF market and found that housed-centrifugal ACFs are used primarily as carpet dryers. Additionally, DOE observed that housed-centrifugal ACFs with input powers greater than or equal to 125 W typically have impeller diameters of 4 in. to 20 in., while axial ACFs with input powers greater than 125 W often have impeller diameters exceeding 20 in. DOE also reviewed housed centrifugal ACF efficiency data and found that the most efficient housed centrifugal ACFs can be 3 to 4 times less efficient than the most efficient axial ACFs with a comparable diameter. Since housed centrifugal ACFs have a different construction, are only used as carpet dryers, are smaller, and are less efficient than axial ACFs, DOE has created a separate equipment class for housed centrifugal ACFs. DOE did not consider different diameter ranges for the housed centrifugal ACF equipment class because it did not observe a significant variation in efficiency for housed centrifugal ACFs with diameter. The proposed equipment classes for ACFs are summarized in Table IV–6.

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[51] *See cecnet.net/agriculture; www.ecirec.coop/rebate-forms-and-specifications;* and *www.tiprec.com/rebates.*

Table IV-6 Proposed Equipment Classes for ACFs

Equipment Class	Equipment Categories Grouped into Equipment Class, as defined in TP Final Rule
12-in. to less than 36-in. diameter axial ACFs	Axial Air Circulating Axial Panel Fans Box Fans Cylindrical ACFs Unhoused ACFHs
36-in. to less than 48-in. diameter axial ACFs	
48-in. diameter or greater axial ACFs	
Housed Centrifugal ACFs	Housed Centrifugal ACFs

2. Scope of Analysis and Data Availability

a. General Fans and Blowers

DOE conducted the GFB engineering analysis for this NOPR using a database of confidential sales information provided by AMCA (''AMCA sales database''), performance data from manufacturer online fan selection software, and performance data provided from confidential manufacturer interviews.

In response to the July 2022 TP NOPR, DOE received comments about the data used in its historical analyses. Specifically, AHRI expressed concern with DOE's use of the AMCA sales database in the December 2014 NODA, the May 2015 NODA, and the November 2016 NODA, which contains efficiencies established at a variety of different speeds. (Docket No. EERE–2021–BT–TP–0021, AHRI, No. 40 at p. 13). AHRI stated that this approach was inconsistent with the ASRAC Working Group agreement for establishing product performance and, as disclosed during ASRAC negotiations, much of the data in the database was not certified performance and may not be reliable for evaluating the impact of efficiency standards. *(Id.)*

With respect to the AMCA sales database providing efficiency data at a variety of speeds, DOE notes that, in accordance with the DOE test procedure, fans must be tested at a range of duty points over which they may operate. Duty points are characterized by a given airflow and pressure at a corresponding operating speed. In other words, fans could be tested at a variety of different speeds depending on the duty point at which the fan is being operated. As discussed in section IV.B of this document, DOE evaluated the entire range of duty points when developing the proposed efficiency levels for each class; therefore, DOE has used the performance data provided in the AMCA sales database as a basis for its engineering analysis. Furthermore, in response to the data in the database not being certified performance data, DOE compared the fan models in the AMCA sales database with the fan models in the AMCA Certified Rating Program.[52] DOE found that the fan models in the AMCA sales database are certified as part of AMCA's Certified Rating Program.

The AMCA sales database that DOE used in this analysis is the same database that was used in the May 2015 NODA and the November 2016 NODA. To validate that the AMCA sales database remains representative of the current market, DOE verified the data with current manufacture product literature. DOE selected several fans from the AMCA sales database from each manufacturer and equipment class and verified that those fans are currently available with the same performance data. DOE specifically checked that the model, diameter, operating pressure, airflow, and brake horsepower (''bhp'') aligned between the AMCA sales database and current product literature. DOE was able to verify a majority of the fans selected from each manufacturer and equipment class. Additionally, DOE obtained recent performance and sales data from confidential manufacturer interviews and determined that the data were consistent with the data in the AMCA sales database; therefore, DOE has tentatively concluded that the AMCA sales database that it uses in its engineering analysis for this NOPR is representative of the current market.

DOE notes that it made some updates to the AMCA sales database to ensure consistency with the proposed scope and equipment classes for PRVs. The AMCA sales database grouped all centrifugal PRVs together; however, as discussed in section IV.A.1.a, DOE has separated centrifugal PRVs by whether they are supply or exhaust (ducted or non-ducted). To separately analyze the two classes, DOE manually recategorized the centrifugal PRVs as either supply or exhaust fans using the manufacturer and model provided in the AMCA sales database for most fans to identify from manufacturer literature which centrifugal PRVs were supply and which were exhaust. Centrifugal PRVs that could not be identified by their model name were left categorized as exhaust for the analysis since, based on data collected during confidential manufacturer interviews, DOE believes that there are more centrifugal PRV exhaust fan product lines and models than centrifugal PRV supply fans.

Additionally, DOE determined that the AMCA sales database included many radial fans that are considered out of scope in the DOE test procedure. 10 CFR 431.174((a)2)(i). As discussed in section III.B.1, radial fans that are unshrouded and have an impeller diameter less than 30 in. or a blade width of less than 3 in. are excluded from the scope of the DOE test procedure. DOE identified these radial fans by looking up each model in manufacturer product literature to determine whether it contained a shrouded impeller. Some fans in the database could not be identified by model, or the impeller characteristics could not be determined from their catalogs. DOE opted to include these fans in the database for analysis because including them likely results in a more conservative estimate of FEI since DOE has found that unshrouded impellers typically have lower FEI.

DOE acknowledges that there are limitations to the data provided in the AMCA sales database. For example, factors such as drive type, motor horsepower, and the presence of motor controllers were not specified in the AMCA sales database, unless indicated by the model number. Additionally, DOE estimates that AMCA members make up 60 percent of fan manufacturers. DOE understands that the AMCA sales database includes only a portion of the sales data from AMCA members; however, given the range in equipment classes, FEIs, and costs in the AMCA sales database, DOE believes that the data are representative of the U.S. GFB market. Furthermore, to supplement the data from the AMCA sales database, DOE also pulled

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[52] Detail on AMCA's Certified Ratings Program can be found at *www.amca.org/certify/#about-crp* (last accessed September 2022).

performance data from online fan manufacturer selection software. DOE notes that it did not select representative units, such as a particular fan model, to conduct its analysis since fan performance relies on fan diameter and operating point. Instead, DOE identified between three and ten representative diameters and operating points for each equipment class in the AMCA sales database and pulled additional performance data for these operating points from manufacturer fan selection software. Each representative operating point was defined by equipment class, diameter, operating pressure, and airflow. DOE analyzed data points from multiple fan models and manufacturers for each representative diameter and operating point representing a variety of fan designs and efficiencies. Using the data from manufacturer fan selection software, DOE was able to identify the drive type, motor horsepower, and whether or not motor controllers were present for each evaluated fan.

More detail on the databases DOE used in its analyses can be found in chapter 5 of the NOPR TSD.

b. Air Circulating Fans

During manufacturer interviews conducted prior to the October 2022 NODA, manufacturers recommended that DOE use ACF data from a publicly available database provided by the Bioenvironmental and Structural Systems Laboratory associated with the University of Illinois-Champaign (''BESS Labs database'').[53] Based on this feedback, DOE conducted its October 2022 NODA analyses using data from the BESS Labs database and data collected from ACF testing performed by DOE at BESS Labs. DOE referred to this collective database as the ''BESS Labs combined database'' in the October 2022 NODA. DOE notes that, although BESS Labs uses the test setups defined in the 2012 edition of AMCA 230 for its testing, BESS Labs does not apply standard air density conversions to its measurements, which are required by the DOE test procedure. *See* section 2.2.2 of appendix B to subpart J to 10 CFR part 431. Therefore, in the October 2022 NODA, DOE applied conversion formulas to the BESS Labs combined database performance data to align the airflow and input power calculations with the DOE test procedure. Details on these conversions can be found in chapter 5 of the TSD.

As discussed in section III.B.2, all ACFs with input power less than 125 W are outside the proposed scope of this rulemaking. Therefore, DOE removed all ACFs with input powers less than 125 W from the BESS Labs combined database prior to its analysis for this NOPR.

In the October 2022 NODA, DOE requested comment on whether the BESS Labs combined database was representative of the performance of the entire ACF market. 87 FR 62038, 62045. In response, AMCA commented that it expects the fan efficiencies reported in the BESS Labs database to be higher than the typical efficiencies seen on the market for ACFs. AMCA stated that this is because the fans in the BESS Labs database are typically agricultural fans, and these fans are the subject of utility rebates to encourage the production of higher-efficiency fans. AMCA further stated that it is unlikely performance data for a fan was voluntarily added to the public BESS Labs database unless the fan was eligible for these utility rebates. (AMCA, No. 132 at p. 4–5) Greenheck also commented that the ACF efficiencies in the BESS Labs database would generally be higher than typical ACFs on the market because of their participation in rebate efficiency incentive programs, and Greenheck suggested that DOE utilize more data sources than just the BESS Labs combined database. (Greenheck, No. 122 at p. 2)

In the October 2022 NODA, DOE also requested information on ACF performance data. 87 FR 62038, 62045. In response, AMCA commented that ACF catalog data is publicly available. However, AMCA also stated that it believes that public performance data for fans not listed in the BESS Labs database was likely either not collected using the most recent version of AMCA 230 or not collected using any version of AMCA 230 at all. AMCA further commented that testing of ACFs at an AMCA-accredited facility yielded performance data that was inconsistent with the performance data published in catalogs for certain tested fans, and because of this, AMCA cautioned DOE on the use of catalog data that has not been certified by a third party. (AMCA, No. 132 at p. 5–6) Similarly, Greenheck recommended that DOE only use ACF data that has been certified by an independent performance certification program to ensure that the data are accurate. (Greenheck, No. 122 at p. 2) In the October 2022 NODA, DOE discussed a comment from AMCA stating that ACF product literature may advertise performance calculated using outdated versions of AMCA 230 and that all versions aside from AMCA 230–15 had at least one error pertaining to the calculations of thrust, airflow, or input power. 87 FR 62038, 62043–62044. A table summarizing these errors can be found in the October 2022 NODA. *Id.*

In the October 2022 NODA, DOE also requested comment on whether the fan affinity laws could be used to extrapolate ACF performance data to smaller and larger diameters to increase the size of its ACF dataset. 87 FR 62038, 62045. In response, NEEA stated that since the fan affinity laws assume that efficiency remains constant, utilizing them for determining efficiency gains would be incorrect. Instead, NEEA recommended that DOE obtain data on smaller- and larger-diameter ACFs by either testing additional smaller- and larger-diameter ACFs or by using empirical relationships to extrapolate data to smaller and larger diameters. (NEEA, No. 129 at p. 3–4) AMCA stated that the fan affinity laws require knowledge of the impeller shaft power, which is often not measured for ACFs. AMCA added that electrical input power, which is often measured for ACFs, cannot be scaled to obtain reasonable estimates. (AMCA, No. 132 at p. 6) In response to this feedback, DOE did not utilize the fan affinity laws to extrapolate fan performance data to different diameters and instead included catalog data in its dataset for this NOPR.

DOE acknowledges that the BESS Labs combined database likely contains higher efficiency fans than the overall ACF market, since many agricultural incentive programs require that fans be tested at BESS Labs and meet certain performance requirements. Additionally, DOE notes that the BESS Labs combined database contains data on axial ACFs only. Therefore, to supplement the BESS Labs combined database and gain additional information representative of the ACF market, DOE collected ACF catalog data from manufacturer and distributor websites. DOE did not consider catalog data in the October 2022 NODA because catalog data did not include information on the air density measured during testing, which is required to calculate FEI. Since DOE updated the ACF metric to be efficacy instead of FEI, DOE was able to use catalog data for this NOPR. In response to AMCA and Greenheck's concerns about the accuracy of catalog data that have not been certified by a third party, DOE notes that, while the catalog data it collected is not certified by a third party, there were no ACFs listed in AMCA's certified product

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[53] BESS Labs is a research, product testing, and educational laboratory. BESS Labs provides engineering data to aid in the selection and design of agricultural buildings and assists equipment manufacturers in developing better products. Test reports for ACFs are publicly available at *bess.illinois.edu/searchc.asp.*

database at the time of DOE's market review,[54] and DOE is not aware of any other certification programs for ACFs.

In response to AMCA's concerns about manufacturers' use of outdated and inaccurate versions of AMCA 230 to generate catalog data, DOE applied a correction factor to some catalog data. DOE is aware that many ACF manufacturers may use an outdated version of AMCA 230 and that the calculation methods used in these older versions do not align with AMCA 230–15 or with AMCA 230–23, which is referenced by the DOE test procedure. *See* section 2.2.2 of appendix B to subpart J of 10 CFR part 431. In DOE's review of the ACF market and product literature, it observed that the 1999 edition of AMCA 230 (''AMCA 230–99'') was the most common test method manufacturers cited in their product literature for measurement of ACF performance data, while a small number of manufacturers cited AMCA 230–15. DOE did not find any other methods that manufacturers cited for measuring ACF performance. Therefore, for all manufacturers that did not explicitly state in their product literature that they collected their ACF performance data using AMCA 230–15, DOE applied a correction factor to the catalog data to account for differences in the calculation methods between AMCA 230–99 and the DOE test procedure. DOE acknowledges that this approach may result in lower efficacy values for ACFs where a correction factor was already applied; however, DOE notes that it lacks other sources of ACF performance data aside from the BESS Labs combined database and this catalog data. DOE combined the corrected catalog data and the BESS Labs data, herein referred to as the ''updated ACF database,'' and used this database for its analysis of ACFs in this NOPR.

DOE also removed outliers from the dataset using a box plot approach. For axial ACF catalog data, DOE removed extremely high-efficacy outliers and did not identify any extremely low-efficacy outliers. For axial ACFs from the BESS Labs combined database, DOE only removed extremely high-efficacy outliers because ACFs in the BESS Labs combined database are generally expected to have higher efficacies than the overall ACF market. DOE did not remove outliers for housed centrifugal ACFs.

3. Technology Options

In the February 2022 RFI, DOE identified five technology options that would be expected to improve the efficiency of ACFs, as expected to be measured by a future DOE test procedure. These technology options were improved aerodynamic design, blade shape, more efficient motors, material selection, and variable-speed drives (''VSDs''). 87 FR 7048, 7052. In the October 2022 NODA, DOE focused its analyses on aerodynamic redesign and more efficient motors. 87 FR 62038, 62042. In response to the October 2022 NODA, the CA IOUs suggested that DOE investigate individual components of improved aerodynamic design so that incremental efficiency levels could be evaluated in the engineering analysis. (CA IOUs, No. 127 at p. 2) DOE has since identified several additional technology options that would be expected to improve the efficiency of GFBs and ACFs, including options that are components of aerodynamic design. The technology options that DOE considered for this NOPR are:

- Improved housing design;
- Reduced manufacturing tolerances;
- Addition of guide vanes;
- Addition of appurtenances;
- Improved impeller design;
- Impeller topology;
- Increased impeller diameter;
- Impeller material;
- More efficient transmissions;
- More efficient motors; and
- Motor controllers.

DOE notes that not every technology option listed above will be analyzed for each equipment class in this NOPR. For example, DOE did not analyze increased impeller diameter for ACFs because impeller diameter is used to separate ACF equipment classes (*see* section IV.A.1.b). The following discussion provides a brief overview of the technology options under consideration and addresses stakeholder comments that DOE has received on the October 2022 NODA.

Improved housing design includes any changes to the enclosure of a fan, such as modifying the volute[55] for centrifugal fans or reducing the blade-to-housing clearance for axial fans. In response to the October 2022 NODA, the CA IOUs stated that a fan's blade-to-housing clearance determines its static pressure capabilities and efficiency, and fans with larger clearances generally have lower efficiency. They also stated that the use of a wall ring can improve the efficiency of an ACF. (CA IOUs, No. 127 at pp. 2–3) DOE has considered the addition of a wall ring under the ''improved housing design'' technology option. Additionally, DOE considered the effects of reduced running clearances as a component of the ''reduced manufacturing tolerances'' technology option. During manufacturer interviews, manufacturers stated that reducing the manufacturing tolerances for fan components can increase efficiency. Therefore, DOE considered reduced manufacturing tolerances as a technology option for this NOPR.

The addition of guide vanes reduces pressure loss by directing and smoothing airflow as it exits a fan. DOE observed in its market research that the integration of guide vanes into the outlet of a fan can improve efficiency by over 10 percent. For example, DOE observed that vane axial fans can achieve up to 20-percent higher FEIs than similarly sized tube axial fans. Appurtenances are similar to guide vanes but are not integral to the fan—rather, appurtenances can be added to change the performance of a fan and fans may be sold with different appurtenances to provide the end user with the desired effect. In the October 2022 NODA, DOE summarized a comment from ebm-papst stating that the use of outlet guide vanes or appurtenances, such as inlet cones on housings or winglets on impellers, could improve the fan efficiency. 87 FR 62038, 62042. DOE recognizes that the addition of appurtenances described by ebm-papst has the potential to increase fan efficiency. Therefore, DOE considered the addition of guide vanes and appurtenances as technology options in this NOPR.

Regarding impeller design, DOE considered any aerodynamic improvement of an impeller that does not include a change to its topology under the impeller design technology option. This includes modifications, such as incorporating beneficial ridges into the blade surface as well as improving impeller blade surface quality. DOE observed the presence of these modifications to blade design during teardowns of GFBs and ACFs. Therefore, DOE considered improved impeller design as a technology option in this NOPR.

Regarding fan impeller topology, DOE considered changes in the orientation or basic shape of the blades, such as switching from a backward-curved blade to an airfoil blade. In the October 2022 NODA, DOE summarized a comment from the Joint Commenters encouraging DOE to evaluate more efficient blade designs as a technology option because of their energy savings potential. The Joint Commenters added that the use of advanced blade designs,

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[54] AMCA's certified product database for ACFs can be found at *www.amca.org/certify/certified-product-search/product-type/air-circulating-fan.html* (last accessed 4/10/23).

[55] A volute is a spiral or scroll-shaped housing used with centrifugal fans.

such as airfoil blades, can improve the efficiency of a fan relative to traditional single-thickness blades. 87 FR 62038, 62042. In addition, DOE received comment from the CA IOUs in response to the October 2022 NODA stating that impeller blades may have either a ''true'' or ''progressive'' pitch, and that the pitch of the blades will affect efficiency. (CA IOUs, No. 127 at p. 2) DOE's research and feedback received during manufacturer interviews also indicated that certain impeller topologies can be more efficient than others. Therefore, DOE considered impeller topology as a technology option.

In response to the October 2022 NODA, AHAM commented that DOE's use of general blade design as a technology option for ACFs did not factor in specific differences in application of different blade shapes between unique fan configurations, including ACFs with horizontal axes, ACFs with vertical axes, or bladeless ACFs. AHAM added that DOE has not tested these different fan configurations. (AHAM, No. 123 at p. 8) DOE notes that the DOE test procedure specifies testing ACFs only in a horizontal configuration. DOE also notes that bladeless fans are excluded from the proposed scope for ACFs, as discussed in section III.B.2 of this document. Therefore, DOE did not consider differences in axis orientation or bladeless fans in its evaluation of ACF impeller topology or improved impeller design.

DOE received feedback during confidential GFB manufacturer interviews that increasing the diameter of a fan impeller can improve the efficiency of a fan. Additionally, when comparing fans on the market with different diameters and otherwise similar characteristics, DOE observed that fans with larger diameters were typically more efficient for certain equipment classes; therefore, DOE considered increased impeller diameter as a technology option in this NOPR.

When reviewing available data from the market, its databases, and information received during confidential manufacturer interviews, DOE could not distinguish between the effects of improved housing design, reduced manufacturing tolerances, addition of appurtenances, and improved impeller design on the performance of GFBs; therefore, DOE has grouped these technology options together and collectively refers to them as ''aerodynamic redesign'' for GFBs in the remainder of this document. For ACFs, DOE additionally lacked quantitative efficiency data regarding specific impeller topologies and the addition of guide vanes, and therefore grouped the addition of guide vanes as well as any blade adjustments that improve the efficiency of ACFs, such as the curvature or pitch, along with improved housing design, reduced manufacturing tolerances, addition of appurtenances, and improved impeller design under the umbrella of aerodynamic redesign for ACFs in the remainder of this document. The technology options considered under aerodynamic redesign for both GFBs and ACFs are summarized in Table IV–7.

DOE previously considered ''material selection'' in general as a technology option in the February 2022 RFI. 87 FR 7048, 7052. For this NOPR, DOE is clarifying that material selection is specific to impeller materials. DOE did not receive comments from stakeholders pertaining to material selection for either the February 2022 RFI or the October 2022 NODA; however, during confidential interviews, manufacturers stated that minimal efficiency gains would be achieved by changing the blade material. When reviewing manufacturer fan selection software data, DOE identified similar fans with different blade materials and investigated the impact of different materials on FEI. Consistent with manufacturer feedback, DOE found that material selection of the impeller had minimal or no impact on efficiency for either GFBs or ACFs. Therefore, DOE did not consider material selection as a technology option in this NOPR.

With regard to transmissions, DOE notes that the DOE test procedure includes a loss factor associated with belt-drive transmissions, while direct-drive transmissions are treated as having no loss when calculating efficiency. This indicates that replacing a belt-drive with a direct-drive transmission can improve efficiency. For ACFs, DOE considered the change from belt-drive to direct-drive as a technology option. For GFBs, as discussed in section IV.A.1.a, DOE is proposing to establish separate equipment classes for GFBs sold with or without motor controllers to account for the added utility provided by GFBs with motor controllers (*i.e.,* variable-speed operation to allow a fan to adapt to changing load requirements). Belt-drive transmissions can be manually adjusted during installation to achieve all airflow and pressure operating requirements in a fan's operating range for different field applications, whereas direct-drive fans would only be able to achieve all operating points within the fan's operating range if paired with a motor controller. As a result, DOE did not consider the shift from belt-drive to direct-drive transmission as a technology option for GFBs to maintain the added utility provided by belt-drive transmission.

Regarding motors, motor efficiency can depend on motor topology as well as the individual design features of a single motor topology. For example, most motors used in ACFs are permanent split capacitor (''PSC'') motors, and these motors have a wide range of operating efficiencies. In addition, some ACFs use electronically commutated motors (''ECMs''). ECMs operate in a higher efficiency range than PSC motors, so using an ECM may improve the overall efficiency of an ACF. In this NOPR, DOE considers both switching to a more efficient motor topology and improved efficiency of a single motor topology in the more efficient motors technology option.

For GFBs, DOE learned from confidential manufacturer interviews that motors are not always sold as integral parts of a fan. Many sales of GFBs do not include a motor and require the customer to provide this part. Furthermore, the motors used for GFBs are nearly all 3-phase induction motors currently regulated by DOE, including motors between 100 and 150 hp. *See* 10 CFR 431.25. On June 1, 2023, DOE published an energy efficiency standards direct final rule for these electric motors. 88 FR 36066. In this rule, DOE increased the minimum required efficiency of induction motors between 100 and 250 hp from IE 3 to IE 4. 88 FR 36066, 36144. IE 3 and IE 4 motor efficiencies are defined in IEC 60034–30–1:2014: ''Rotating Electrical Machines—Part 30–1: Efficiency classes of line operated AC motors (IE code),'' (''IEC 60034–30–1:2014'') published by the International Electrotechnical Commission. The compliance date of this rule is June 1, 2027 and any standards promulgated as a result of this fans rulemaking would take effect after that date.

Because of the new 2027 electric motor standards, there will be impacts on the motor market from a product availability, size, and technology standpoint as the efficiency moves from IE 3 to IE 4. These changes would need to be considered in this rulemaking, but electric motor manufacturers are still in the design and planning process to migrate their product offerings to be in compliance with the 2027 electric motors standards recently adopted. If DOE were closer to the 2027 compliance date or this was a first-time regulation for these induction motors, DOE would be able to better understand how manufacturers were going to fully respond and the innovations that may be introduced into the market to be able to carefully consider how the motors offerings could be considered as part of the CIFB designs affecting the fan efficiencies. At this time, DOE does not have sufficient data to fully evaluate the impact of those efficiency and technology changes on the proposed efficiency levels (''ELs''). DOE has therefore not evaluated more efficient motors as a technology option for GFBs in this NOPR; however, DOE may consider more efficient motors as a viable technology option for improving GFB efficiency in a future rulemaking.

DOE evaluated more efficient motors for ACFs in the October 2022 NODA. 87 FR 62038, 62042. DOE also assumed that all ACFs are sold with a motor. *Id.* Furthermore, DOE requested comment on its estimated base manufacturer production cost for ACFs excluding motors. 87 FR 62038, 62053. In response, AMCA commented that, to the best of its knowledge, ACFs are always sold with motors. (AMCA, No. 132 at p. 12) In this NOPR, DOE therefore continued with its assumption that all ACFs are sold with motors.

In the October 2022 NODA, DOE assumed that most motors paired with ACFs are lower efficiency induction motors that were not regulated by DOE and requested comment on that assumption. 87 FR 62038, 62042. DOE also requested data on the percentage of ACFs sold with split-phase, PSC, shaded-pole and ECMs. 87 FR 62038, 62049. In response, AMCA commented that some of its members sell ACFs with shaded-pole motors, PSC motors, polyphase motors, or ECMs. (AMCA, No. 132 at p. 3) NEMA commented that, depending on the horsepower requirements, a split-phase, shaded-pole, capacitor start/capacitor run, or three-phase motor could be used for ACFs. NEMA added that shaded-pole motors are often used at 0.1 hp and under for ACFs, while PSC motors are very common for 1 hp and under. (NEMA, No. 125 at p. 3) In response to this feedback, DOE conducted a review of its updated ACF database (discussed further in section IV.A.2.b) and identified ACFs sold with multiple different motor topologies, including PSC, polyphase, and EC motors. Additionally, DOE identified many ACFs using PSC motors at high and low motor efficiencies. Because DOE has identified that ACF motor efficiency may be improved through changing motor topology as well as improving efficiency within a single motor topology, it considered both switching to a more efficient motor topology and improving efficiency within a single motor topology as components of the more efficient motors technology option for ACFs.

Regarding motor controllers, motor controllers are used to change the operating point of fans by altering their motor speed. This allows a fan to operate at a lower speed when possible, which can result in a reduction of power consumption. In response to the October 2022 NODA, the Efficiency Advocates encouraged DOE to evaluate fans that operate at multiple speeds, rather than just the highest speed, because lowering the fan speed can significantly reduce the amount of power used by a fan. (Efficiency Advocates, No. 126 at p. 2–3) Conversely, AMCA stated that the utility of ACFs to provide the necessary air-throw distance and air velocity may be diminished or removed entirely by reducing the fan speed with motor controllers, which is a negative impact on product utility. (AMCA, No. 132 at p. 3) While DOE acknowledges that fan power consumption can be reduced by lowering the speed of a fan, it notes that the DOE test procedure for ACFs specifies testing and reporting efficacy for ACFs at the maximum speed of the fan. *See* appendix B to subpart J of 10 CFR part 431, section 2.2.1. DOE's analysis in this NOPR remains consistent with the DOE test procedure for ACFs, so DOE did not evaluate efficiencies at less than maximum speed. Therefore, DOE did not consider motor controllers as a technology option for ACFs in this NOPR.

In response to the October 2022 NODA, the CA IOUs commented that choosing a low-speed range for a particular impeller improves its efficiency. (CA IOUs, No. 127 at p. 2) DOE notes the speed and operating point of a fan are strongly related and that any change to the speed of a fan will likely change the utility of that fan. Therefore, DOE did not consider reduced speed as a technology option for this NOPR.

As discussed in section IV.A.1.a, GFBs with motor controllers allow a fan to adapt to changing load requirements. While this may result in energy savings during application, the DOE test procedure for fans does not account for these possible changes in operation and energy savings. As a result, DOE is proposing to establish separate equipment classes for GFBs sold with and without motor controllers and is not considering motor controllers as a technology option.

Table IV–7 lists the technology options for GFBs and ACFs that DOE evaluated in its screening analysis. Both GFBs and ACFs include an aerodynamic redesign technology option, which contains technology options that DOE determined to be viable, but for which DOE lacked sufficient data to fully analyze individually.

Table IV-7 Technology Options Evaluated in this NOPR

GFBs	ACFs
• Aerodynamic redesign ○ improved housing design ○ reduced manufacturing tolerances ○ addition of appurtenances ○ improved impeller design • Addition of guide vanes • Impeller topology • Increased impeller diameter	• Aerodynamic redesign ○ improved housing design ○ reduced manufacturing tolerances ○ addition of appurtenances ○ improved impeller design ○ addition of guide vanes ○ impeller topology • Increased impeller diameter • More efficient transmissions • More efficient motors

Further details on technology options that DOE considered for this NOPR can be found in chapter 3 of the NOPR TSD.

B. Screening Analysis

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

(1) *Technological feasibility.* Technologies that are not incorporated in industrial equipment or in commercially viable, existing prototypes will not be considered further.

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

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

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

(5) *Unique-pathway proprietary technologies.* If a technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns.

10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(c)(3) and 7(b).

In summary, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed five criteria, it will be excluded from further consideration in the engineering analysis.

Through a review of each technology, DOE tentatively concludes that the technologies listed in Table IV–7 of this document met all five screening criteria to be examined further as design options in DOE's NOPR analysis. Comments DOE received regarding screening for these technologies are discussed below.

In response to the October 2022 NODA, DOE received several comments pertaining to how the screening criteria apply to aerodynamic redesign, blade shape, and motors. AMCA stated that aerodynamic efficiency improvements can often lead to an increase in the cost and complexity of manufacturing, which can have an adverse impact on the practicability of manufacturing. AMCA added that some ACF components that can be adjusted to improve efficiency are patentable, including impellers, impeller blades, impeller rings, housings, outlet appurtenances, and motors, which relates to the screening criteria for unique-pathway proprietary technologies. (AMCA, No. 132 at p. 3). AMCA also commented that the removal of a safety guard on an ACF to increase its efficiency would decrease the safety of an ACF, which is an adverse impact on health or safety. *Id.*

Regarding AMCA's comment on the potential for increased cost or complexity of manufacturing associated with an aerodynamic redesign, DOE notes that it accounted for this increased cost and complexity through conversion costs, which are discussed in section IV.J. Regarding patentable technologies, DOE notes that in manufacturer interviews, it specifically asked about whether patentable technologies could pose a problem in meeting energy conservation standards. In response, no GFB or ACF manufacturers expressed concerns regarding patents. Therefore, DOE has tentatively concluded that none of the proposed design options meet the unique pathway-proprietary technologies screening criteria.

In terms of safety guards, DOE agrees that the removal of a safety guard would compromise the safety of a fan.

DOE notes that the motor efficiency technology options are based on general industry standards rather than specific motor designs that could be patented; therefore, DOE has tentatively concluded that the unique-pathway proprietary technologies screening criterion does not apply to the more-efficient motor technology option.

DOE did not receive comment related to screening for any other technology options. The remaining technology options that DOE did not screen from its analysis are listed in Table IV–8.

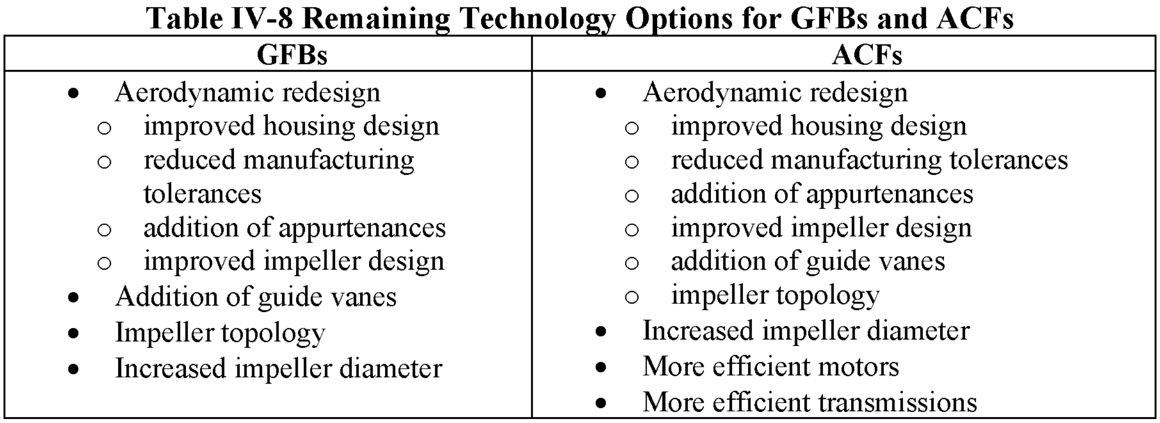

Table IV-8 Remaining Technology Options for GFBs and ACFs

GFBs	ACFs
• Aerodynamic redesign ○ improved housing design ○ reduced manufacturing tolerances ○ addition of appurtenances ○ improved impeller design • Addition of guide vanes • Impeller topology • Increased impeller diameter	• Aerodynamic redesign ○ improved housing design ○ reduced manufacturing tolerances ○ addition of appurtenances ○ improved impeller design ○ addition of guide vanes ○ impeller topology • Increased impeller diameter • More efficient motors • More efficient transmissions

DOE has initially determined that these technology options are technologically feasible because they are being used or have previously been used in commercially available equipment or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (*i.e.,* practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety, unique-pathway proprietary technologies). For additional details, see chapter 4 of the NOPR TSD.

C. Engineering Analysis

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

1. General Fans and Blowers

a. Baseline Efficiency

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

As discussed in section II.B.1, there are currently no energy conservation standards for GFBs. In this analysis, DOE set the baseline efficiency as the lowest reasonable efficiency on the market after removing potential outliers for each analyzed equipment class.

DOE established baseline ELs using performance data in the AMCA sales database. DOE filtered the database by equipment class and evaluated the fan performance range for each equipment class. Additionally, as described in section IV.A.3, DOE based its GFB analysis on design options that specifically improve fan performance. DOE did not consider improvements to the motor, transmission, or motor controllers. Therefore, for this analysis, DOE calculated FEI according to the bare shaft method described in the DOE Test Procedure. *See* sections 2.2 and 2.6 of appendix A to subpart J of 10 CFR part 431. For both the AMCA sales database and any manufacturer fan selection software data, DOE recalculated FEI on a bare shaft basis. Accordingly, the standards proposed in this notice are based only on fan design and exclude any impact that the motor, transmission, or motor controllers may have on fan efficiency.

Based on a review of the market, DOE tentatively determined that the FEI values corresponding to the 5th percentile in the AMCA sales database were generally representative of baseline efficiency across all diameters and duty points within a given equipment class. Defining baseline efficiency at the 5th percentile enabled DOE to remove potential outlier fans and fans that may no longer exist on the market. DOE compared the 5th percentile for each equipment class to data retrieved from manufacturer fan selection software to ensure that baseline efficiencies were representative of the current market. In instances where the 5th percentile removed a substantial number of models that had FEI values consistent with what was seen on the market, DOE adjusted the baseline efficiency to align with the distribution of FEIs observed in the manufacturer fan selection software. Additional details on the development of baseline efficiency levels for each equipment class are included in chapter 5 of the NOPR TSD.

b. Selection of Efficiency Levels

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

In this NOPR, DOE relied on a combination of the efficiency level and design-option approaches. DOE used the efficiency level approach to determine the baseline, max-tech, and aerodynamic redesign efficiency levels and used the design-option approach to gap fill intermediate efficiency levels.

General Approach

DOE applied design options to the initial efficiency levels evaluated above baseline for each equipment class. As discussed in section IV.A.3, DOE has identified the following design options for GFBs:

- Impeller topology;
- Addition of guide vanes;
- Increased impeller diameter; and
- Aerodynamic redesign (improved housing design, reduced manufacturing tolerances, addition of appurtenances, improved impeller design).

For each equipment class, DOE evaluated both the AMCA sales database as a whole and data from manufacturer fan selection software for specific representative diameters and operating points to set the efficiency levels and associated design options for its analysis. DOE used data pulled from manufacturer fan selection software to understand the incremental impact of design options on fan performance and cost. DOE then applied these incremental FEI increases to the baseline fan for each equipment class to set intermediate efficiency levels.

To estimate the incremental increases in FEI, DOE first selected between three and six representative operating points based on the fan diameters, operating pressures, and airflows that were most common for each equipment class in the AMCA sales database, as discussed in section IV.A.2.a. DOE then used manufacturer fan selection software to obtain data for each representative operating point at a specific diameter, airflow, and pressure. From the manufacturer fan selection software, DOE evaluated how FEI changed as various design options were applied while holding constant the diameter (for all equipment classes except PRVs) and duty point. DOE calculated bare shaft FEI for fans evaluated using manufacturer fan selection software to eliminate the effects of transmission on the efficiency. Additional details on how manufacturer fan selection software was evaluated and used in the development of intermediate efficiency levels are included in chapter 5 of the NOPR TSD.

DOE recognizes that relying on data from fans at representative diameters and operating points to characterize efficiency improvements may not sufficiently account for the entire range of duty points and diameters typical for each equipment class. Therefore, after determining the impact of potential design options on fan efficiency using the manufacturer fan selection software, DOE used the AMCA sales database to validate the estimated incremental FEI increases for each design option. In its review of the market, DOE found that most manufacturer model numbers correspond to a specific impeller type and design. To make comparisons between fan models in the AMCA sales database, DOE used the model numbers included in the AMCA sales database to characterize each fan's impeller. DOE then evaluated the potential efficiency gain of each design option across the entire range of operating points in the AMCA sales database. For example, for centrifugal housed fans, DOE calculated the average increase in FEI that would be observed for a fan with a backward-inclined impeller at a given diameter compared to a fan with a forward-curved impeller at the same diameter. DOE evaluated the AMCA sales database in this way to confirm that its estimated increases in FEI seemed feasible across the range of operating duty points, since the AMCA sales database contains data points at a variety of duty points for each equipment class.

In response to the July 2022 TP NOPR, AHRI commented that fan performance in the AMCA sales database was never confirmed to be reflective of embedded fans, including system effect, and that finalizing the determination using the analysis conducted to date, especially if embedded fans are within the scope, would be inappropriate. (Docket No. EERE–2021–BT–TP–0021, AHRI, No. 40 at p. 13) DOE notes that, as discussed in III.B.1, embedded fans listed in Table III–1 are outside the scope of this analysis. All other fans within the scope of this rulemaking would be tested in accordance with the DOE test procedure, which reflects performance of fans outside of equipment into which they may be installed and does not evaluate system effects.

Additionally, in response to the October 2022 NODA, Morrison suggested that the data evaluation and analysis conducted in the 2016 NODA should be restarted to address current stakeholder concerns and account for changes in the market environment, including widespread adoption of building codes and use of the FEI metric. (Morrison, No. 128 at p. 3) In response to the July 2022 TP NOPR, AHRI commented that it is not reasonable to assume that substitutions can be made for any fan within 20 percent of static pressure or airflow requirements and within two inches of the original diameter tolerances. AHRI stated that selecting a fan that two inches larger in diameter would translate to a four-inch increase in housing size. Additionally, AHRI commented that commercial heating, ventilation, and air conditioning (''HVAC'') equipment fan selection requires design to a specific airflow and static pressure and that in virtually all cases, a two-percent selection window is required so the 20 percent selection window would not satisfy the heating, cooling or ventilation needs for the application. (Docket No. EERE–2021–BT–TP–0021, AHRI, No. 40 at p. 12–13) Furthermore, AHRI commented that variable air volume systems and systems with economizers need to operate over a range of airflow. Low static, high airflow fans (forward-curved fans) are used in these applications; therefore, the number of fans that would require redesign is closer to 100 percent than the 30 percent included in the NODA 3 (2016 NODA) analysis. *(Id.)*

DOE notes that all analyses from the 2016 NODA have been reevaluated in this NOPR to reflect current market trends and industry standards. While DOE maintained some structural elements from the 2016 NODA, such as some equipment classes and use of the AMCA sales database, DOE updated its efficiency levels and cost analyses based on manufacturer feedback from recent interviews, publicly available sales data, and a thorough review of the current market. Additionally, in this analysis, DOE did not assume that static pressure or airflow could vary by 20 percent or that the diameter of embedded fans could increase by any amount. In its analysis for this NOPR, DOE evaluated efficiency increases with operating point and diameter remaining constant for fan equipment classes that could be embedded in equipment, which is discussed in more detail in section IV.C.1.b (subsection Determination of Efficiency Levels). Additionally, DOE's analysis reflects that forward-curved fans should be preserved in the market and would likely be redesigned to do so. In section IV.C.1.b (see subsection Parallel Design Path for Forward-curved Fans), DOE describes how it analyzed forward-curved fans. DOE also evaluated the potential impact of duty point on whether a fan could be redesigned to higher FEI levels. Using the AMCA sales database, DOE developed FEI distributions for each equipment class to evaluate how FEI varied with specified design pressure, airflow, and diameter. Based on these FEI distributions, DOE was not able to identify any duty point ranges with disproportionately lower fan availability at higher FEI values for any equipment class. DOE has tentatively determined that the efficiency relationships it developed based on the selected representative operating points could be applied to fans at other diameters and duty points; therefore, there is only one set of efficiency levels for each equipment class.

Determination of Efficiency Levels

The first design option that DOE evaluated for most equipment classes was changing the fan impeller. Based on its review of the market, DOE determined that manufacturers often have a variety of impeller topologies available for each fan class. For example, some manufacturers have economy impellers, which are less efficient and less expensive than other available impellers. DOE also found that manufacturers may have impellers that are designed to operate at different duty points, such as high-pressure impellers. These impellers achieve different levels of performance based on blade shape, blade pitch, number of blades, etc. Therefore, rather than attempt to characterize each of these individual impellers and how they may impact FEI, DOE evaluated manufacturer fan selection software to estimate the average increase in FEI for a typical impeller change for each equipment class and then used the AMCA sales database to validate that these increases are applicable to the broader fans market. DOE notes that the centrifugal housed equipment class is the only equipment class for which specific impeller changes were characterized. This is because DOE was able to identify distinct differences in efficiency between forward-curved, backward-inclined or backward-curved,[56] and airfoil impellers for centrifugal housed fans. The impeller change design options were either applied to the baseline fan or applied successively to a previous impeller change.

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[56] In reviewing both the AMCA sales database and manufacturer fan selection software, DOE was unable to distinguish between backward-inclined and backward-curved impellers for many fan models. It is also DOE's understanding that both backward-inclined and backward-curved impellers perform similarly regarding fan efficiency. Therefore, DOE considered both backward-inclined and backward-curved impellers together as a single design option.

DOE followed a similar method of analyzing both the manufacturer fan selection software and the AMCA sales database to estimate the increase in FEI that could be achieved for design options other than impeller changes, including substituting a tube axial fan for a vane axial fan, substituting a mixed flow fan for a centrifugal inline fan, and increasing the PRV fans diameter. Additional details on how DOE estimated the incremental increases in FEI for each design option and for each equipment class are included in chapter 5 of the NOPR TSD.

For many categories of fans, increasing the diameter of a fan could increase efficiency when a fan operates at the same duty point; however, during manufacturer interviews, DOE received feedback that increasing the diameter of a fan is only applicable to certain fan classes. Specifically, DOE learned that increasing the diameter of a fan that would be embedded in OEM equipment could impact the overall performance of the equipment, could impact its utility for use in space-constrained OEM equipment, and would substantially increase OEM redesign costs. Alternatively, for fan types that do not have space-constraints, a fan could typically be increased by one or two sizes without impacting the utility of the fan.

For fan equipment classes that could be embedded, either into other equipment or into spaced constrained applications, such as ducted ventilation systems, DOE did not consider increased impeller diameter as a design option. These types of fans include axial inline, panel, centrifugal housed, centrifugal unhoused, and centrifugal inline fans.

For radial fans, DOE analyzed the diameter increase design option since this fan class is typically not used in space-constrained applications; However, DOE did not observe consistent efficiency changes with increased diameter for radial fans; therefore, DOE did not consider larger fan diameter as a design option for radial fans.

In general, PRVs (axial PRV, centrifugal PRV exhaust, and centrifugal PRV supply) are not subject to the same size and weight constraints experienced by other embedded fan classes. These units are placed in open air environments to supply or exhaust air from the top of a building, which enables them to increase in size. DOE found that increasing PRV diameter consistently increases the efficiency; therefore, DOE considered diameter increase as a design option for axial and centrifugal PRVs.

DOE requests comment on its understanding that the diameter increase design option could be applied to non-embedded, non-space-constrained equipment classes.

In its analysis for axial and centrifugal PRVs, DOE used an 18-percent increase in diameter to represent a diameter increase and rounded the impeller diameter to the nearest whole number, since DOE found that the 18-percent increase was representative of the fan sizes available on the market. For example, the increased diameter design option for a 15-in. diameter fan would increase the fan diameter to 18-in. and a 36-in. diameter fan would increase to a 42-in. diameter fan. When analyzing its data sources, DOE found that this 18 percent diameter increase when maintaining the operating point could result in a range of FEI increases, from as low as 4-percent to as high as 30-percent, corresponding to a FEI increase of approximately 0.03 to 0.30. For this NOPR analysis, DOE assumed that a diameter increase for centrifugal PRV exhaust and supply fans would result in a 0.03 increase in FEI and a diameter increase for axial PRV fans would result in a 0.09–0.10 increase in FEI. DOE recognizes that initial diameter size, operating airflow, and operating pressure may impact how effective an impeller diameter increase is for increasing FEI. Specifically, the duty points that DOE chose to evaluate may be duty points where a diameter increase is very effective at increasing fan efficiency or may be duty points where a diameter increase has minimal impact on fan efficiency. DOE could adjust the efficiency gains from an impeller diameter increase in its analysis so that there is a larger FEI gain for all PRVs, and where PRVs could reach higher FEI values for a lower cost. Alternately, DOE could decrease the FEI gain for axial PRVs from an impeller diameter increase, allowing axial PRVs to reach higher FEI values for a higher cost since the impeller diameter increase would no longer provide such a large increase in FEI.

DOE requests comment on whether the FEI increases associated with an impeller diameter increase for centrifugal PRVs and for axial PRVs are realistic. Specifically, DOE requests comment on whether it is realistic for axial PRVs to have a FEI increase that is 3 times greater than that for centrifugal PRVs when starting at the same initial diameter. Additionally, DOE requests comment on the factors that may impact how much an impeller diameter increase impacts a FEI increase.

In its analysis, DOE applied the impeller changes and aerodynamic redesigns for PRVs to the baseline fan such that PRVs could reach higher efficiency levels while maintaining the baseline impeller diameter. While manufacturers would have the option of achieving higher efficiencies by increasing fan diameter, DOE assumed that if manufacturers were to change the impeller or redesign a PRV, manufacturers would apply these design changes to their entire diameter range, enabling the baseline diameter fan to reach the higher efficiency levels.

The design path for all PRVs is shown in Table IV–11. For the PRV equipment classes, the impeller change(s) and diameter increase(s) are ordered by FEI increase, where the design option with the smallest FEI increase is ordered first. DOE could consider an analysis with a different ordering of design option based on MSP increase or cost-effectiveness. Alternately, DOE could consider an analysis that does not include increased fan diameter as a design option. In this alternative analysis, DOE could consider an additional impeller change as a design option to increase FEI. However, based on its analysis, DOE expects that removing increased fan diameter as a design option in its analysis would increase the cost to achieve a higher efficiency of a PRV.

DOE requests comment on the ordering and implementation of design options for centrifugal PRV exhaust and supply fans and axial PRV fans.

DOE additionally determined that manufacturers may improve efficiency through aerodynamic redesign, as described in section IV.A.3 of this document. It is DOE's understanding that aerodynamic redesign may require significant product and capital investment. Accordingly, DOE only applied aerodynamic redesign after applying the design options DOE expected would be less cost-intensive for manufacturers. Additionally, the impact of aerodynamic redesign on efficiency is expected to vary significantly depending on the design choices made by the manufacturer. Therefore, DOE determined that the design option approach would not be appropriate for evaluating efficiency improvements for aerodynamic redesign. Instead, DOE evaluated aerodynamic redesign using the efficiency level approach. Generally, DOE set the FEIs for aerodynamic redesigns by assigning evenly spaced FEIs between the highest non-redesign EL (*i.e.,* the EL immediately before the first aerodynamic redesign) and the max-tech EL. A numerical example demonstrating how FEIs were assigned to the aerodynamic redesign ELs for the centrifugal PRV exhaust equipment class is provided in the following section.

Existing Efficiency Standards

DOE also evaluated other efficiency programs to inform the development of its efficiency levels. Energy efficiency provisions for commercial fans are prescribed in U.S. building codes, primarily developed by the International Code Council and specified in the International Energy Conservation Code (''IECC''). The IECC was most recently updated in 2021 (''IECC–2021'') and specifies that commercial buildings shall comply with the requirements of ASHRAE 90.1.[57] The most recent edition of ASHRAE 90.1 was published in September 2022, and sets an FEI target of 1.00 for all fans within the scope of ASHRAE 90.1.[58] While the standards established under IECC and ASHRAE 90.1 are not federally mandated, they are used by individual States and municipalities to support the development of local building codes. DOE is also aware that the CEC has finalized a rulemaking, which requires manufacturers to report fan operating boundaries that result in operation at an FEI of greater than or equal to 1.00 for all fans within the scope of that rulemaking.[59] Furthermore, during confidential manufacturer interviews, DOE received feedback that an FEI of 1.00 is a realistic efficiency target and DOE does not have any indication that an FEI of 1.00 would not be achievable for all fan equipment classes.

Based on this feedback and to align with the aforementioned standards, DOE elected to evaluate an efficiency level at an FEI of 1.00 for all fan classes. The efficiency level and design option that corresponds to an FEI of 1.00 differs for each equipment class depending on the FEI difference between the baseline and max-tech efficiency levels for each equipment class and the efficiency gain identified for each design option. For the axial inline, centrifugal inline, and centrifugal unhoused equipment classes, DOE determined that an FEI of 1.00 could be achieved using the identified design options. Therefore, each of these equipment classes has specific design options associated with the EL set at an FEI of 1.00. For example, for the centrifugal inline equipment class, DOE tentatively determined through the design option approach that an FEI of 1.00 could be achieved by using a mixed flow impeller (EL 3). For all other equipment classes, DOE assumed that manufacturers could achieve an FEI of 1.00 through an aerodynamic redesign.

For equipment classes that had an aerodynamic redesign assigned at an EL with an FEI of 1.00, DOE evenly spaced all other aerodynamic redesign ELs at FEIs above and below a value of 1.00, where applicable. For example, the centrifugal PRV exhaust equipment class has a total of four aerodynamic redesign ELs, with the second aerodynamic redesign (EL 4) corresponding to an FEI of 1.00. The highest non-redesign EL occurs at EL 2, corresponding to an FEI of 0.76, and max- tech occurs at EL 6, corresponding to an FEI of 1.37. Therefore, the first aerodynamic redesign was set at the midpoint between EL 2 and EL 4, corresponding to an FEI of 0.88, and the third aerodynamic redesign was set as the midpoint between an FEI of 1.00 and the max-tech EL, corresponding to an FEI of 1.19.

Parallel Design Path for Forward-Curved Fans

DOE received feedback during interviews that forward-curved impellers should be preserved in the market because they offer distinct utility over backward-inclined or airfoil impellers and typically operate at lower pressures where efficiency is inherently lower. However, as discussed in section IV.A.1.a, DOE has tentatively determined that forward-curved fans do not require a separate equipment class since the FEI metric is a function of operating pressure and accounts for the inherently lower efficiency at lower pressures.

Instead, to assess any costs associated with preserving forward-curved fans, DOE evaluated two parallel design paths for centrifugal housed fans. DOE used the first design path (hereafter referred to as the ''primary design path'') to evaluate all fans with impellers other than forward-curved impellers. For the primary design path, DOE observed a significant number of fans with backward-inclined impellers that exhibited FEIs similar to those with forward-curved impellers, despite backward-inclined impellers generally being more efficient. Therefore, DOE assigned the same baseline FEI to both design paths and assumed baseline efficiency on the primary design path to be represented by an inefficient backward-inclined fan which would meet EL 1 via aerodynamic redesign of the backward-inclined impeller. EL 2 on the primary design path represents substituting a more typical backward-inclined impeller with an airfoil impeller to achieve an FEI of 1.00.

For the second design path (hereafter referred to as the ''forward-curved design path''), DOE assumed that the baseline efficiency was represented by a forward-curved fan that would meet all subsequent ELs via aerodynamic redesign while maintaining a forward-curved impeller. The design options for both design paths are summarized in Table IV–9 and additional details on how DOE defined the efficiency levels for the separate centrifugal housed design paths are provided in chapter 5 of the NOPR TSD.

Additionally, for the forward-curved design path, EL 4 approaches max-tech for forward-curved fans. Although DOE identified fans with forward-curved impellers above this EL, DOE could not confirm that forward-curved fans could be designed above this EL at all duty points. Therefore, DOE defined the third aerodynamic redesign on the forward-curved design path (EL 4) as the max-tech for forward-curved impellers and assumed that any fans above this FEI would need to transition to a backward-inclined or airfoil impeller. As such, all fans above EL 4 were analyzed using the primary design path.

DOE notes that, in practice, manufacturers may substitute forward-curved impellers with a backward-inclined or airfoil impeller to improve efficiency. However, based on DOE's review of the market and stakeholder feedback on the importance of maintaining fans with forward-curved impellers, DOE could not determine a representative percentage of forward-curved fans that would be redesigned versus substituted with a different impeller. Therefore, to avoid underestimating the costs required to preserve forward-curved impellers, DOE assumed that all forward-curved fans currently on the market would maintain their impellers and follow the forward-curve design path.

DOE utilized a dual-design path approach for centrifugal housed fans to consider the fact that manufacturers may be required to incur higher conversion costs to maintain use of forward-curved impellers. DOE estimated the costs associated with redesigning forward-curved fans using

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[57] International Code Council. ''2021 International Energy Conservation Code Chapter 4: Commercial Energy Efficiency''. September 2021. Available at *codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency.*

[58] ASHRAE. ''Standard 90.1–2022—Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.'' September 2022. Available at *www.ashrae.org/technical-resources/bookstore/standard-90-1.*

[59] California Energy Commission. Commercial and Industrial Fans and Blowers. Docket No. 22–AAER–01. Available at *efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=22-AAER-01.*

the same method used to estimate aerodynamic redesign conversion costs for all other equipment classes and product types, as discussed in section IV.J.2.c. However, DOE may revise its analysis to consider additional conversion costs for forward-curved fans if sufficient data is provided to demonstrate that these fans may experience unique challenges in meeting higher FEI values.

DOE requests comment on its approach for estimating the industry-wide conversion costs that may be necessary to redesign fans with forward-curved impellers to meet higher FEI values. Specifically, DOE is interested in the costs associated with any capital equipment, research and development, or additional labor that would be required to design more efficient fans with forward-curved impellers. DOE additionally requests comment and data on the percentage of forward-curved impellers that manufacturers would expect to maintain as a forward-curved impeller relative to those expected to transition to a backward-inclined or airfoil impeller.

Table IV-9 Centrifugal Housed Fan Design Paths

EL	Design Options – Primary Design Path	Design Options– Forward-curved Design Path
EL0	Inefficient Backward-inclined Impeller	Baseline Forward-curved Impeller
EL1	Typical Backward-inclined Impeller	Aerodynamic Redesign 1*
EL2	Airfoil Impeller	Aerodynamic Redesign 1*
EL3	Aerodynamic Redesign 1	Aerodynamic Redesign 2
EL4	Aerodynamic Redesign 2	Aerodynamic Redesign 3
EL5**	Aerodynamic Redesign 3	-

*The first aerodynamic redesign for the forward-curved design path was split into two ELs to maintain alignment with the main design path. Equivalent conversion costs were assumed for EL 1 and EL 2.
**EL 4 is assumed to approach max-tech for forward-curved fans. Therefore, all forward-curved fans are assumed to transition to a backward-inclined or airfoil impeller above EL 4 and both the primary and forward-curved design paths converge for EL 5.

Efficiency Levels for General Fans and Blowers Sold With a Motor

As discussed in the May 2023 TP Final Rule, DOE adopted the FEP and FEI calculations specified in AMCA 214–21, which provides a method for calculating the FEI of fans sold with motors based on a table of polyphase regulated motors (*See* Annex A of AMCA 214–21). 88 FR 27312, 27348. However, as discussed in the May 2023 TP Final Rule, the DOE test procedure replaces Annex A of AMCA 214–21 with a reference to the current energy conservation standards for polyphase regulated motors in 10 CFR 431.25, with the intention that the values of regulated polyphase motor efficiencies would remain up to date with any potential future updates established by DOE. 88 FR 27312, 27349.

In a final rule published on June 1, 2023, DOE finalized amended energy conservation standards for electric motors. These standards adopted amended efficiency requirements for motors rated at or between 100 hp and 250 hp. Therefore, for GFBs sold with a motor rated at or between 100 hp and 250 hp, FEI would be evaluated using the amended efficiencies specified in table 8 of 10 CFR 431.25, in accordance with the DOE test procedure. However, the motor efficiencies used to calculate the reference fan FEP have not been similarly updated based on the amended standards for electric motors. Therefore, the reference fan FEP for GFBs with a motor rated at or between 100 hp and 250 hp would be calculated using a motor efficiency that would not be compliant with the adopted energy conservation standards for electric motors and would no longer be available on the market. In other words, the reference fan used in the FEI calculation would have a lower efficiency than that required for electric motors, resulting in an inappropriately greater FEI for the tested fan.

To avoid providing an unintended advantage to these GFBs, DOE proposes that the FEI level for GFBs sold with a motor rated at or between 100 hp and 250 hp would be calculated by applying a correction factor to the FEI standard for GFBs sold with any other sized motor. This correction factor would be designed to offset the difference in motor efficiencies specified for the reference fan versus the amended motor efficiency standards. DOE found that, at a given duty point, the correction factor, A, can be expressed as a function of the motor efficiency as follows:

$$A = \frac{\eta_{mtr,2023}}{\eta_{mtr,2014}}$$

Where $\eta_{mtr,2023}$ is the motor efficiency in accordance with table 8 at 10 CFR 431.25, and $\eta_{mtr,2014}$ is the motor efficiency in accordance with table 5 at 10 CFR 431.25 and Annex A of AMCA 214–21, and FEP_{act} is determined according to the DOE test procedure in appendix A to subpart J of part 431. The FEI in accordance with the proposed TSL would be multiplied by this correction factor to result in the FEI standard. For fans with motors rated below 100 hp, the correction factor, A, would be equal to 1.00. DOE is also proposing to add the motor efficiency requirements specified in Table 5 at 10 CFR 431.25 for motors rated at or between 100 hp and 250 hp in 10 CFR 431.175 and reference these values for the correction factor calculation to ensure that these motor efficiency values are not inadvertently removed in any separate motors rulemakings.

Efficiency Levels for General Fans and Blowers With a Motor Controller

As discussed in the May 2023 TP Final Rule, DOE adopted the FEP and FEI calculation as specified in AMCA 214–21 but did not develop a control credit for fans with a controller to offset the losses inherent to the motor controller when calculating the FEI of these fans at a given duty point. In the May 2023 TP Final Rule, DOE stated that, to the extent use of a controller impacts the energy use characteristics of a fan or blower, the test procedure should account for such impact and that appropriate consideration of any such impact would be part of the evaluation of potential energy conservation standards. 88 FR 27312, 27371. DOE further stated that the FEP [and FEI] metric penalizes the use of VFDs (variable speed drives which are a category of motor controller), since these metrics incorporate the losses from the VFD and that appropriate consideration of any such impact would be part of the evaluation of potential energy conservation standards. 88 FR 27312, 27372.

To avoid penalizing GFBs sold with a motor controller, DOE proposes that the FEI standard for GFBs sold with a motor controller be calculated by applying a credit to the FEI standard for GFBs sold without a motor controller, where the credit is designed to offset the losses inherent to the motor controller. To determine the credit, DOE compared the FEP values of fans with a motor controller ($FEP_{act,mc}$) to the FEP values of the same fans without a motor controller, as calculated in accordance with section 6.4.2.4 of AMCA 214–21 which represents typical motor and motor controller performance, and using the fan selection duty points provided in the sample of consumers.[60] (*See* section IV.E.1). DOE found that, at a given duty point, the credit can be expressed as a function of the FEP, in kW, as follows:

$$Credit = 0.03 \times FEP_{act} + 0.08$$

Where FEP_{act} is the actual fan electrical input power of the fan with a motor controller at the given duty point.

To convert the credit into a multiplier to the FEI and to calculate the FEI values at each efficiency level considered for GFBs with a motor controller, DOE relied on the following equation:

$$FEI_{EL\_mc} = FEI_{EL\_no\_mc} \times \frac{FEP_{act} - Credit}{FEP_{act}}$$

Where $FEI_{EL\_no\_mc}$ is the FEI value at a given EL for a fan without a motor controller.

When applying this equation, DOE observed that for GFBs with a motor controller and with FEP values above 20 kW, the value of the multiplier to the FEI is approximately constant and equal to 0.966. Therefore, DOE proposes to simplify the calculation of FEI standards for fans with motor controllers as follows:

Table IV-10: FEI levels for GFBs with Motor Controller

Fans with motor controller with:	**FEI level for Fans with motor controller***
$FEP_{act} < 20$ kW (26.8 hp)	$B = \frac{FEP_{act} - Credit}{FEP_{act}}$; where: $Credit = 0.03 \times FEP_{act} + 0.08$ **[SI]** $Credit = 0.03 \times FEP_{act} + 0.08 \times 1.341$ **[IP]**
$FEP_{act} \geq 20$ kW (26.8 hp)	$FEI_{EL\_no\_mc} \times 0.966$

*Rounded to the hundredth

Further, considering the proposed addition of default calculation methods to represent the combined motor and motor controller efficiency (see section III.C.1.b), in the final rule, DOE may also consider an alternative credit calculation based on the proposed equations in section III.C.1.b which represent baseline (and not typical) motor and motor controller performance, and would potentially result in a higher credit.

DOE requests comment on the equations developed to calculate the credit for determining the FEI standard for GFBs sold with a motor controller and with an FEP_{act} less than 20 kW and on potentially using an alternative credit calculation based on the proposed equations in section III.C.1.b of this document. Additionally, DOE requests comment on its use of a constant value, and its proposed value, of the credit applied for determining the FEI standard for GFBs with a motor controller and an FEP_{act} of greater than or equal for 20 kW.

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[60] For this calculation, DOE used the AMCA 214–21 equations for the motor and motor controller which are representative of the losses of typical variable frequency drives instead of equations discussed in section III.C.1 which were developed as representative of less efficient, baseline, motor and motor controller combinations (*i.e.,* representative of lowest market efficiency).

c. Higher Efficiency Levels

As part of DOE's analysis, the maximum available efficiency level is the highest efficiency unit currently available on the market. DOE also defines a ''max-tech'' efficiency level to represent the maximum possible efficiency for a given product. Similar to the baseline efficiency levels, DOE established max-tech efficiency levels by reviewing the performance data in the AMCA sales database. DOE initially evaluated max-tech for each class using the FEI corresponding to the 95th percentile (*i.e.,* the FEI resulting in a 5-percent pass rate). DOE used the 95th percentile instead of the absolute maximum FEI observed in the AMCA sales database to avoid setting a max-tech FEI that may not be achievable across most of a fan's operating range. DOE further refined these levels based on manufacturer fan selection software performance data collected at the representative diameters and operating points for each class. Additional details on the selection of max-tech efficiency levels can be found in chapter 5 of the NOPR TSD.

As previously described, DOE assigned design options and corresponding FEIs to each equipment class based on the analysis described in sections IV.C.1.a–b. DOE conducted this analysis up to a max-tech EL for each equipment class. Final results are shown in Table IV–11. These results were used in all downstream analyses for this NOPR.

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Table IV-11 Summary of Efficiency Levels for All GFB Equipment Classes

		EL0	EL1	EL2	EL3	EL4	EL5†	EL6†	EL7†
Axial Inline	Design Option	Baseline: tube axial	Impeller change	Switch to vane axial	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	-	-
	FEI	0.84	0.87	1.00	1.18	1.36	1.55	-	-
Panel	Design Option	Baseline	Impeller change	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	4th Aero redesign	-	-
	FEI	0.80	0.86	1.00	1.24	1.48	1.73	-	-
Axial PRV	Design Option	Baseline	Impeller change 1	Impeller change 2	Diameter Increase*	Diameter Increase*	1st Aero redesign	2nd Aero redesign	3rd Aero redesign
	FEI	0.66	0.69	0.72	0.75	0.85	1.00	1.25	1.49
Centrifugal PRV Exhaust	Design Option	Baseline	Diameter Increase	Impeller change*	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	4th Aero redesign	-
	FEI	0.67	0.7	0.72	0.86	1.00	1.20	1.39	-
Centrifugal PRV Supply	Design Option	Baseline	Diameter Increase	Impeller change*	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	4th Aero redesign	-
	FEI	0.69	0.72	0.76	0.88	1.00	1.19	1.37	-
Centrifugal Housed Main Path	Design Option	Baseline	Impeller change	Airfoil Impeller	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	-	-
	FEI	0.63	0.93	1.00	1.15	1.31	1.46	-	-
Centrifugal Housed FC Path**	Design Option	Baseline	Impeller change	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	-	-	-
	FEI	0.63	0.93	1.00	1.15	1.31	-	-	-
Centrifugal Unhoused	Design Option	Baseline	Impeller change 1	Impeller change 2	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	-	-
	FEI	0.94	1.00	1.10	1.23	1.35	1.49	-	-
Centrifugal Inline	Design Option	Baseline	Impeller Change	Guide Vanes	Mixed flow*	MF with guide vanes	1st Aero redesign	2nd Aero redesign	-
	FEI	0.65	0.70	0.77	1.00	1.07	1.28	1.46	-
Radial	Design Option	Baseline	Impeller change 1	Impeller change 2	1st Aero redesign	2nd Aero redesign	3rd Aero redesign	-	-
	FEI	0.82	0.87	0.93	1.00	1.17	1.34	-	-

*Design option applied relative to baseline fan instead of previous EL.

** The centrifugal housed forward-curved path was applied to uniquely consider the costs associated with redesigning forward-curved fans. *See* section IV.C.1.b for additional details.

† Dash marks are used to indicate that the specified EL does not apply to the corresponding equipment class.

Potential Adjustments to Efficiency Levels Based on AMCA 211 Tolerances

GFBs can be certified by AMCA to bear the AMCA certified ratings seal. AMCA publishes a manual prescribing the technical procedures to be used in connection with the AMCA Certified Ratings Program for fan air performance: ''AMCA 211–22 (Rev. 01–23)—Certified Ratings Program—Product Rating Manual for Fan Air Performance'' (''AMCA 211–22'')

Certified AMCA GFBs are subject to precertification and periodic check tests as defined in section 10 of AMCA 211–22. When products are check tested, the check test performance must be within the tolerance for airflow, pressure, and power when compared with the manufacturer's catalog data. Specifically, section 10 of AMCA 211–22 allows for a 5 percent tolerance on the fan shaft power when conducting a precertification check test and a 7.5 percent tolerance when conducting a periodic check test.

As discussed in section IV.A.2.a, DOE conducted the GFB engineering analysis for this NOPR primarily using a database of confidential sales information provided by AMCA, which includes AMCA certified data related to fan shaft power at a given duty point. DOE also relied on manufacturer fan selection software from manufacturers that are AMCA members, which frequently provided data that was AMCA certified.

DOE understands that it may be common practice for manufacturers to include the AMCA 211–22 tolerance when submitting performance data to AMCA. As a result, the fan shaft power data included in the AMCA sales database and manufacturer fan selection software may include a 5 to 7.5-percent tolerance and may be underestimated.[61] For the final rule, DOE is considering adjusting the fan shaft power values included in the performance data used in its analysis to account for this tolerance. In the final rule, DOE is also considering adjusting the values of FEI associated to each efficiency level analyzed to account for this tolerance.

DOE may consider revising the brake horsepower values in the AMCA sales database and from manufacturer fan selection software by increasing each value by 5 percent. DOE used the 5-percent precertification check test tolerance for the adjustments, as DOE expects this would be the tolerance applied to any ratings certified to AMCA. This would result in lower FEI values for each data point and could result in lower FEI values associated with each EL.

To determine how this may impact the analysis, DOE increased the brake horsepower values in the AMCA sales database by 5 percent and recalculated the bare shaft FEIs of all fans in the database. As discussed in section IV.C.1, the baseline and max-tech FEIs of all equipment classes were determined based on percentiles in the AMCA sales database. DOE used the same percentiles to determine the baseline and max-tech for each equipment class using the recalculated bare shaft FEIs. For efficiency levels that were based on the design option approach (*e.g.,* impeller changes), DOE maintained the percent increases in FEI associated with each design option to determine the adjusted FEI. For ELs that were based on the efficiency level approach (*i.e.,* aerodynamic redesigns), DOE adjusted the FEI levels to maintain the same percentage of models that meet each aerodynamic redesign efficiency level (*i.e.,* pass rate). The FEI values in Table IV–12 show what the results of the engineering analysis may look like if the tolerance that is allowed in AMCA 211–22 is considered in the databases.

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[61] For example, a manufacturer may report a value of 92.5 instead of 100 to incorporate a 7.5 percent tolerance.

Table IV-12 Summary of Efficiency Levels for All GFB Equipment Classes Considering a 5-percent AMCA 211-22 Tolerance Allowance

	EL0	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Axial Inline	0.80	0.83	0.96	1.12	1.30	1.48	-	-
Panel	0.76	0.82	0.95	1.18	1.41	1.65	-	-
Axial PRV	0.63	0.67	0.69	0.72	0.82	0.95	1.19	1.42
Centrifugal PRV Exhaust	0.64	0.67	0.68	0.82	0.95	1.14	1.33	-
Centrifugal PRV Supply	0.65	0.68	0.72	0.83	0.95	1.13	1.29	-
Centrifugal Housed Main Path	0.60	0.90	0.96	1.09	1.24	1.39	-	-
Centrifugal Housed FC Path*	0.60	0.90	0.96	1.09	1.24	1.39	-	-
Centrifugal Unhoused	0.89	0.94	1.04	1.17	1.28	1.42	-	-
Centrifugal Inline	0.62	0.66	0.73	0.95	1.02	1.22	1.39	-
Radial	0.78	0.83	0.89	0.95	1.11	1.27	-	-

*Design option applied relative to baseline fan instead of previous EL.

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DOE requests comments on whether it should apply a correction factor to the analyzed efficiency levels to account for the tolerance allowed in AMCA 211–22 and if so, DOE requests comment on the appropriate correction factor. DOE requests comment on the potential revised levels as presented in Table IV–12. Additionally, DOE requests comments on whether it should continue to evaluate an FEI of 1.00 for all fan classes if it updates the databases used in its analysis to consider the tolerance allowed in AMCA 211–22.

Additionally, DOE does not anticipate that the efficiency levels captured in Table IV–12 would impact the cost, energy, and economic analyses presented in this document. As such, DOE considers the results of these analyses presented throughout this document applicable to the efficiency levels with a 5% tolerance allowance. DOE seeks comment on the analyses as applied to the efficiency levels in Table IV–12.

d. Cost Analysis

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

- *Physical teardowns:* Under this approach, DOE physically dismantles commercially available equipment, component-by-component, to develop a detailed bill of materials for the equipment.
- *Catalog teardowns:* In lieu of physically deconstructing equipment, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the equipment.
- *Price surveys:* If neither a physical nor catalog teardown is feasible (for example, for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable) or cost-prohibitive and otherwise impractical (*e.g.,* large commercial boilers), DOE conducts price surveys using publicly available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

In the present case, DOE conducted its analysis for GFBs using a combination of price surveys from manufacturer fan selection software, the AMCA sales database, and physical teardowns. DOE notes that due to time constraints and the variety of fans available in the market (*e.g.,* commercial or industrial application, construction class, equipment class), DOE was unable to conduct sufficient teardowns to rely solely on a manufacturer production cost (''MPC'') approach informed by physical teardowns. Therefore, DOE used manufacturer sales prices (''MSP'') for its cost analysis since DOE had substantially more MSP data than MPC data available for GFBs. When DOE pulled data from manufacturer fan selection software, the fan MSP was typically included; if the MSP was not included, DOE requested quotes to obtain a sales price. The AMCA sales database includes confidential total sales value and total sales volume for each fan model. DOE divided the total sales value by the sales volume to calculate the MSP for a single fan. MSPs from the AMCA sales database were adjusted to 2022 dollars to account for inflation.[62]

DOE recognizes that fan costs would not follow a simple scaling model as there are several factors that could impact the sales price of a fan, including construction class,[63] drive assembly, production volume, manufacturer purchasing power, mark-up, commercial or industrial application, etc. To account for these factors, DOE averaged MSPs from the AMCA sales database at each diameter for each fan equipment class to conduct its cost analysis. Average MSPs were obtained at a range of duty points that DOE determined to be reflective of the entire market, rather than only at the specific representative operating points that DOE selected. Additionally, based on its analysis of manufacturer fan selection software, DOE determined that fans may be sold with a variety of motors, each with a distinct cost that contributes to the overall selling price. Therefore, DOE decided to use average MSPs to account for the variety of motors on the market, rather than attempt to evaluate fan costs without a motor by subtracting an assumed unique motor cost from each fan in the AMCA sales database. This process was completed to ensure that all fan design options were evaluated with constant motor and motor controller cost estimates and DOE notes that the MSP change from EL to EL ultimately drives the downstream analyses. While DOE recognizes that an average is not representative of all fan designs, DOE had limited data and therefore determined that an average would provide the most representative estimate based on the data available.

DOE used data from both the AMCA sales database and sales data pulled from manufacturer fan selection software to create an MSP versus diameter curve for each equipment class. First, DOE averaged the MSPs in the AMCA sales database, as discussed earlier, to generate an MSP-versus-diameter curve. DOE then calibrated this curve with MSPs from manufacturer fan selection software. DOE used the MSP-versus-diameter curves to determine the baseline MSP for each equipment class at a given diameter.

As discussed in section IV.C.1.b, DOE used individual design options for the lower ELs in each class and aerodynamic redesign for the higher ELs. To determine the incremental costs associated with the design option ELs above baseline, DOE compared the MSPs of similarly constructed fans operating at the same duty point. For example, DOE evaluated the increase in MSP for impeller changes by calculating the percentage change in MSP for two fans operating at the same duty point and with similar housings, but different impeller designs. DOE averaged changes in MSP for each analyzed fan within each equipment class to obtain typical incremental costs for each design option, which were applied above baseline to obtain MSPs for each efficiency level. For fans where diameter increases were evaluated as a design option, DOE used the diameter-versus-MSP curves to estimate the increase in MSP relative to the baseline fan. As discussed in section IV.C.1.b, DOE used an 18-percent increase as the standard value for each impeller diameter increase. MSPs corresponding to each EL assume no change in motor or drive costs since DOE kept the motor and drive costs constant over all ELs; therefore, the change in MSP at each design option EL is reflective of the cost of incorporating the corresponding design option.

DOE additionally conducted teardowns to validate the MSPs applied to each EL. For axial inline fans, DOE initially estimated a high MSP from manufacturer fan selection software for replacing a tube axial fan with a vane axial fan; however, teardown data suggested that a lower MSP would be more realistic. DOE believes this discrepancy is due to differences in production volume between tube axial and vane axial fans, with vane axial fans having lower production volumes in the current market. In the presence of energy conservation standards, however, DOE expects that production volumes for vane axial fans would increase, reducing this price difference. Therefore, DOE adjusted the MSP for substituting a tube axial fan with a vane axial fan assuming equivalent production volumes in the presence of energy conservation standards.

Similarly, for centrifugal inline fans, DOE found that the average MSP when substituting a centrifugal inline impeller with a mixed-flow impeller was higher than would have been expected based on the teardown data. DOE believes this may be due to a mix of lower production volumes in the current market, underlying conversion costs, and increased markups for mixed-flow fans in the current market. Therefore, DOE reduced the MSP when substituting a centrifugal inline impeller with a mixed-flow impeller. To account for any costs associated with redesigning a centrifugal inline fan, DOE modelled most costs for applying a mixed-flow impeller as conversion costs, similar to those applied for aerodynamic redesigns.

As discussed, DOE evaluated aerodynamic redesigns as the final ELs for all equipment classes. DOE assumed a constant MSP for each aerodynamic redesign EL, with no change in MSP from the last design option EL to the first aerodynamic redesign EL. DOE assumed that the redesign, reengineering, and new production equipment required for aerodynamic redesign efficiency levels would result in significant one-time capital and product conversion costs. To account for expected manufacturer markups at these ELs, DOE applied a conversion cost markup that increases as capital costs increase. Aerodynamic redesign conversion costs are further discussed in section IV.J.2.c of this NOPR.

DOE assumed that shipping costs remained constant over all analyzed ELs for all equipment classes except for PRVs, where the increased diameter design options are expected to have a substantial impact on equipment dimensions and weight. To estimate shipping costs for PRVs, DOE used data from product teardowns and product literature for the representative operating points. DOE compared measured shipping dimensions from physical teardowns with listed unit dimensions in manufacturers' product literature and extrapolated the difference between them to estimate representative shipping dimensions for the units that DOE did not tear down. These dimensions were then used to estimate the number of PRVs that could be shipped per truck load. Based on this analysis, an additional shipping cost for each individual PRV was then applied to DOE's estimated MSPs.

DOE requests comment on its method to use both the AMCA sales database and sales data pulled from manufacturer fan selection data to estimate MSP. DOE also requests comment on the use of the MSP approach for its cost analysis for GFBs or whether an MPC-based approach would be appropriate. If interested parties believe an MPC-based approach would be more appropriate, DOE requests MPC data for the equipment classes and efficiency levels analyzed, which may be confidentially

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[62] DOE used the Federal Reserve Economic Data's ''Producer Price Index by Industry: Fan, Blower, Air Purification Equipment Manufacturing'' to account for inflation to 2022 dollars. DOE used a multiplication factor of 1.4 to convert from 2012 dollars to 2022 dollars. (*fred.stlouisfed.org/series/PCU333413333413*)

[63] Fans can be grouped into three AMCA construction classes (Class I–III) based on operation static pressure and outlet velocity. A Class I fan would have a lower operating static pressure and outlet velocity than a Class III fan. As a result, Class I fans tend to have a less-rugged construction than Class II–III fans.

submitted to DOE using the confidential business information label.

2. Air Circulating Fans

In the following sections, DOE discusses the engineering analysis performed to establish a relationship between ACF efficacy and MPC.

a. Representative Units

When performing engineering analyses for energy conservation standards rulemakings, rather than model every possible set of characteristics an equipment could have, DOE often evaluates the efficiency and cost of specific units that are most representative of the equipment. These representative units are typically chosen based on size or performance-related features. In the October 2022 NODA, DOE modeled five ACF representative units: a 12-in. ACF with a 0.01 hp motor; a 20-in. ACF with a 0.33 hp motor; a 24-in. ACF with a 0.5 hp motor, a 36-in. ACF with a 0.5 hp motor; and a 50-in. ACF with a 1 hp motor. 87 FR 62038, 62046. In the October 2022 NODA, DOE requested comment on whether the motor hp it has associated with each representative diameter (*i.e.,* 0.1 hp for 12 in., 0.33 hp for 20 in., 0.5 hp for 24 in. and 36 in., and 1 hp for 50 in.) appropriately represented the motor hp for fans sold with those corresponding diameters. *Id.*

In response to the October 2022 NODA, AMCA commented that DOE should consider decoupling fan size and motor nameplate hp for its representative units because the motor nameplate hp is not always representative of how much loading is placed on the motors and may therefore mislead any estimates of efficiency. (AMCA, No. 132 at p. 7)

In response to stakeholder concerns about establishing representative motor powers for the engineering analysis, DOE reevaluated its approach. After reviewing the updated ACF database, which contains catalog data not included in the October 2022 NODA analysis, DOE found that motor nameplate power may vary too much from fan to fan to establish a single representative motor power for a given fan diameter. Instead, for this NOPR analysis, DOE used the distribution of motor nameplate powers for each representative diameter to determine weighted averages for motor efficiency and motor costs. Further details on these distributions and their use can be found in chapter 5 of the NOPR TSD.

For this NOPR, DOE evaluated slightly different representative units than it evaluated in the October 2022 NODA analysis. DOE did not consider a 12-in. representative unit for the NOPR because ACFs with input powers less than 125 W were excluded from the scope, which significantly reduced the number of in-scope 12-in. ACFs in DOE's updated ACF database. As discussed in section IV.A.1.b, DOE identified three equipment classes for axial ACFs, a 12-in. to less than 36-in. diameter axial ACF class, a 36-in. to less than 48-in. diameter axial ACF class, and a 48-in. diameter or greater axial ACF class. DOE defined a single representative unit for each axial ACF equipment class. DOE reviewed ACF diameters in its updated ACF database and determined that the most common diameters for the 12-in. to less than 36-in. diameter range, the 36-in. to less than 48-in. diameter range, and the 48-in. diameter or greater range were 24 in., 36 in., and 52 in., respectively. Therefore, DOE used these three diameters as its representative units for the ACF analysis. DOE did not consider the 20-in. or 50-in. representative units included in the October 2022 NODA because neither of these sizes were the most common diameter for axial ACFs in the corresponding diameter range. For housed centrifugal ACFs, DOE chose 11 in. as the representative unit, since it is the most common diameter for housed centrifugal ACFs in the updated ACF database, Further details regarding the selection of representative units can be found in chapter 5 of the NOPR TSD.

b. Baseline Efficiency and Efficiency Level 1

Motors

As discussed in section IV.C.1.a, baseline models are typically either the most common or the least efficient units on the market. In the October 2022 NODA, DOE assigned split-phase motors to be the baseline technology option for ACFs because split-phase motors are the least efficient type of motor used for ACFs. 87 FR 62038, 62048. As discussed in the October 2022 NODA, the BESS Labs combined database contained ACFs sold with PSC motors, polyphase motors, and ECMs, but no split-phase motors. *Id.* Therefore, DOE used the lowest efficiencies observed in the BESS Labs combined database, associated with low-efficiency PSC motors, to establish EL 1. To estimate baseline efficiencies from EL 1, DOE applied an efficiency loss associated with switching from a low-efficiency PSC motor to a split-phase motor. 87 FR 62038, 62049.

In the October 2022 NODA, DOE requested feedback on the methodology used to determine the baseline efficiency values for the representative units and on the expected average improvement in ACF efficiency when a split-phase motor is replaced by a low-efficiency PSC motor. 87 FR 62038, 62049. In response, the Efficiency Advocates stated that, since DOE utilized the BESS Labs combined database to determine efficiency in the October 2022 NODA, that baseline efficiency could be higher than the actual least efficient ACFs on the market. (Efficiency Advocates, No. 126 at p. 1) In response to stakeholder feedback and after reviewing its updated ACF database, DOE utilized a different methodology for determining baseline efficiency in this NOPR. Rather than determining EL 1 and back-calculating baseline from EL 1, DOE defined the baseline efficiencies for each representative unit using the minimum efficiency values in its updated ACF database. Additionally, as discussed in section IV.A.3 of this NOPR, additional review of the ACF market indicated that very few ACFs use split-phase motors compared to the number of ACFs that use PSC motors. Therefore, DOE decided to consider low-efficiency PSC motors as a baseline design option for ACFs in this NOPR.

As discussed in section IV.A.2.b, DOE included catalog data in its updated ACF database to supplement the BESS Labs combined database. DOE did not consider catalog data in the October 2022 NODA because catalog data did not include information on the air density measured during testing, which is required when calculating FEI. Since DOE updated the ACF efficiency metric to be efficacy instead of FEI, DOE was able to use catalog data for efficiency information for this NOPR. Therefore, DOE expects the minimum efficacy values used in this NOPR analysis to be more representative of the baseline fans on the market than those used in the October 2022 NODA.

Transmission

In the October 2022 NODA, since DOE did not consider more efficient transmissions as a design option, the baseline fan was not defined by a transmission type. However, in this NOPR analysis, DOE is considering more-efficient transmissions as a design option for ACFs. As discussed in section IV.A.3, using a direct-drive transmission instead of a belt-drive transmission can increase the efficiency of a fan. Manufacturers also indicated in interviews that the fan industry is transitioning away from using belt-drive transmissions in favor of direct-drive transmissions. Therefore, DOE decided to assign a belt-drive transmission as a baseline design option and tentatively determined that a change from belt-drive to direct-drive would be the first design change ACF manufacturers would make to improve efficiency. Therefore, DOE chose a direct-drive transmission as the EL 1 design option. DOE notes, however, that not all the equipment classes it analyzed typically use belt drives. DOE reviewed the housed centrifugal ACF market and concluded that belt drives are not used for housed centrifugal ACFs. Additionally, DOE's review of the axial ACF market indicated that belt drives are not commonly used for axial ACFs less than 36 in. in diameter. DOE found that only 2 percent of ACF models in its updated ACF database with a diameter less than 36 in. had belt drives, while 66 percent of ACF models in its updated ACF database with a diameter of 36 in. or larger had belt drives. Therefore, DOE has determined that a direct-driven fan is representative of both the baseline and EL 1 for the 24-in. axial ACF and centrifugal housed ACF representative units.

For the 36-in. and 52-in. axial ACF representative units, DOE determined EL 1 by applying an efficacy delta to the baseline efficacy representing a transition from a belt-drive transmission to a direct-drive transmission. To estimate this incremental impact on efficacy when transitioning from a belt-drive transmission to a direct-drive transmission, DOE used the equations defined in sections 6.3.1 and 6.3.2 of AMCA 214–21. The equations in section 6.3.1 of AMCA 214–21 define the efficiency of direct-drive transmissions as 100 percent and define the efficiency of belt-drive transmissions based on the shaft power of the fan. Since shaft powers are generally unknown for ACFs, DOE used the equation defined in section 6.3.2 of AMCA 214–21 to determine theoretical motor output powers associated with given shaft powers and transmission efficiencies. DOE then plotted a curve to estimate belt-drive transmission efficiency as a function of motor output power, which was used to estimate the belt-drive efficiencies for all motor hp values in its updated ACF database. To account for the range of motor hp values that could be used in ACFs for each representative unit, DOE determined the percentage of fans in its updated ACF database that corresponded to each motor hp in the database. DOE then used these percentages as weights to calculate a weighted-average belt-drive efficiency for each motor hp.

DOE evaluated the relationship between transmission efficiency and fan efficacy and determined that transmission efficiency and fan efficacy are directly proportional. Therefore, the percent increase in fan efficacy associated with using a more efficient transmission is equal to the percent increase in transmission efficiency. Further details of this analysis can be found in chapter 5 of the NOPR TSD. DOE applied the percent increase in efficiency when transitioning from a belt-drive transmission to a direct-drive transmission to the baseline efficacies for the 36-in. axial ACF and 52-in. axial ACF representative units to determine EL 1. DOE used the resulting weighted-average belt-drive efficiency to determine the percent difference in efficiency between a belt-drive transmission and a direct-drive transmission. Based on this approach, DOE estimated 13.5-percent and 10.4-percent improvements in efficacy when changing from a belt-drive transmission to a direct-drive transmission for the 36-in. axial ACF and 52-in. axial ACF representative units, respectively.

As mentioned previously, DOE defined both the baseline fan and EL 1 as direct driven for the 24-in. axial ACF and the housed centrifugal ACF representative units. Therefore, for these two representative units, DOE set EL 1 equal to the baseline efficacy to account for the fact that there would be no efficacy gain associated with the more-efficient transmission design option. This was done to maintain consistent design options for each EL for all ACF equipment classes.

Further discussion of DOE's methodology for determining baseline efficiency and EL 1 can be found in chapter 5 of the NOPR TSD.

c. Selection of Efficiency Levels

In this section, DOE discusses comments it received on its ACF efficiency analysis in the October 2022 NODA and describes the efficiency analysis methodology it used for this NOPR. As discussed in section IV.C.1.b, DOE typically uses either an efficiency-level approach, a design-option approach, or a combination of the two for its efficiency analysis. In this NOPR, DOE used a combination efficiency-level and design-option approach for its analysis of ACFs. DOE used the efficiency-level approach to determine the baseline and aerodynamic redesign ELs and used the design-option approach to gap fill intermediate ELs. For the design-option approach, DOE used the efficiencies determined for the baseline design options and more-efficient design options to assign incremental efficiency gains for each EL.

General Approach and Related Comments

In the October 2022 NODA, DOE evaluated more-efficient motors and aerodynamic redesign as options for increasing ACF efficiency. 87 FR 62038, 62048. DOE did not conduct a formal screening analysis in the October 2022 NODA; however, as discussed in section IV.B, DOE conducted a formal screening analysis for this NOPR, and screened in the following design options for ACFs:

- Aerodynamic redesign (improved housing design, reduced manufacturing tolerances, addition of appurtenances, improved impeller design, addition of guide vanes, impeller topology);
- Increased impeller diameter;
- More-efficient transmissions (belt drive and direct drive); and
- More-efficient motors.

DOE did not evaluate the efficiency impacts of all these design options in the engineering analysis for ACFs. Specifically, DOE did not consider the efficiency impacts of increased impeller diameter since DOE defined equipment classes based on diameter in section IV.A.1.b. Therefore, when developing the proposed ELs, DOE only considered more-efficient transmissions, more-efficient motors, and aerodynamic redesign as design options for its analysis of ACFs in this NOPR. More-efficient transmissions were associated with EL 0 and EL 1, which were discussed in section IV.C.2.b.

Regarding motors, DOE evaluated multiple motor options for ACFs in the October 2022 NODA, specifically split-phase motors at baseline, PSC 1 motors at EL 1, PSC 2 motors at EL 2, and ECMs at EL 3. 87 FR 62038, 62048. PSC 1 motors were defined as basic PSC motors, while PSC 2 motors were defined as ''more efficient PSC motors''. *Id.* In this NOPR, DOE refers to basic PSC motors as ''low-efficiency PSC motors'' and refers to more-efficient PSC motors as ''high-efficiency PSC motors.'' In the October 2022 NODA, DOE also assumed that airflow, pressure, motor speed, and motor inrush current remained constant when replacing a less-efficient motor with a more-efficient motor and requested feedback on these assumptions. 87 FR 62038, 62049.

In response, AMCA commented that, provided the shaft speed does not change much, the fan affinity laws can be used to predict airflow and total pressure. However, AMCA added that there can be discrepancies between the torque required by the load and the torque produced by the motor for low-power motors. AMCA further stated that, given the very low starting torque of ACFs, inrush current is likely insignificant for ACF motors. (AMCA, No. 132 at p. 9) NEMA stated that while motor performance can be optimized, changing the motor may impact other aspects of fan performance. NEMA specifically stated that more-efficient motors will typically have higher speeds, which may require a redesign of the fan. (NEMA, No. 125 at p. 5) AMCA also stated that motors with higher rotational speeds will generally be more efficient. (AMCA, No. 132 at pp. 16–17) NEMA commented that changing the efficiencies of motors used for ACFs could require the use of a larger, heavier motor and could therefore require other design changes to the fan. (NEMA, No. 125 at p. 2) AMCA also stated that replacing a motor with a more-efficient motor may result in the need for aerodynamic redesign or redesign of the mounting and supports of an ACF because of differences in motor size, shape, or weight. (AMCA, No. 132 at p. 12)

DOE investigated the issue of higher-efficiency motors having higher speeds in the December 2023 ESEMs NOPR TSD.[64] For the typical motor types and sizes used in ACF applications,[65] DOE found only a 0.5-percent to 0.7-percent increase from the minimum full-load speed to the maximum full-load speed. Given the relatively small speed changes between ESEMs with different efficiencies, DOE has tentatively concluded that increases in motor speed associated with transitioning to more-efficient motors would be insignificant and would not require additional changes to fan design.

DOE requests feedback on whether using a more efficient motor would require an ACF redesign. Additionally, DOE requests feedback on what percentage of motor speed change would require an ACF redesign.

Regarding stakeholder feedback that ACFs may need to be redesigned to accommodate differences in motor size or shape when changing to more-efficient motors, DOE expects this type of redesign could be done with minimal efficiency impact because it expects that only motor supports would be redesigned. As discussed in section IV.C.2.d, DOE found that there is sufficient space for an increase in motor volume without needing to redesign other fan components, such as housing or safety guards. Consequently, DOE assumed that the only redesign required for an ACF when switching to a larger motor would be to increase the weight of the motor supports to accommodate an increase motor weight. Therefore, DOE assumed that when changing to a more-efficient motor, the only significant impact to the efficiency of an ACF was the efficiency gained from the motor.

Additionally, AMCA commented in response to the October 2022 NODA that motor nameplate information is generally not very relevant for ACFs because ACF manufacturers often use motors in power ranges outside those listed on motor nameplates. AMCA stated that operating motors above their nameplate load may provide the best material efficiency and that this is possible for ACFs because motors are very well ventilated when used for ACFs. AMCA also stated that the use of a flatter pitch blade may not load a fan to its listed motor horsepower, while a steeper pitch blade may load the motor past its listed horsepower. (AMCA, No. 132 at pp. 6–8) Further, AMCA stated that motor nameplate efficiencies depend on the number of phases and the synchronous speed of the motors and that the actual motor efficiency would be different since motors are used at higher power ratings than their nameplate power ratings for ACFs. (AMCA, No. 132 at pp. 16–17)

In consideration of AMCA's comments, DOE analyzed confidential ESEM testing data to examine how motor efficiency is impacted when motors are operated at loads above their nameplate rating. DOE compared the efficiencies of motors tested at nameplate load, 115 percent of nameplate load, and 125 percent of nameplate load. Through its analysis, DOE found that, on average, motor efficiency increased by a percent change of 1.01 percent for motors tested at 115 percent of nameplate load and motor efficiency increased by a percent change of 1.23 percent for motors tested at 125 percent of nameplate load. DOE notes that these percentages represent percentage changes, rather than nominal changes in motor efficiency. For example, a 0.25 hp motor might have an efficiency of 72.84 percent when tested at 100 percent load compared to an efficiency of 73.54 percent when tested at 115 percent load, representing a percentage increase in efficiency of 0.96 percent (*i.e.,* [73.54 − 72.84]/72.84 = 0.96%). The positive percentage change found for motors tested at both 115 percent and 125 percent of rated load indicates that, up to 125 percent rated load, efficiency generally increases for motors operated at loads above their nameplate rating. Hence, representations of motor efficiency calculated at nameplate load may provide a more conservative estimate of motor efficiency. For the motors that exhibited a decrease in efficiency at 125 percent of rated load, DOE further investigated the percentage change in motor efficiency. For these motors, the average percentage change in motor efficiency remained under 1.5 percent for motors tested at both 115 percent and 125 percent of their rated load, with a maximum percentage change in efficiency of 2.3 percent. Since the average percentage change in motor efficiency from the rated efficiency is small when motors are operated at above their rated loads, DOE has tentatively determined that motor efficiencies calculated at rated load represent adequate estimates of true motor efficiency, even if those motors are operated above their rated loads.

As discussed in section IV.A.3, DOE considered split-phase motors, low-efficiency PSC motors, high-efficiency PSC motors, and ECMs in its October 2022 NODA analysis. 87 FR 62038, 62048. DOE has since reviewed its updated ACF database in response to comments from AMCA and NEMA about motors used in ACFs. Based on the distribution of motor types in the database, DOE tentatively concluded that very few ACFs use shaded-pole, split-phase, or capacitor start/capacitor run motors. Rather, DOE found that the most common motors used in ACFs are PSC motors, and that some ACFs utilize polyphase motors and ECMs. Specific percentages of ACFs in the updated ACF database with each motor type can be found in Chapter 5 of the NOPR TSD.

Furthermore, in the October 2022 NODA, DOE requested comment on whether ACFs with single-phase motors and polyphase motors would be used for different utilities or have different efficiencies because of their end-use applications. 87 FR 62038, 62045. In response, NEMA stated that three-phase motors typically have slightly higher efficiencies than single-phase motors but added that if only a single-phase power supply is available, a three-phase motor could not be used in place of a single-phase motor. NEMA added that at higher motor powers (1.5 hp and above), three-phase motors tend to be equally as or slightly less expensive than single-phase motors. (NEMA, No. 125 at p. 4). DOE's review of motor literature and testing data for motors used in ACFs indicated that polyphase motors are generally more efficient than PSC motors, as stated by NEMA.

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[64] The ESEMs NOPR TSD can be found at *www.regulations.gov/document/EERE-2020-BT-STD-0007-0056.*

[65] DOE's review of the ACF market indicated that low-torque, 6-pole, air-over ESEMs are the most commonly used motor types for ACFs. Table 5.4.2 of the December 2023 ESEM NOPR TSD shows the full-load speeds for these motors at different efficiency levels.

Additionally, DOE acknowledges that, as NEMA stated, in situations where only single-phase power is available, a polyphase motor could not be used in place of a single-phase motor without the use of additional electronics, such as a phase converter. As such, DOE did not consider a change from PSC motor to polyphase motor as a design option for improving efficiency. Additionally, as discussed above, the majority of the ACFs in DOE's updated ACF database utilize PSC motors; therefore, DOE used PSC motors to generally model the efficiencies of induction motors used in ACFs. DOE notes that this approach provides conservative estimates of induction motor efficiency relative to an approach that includes polyphase motor efficiencies since polyphase motors are generally more efficient than PSC motors. DOE considered low-efficiency PSC motors and high-efficiency PSC motors as induction motor design options. Additionally, DOE considered ECMs as a motor design option since they are the most efficient type of motor used in ACFs.

Determination of Efficiency Levels

As discussed in section IV.C.2.b, DOE considered low-efficiency PSC motors and belt-drive transmissions as baseline design options and considered direct-drive transmissions as the design option for EL 1.

DOE received feedback during confidential manufacturer interviews that ACF manufacturers were more likely to improve the efficiency of a motor before performing an aerodynamic redesign. Therefore, DOE considered a high-efficiency PSC motor as the design option for EL 2, prior to considering aerodynamic redesign. DOE modeled the efficiency gain associated with changing from a low-efficiency PSC motor to a high-efficiency PSC motor. DOE determined the efficacy for EL 2 for all equipment classes by estimating efficiencies for low-efficiency PSC motors and high-efficiency PSC motors, determining the efficiency delta between them, and applying that efficiency delta to EL 1. In the October 2022 NODA, DOE estimated the efficiencies of low-efficiency PSC motors and high-efficiency PSC motors using DOE's database of catalog motor data (''motors database''). 87 FR 62038, 62049. DOE associated low-efficiency PSC motors with EL 1 and high-efficiency PSC motors with EL 2 in the October 2022 NODA analysis. DOE estimated the increase in FEI from EL 1 to EL 2 by applying the percent increase in efficiency from a low-efficiency PSC motor to a high-efficiency PSC motor directly to the EL 1 FEI value. DOE requested comment on its determined efficiency gains when replacing a low-efficiency PSC motor with a high-efficiency PSC motor and whether catalog performance data for PSC motors were representative of the performance of motors used in ACFs. *Id.*

In response, NEEA commented that it agreed with DOE's approach to model the efficiency improvements for the overall fan as equal to the motor efficiency improvements when only the motor is changed and nothing else, such as the duty point, motor speed, drive type, etc. (NEEA, No. 129 at p. 3) Greenheck expressed concern that the motor efficiencies used by DOE in its analysis may not have been accurate and stated that Greenheck could not confirm the accuracy of the efficiencies used since the motor database was not included with the supplementary information. Greenheck also requested clarity on which motors were included in DOE's analyses of low-efficiency PSC and high-efficiency PSC motors. Specifically, Greenheck stated motors that DOE deemed low-efficiency PSC motors should be analyzed as a separate dataset from high-efficiency PSC motors, rather than determining low-efficiency PSC motor performance from the average efficiency of all PSC motors. (Greenheck, No. 122 at p. 2) AMCA commented that determining general values for the change in efficiency between one motor type and another is difficult to do with confidence because motors with the same topology and power rating can have different efficiencies. (AMCA, No. 132 at p. 8–9) NEMA commented that the efficiencies of fan motors are often not quantified and that it is incorrect to assume that all ACFs use low-efficiency motors. (NEMA, No. 125 at p. 3) NEMA added that the source of DOE's ESEM catalog data is unclear, given that most motor manufacturers do not publish performance information for the fractional horsepower, single-phase motors that DOE assumed were used for ACFs in its October 2022 NODA analysis. NEMA further stated that catalog motors typically meet or exceed the ratings listed for them in catalogs. (NEMA, No. 125 at p. 3)

In response to stakeholder feedback, DOE adjusted its methodology for determining efficiencies associated with low-efficiency PSC motors and high-efficiency PSC motors in this NOPR. In the October 2022 NODA, DOE determined low-efficiency PSC motor efficiency from the average of all air-over PSC motors in the motors database. 87 FR 62038, 62049. For this NOPR, DOE instead determined low-efficiency PSC motor efficiency from the minimum efficiency of all 6-pole, fan-specific motors in the motors database. The use of the minimum efficiency, rather than the average efficiency, produced a more conservative estimate for low-efficiency PSC motor efficiency. DOE analyzed 6-pole motors specifically because DOE's review of the ACF market indicated that 6-pole motors are most common for ACFs. DOE determined low-efficiency PSC motor efficiencies at all motor powers in its updated ACF database and calculated a weighted average efficiency using the distribution of motor powers for each representative unit. Regarding Greenheck and NEMA's concerns about the accuracy of the motor data in the motors database, DOE acknowledges that the motors in the database are unregulated and therefore the data may be inaccurate. However, DOE notes that it received no additional information on ACF motor efficiencies from stakeholders that it could use instead of the information in the motors database. Regarding NEMA's concerns about the source of the PSC motor data in the motors database, DOE notes that the information it compiled from the database for fan-specific, 6-pole PSC motors consisted of published catalog data from four different motor brands. In response to AMCA's concerns about variations in motor efficiency with the same topology and power rating, DOE acknowledges that motors with the same topology and power rating can have different efficiencies. Therefore, DOE used weighted-average motor efficiencies in this NOPR analysis, which allowed DOE to consider the effects of a wide range of motor efficiencies across many power ratings for a particular motor topology.

Unlike low-efficiency PSC motors, DOE did not use the motors database to determine efficiencies for high-efficiency PSC motors in this NOPR. As part of the electric motors rulemaking, stakeholders made a joint recommendation for the efficiencies at which they believe the standards for ESEMs should be set. (Docket No. EERE–2020–BT–STD–0007, Joint Stakeholders, No. 38 at p. 6, Table 2) The joint recommendation represented the motors industry, energy efficiency organizations and utilities (collectively, ''the Electric Motors Working Group'') and addressed energy conservation standards for high-torque, medium-torque, low-torque, and polyphase ESEMs that are 0.25–3 hp and polyphase, and air-over ESEMs. In reference to this ongoing rulemaking, DOE has tentatively defined its high-efficiency PSC motor efficiencies using the efficiencies recommended by the

ESEM Joint Stakeholders. DOE used the average of the recommended efficiencies for enclosed and open 6-pole PSC motors since DOE's review of the ACF market indicated that both enclosed and open motors are used for ACFs. DOE then calculated weighted-average high-efficiency PSC motor efficiencies using the average recommended efficiencies at different motor powers for each representative unit. DOE then determined the percent difference in efficiency between high-efficiency PSC motors and low-efficiency PSC motors.

DOE evaluated the relationship between motor efficiency and fan efficacy and determined that motor efficiency and fan efficacy are directly proportional. Therefore, the percent increase in efficacy associated with changing to a more efficient motor is equal to the percent increase in motor efficiency. Further details of this analysis can be found in chapter 5 of the NOPR TSD. DOE applied the percent increase in motor efficiency when transitioning from a low-efficiency PSC motor to a high-efficiency PSC motor to EL 1 to determine EL 2 for each representative unit.

DOE recognizes that if it sets a standard at the recommended ESEM efficiencies, high-efficiency PSC motors would effectively become the baseline motor for ACFs. DOE performed a sensitivity analysis to evaluate the impact of setting ESEM standards at the recommended efficiencies on its ACF analysis. DOE found that, given the small number of shipments at EL 0 and EL 1 for ACFs, if EL 2 were set as the baseline EL, there would be a minimal impact on proposed ACF standards due to the low shipments below EL2 (see IV.F.8). DOE notes that if it sets a standard in the ESEM rulemaking at the recommended ESEM levels, DOE may consider using EL2 proposed in this NOPR as baseline for ACFs in a future final rule.

In response to the October 2022 NODA, NEEA commented that DOE's assumption that the least-efficient fans in the BESS Labs combined database used the least-efficient motors may be incorrect, since these fans could instead have non-motor-related performance features that caused them to have low efficiencies. NEEA added that this could cause non-representative ELs in DOE's analysis since some of DOE's ELs are based on motor efficiency increases. (NEEA, No. 129 at p. 2) DOE notes that information on the specific motor models integrated into ACFs, including motor efficiency, is not often publicly available. DOE also notes that it requested quantitative efficiency data on ACF motors in the October 2022 NODA, and it has not received any quantitative information on motor efficiency from stakeholders. 87 FR 62038, 62063. As discussed in section IV.A.2.b, DOE's dataset now includes catalog data in addition to the BESS Labs combined database. Therefore, as discussed in section IV.C.2.b, DOE expects the baseline efficacies that it used in this analysis to be more representative of the least efficient ACFs on the market than the baseline used in the October 2022 NODA. Additionally, as previously discussed, DOE updated its methodology for determining motor efficiencies for low-efficiency and high-efficiency PSC motors. Given these adjustments, DOE expects that the EL 2 efficacies are representative of ACFs with high-efficiency PSC motors.

In the October 2022 NODA, DOE considered ECMs as the design option for EL 3 and considered aerodynamic redesign as the design option for EL 4. In response, the CA IOUs commented that DOE should consider aerodynamic efficiency improvements at ELs lower than max-tech because they expect that manufacturers would consider aerodynamic redesigns before switching to ECMs. The CA IOUs also recommended that DOE consider intermediate aerodynamic redesign levels rather than a single ''maximum'' option. (CA IOUs, No. 127 at p. 2) The Efficiency Advocates recommended that DOE consider more ELs in its efficiency analysis to better represent the range of ACF efficiencies presented in its analysis, and that DOE specifically consider aerodynamic redesign. The Efficiency Advocates stated that additional ELs could be used to bridge the large gap between EL 3 and EL 4 in the October 2022 NODA. (Efficiency Advocates, No. 126 at p. 2)

In response to this feedback, DOE did not consider ECMs as a design option immediately after considering high-efficiency PSC motors in this NOPR; rather, DOE evaluated three aerodynamic redesign ELs—EL 3, EL 4, and EL 5—and considered ECMs as the max-tech design option at EL 6. DOE assumed that more complex aerodynamic redesign would be needed for EL 4 compared to EL 3 and for EL 5 compared to EL 4.

In response to the October 2022 NODA, NEEA stated that the wide distribution of efficiencies in the BESS Labs combined database was likely due to factors other than variation in motor efficiency since the database consists of fans that use the same kind of motor (PSC). DOE infers from this comment that variations in ACF efficiency in the updated ACF database, which, like the BESS Labs combined database, contained many ACFs with PSC motors, can largely be attributed to differences in aerodynamic efficiency between fans. Therefore, although DOE could not relate specific design options to a given efficacy for its three aerodynamic redesign levels, DOE defined aerodynamic redesign levels using an efficiency-level approach from its updated ACF database. Since DOE anticipated that more complex redesigns would be required at EL 4 than EL 3, DOE defined EL 3 as 33 percent of the way between EL 2 and EL 4 for all equipment classes.

DOE took different approaches for establishing EL 4 for axial ACFs and housed centrifugal ACFs. For axial ACFs, DOE referenced agricultural fan efficiency incentive programs to set the efficacies at EL 4. All agricultural fan efficiency incentive programs that DOE found use units of thrust per kilowatt (''thrust/kW'') to define minimum performance targets to qualify for the incentives. DOE converted these targets into units of CFM/W. Details of this conversion can be found in chapter 5 of the NOPR TSD. As discussed in section IV.C.2.a of this NOPR, ACF performance targets are defined by diameter. To be consistent with its lowest-diameter equipment class, DOE averaged the incentive program performance targets for the 12-in. to less than 24-in. diameter range and the 24-in. to less than 36-in. diameter range to estimate EL 4 for the 24-in. axial ACF representative unit. DOE used the performance targets for the 36-in. to 48-in. diameter range and 48-in. or greater diameter range to estimate EL 4 for the 36-in. axial ACF and 52-in. axial ACF representative units, respectively.

For housed centrifugal ACFs, DOE could not use the agricultural fan efficiency incentive programs to define EL 4 because housed centrifugal ACFs are not used in agricultural applications. Since DOE assumed that more complex redesigns would be required at EL 5 than EL 4, DOE also assumed that the efficiency gain between EL 5 and EL 4 would be greater than the efficiency gain between EL 4 and EL 3. To reflect this assumption, DOE defined EL 4 as halfway between EL 2 and EL 5 for housed centrifugal ACFs.

DOE defined EL 5 for each equipment class based on the maximum efficacies in the updated ACF database. DOE used the maximum efficacies in the updated ACF database to define EL 5 since DOE found that the maximum efficacy ACFs in the updated ACF database did not have ECMs. Therefore, these ACFs did not correspond to the max-tech level, and DOE instead assumed that these ACFs utilized highly efficient aerodynamic designs to achieve high efficacies. As discussed in section IV.A.2.b, DOE removed some high-efficacy outliers from the ACF database prior to determining the maximum efficacies for EL5.

As discussed previously, DOE considered an ACF with an ECM and a highly efficient aerodynamic design to be the max-tech design option. DOE's research indicated that ECMs are the most efficient type of motor used in ACFs, and, as indicated in the CA IOUs' comment on aerodynamic redesign, ACF manufacturers may consider implementing aerodynamic redesign prior to switching to an ECM. To determine the max-tech efficiency, DOE applied an incremental efficiency gain associated with changing from a high-efficiency PSC motor to an ECM to EL 5 for each equipment class.

In the October 2022 NODA, DOE used a database of dedicated-purpose pool pump (''DPPP'') motors to determine efficiencies for ECMs and high-efficiency PSC motors and the efficiency gain expected when switching from a high-efficiency PSC motor to an ECM. 87 FR 62038, 62050. DOE requested comment on its use of DPPP motors for comparing efficiencies of PSC motors and ECMs. *Id.* In response, NEMA commented that DPPP motor efficiency levels should not be used to compare PSC to ECM motor efficiency. NEMA stated that the DPPP efficiency regulations define system (motor and pump) efficiency levels and not standalone motor efficiencies. NEMA also stated that it had concerns with applying a market like DPPP, which has a dedicated purpose and experiences less variety of designs and manufacturers, to the much more diverse market of fans and blowers. (NEMA, No. 125 at p. 5)

In response to NEMA's concerns about its use of DPPP motors to model the efficiencies of ECMs, DOE adjusted its methodology for determining ECM efficiencies. To determine the efficiencies of ECMs, DOE first considered the motor efficiencies specified in IEC 60034–30–1:2014. The motor efficiencies defined in the IE code are intended to serve as reference points for governments to use when defining efficiency standards. DOE understands that the current IE 1 through IE 4 efficiencies defined in IEC 60034–30–1:2014 are intended to represent induction motor efficiencies. DOE also understands that, should a higher IE motor efficiency, IE 5, be defined in a future standard, the IE 5 efficiencies would likely align with ECM efficiencies. DOE used theoretical IE 5 efficiencies to estimate the efficiencies of ECMs and assumed that the efficiencies included the effects of ECM controllers. The IE 1 through IE 4 levels defined in IEC 60034–30–1:2014 are based on a 20-percent reduction in power losses going from one IE level to the next. For example, IE 4-level efficiency is determined from IE 3-level efficiency by assuming a 20-percent reduction in power losses. Therefore, DOE estimated IE 5 efficiency by assuming a 20-percent reduction in power losses from the IE 4 efficiency. DOE determined the percent difference between the estimated IE 5 efficiency and the estimated high-efficiency PSC motor efficiency. As discussed previously, DOE determined that a percent increase in motor efficiency corresponds to an equal percent increase in efficacy. Therefore, DOE applied the percent increase in motor efficiency when transitioning from a high-efficiency PSC motor to an ECM to EL 5 to determine EL 6. Further details on the methodology DOE used to determine the efficacies for each EL can be found in chapter 5 of the NOPR TSD. The efficacies determined for each EL and representative unit and design options associated with each EL are shown in Table IV–13.

Table IV-13 Summary of Efficiency Levels for all ACF Representative Units (CFM/W)

EL	Design Option	Representative Units			
		24-in. axial ACF	36-in. axial ACF	52-in. axial ACF	11-in. housed centrifugal ACF
0	Baseline	2.98	5.21	8.39	1.33
1	Direct-drive	2.98	5.91	9.26	1.33
2	High-efficiency PSC motor	3.18	6.48	10.6	1.44
3	Aerodynamic redesign 1	6.14	10.1	14.2	2.17
4	Aerodynamic redesign 2	12.2	17.3	21.5	3.65
5	Aerodynamic redesign 3	20.0	25.2	27.2	5.87
6	ECM	24.3	29.8	30.8	7.02

As discussed in section V.C.1.b, DOE notes that the standards it is proposing for axial ACFs are discrete efficacy values in CFM/W. This approach aligns with the method used by agricultural fan efficiency incentive programs, where performance targets are specified for certain diameter ranges. However, DOE notes that setting a standard for efficacy in this way may not fully incorporate the effect of diameter on the ACF efficacy. Setting a standard using this approach could also make it easier for larger diameter fans to meet the standard and more difficult for smaller diameter fans to meet the standard. DOE recognizes that there is generally a linear relationship between efficacy in CFM/W and fan diameter. DOE notes that it is additionally considering setting efficacy standards for axial ACFs as a linear function of diameter, similar to the approach used for ceiling fans (*see* 10 CFR 430.32(s)(1)). To establish a linear equation for efficacy as a function of diameter, DOE may consider in the final rule, for example, plotting efficacies for each representative unit versus the representative unit diameters and determining a best-fit line through these points. The efficacy standard would then change continuously as a function of diameter. While this approach would not align with the approach used by agricultural fan efficiency incentive programs, it might better incorporate the effect of diameter when setting standards for ACFs, specifically for ACFs with diameters at the periphery of the diameter range.

DOE requests feedback on whether setting an ACF standard using discrete efficacy values over a defined diameter range appropriately represents the differences in efficacy between axial ACFs with different diameters, and if not, would a linear equation for efficacy as a function of diameter be appropriate.

Input Power Estimation

In addition to determining efficacy values associated with each EL, DOE also developed estimates of input power associated with each EL. These input power estimates were used in the LCC and PBP analyses, discussed in section IV.F. For each representative unit, DOE developed input power versus efficacy curves based on the data in the updated ACF database and then estimated the input powers associated with each efficiency level. Further details on DOE's methodology for estimating input powers are discussed in chapter 5 of the NOPR TSD.

d. Cost Analysis

In this section, DOE discusses its approach to estimating MPCs for ACFs in this NOPR and discusses comments relating to its cost analysis in the October 2022 NODA. As discussed in section IV.C.1.d, the cost analysis portion of the engineering analysis is conducted using physical teardowns, catalog teardowns, price surveys, or a combination of these approaches. In the case of ACFs, DOE conducted its analysis using physical teardowns, which involve deconstructing equipment and recording every part and material used to make them. The resulting bill of materials (''BOM'') provided the basis for DOE's MPC estimates. DOE builds these MPCs based on the cumulative estimated cost of materials, labor, depreciation, and overhead for each equipment. Further details on these cost inputs can be found in chapter 5 of the NOPR TSD.

To support the October 2022 NODA, DOE estimated the MPCs of unhoused and housed ACFs across all efficiency levels and representative diameters using data gathered from teardowns of nine ACFs. 87 FR 62038, 62052. In the October 2022 NODA, DOE assumed that all ACFs were manufactured in China and that all materials and parts were sourced from China. DOE used the BOMs developed for each ACF and catalog teardowns to estimate MPCs for baseline ACFs. DOE then used incremental MPCs estimated for each design option to estimate MPCs for higher efficiency levels. *Id.*

DOE made several updates to its MPC estimation approach pertaining to axial ACFs in this NOPR. First, DOE adjusted how it considered ACF housings compared to the October 2022 NODA. As discussed in section IV.A.1.b, DOE considered air circulating axial panel fans, box fans, cylindrical ACFs, and unhoused ACFHs under the axial ACFs class. To account for the different housing configurations used in these four subcategories, DOE developed separate MPC estimates for housed ACFs with panel housing, housed ACFs with cylindrical housing, and unhoused ACFHs. DOE assumed that the costs of box housing and panel housing were comparable; therefore, DOE did not generate separate MPC estimates for ACFs with box housing. DOE averaged the MPCs of air circulating axial panel fans (and box fans), cylindrical ACFs, and unhoused ACFHs to estimate an overall MPC for axial ACFs. DOE did not include the cost of mounting gear, casters, or wheels in its MPC estimates for any equipment class because these features do not affect the efficacy of an ACF. Second, based on information received during confidential manufacturer interviews and further review of the ACF market, DOE updated its assumptions about manufacturing location and the source of purchased parts for this NOPR. Specifically, DOE concluded that most ACFs are made in the United States and that most ACF manufacturers source parts from suppliers in the United States and abroad. DOE understands that there are variations between OEMs in the ACF industry and chose production factors and modeling methods to reflect the range of OEMs. Further details on the development of the MPC estimates for axial ACFs can be found in chapter 5 of the NOPR TSD.

DOE did not evaluate housed centrifugal ACFs in the October 2022 NODA. To develop the MPC estimates for housed centrifugal ACFs, DOE performed teardowns on three housed centrifugal ACFs and created BOMs for each. DOE assumed that all housed centrifugal ACFs are manufactured in China and that all parts were purchased in China based on its review of the housed centrifugal market. DOE used these BOMs and catalog teardowns to estimate MPCs for housed centrifugal ACFs. Further details of the development of the MPC estimates for housed centrifugal ACFs can be found in chapter 5 of the NOPR TSD.

In the October 2022 NODA, DOE assumed that motors included in ACFs are purchased parts and determined the incremental MPCs associated with changing from a split-phase motor to a low-efficiency PSC motor, high-efficiency PSC motor, or ECM using data in its internal parts database. 87 FR 62038, 62053. DOE did not have sufficient pricing information for split-phase motors, so DOE approximated the split-phase motor MPC using prices for shaded-pole motors for the October 2022 NODA. *Id.* DOE estimated low-efficiency PSC motor MPCs by developing a best-fit line for motor price as a function of motor power and used this line to estimate low-efficiency PSC motor MPCs at the representative motor powers. DOE estimated high-efficiency PSC motor MPCs by determining the 95th percentile PSC motor MPC of the data it had available for each representative motor power and establishing a best-fit line for the 95th percentile MPCs as a function of motor power. DOE estimated ECM MPCs by establishing a best-fit line for the MPCs of ECMs as a function of motor power. 87 FR 62038, 62053. *Id.*

In response to the October 2022 NODA, NEMA commented that DOE's estimated motor costs were lower than actual motor costs. NEMA further stated that the cost of motors for commercial applications would generally be lower than those for industrial applications. (NEMA, No. 125 at p. 6) In response to this feedback, DOE reevaluated its motor costs for this NOPR. DOE's research indicates that most ACFs are sold in higher volumes, which suggests a commercial market, rather than an industrial market. In general, DOE finds that industrial equipment is sold in lower volumes and is manufactured for specific applications, and DOE has not observed that ACFs are typically sold or manufactured in this way. Therefore, DOE did not consider a separate MPC for industrial ACFs in this NOPR. DOE reviewed market information for fan motors and determined current fan motor sales prices. As such, DOE believes that its updated motor costs are more representative of the current fan motor market than those estimated in the October 2022 NODA.

In this NOPR, DOE also reevaluated how it estimated motor costs. For both low-efficiency PSC motors and high-efficiency PSC motors, DOE identified specific PSC fan motors and used the costs of these motors to estimate MPCs. Rather than using a single motor cost, DOE determined a weighted-average motor cost at each hp in its updated

ACF database. As discussed in section IV.C.2.c, DOE determined the percentage of motor hp values in the updated ACF database for each representative unit. DOE used these percentages and the MPCs determined for each motor type to calculate the weighted-average motor MPCs for each representative unit. Further details of DOE's modeling of ACF motor costs can be found in chapter 5 of the NOPR TSD.

Additionally, as discussed in section IV.C.2.c of this NOPR, DOE received feedback from NEMA and AMCA that changing to a more-efficient motor could also require changes to fan design. Specifically, NEMA commented that changing ACF motor efficiencies could require the use of a larger, heavier motor and could therefore require other design changes to the fan. (NEMA, No. 125 at p. 2) AMCA stated that replacing a motor with a more-efficient motor may result in the need for aerodynamic redesign or redesign of a fan's mounting and supports because of differences in motor size, shape, or weight. (AMCA, No. 132 at p. 12)

To evaluate these concerns, DOE estimated costs to redesign an ACF if a larger motor replaced a smaller motor. DOE evaluated the effects of motor volume and motor weight when considering a change from a smaller motor to a larger motor. DOE found during ACF teardowns that there is sufficient space for an increase in motor volume without needing to redesign other fan components, such as housing or safety guards. Therefore, DOE assumed that the only redesign required for an ACF when switching to a larger motor would be to increase the weight of the motor supports to accommodate an increased motor weight, which is consistent with what DOE has observed in teardowns. DOE used data gathered during ACF teardowns to approximate a relationship between motor weight and the cost of motor support materials. DOE used this relationship to estimate the increase in cost that would be expected for a given increase in motor weight. DOE found that even for a 100-percent increase in motor weight, which DOE believes is highly conservative, motor support costs increased fan MPC by 1.5 percent or less. Therefore, DOE has tentatively concluded that additional material costs would be minimal if a manufacturer incorporated a heavier motor into an ACF.

For this NOPR, DOE evaluated belt drives and low-efficiency PSC motors as the baseline design options, as discussed in section IV.C.2.c. To determine the baseline costs, DOE first determined the cost of a baseline ACF without a motor or transmission (''bare-shaft ACF'') for each representative unit. Then, DOE added the costs determined for a belt drive and a low-efficiency PSC motor to the base-shaft ACF to calculate the MPC of the baseline ACF for each representative unit. DOE did not find a significant difference in MPC between belt drives associated with different motor hp, so DOE chose a single belt drive cost for each representative unit. Further details on belt drive costs and baseline MPCs can be found in chapter 5 of the NOPR TSD.

For this NOPR, DOE assigned a direct-drive transmission as the design option for EL 1. DOE assumed that a change from a belt-drive transmission to a direct-drive transmission would involve the removal of the belt drive with no other adjustments to the ACF. Therefore, for the 36-in. and 52-in. axial ACF representative units, DOE estimated the cost associated with this design option by subtracting the belt drive MPC from the baseline MPC. For the 24-in. axial ACF and housed centrifugal ACF representative units, DOE set the EL 1 MPC equal to the baseline MPC.

DOE assigned a high-efficiency PSC motor as the ACF design option for EL 2 in this NOPR. For all equipment classes, DOE determined the EL 2 MPC by adding the estimated cost difference between a high-efficiency PSC motor and a low-efficiency PSC motor to the EL 1 MPC. The MPCs DOE estimated for low-efficiency PSC motors and high-efficiency PSC motors are included in chapter 5 of the NOPR TSD.

DOE associated EL 3, EL 4, and EL 5 in this NOPR with three different levels of aerodynamic redesign. In the October 2022 NODA, DOE defined a single aerodynamic redesign level at max-tech. DOE assumed that the redesign, reengineering, and new equipment that could be required for the aerodynamic redesign would result in a significant one-time conversion cost, such that aerodynamic redesigns would have a significantly greater impact on conversion costs than they would on MPCs. Therefore, DOE assumed that the change in MPC associated with the aerodynamic redesign was negligible compared to the conversion costs incurred by the manufacturer to implement this redesign. In this NOPR, DOE assumed that MPCs for EL 3, EL 4, and EL 5 were equal to the MPC for EL 2 for all equipment classes. DOE assumed that the complexity of ACF redesign would increase as ELs increase; therefore, DOE estimated that manufacturer investment in engineer time and equipment would increase with each EL. Information on DOE's estimated conversion costs can be found in section IV.J.2.c of this NOPR and in chapter 12 of the NOPR TSD.

DOE defined an ECM as the design option for EL 6. For all equipment classes, DOE determined the EL 6 MPC by adding the estimated cost delta between an ECM and a high-efficiency PSC motor to the EL 5 MPC. The MPCs DOE estimated for high-efficiency PSC motors and ECMs can be found in chapter 5 of the NOPR TSD.

To account for manufacturers' non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (''MSP'') is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (SEC) 10–K reports filed by publicly traded manufacturers primarily engaged in air circulating fan manufacturing. DOE then adjusted these manufacturer markups based on feedback manufacturers during interviews. DOE used a manufacturer markup of 1.5 in this NOPR analysis. The manufacturer markups used in this NOPR are discussed in more detail in section IV.J.2.a of this document and in chapter 12 of the NOPR TSD. The MSPs determined for ACFs are shown in Table IV–14.

Table IV-14 Estimated MSPs for ACF Equipment Classes and ELs

Representative Unit	EL 0	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6
24-inch axial ACF	$166.67	$166.67	$193.94	$193.94	$193.94	$193.94	$239.99
36-inch axial ACF	$412.43	$319.29	$346.68	$346.68	$346.68	$346.68	$396.86
52-inch axial ACF	$644.45	$549.53	$589.74	$589.74	$589.74	$589.74	$650.82
11-inch housed centrifugal ACF	$119.70	$119.70	$169.49	$169.49	$169.49	$169.49	$216.09

3. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or ''curves'') in the form of FEI versus MSP (in dollars) for GFBs or efficacy versus MSP for ACFs.

For GFBs, as discussed in section IV.C.1.d, DOE developed baseline MSP versus diameter curves and incremental costs for each design option for each equipment class. DOE used these correlations to estimate the MSP at each EL for each equipment class at all nominal impeller diameters. As such, each equipment class has multiple MSP versus FEI curves representing the range of impeller diameters that exist on the market. As discussed in section IV.C.1.b, the FEIs at each EL remain constant for each equipment class, regardless of impeller diameter. These FEIs were developed by determining the FEIs for the baseline equipment and implementing design options above baseline until all available design options were employed (*i.e.,* at the max-tech level). In contrast to the ACF analysis which used MPCs, DOE directly estimated MSPs for GFBs using the AMCA sales database and manufacturer fan selection software.

For ACFs, DOE developed curves for each representative unit. The methodology for developing the curves started with determining the efficacy for baseline equipment and the MPCs for this equipment. Above the baseline, DOE implemented design options until all available design options were employed (*i.e.,* at the max-tech level). To convert from MPCs to MSPs, DOE applied manufacturer markups as described in section 0.

Table IV–15 provides example cost-efficiency results from the GFB engineering analysis for the axial inline equipment class. Results are provided at an impeller diameter of 15 in. and an impeller diameter of 48 in.; however, as noted previously, DOE applied the same relative increases in MSP to obtain results at all impeller diameters for GFBs.

Table IV–16 contains example cost-efficiency results from the ACF engineering analysis for the 24-in. representative unit. As noted previously, ACF results were not scaled to all impeller diameters. Rather, the cost-efficiency results in Table IV–16 are relevant to all ACFs with an impeller diameter greater than or equal to 12 in. and less than 36 in.

See chapter 5 of the NOPR TSD for additional detail on the engineering analysis and appendix 5A of the NOPR TSD for complete cost-efficiency results.

Table IV-15 Axial PRV Example Engineering Results

EL	Design Option	FEI	MSP at 24 inches ($2022)	MSP at 48 inches ($2022)
0	Baseline	0.66	$2,522	$4,180
1	Blade change 1	0.69	$3,751	$6,144
2	Blade change 2	0.72	$3,800	$6,222
3	+1 Diameter increase	0.75	$2,733	$5,106
4	+2 Diameter increase	0.85	$3,028	$6,491
5	Aerodynamic redesign 1	1.00	$3,800	$6,222
6	Aerodynamic redesign 2	1.25	$3,800	$6,222
7	Aerodynamic redesign 3	1.49	$3,800	$6,222

Table IV-16 Air Circulating Fan Engineering Results - Impeller Diameter ≥ 12 in. and < 36 in.

EL	Design Options	Efficacy (CFM/W)	MSP ($2022)
0	Baseline – Baseline Motor with Direct Drive*	2.98	$111.11
1	Baseline Motor with Direct Drive	2.98	$111.11
2	More Efficient Induction Motor, Direct Drive	3.18	$129.29
3	More Efficient Induction Motor, Direct Drive, Aerodynamic Redesign 1	6.14	$129.29
4	More Efficient Induction Motor, Direct Drive, Aerodynamic Redesign 2	12.2	$129.29
5	More Efficient Induction Motor, Direct Drive, Aerodynamic Redesign 3	20.0	$129.29
6	ECM, Direct-Drive, Aerodynamic Redesign 3	24.3	$159.99

* EL0 is equivalent to EL1 because DOE found that belt drives are uncommon for ACFs with an impeller diameter < 36 inches.

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.,* retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis and in the manufacturer impact analysis. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin.

For GFBs, the main parties in the distribution chain are OEMs, distributors (including manufacturer in-house distributors), and contractors. DOE distinguished fan manufacturers in-house by OEMs from other fans and blowers and identified the distribution channels and associated fraction of shipments (*i.e.,* percentage of sales going through each channel) by equipment class.

For ACFs, the main parties in the distribution chain distributors (including ACF manufacturer in-house distributors) and contractors. In the October 2022 NODA, DOE identified the distribution channels and fraction of shipments associated with each channel based on feedback from manufacturer interviews. 87 FR 62038, 62054. DOE did not receive any comments on these channels and relied on the same distribution channels for this NOPR. In addition, as discussed in section IV.F.5 of this document, DOE included a motor or belt replacement as potential repairs for ACFs. Therefore, DOE additionally identified distribution channels associated with the purchase of a replacement motor or belt.

DOE developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of equipment with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[66]

DOE relied on economic data from the U.S. Census Bureau as well as data from RS Means[67] to estimate average baseline and incremental markups.

Chapter 6 of the NOPR TSD provides details on DOE's development of markups for fans and blowers.

DOE seeks comment on the distribution channels identified for GFBs and ACFs and fraction of sales that go through each of these channels.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of fans and blowers at different efficiencies in representative applications, and to assess the energy savings potential of increased fan and blower efficiency. The energy use analysis estimates the range of energy use of fans and blowers in the field (*i.e.,* as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

To characterize variability and uncertainty, the energy use is calculated for a representative sample of fan and blower consumers. This method of analysis, referred to as a Monte Carlo method, is explained in more detail in section IV.F of this document. Results of the energy use analysis for each equipment class group or representative unit were derived from a sample of 10,000 consumers. This section presents DOE's approach to develop consumer samples and energy use inputs that DOE applied in the energy use analysis.

1. General Fans and Blowers

For GFBs, annual energy use depends on the annual hours of operation, operating pressure and airflow, and load profile. It includes the electricity consumed by the motor driving the fan, as well as losses related to any belts and motor controller (*e.g.,* variable speed drive or ''VFD'') included in the fan.

Sample of Consumers

DOE developed a consumer sample to represent consumers of GFBs in the commercial and industrial sectors. DOE used the sample to determine fan and blower annual energy consumption as well as to conduct the LCC and PBP analyses.

To develop this sample, DOE used 2012 sales data from AMCA corresponding to 92,287 units sold

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

[67] RS Means Electrical Cost Data 2023. Available at: *www.rsmeans.com.*

(''2012 AMCA sales data'').[68] The data included information on the design operating flow, operating pressure, and shaft input power for which each fan was purchased and representative of fans sold as standalone equipment (*i.e.,* not incorporated in another equipment). In addition, to represent fans sold incorporated in other equipment (*i.e.,* embedded fans manufactured in-house by OEMs or ''OEM fans''), DOE used data specific to HVAC equipment in which these fans are used to characterize the fan impeller topology (*i.e.,* category code) typically used in HVAC equipment and in the scope of this analysis to identify the range of operating flow, pressure, and shaft input power specific to these fans. Based on this information, DOE identified fan models from the 2012 AMCA sales data with the same equipment class, category code and shaft input power. DOE used these models to develop a sample representative of OEM fans. DOE then used sales data for the whole U.S. market to develop weights for each fan model and develop the fan consumer sample (where each consumer is assigned with a fan model and associated fan equipment class, category code, power bin, design operating flow, operating pressure, and shaft input power). Specifically, DOE developed the weights such that for each equipment class, the sample included the same proportions of GFBs by market segment (*i.e.,* fans sold as standalone equipment and OEM fans), category code, and power bin as in the total U.S. market.

In addition, each consumer in the sample was assigned a sector and a configuration (*i.e.,* direct or belt driven and with or without VFD). The sector determines the field use characteristics, such as annual operating hours, load profile, and equipment lifetimes as well as the economic parameters (*i.e.,* electricity prices and discount rates). To estimate the percentage of consumers in the industrial and commercial sectors, DOE primarily relied on data from the DOE–AMO report ''U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base'' (''MSMA report'').[69] To estimate the percentage of consumers that operate a fan with or without belts, and with or without VFDs, DOE relied on information from manufacturer interviews.

Annual Operating Hours

To develop distributions of annual operating hours, DOE relied on information from the MSMA report, which provides distributions of annual operating hours for fans used in the commercial and industrial sector.

Load Profiles

DOE relied on the design flow and pressure, associated shaft input power, and fan configuration information of each fan in the sample to characterize the operating flow and pressure and associated shaft input power. DOE further relied on information from manufacturer interviews to estimate the share of fans that operate at constant load or at variable load by equipment class.[70] Based on this information, DOE estimated the percentage of fans operating at variable load as shown in Table IV–17.

Table IV-17: Load characterization by Equipment Class

Equipment Class	Variable Load	Constant Load
Axial Inline Fans	49.1%	50.9%
Axial Panel Fans	22.6%	77.4%
Centrifugal Housed Fans	40.1%	59.9%
Centrifugal Inline Fans	15.0%	85.0%
Centrifugal Unhoused Fans	65.2%	34.8%
Axial Power Roof Ventilator - Exhaust	23.0%	77.0%
Centrifugal Power Roof Ventilator - Exhaust	23.0%	77.0%
Centrifugal Power Roof Ventilator - Supply	34.0%	66.0%
Radial Housed Fans	0.3%	99.7%

For fans operating at constant load, DOE reviewed information from the MSMA report which indicates that the majority of constant load fans operate at or above 75 percent of the motor full load.[71] This indicates that constant load fans primarily operate near the design point. Therefore, in this NOPR, for both the commercial and industrial sectors, DOE assumed that all constant load fans operate at the design point.[72]

For fans used at variable load, in the commercial sector, DOE relied on information previously provided by AHRI to develop a variable load profile (Docket No. EERE–2013–BT–STD–0006, AHRI, No. 129, at p. 2). In the industrial sector, DOE did not find any data to characterize the typical load profile and given the wide range of possible applications, DOE assumed equal weights at each of the considered load points.[73] DOE has tentatively determined that while DOE has not found data to characterize the field operating loads of GFBs used in the industrial sector, using a weighted-average across multiple load points and weighting all those points equally is a more representative load profile when compared to calculating the efficiency at a single point.

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[68] Air Movement and Control Association (AMCA). 2012 Detailed Confidential Fan Sales Data from 17 Manufacturers. November 2014.

[69] Prakash Rao et al., ''U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base,'' January 12, 2021. Available at: *doi.org/10.2172/1760267.*

[70] DOE also reviewed information from the MSMA report. However, the information provided in the MSMA report did not differentiate fans by equipment class, and DOE therefore relied on the information collected during manufacturer interviews instead.

[71] *See: motors.lbl.gov/analyze/kb-0q19q1M.*

[72] Based on typical motor sizing practices, which suggest a motor horsepower equal to 1.2 (*i.e.,* the design fan shaft input power), DOE believes that the design point represents 1/1.2 = 83 percent of the motor full load. The 1.2 sizing factor is based on input from the Working Group (Docket No. EERE–2013–BT–STD–0006; No. 179, Recommendation #10 at p. 6).

[73] The load profile is represented by four load points defined as 25, 50, 75, and 100 percent of the design flow as well as the percentage annual operating hours spent at each of these points (*i.e.,* weights).

NEEA commented that the assumptions made for the load profiles presented in the 2016 NODA LCC are outdated and that DOE should collect additional information on load profiles for fans and blowers.[74] NEEA recommended that DOE collect end-user data, use information on fan loading information from the MSMA report, or reach out to fan operation professionals in order to update DOE's load profile assumptions. (NEEA, No. 129 at p. 7) DOE reviewed the energy use data provided in the MSMA report. However, DOE notes that the load fraction provided in the MSMA report are in terms of average fraction of motor full load output power and are not expressed in terms of percentage time spent at a given percentage of design flow.[75] Therefore, DOE could not use this information to develop the load profiles for variable load fans. In addition, DOE did not receive any data on load profile in response to the February 2022 RFI.[76] Instead, as previously stated, in this NOPR, for fans used in the commercial sector with VFDs, DOE relied on information previously provided by AHRI to develop a variable load profile in the commercial sector (Docket No. EERE–2013–BT–STD–0006, AHRI, No. 129, at p. 2). In the industrial sector, as stated previously, DOE did not find any information to help characterize the load profile and assumed equal weights at each of the considered load points.

In response to the October 2022 NODA, NEEA commented that DOE should account for different power load relationships associated with different fan control methods. NEEA stated that fans can operate below 100 percent of the design flow. NEEA noted that DOE captured this operation in its 2016 NODA analysis through the use of load profiles.[77] NEEA noted that in its previous annual energy use calculation, DOE relied on the affinity laws as representative of the power load relationship for all fans, regardless of the control method. NEEA added that while the installation of variable speed control can dramatically reduce a fan's energy consumption, in DOE's analysis its power load relationship (and therefore energy use) is assumed to be equal to that of the same fan operating with a more consumptive control strategy. NEEA commented that using the fan laws is an unreasonable proxy for other power load relationships. Instead, NEEA commented that various equipment and appurtenances allow fans to meet reduced flow rates, and the relationship between the required flow and a fan's power draw is unique to each equipment or ''control method'' (*e.g.,* the use of outlet vanes, disc throttle, inlet vanes, and controllable pitch blades). NEEA provided further examples of such relationships and associated references.[78] NEEA added that the installation of a drive is often considered an energy efficiency opportunity for fan systems. NEEA stated that the installation of VFDs has been identified as the measure with the largest savings opportunity for industrial fans and the second largest savings for commercial fans.[79] NEEA commented that the savings associated with installing a VFD are directly related to a more efficient power-load relationship, and that assuming all load control methods follow the fan laws would understate the energy use of fans without VFDs. Therefore, NEEA commented that DOE should account for the different power-load relationships associated with different load control methods and applying different power-load relationships based on the distribution of flow control methods seen in the market. In addition, NEEA recommended that DOE consider the power-load relationship for fans operating without a load control method by developing ''representative'' fan performance curves to model the energy consumption of fans that do not have load control. NEEA recommended that DOE develop representative fan curves, similar to those developed for the energy use analysis in the December 2015 Pumps Final Rule,[80] which would enable DOE to account for fan-specific performance. NEEA noted that this performance curve method was used in DOE's first NODA [81] but was removed in the second NODA.[82] Lastly, NEEA recommended that DOE utilize published power load equations to determine energy uses for fans with non-VFD controls.[83] (NEEA, No. 129 at pp. 4–7)

As noted by NEEA, different categories of controls result in different energy savings, which do not always follow the fan affinity laws. However, based on the MSMA report, DOE estimates that the majority of fans do not have load control (88 percent), and that the majority of fans with load control utilize VFDs (9 percent), while 1 percent of fans with load control rely on other categories of controls and another 1 percent of fans had an unknown configuration.[84] Therefore, in this NOPR, for fans with load control (and operating at variable load) DOE only considered VFDs as the primary load control equipment and applied the affinity laws when calculating the resulting savings. For fans without load control and operating at constant load, as stated earlier, DOE believes the majority of these fans operate near the design point. In addition, although DOE developed information on typical fan curves as part of previous analysis as noted by NEEA, the AMCA data did not provide sufficient information to relate the design point to a location on the fan curve. Therefore, for constant load fans, DOE was unable to utilize this information in combination with the 2012 AMCA data to estimate the energy use at a reduced flow and thus assumed operation at the design point.[85]

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[74] NEEA cited: 2016 NODA Life-Cycle Cost (LCC) and Payback Period (PBP) Analyses Spreadsheet, Tab ''Sectors and Applications,'' Notes cell B49. Available at: *www.regulations.gov/document/EERE-2013-BT-STD-0006-0190.*

[75] *See* for example: *motors.lbl.gov/analyze/3-0819.*

[76] DOE notes that although the February 2022 RFI did not specifically request feedback on such load profiles, DOE stated that it received written comments from the public on any subject within the scope of this document (including those topics not specifically raised in the RFI), as well as the submission of data and other relevant information. 87 FR 7048.

[77] NEEA cited the November 2016 NODA Life-Cycle Cost (LCC) and Payback Period (PBP) Analyses Spreadsheet. Available at: *www.regulations.gov/document/EERE-2013-BT-STD-0006-0190.*

[78] *Improving Fan System Performance: A Sourcebook for Industry,* Figure 2–20, Page 43. May 2014. Available at: *www.energy.gov/sites/default/files/2014/05/f16/fan_sourcebook.pdf;* and *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* Chapter 18: Variable Frequency Drive Evaluation Protocol, Table 1, Page 12. Available at: *www.nrel.gov/docs/fy17osti/68574.pdf.*

[79] NEEA cited: U.S. Industrial and Commercial Motor System Market Assessment Report Volume 3: Energy Saving Opportunity, 7/2022, Figure 17 and Figure 18. Available at: *eta-publications.lbl.gov/sites/default/files/u.s._industrial_and_commercial_motor_system_market_assessment_report_volume_3_energy_saving_opportunity_p_rao.pdf.*

[80] NEEA referenced: 2015–12–30 Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Pumps. NEEA commented that section 7.2.1.3 outlined the process to develop representative performance curves. Available at: *www.regulations.gov/document/EERE-2011-BT-STD-0031-0056.*

[81] NEEA cited: 2014–12–03 NODA Life-Cycle Cost (LCC) Spreadsheet. Available at: *www.regulations.gov/document/EERE-2013-BT-STD-0006-0034.*

[82] *See:* 2015–04–21 NODA Life-Cycle Cost (LCC) Spreadsheet. Available at: *www.regulations.gov/document/EERE-2013-BT-STD-0006-0060.*

[83] NEEA referenced this study: *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* Chapter 18: Variable Frequency Drive Evaluation Protocol, Table 1, Page 12. Available at: *www.nrel.gov/docs/fy17osti/68574.pdf.*

[84] *See: motors.lbl.gov/analyze/4b-0j0Bd0.*

[85] As noted by NEAA, DOE updated its methodology between its first NODA and second NODA in order to enable the utilization of the AMCA 2012 data which represented thousands of fan selection data. While the first NODA relied on

Drive Components

The fan energy use calculation includes motor, VFD (if present) and transmission (*i.e.,* belt) losses. To represent the performance of the motor and belts, DOE used the mathematical models from the DOE test procedure (*See* 87 FR 27312) which assumes the motor is compliant with the upcoming DOE standard for electric motors at 10 CFR 431.25 and characterizes belt efficiency based on a model published in AMCA 214–21 as referenced in the DOE test procedure.[86] To represent the performance of the motor combined with a VFD, DOE used the mathematical models from section 6.4 of AMCA 214–21 which is representative of typical motor and VFD combinations, as referenced in the DOE test procedure. DOE further relied on information from manufacturer interviews to estimate the share of belt-driven fans.

2. Air-Circulating Fans

DOE calculated the energy use of ACFs by combining ACF input power consumption from the engineering analysis with annual operating hours. For each consumer in the sample, DOE associates a value of ACF annual operating hours drawn from statistical distributions as described in the remainder of this section.

Sample of Consumers

In the October 2022 NODA, DOE included commercial, industrial, and agricultural applications in the energy use analysis of ACFs with input power greater than or equal to 125 W. 87 FR 62038, 62056. DOE did not receive any comments on this approach. Accordingly, in the NOPR, DOE created a sample of 10,000 consumers for each representative unit to represent the range of air-circulating fan energy use in the commercial, industrial, and agricultural sectors.

Annual Operating Hours

In the October 2022 NODA, DOE estimated that air circulating fans with input power greater than or equal to 125 W operate, on average, 12 hours per day, consistent with the hours of use estimated for large-diameter ceiling fans in the Ceiling Fan Preliminary Analysis.[87] To represent a range of possible operating hours around this representative value, DOE relied on a uniform distribution between 6 hours per day and 18 hours per day (assuming a uniform distribution of operating hours due to the limited availability of information). 87 FR 62038, 62056–62057

In response to the October 2022 NODA, ebm-papst stated that the usages of agricultural fans, residential fans, commercial fans, and basket fans used for distribution transformers are all very different. (ebm-papst, No. 8 at p. 4) AMCA commented that ACFs and ceiling fans in commercial and industrial buildings serve similar functions during warmer months, which is to provide a low-energy method for cooling. AMCA added however that ACFs are often not used during cooler months, while ceiling fans are either used in a reversed direction mode or run at a lower speed. Therefore, only ceiling fan usage during warmer months can be used as a proxy for ACF usage, and the annual operating hours of ceiling fans will be greater than those of ACFs. AMCA added that ACFs used for horticulture applications may have different usage hours than that of other ACFs or ceiling fans. (AMCA, No. 132 at p. 13)

DOE established the annual operating hours as the product of the daily operating hours and the number of operating days per year. In line with the information presented in the October 2022 NODA, for all ACFs except centrifugal housed ACFs, DOE assumed average daily operating hours of 12 hours per day. To reflect the variability in usage by application as noted by ebm-papst, DOE relied on a uniform distribution between 6 and 18 hours per day. For centrifugal housed ACFs, DOE relied on lower operating hours as these fans are primarily used for carpet drying applications and are less likely to operate 12 hours per day on average. DOE did not receive any feedback on daily operating hours and assumed average daily operating hours of 6 hours per day. To represent a range of possible operating hours around this representative value, DOE relied on a uniform distribution between 0 hours per day and 12 hours per day.

With the exception of centrifugal housed ACFs, ACFs are primarily used for cooling purposes in the commercial sector (*e.g.,* to cool people in loading docks, warehouses, gyms, etc.), in the industrial sector, (*e.g.,* to cool people in factory workstations, etc.), and in the agricultural sector (*e.g.,* to reduce livestock heat stress). To establish the number of annual operating days for ACFs other than centrifugal housed ACFS, and to reflect AMCA's note that these ACFs are not used in cooler months, DOE relied on weather data to estimate a distribution of annual operating days for ACFs. While some ACFs may also be used for non-cooling purposes,[88] DOE did not find any data to establish the market share of such applications and assumed all ACFs are used for cooling purposes, as this is the primary application of ACFs. Based on input from manufacturer interviews, DOE further estimated that 20 percent of ACFs are used in the commercial sector, 20 percent in the industrial sector, and 60 percent in the agricultural sector. In the case of centrifugal housed ACFs, which are primarily used for carpet drying, DOE assumed these are exclusively used in the commercial sector and throughout the year.

Input Power

In the October 2022 NODA, DOE described that DOE may consider calculating the energy use by combining air circulating fan input power consumption in each mode (*e.g.,* high speed, medium speed, low speed) from the engineering analysis with operating hours spent in each mode and assuming an equal amount of time spent at each tested speed. 87 FR 62038, 62055–62057. Consistent with the May 2023 TP Final Rule, DOE estimates that these fans are primarily used at high speed and assumed operation at high speed only.

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

DOE seeks comment on the overall methodology and inputs used to estimate GFBs and ACFs energy use. Specifically, for GFBs, DOE seeks feedback on the methodology and assumptions used to determine the operating point(s) both for constant and variable load fans. For ACFs, DOE requests feedback on the average daily operating hours, annual days of operation by sector and application, and input power assumptions. In addition, DOE requests feedback on the market share of GFBs and ACFs by sector (*i.e.,* commercial, industrial, and agricultural).

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representative units and representative fans curves, as well as confidential data from a single manufacturer to develop distributions of operating points, the second NODA relies on fan selection data and sales data from 17 manufacturers to inform the LCC sample and location of the operating points.

[86] ANSI/AMCA Standard 214–21 ''Test Procedure for Calculating Fan Energy Index (FEI) for Commercial and Industrial Fans and Blowers.''

[87] *See* section 7.4.2 of Chapter 7 of the Ceiling Fan Preliminary Analysis Technical Support Document. Available at: *www.regulations.gov/document/EERE-2021-BT-STD-0011-0015.*

[88] This include fans that are also used for cooling and may be left on during cooler months as they are also used for non-cooling applications (*e.g.,* ACFs used for reducing foul odors/manure gases/moisture/dust, drying, cooling machinery).

F. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for fans and blowers. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating costs and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- The LCC is the total consumer expense of the equipment over the life of that equipment, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment.
- The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of more efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of fans and blowers in the absence of new or amended energy conservation standards. The PBP for a given efficiency level is also measured relative to the no-new-standards case efficiency distribution.

For each considered TSL in each equipment class, DOE calculated the LCC and PBP for a nationally representative set of consumers. As stated previously, DOE developed consumer samples from a variety of data sources as described in section IV.F of this document. For each sample consumer, DOE determined the energy consumption for the fans and blowers and the appropriate energy price. By developing a representative sample of consumers, the analysis captured the variability in energy consumption and energy prices associated with the use of fans and blowers.

Inputs to the calculation of total installed cost include the cost of the equipment—which includes MPCs, manufacturer markups (including the additional manufacturer conversion cost markups where appropriate), retailer and distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, equipment lifetimes, and discount rates. DOE created distributions of values for equipment lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

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

DOE calculated the LCC and PBP for consumers of fans and blowers as if each were to purchase new equipment in the expected year of required compliance with new or amended standards. New standards would apply to fans and blowers manufactured 5 years after the date on which any new standard is published. (42 U.S.C 6316(a); 42 U.S.C. 6295(l)(2)) At this time, DOE estimates publication of a final rule in the second half of 2024. Therefore, for the purposes of its analysis, DOE used 2030 as the first full year of compliance with any new standards for fans and blowers.

Table IV–18 Summary of Inputs and Methods for the LCC and PBP Analysis* summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the NOPR TSD and its appendices.

Table IV-18 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Equipment Cost	Derived by multiplying MPCs by manufacturer (including a manufacturer conversion markup where appropriate) and distribution channel markups and sales tax. Used historical data to derive a price index to project product costs.
Installation Costs	Assumed no change with efficiency level, except for PRVs where there is an increase in size.
Annual Energy Use	Fan electrical input power multiplied by the annual operating hours at the considered operating point(s); Variability: By sector and application.
Energy Prices	Electricity: Based on EEI data for 2022. Variability: By sector.
Energy Price Trends	Based on *AEO2023* price projections.
Repair and Maintenance Costs	GFBs: Assumed no change with efficiency level. ACFs: Relied on different belt and motor repair costs by EL.
Equipment Lifetime	Average for GFBs: 16.0 years. Average for ACFs: 6.3 years.
Discount Rates	Calculated as the weighted average cost of capital for entities purchasing fans. Primary data source was Damodaran Online.
Compliance Date	2030 (first full year)

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

In response to the October 2022 NODA, AMCA commented that DOE should refer to interviews with individual manufacturers for feedback on the inputs and considered methods used for the LCC and PBP analyses. (AMCA, No. 132 at p. 14) As noted throughout this section, DOE relied on input from manufacturer interviews where available.

1. Equipment Cost

To calculate equipment costs, DOE multiplied the MSPs developed in the engineering analysis by the distribution channel markups described previously (along with sales taxes). DOE used different markups for baseline equipment and higher-efficiency equipment because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency equipment. Further, as described in section IV.C of this document, at ELs with associated manufacturer conversion costs, DOE applied a manufacturer conversion markup when calculating the equipment price of re-designed units.

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to ''learning'' or ''experience'' curves. Experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level.

For GFBs, to develop an equipment price trend for the NOPR, DOE derived an inflation-adjusted index of the Producer Price Index (PPI) for industrial and commercial fans and blowers equipment over the period 2003–2022.[89] These data show a general price index increase from 2003 through 2009, a slower growth trend over the period 2009–2020, and a high increase since 2020. However, the outbreak of COVID–19 pandemic caused immense uncertainties in global supply chain and international trade resulting in price surges across all sectors since 2020. DOE believes that the extent to which these macroeconomic trends will continue in the future is very uncertain. Therefore, DOE used a constant price assumption as the default trend to project future fan prices. Thus, for GFBs, prices projected for the LCC and PBP analysis are equal to the 2022 values for each efficiency level in each equipment class.

For ACFs, DOE did not find PPI data specific to ACFs, and instead, DOE adopted a component-based approach to develop a price trend by identifying ACF components most likely to undergo a price variation over the forecast period. Using this approach, the price trend only applies to the cost of the component and not to the total cost of the ACF. For EL0 through EL5, which are efficiency levels that assume AC induction motors, DOE determined that ACF motors are the most likely component to undergo price variation over time and analyzed long-term trends in the integral and fractional horsepower motors PPI series.[90] The deflated price index for integral and fractional horsepower motors was found to align with the copper, steel, and aluminum deflated price indices. DOE believes that the extent to which these commodity price trends will continue in the future is very uncertain and therefore does not project commodity prices. In addition, the deflated price index for fractional horsepower motors was mostly flat during the entire period from 1967 to 2020. Therefore, DOE relied on a constant price assumption as the default price factor index to project future ACF prices at EL 0 through EL 5. At EL 6, which assumes an ECM motor, DOE did not find any historical data specifically regarding ECM motors. For its analysis, DOE assumed that the circuitry and electronic controls associated with ECM motors would potentially be the most affected by price trends driven by the larger electronics industry as a whole. DOE obtained PPI data on ''Semiconductors and related

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[89] Series ID PCU3334133334132. Available at: *www.bls.gov/ppi/*.

[90] Series ID PCU3353123353123 and PCU3353123353121. Available at: *www.bls.gov/ppi/*.

device manufacturing'' [91] between 1967 and 2022 to estimate the historic price trend in electronic components. These data show a price decline over the entire period. Therefore, DOE applied a decreasing price trend for the controls portion of the ECM price. *See* chapter 8 for more details on the price trends.

DOE requests feedback on the price trends developed for GFBs and ACFs.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment.

For GFBs, DOE found no evidence that installation costs would be impacted with increased efficiency levels and did not include installation costs in its analysis, except at efficiency levels where an increase in size is assumed (*i.e.,* for PRVs). In this case, DOE incorporated higher installation (*i.e.,* shipping) costs due to the change in size.

For ACFs, DOE stated in the October 2022 NODA that it found no evidence that installation costs would be impacted with increased efficiency levels and, as a result, DOE was not planning on including installation costs in the LCC. 87 FR 62038, 62058. DOE did not receive any comments to the October 2022 NODA related to installation costs and continued with this approach for ACFs.

DOE requests feedback on the installation costs developed for GFBs and on whether installation costs of ACFs may increase at higher ELs.

3. Annual Energy Consumption

For each sampled consumer, DOE determined the energy consumption for a fan at different efficiency levels using the approach described previously in section IV.E of this document.

4. Energy Prices

Because marginal electricity prices more accurately capture the incremental savings associated with a change in energy use from higher efficiency, they provide a better representation of incremental change in consumer costs than average electricity prices. Therefore, DOE applied average electricity prices for the energy use of the equipment purchased in the no-new-standards case, and marginal electricity prices for the incremental change in energy use associated with the other efficiency levels considered.

DOE derived electricity prices in 2022 using data from EEI Typical Bills and Average Rates reports. Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the commercial and industrial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[92]

DOE's methodology allows electricity prices to vary by sector, region, and season. In the analysis, variability in electricity prices is chosen to be consistent with the way the consumer economic and energy use characteristics are defined in the LCC analysis. For fans and blowers, DOE considered sector-specific electricity prices. *See* chapter 8 of the NOPR TSD for details.

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes from the Reference case in *AEO2023,* which has an end year of 2050.[93] To estimate price trends after 2050, the 2050 prices were held constant.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing equipment components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency entail no, or only minor, changes in repair and maintenance costs compared to baseline efficiency equipment.

For GFBs, DOE found no evidence that maintenance and repair costs would be impacted with increased efficiency levels. Therefore, because DOE expresses results in terms of LCC savings, DOE did not account for maintenance and repair costs in the LCC.

For ACFs, in the October 2022 NODA, DOE stated that it did not find any information supporting changes in maintenance costs as a function of efficiency. 87 FR 62038, 62058. DOE did not receive any comments in response to the October 2022 NODA related to maintenance costs; DOE continues to believe these do not vary by efficiency and did not include maintenance costs in its analysis.

In the October 2022 NODA, DOE identified the motor replacement as a potential repair for ACFs. DOE requested feedback on its assumptions about repair practices of ACFs. 87 FR 62038, 62058.

In response, AMCA commented that belt replacement could be the only significant maintenance or repair necessary for ACFs. AMCA added that DOE should reference manufacturer interviews for further information. AMCA added that ACFs are often used in environments with harsher conditions than other fans and experience higher temperatures, higher moisture content, higher particulate concentrations, and more power source fluctuations than do other fans. Because of this, AMCA stated that ACF repairs and replacements are more frequent than for other fans. (AMCA, No. 132 at pp. 14–15)

For ACFs, DOE found no evidence that maintenance costs would be impacted with increased efficiency levels and did not include maintenance costs in its analysis. However, DOE did include repair costs associated with belt repair at EL 0, which represents belt driven ACFs as appropriate. In addition, although stakeholder feedback did not indicate the possibility of a motor repair for ACFs, DOE identified several ACF manufacturers offering replacement motors. DOE assumed such repair is not frequent as it was not identified as a potential repair by stakeholders. Therefore, DOE assumed that only 5 percent of ACFs include a motor repair and estimated the repair costs associated with motor replacement. In order to calculate these repair costs, DOE relied on inputs from the engineering analysis.

DOE requests feedback on whether the maintenance and repair costs of GFBs may increase at higher ELs. Specifically, DOE requests comments on the frequency of motor replacements for ACFs. DOE also requests comments on whether the maintenance and repair costs of ACFs may increase at higher ELs and on the repair costs developed for ACFs.

6. Equipment Lifetime

For GFBs, in the NODA DOE used average lifetimes of 30 years in the industrial sector based on input from a subject matter expert, and 15 years in the commercial sector based on the expected lifetimes of HVAC equipment. Across all sectors and equipment classes, the average lifetime for GFBs is 16 years. To characterize the range of possible lifetimes, DOE developed Weibull distributions of equipment lifetimes.

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[91] Series ID: PCU334413334413. Available at *www.bls.gov/ppi/.*

[92] Coughlin, K. and B. Beraki. 2019. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL–2001203. Available at: *ees.lbl.gov/publications/non-residential-electricity-prices.*

[93] EIA. *Annual Energy Outlook 2023 with Projections to 2050.* Washington, DC. Available at: *www.eia.gov/forecasts/aeo/* (last accessed June 6, 2023).

For ACFs, in the October 2022 NODA, DOE stated that it did not find lifetime data specific to ACFs and was considering using 30 years, similar to GFBs lifetimes in a previous DOE analysis. (November 2016 NODA)

In response to the October 2022 NODA, AMCA commented that DOE should assume a lifetime of 10 years instead of 30, because ACFs often are used in non-conditioned spaces or agricultural environments that expose them to dust, debris, moisture, and other debilitating factors. In addition, AMCA stated that in a previous report,[94] DOE estimated average lifetimes of fractional (*i.e.,* less than 1 horsepower) electric motors to 10 to 15 years. AMCA added that ACFs are typically used in areas without air conditioning and experience higher air temperatures, higher humidity, higher concentrations of particulate matter in the air, and greater fluctuations in power quality, compared to fans in buildings with full HVAC systems and tight envelopes. For these reasons, AMCA stated that it is unlikely for an ACF to have a lifetime of 30 years. Instead, AMCA recommended using a value of 10 years, which is the lower end of the motor life expectancy in the DOE report. (AMCA, No. 132 at pp. 2, 18–19)

In this analysis, as suggested by AMCA, DOE relied on separate lifetimes for ACFs and GFBs. DOE considered two separate lifetimes for ACFs depending on whether the lifetime included a motor replacement or not. For ACFs that do not include a motor replacement, DOE assumed the average lifetime was equal to the estimated average motor lifetime of 6 years based on input from manufacturer interviews. DOE believes this value is more representative of ACF motor lifetimes as it is more recent and specific to the ACFs compared to the estimate provided by AMCA, which relied on a general motor and pump study published in 1980. For ACFs that include a motor replacement, DOE assumed an average lifetime of 12 years (*i.e.,* twice the motor lifetime). DOE further assumed 5 percent of ACFs have a motor repair (*see* section IV.F.5 of this document), while 95 percent of ACFs do not, resulting in an overall average lifetime of 6.3 years. To characterize the range of possible lifetimes, DOE developed Weibull distributions of equipment lifetimes.

DOE requests comments on the average lifetime estimates used for GFBs and ACFs.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate for consumers to estimate the present value of future operating cost savings. DOE estimated a distribution of discount rates for fans and blowers based on the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[95] The LCC analysis estimates net present value over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long-time horizon modeled in the LCC analysis, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish commercial, industrial, and agricultural discount rates for fans and blowers, DOE estimated the weighted-average cost of capital using data from Damodaran Online.[96] The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing. DOE estimated the cost of equity using the capital asset pricing model, which assumes that the cost of equity for a particular company is proportional to the systematic risk faced by that company. The average discount rates in the commercial, industrial, and agricultural sectors are 6.77, 7.25, and 7.15 percent, respectively.

DOE did not receive any comments related to discount rates.

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

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

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of equipment efficiencies under the no-new-standards case (*i.e.,* the case without new energy conservation standards).

To estimate the energy efficiency distribution of GFBs for 2030, DOE relied on the 2012 AMCA sales data from the sample (*see* section IV.E.1 of this document). DOE notes that since 2012, the ASHRAE Standard 90.1–2010 *Energy Standard for Buildings Except Low-Rise Residential Building* (''ASHRAE Standard 90.1'') includes limits on the FEI of certain fans and has been adopted in some States.[97] In addition, the California Energy Commission recently finalized reporting requirements to promote fan selections at duty points with FEI ratings greater than or equal to 1.00.[98] However, DOE reviewed recent manufacturer catalogs and found that the market has not changed significantly since 2012 (*see* detailed discussion in section IV.A.2.a of this document). Therefore, in this NOPR, DOE relied on the 2012 efficiency distributions to characterize the no-new-standards case in 2030. The estimated market shares for the no-new-standards case for GFBs are shown in Table IV–19.

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[94] AMCA referenced the following study: 1980. ''Classification and evaluation of electric motors and pumps.'' United States. Available at: *doi.org/10.2172/6719781.*

[95] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; interest rates at which a consumer is able to borrow or lend. The implicit discount rate is not appropriate for the LCC analysis because it reflects a range of factors that influence consumer purchase decisions, rather than the opportunity cost of the funds that are used in purchases.

[96] Damodaran Online, *Data Page: Costs of Capital by Industry Sector* (2021). Available at: *pages.stern.nyu.edu/~adamodar/*(last accessed April 22, 2022).

[97] *See* 2020 Florida Building Code, Energy Conservation, 7th edition—Section C403.2.12.3 Fan Efficiency, effective December 31, 2020; 2021 Oregon Efficiency Specialty Code (OEESC): The 2021 OEESC, based on ASHRAE Standard 90.1–2019, effective April 1, 2021.

[98] These requirements take effect in November 2023. *See www.energy.ca.gov/rules-and-regulations/appliance-efficiency-regulations-title-20/appliance-efficiency-proceedings-11.*

Table IV-19: No New Standards Case Efficiency Distribution in 2030 - GFBs

Equipment Class	EL0	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Axial Inline	5.2%	7.4%	20.8%	37.4%	24.5%	4.8%	N/A	N/A
Axial Panel	8.1%	11.7%	31.6%	32.0%	13.2%	3.4%	N/A	N/A
Centrifugal Housed	20.8%	5.6%	22.8%	31.9%	16.6%	2.5%	N/A	N/A
Centrifugal Inline	8.4%	5.9%	32.7%	13.7%	26.9%	10.2%	2.3%	N/A
Centrifugal Unhoused	4.2%	6.0%	21.8%	50.1%	15.4%	2.5%	N/A	N/A
Axial Power Roof Ventilator	6.1%	4.4%	2.5%	13.0%	24.5%	30.9%	13.4%	5.3%
Centrifugal Power Roof Ventilator - Exhaust	7.9%	1.3%	9.7%	16.6%	33.8%	24.8%	6.0%	N/A
Centrifugal Power Roof Ventilator – Supply	6.3%	3.8%	16.2%	25.6%	35.6%	9.1%	3.3%	N/A
Radial Housed	7.3%	3.5%	7.0%	32.7%	27.2%	22.2%	N/A	N/A

The entry "N/A" indicates the EL is not available for the considered equipment class.

In the October 2022 NODA, DOE stated that it would rely on information from the BESS Labs dataset to develop efficiency distribution and that it would randomly assign an equipment efficiency to each consumer drawn from the consumer samples. 87 FR 62038, 62060. DOE did not receive any comments on this topic.

For ACFs, DOE collected model performance data from the BESS Labs database as well as information from manufacturer catalogs. As noted in section IV.A.1.a, the BESS Labs database contains fans with higher efficiencies than the overall ACF market and is not representative of the ACF market as a whole. DOE collected catalog data from manufacturer and distributor websites to supplement the BESS Labs database. DOE relied on the performance data from both datasets establish the no-new-standards case efficiency distribution of ACFs in 2030 and used a weighted average when calculating the overall efficiency distributions to reflect that fact that the models in the BESS Labs database are representative of the top of the market in terms of efficiency.[99] DOE did not find historical performance data for ACFs and assumed the efficiency distribution would remain the same over time. The resulting market shares for the no-new-standards case for ACFs are shown in Table IV–20.

Table IV-20: No New Standards Case Efficiency Distribution in 2030 - ACFs

Equipment Class*	EL0	EL1	EL2	EL3	EL4	EL5	EL6
Axial ACFs; 12" ≤ D < 36"	0%	1%	6%	41%	45%	6%	2%
Axial ACFs; 36" ≤ D < 48"	5%	3%	9%	52%	31%	0%	0%
Axial ACFs; 48" ≤ D	6%	0%	19%	57%	17%	1%	0%
Housed Centrifugal ACFs	5%	0%	24%	48%	21%	2%	0%

[*] D: diameter in inches

See chapter 8 of the NOPR TSD for further information on the derivation of the efficiency distributions.

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the fans and blowers purchased by each sample consumer in the no-new-standards case. The resulting percentage shares within the sample match the market shares in the efficiency distributions.

DOE requests feedback and information on the no-new-standards case efficiency distributions used to characterize the market of GFBs and ACFs. DOE requests information to support any efficiency trends over time for GFBs and ACFs.

9. Payback Period Analysis

The payback period is the amount of time (expressed in years) it takes the consumer to recover the additional installed cost of more-efficient equipment, compared to the no-new-standards case equipment, through energy cost savings. Payback periods that exceed the life of the equipment mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the equipment and the change in the first-year annual operating expenditures relative to the baseline. DOE refers to this as a "simple PBP" because it does not consider changes over time in operating cost savings. The PBP calculation uses the same inputs as the LCC analysis when deriving first-year operating costs.

As noted previously, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing equipment complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C

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[99] Specifically, to reflect that the BESS data is not representative of the majority of the ACF market, DOE assumed that a quarter of ACFs are represented by the BESS labs data and applied a weight of 0.25 to the BESS Labs database and a weight of 0.75 to the catalog data collected from manufacturer and distributor websites.

6316(a); 42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the standards would be required.

G. Shipments Analysis

DOE uses projections of annual equipment shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[100] The shipments model takes an accounting approach, tracking market shares of each equipment class and the vintage of units in the stock. Stock accounting uses equipment shipments as inputs to estimate the age distribution of in-service equipment stocks for all years. The age distribution of in-service equipment stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

1. General Fans and Blowers

DOE first estimated total shipments in the base year. For fans sold as a standalone equipment by equipment class, DOE relied on the estimate in the November 2016 NODA, which relied on a market research report,[101] and AMCA confidential sales data from 2012. To estimate the shipments of fans sold incorporated in other equipment (''OEM fans''), DOE first identified HVAC equipment that incorporate the embedded fans in the scope of analysis (*i.e.,* HVAC equipment not listed in Table III–1). DOE then determined the average quantity of fans used in each of the identified HVAC equipment and estimated the total number of HVAC fans as the product of HVAC equipment sales and average number of fans per equipment. The OEM fan shipments in scope were then calculated by subtracting the estimated number of standalone fans purchased by OEMs from the total number of fans in HVAC equipment, to avoid double counting. *See* chapter 9 for more details.

AHRI provided feedback on shipments values published in the November 2016 NODA. Specifically, AHRI disagreed with DOE's estimate of air handling units and estimated the shipments to be 65,000 units per year. AHRI further commented that 75 percent of these units have variable air volume (''VAV'') capability, and that 60–70% of those are equipped with variable speed drives; AHRI questioned whether DOE accounted for this in its energy use analysis. Finally, AHRI commented that they identified approximately 40 percent of air handling units with either a return or an exhaust fan, as opposed to 50 percent assumed in the November 2016 NODA. (AHRI, No. 130 at pp. 7–8)

DOE reviewed the information provided by AHRI and agrees with the more recent shipments estimate of 65,000 units per year. In addition, DOE accounted for variable load operation in its energy use analysis as described in section IV.E.1 of this document. However, DOE did not estimate the percentage of VAV units by HVAC equipment but by GFBs equipment class (up to 65 percent depending on the equipment class). Finally, for this NOPR, DOE estimated the percentage of air handling units with either a return or an exhaust fan as 30 percent based on more recent input from manufacturer interviews.

AHRI disagreed with DOE's estimate of panel fans per air-cooled water chiller and the number of air-cooled water chillers shipped. AHRI stated that the average number of panel fans per unit is seven instead of the DOE estimate of 14 in the November 2016 NODA. AHRI also stated that the number of air-cooled chillers shipped is 26,000 per year. (AHRI, No. 130 at pp. 9–10)

DOE reviewed the information provided by AHRI as well as additional information from previous comments estimating average annual shipments of air-cooled chillers to 27,000 units per year based on the U.S. Census MA35M/MA333M series.[102] DOE agrees with the more recent shipments estimate of 26,000–27,000 units per year and 7 fans per unit for air-cooled water chillers. As such, DOE relied on this estimate (27,000) rather than on the values published in the November 2016 NODA.

AHRI disagreed with DOE's estimate of commercial unitary air conditioners and heat pumps with and without return/exhaust fans. AHRI stated that less than 10 percent of units under 240,000 Btu/h have return/exhaust fans and about 70 percent of units over 240,000 Btu/h have return/exhaust fans. AHRI also commented that 80 percent of units over 240,000 Btu/h have variable speed drives and VAVs. AHRI commented that these estimates were based on a survey of its members. (AHRI, No. 130 at p. 9)

DOE reviewed the information provided by AHRI and agrees with the more recent percentage values to estimate the fraction of units with a return or exhaust fan. As such DOE relied on these estimates rather than on the values published in the November 2016 NODA to estimate the number of fans per unit in commercial unitary air conditioners and heat pumps.

To project shipments of fans in the industrial sector, DOE assumed in the no-new-standards case that the long-term growth of fan shipments will be driven by long-term growth of fixed investments in equipment including fans, which follow the same trend as the gross domestic product (''GDP''). DOE relied on fixed investment data from the Bureau of Economic Analysis and *AEO2023* forecast of GDP through 2050 to inform its shipments projection. For the commercial sector, DOE projected shipments using *AEO2023* projections of commercial floor space. In 2030, DOE estimates the total shipments of GFBs to 1.38 million units.

DOE also derived high and low shipments projections based on *AEO2023* economic growth scenarios.

DOE further assumed that standards would have a negligible impact on fan shipments and applied a zero price-elasticity under standards cases. It is likely that following a standard, rather than foregoing a fan purchase under a standards case, a consumer might simply switch brands or fans to purchase a fan that is best suited for their application. As a result, DOE used the same shipments projections in the standards case as in the no-new-standards case.

DOE requests feedback on the methodology and inputs used to project shipments of GFBs in the no-new-standards case. DOE requests comments and feedback on the potential impact of standards on GFB shipments and information to help quantify these impacts.

2. Air Circulating Fans

In the October 2022 NODA, DOE estimated total shipments of ACFs to over 2 million using information from manufacturer interviews indicating shipments estimates of 494,950 units of unhoused air circulating fan heads and 255,100 units of cylindrical air circulating fans and applying expansion factors to determine the shipments of other categories of ACFs included in the scope. 87 FR 62038, 62061. DOE did not

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[100] DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general, one would expect a close correspondence between shipments and sales.

[101] IHS Technology (March 2014), Fans and Blowers, World.

[102] *See:* AHRI data, CEC Docket 17–AAER–06, TN#221201–1, p.10 *https://efiling.energy.ca.gov/GetDocument.aspx?tn=221201-1&DocumentContentId=26700.*

receive any feedback or information on shipments in response to the October 2022 NODA.

For this NOPR, DOE reviewed the information from manufacturer interviews and has determined that the shipments estimates provided were for the total market of axial ACFs (rather than specific to unhoused air circulating fan heads and cylindrical air circulating fans only, as previously determined). In addition, DOE estimated that housed centrifugal ACFs represent one percent of the total ACF market based on the small number of manufacturers identified in the catalog data collected by DOE from manufacturer and distributor websites.

In the October 2022 NODA, DOE estimated that shipments of ACFs follow similar trends as shipments of large-diameter ceiling fans. Therefore, DOE stated that it was considering projecting shipments of air circulating fans with input power greater than or equal to 125 W based on the growth rates projected for shipments of large-diameter ceiling fans.[103] 87 FR 62038, 62061. In response to the October 2022 NODA, ebm-papst suggested that the growth of indoor horticulture, a need for farm animal cooling due to climate change, and a need for auxiliary cooling on distribution transformers due to electrification, as well as climate change could all be reasons for possible growth in the ACFs market. (ebm-papst, No. 8 at p. 4)

DOE agrees with the qualitative comment from ebm-papst regarding the potential causes for future ACF market growth. However, DOE notes that this information does not allow for a quantitative estimation of projected shipments. DOE did not receive any additional feedback on this approach and applied this methodology in the NOPR. In 2030, DOE estimates the total shipments of fans to be 1.30 million units.

DOE requests feedback on the methodology and inputs used to estimate and project shipments of ACFs in the no-new-standards case. DOE requests comments and feedback on the potential impact of standards on ACF shipments and information to help quantify these impacts.

H. National Impact Analysis

The NIA assesses the national energy savings (''NES'') and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[104] (''Consumer'' in this context refers to consumers of the equipment being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual equipment shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, equipment costs, and NPV of consumer benefits over the lifetime of fans and blowers sold from 2030 through 2059.[105]

DOE evaluates the impacts of new or amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each equipment class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each equipment class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.,* the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of equipment with efficiencies greater than the standard.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV–21 summarizes the inputs and methods DOE used for the NIA analysis for the NOPR. Discussion of these inputs and methods follows the table. *See* chapter 10 of the NOPR TSD for further details.

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[103] *See* docket No. EERE–2021–BT–STD–0011–0015.

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

[105] Because the anticipated compliance date is late in the year, for analytical purposes, DOE conducted the analysis for shipments from 2030 through 2059.

Table IV-21 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2030 (first full year)
Efficiency Trends	No-new-standards case: constant trend Standards cases: constant trend
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Price Trends	*AEO2023* projections (to 2050) and held constant thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2023*.
Discount Rate	3 percent and 7 percent
Present Year	2024

1. Equipment Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered equipment classes for the first full year of anticipated compliance with an amended or new standard. To project the trend in efficiency absent amended standards for GFBs and ACFS over the entire shipments projection period, DOE assumed a constant efficiency trend. The approach is further described in chapter 10 of the NOPR TSD.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the first full year that standards are assumed to become effective (2030). In this scenario, the market shares of equipment in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of equipment above the standard would remain unchanged.

To develop standards case efficiency trends after 2030, DOE assumed a constant efficiency trend, similar to the no-new standards case.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case (''TSL'') and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2023.* Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency equipment is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the equipment due to the increase in efficiency. For example, when a consumer realizes that a more efficient fan used for cooling will lower the electricity bill, that person may opt for increased comfort in the building by using the equipment more, thereby negating a portion of the energy savings. In commercial buildings, however, the person owning the equipment (*i.e.,* the building owner) is usually not the person operating the equipment (*i.e.,* the renter). Because the operator usually does not own the equipment, that person will not have the operating cost information necessary to influence how they operate the equipment. Therefore, DOE believes that a rebound effect is unlikely to occur in commercial buildings. In the industrial and agricultural sectors, DOE believes that fans are likely to be operated whenever needed for the required application, so a rebound effect is also unlikely to occur in the industrial and agricultural sectors. Therefore, DOE did not apply a rebound effect for fans and blowers.

DOE requests comment and data regarding the potential increase in utilization of GFBs and ACFs due to any increase in efficiency.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (''NEMS'') is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[106] that EIA uses to prepare its

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[106] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009.

Continued

Annual Energy Outlook. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the NOPR TSD.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each equipment shipped during the projection period.

As discussed in section IV.F.1 of this document, DOE developed price trends for GFBs and ACFs based on historical PPI data. DOE applied the same trends to project prices for each equipment class at each considered efficiency level.

For GFBs, DOE applied constant equipment price trends. For ACFs, DOE also applied a constant price trend except for ACFs at EL6 where a declining price trend was used. By 2059, which is the end date of the projection period, the average ACF price at EL6 is projected to drop 14 percent relative to 2022. DOE's projection of product prices is described in appendix 10C of the NOPR TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price projections on the consumer NPV for the considered TSLs for GFBs and ACFs. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a high price decline case based on historical PPI data and (2) a low price decline case based on the *AEO2023* ''deflator—industrial equipment'' forecast for GFBs and historical PPI data for ACFs. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the NOPR TSD.

The energy cost savings are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average commercial and industrial energy price changes in the Reference case from *AEO2023,* which has an end year of 2050. To estimate price trends after 2050, the 2050 price was used for all years. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2023* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the NOPR TSD.

In addition, for ACFs, the NPV calculation also includes the total repair costs which are calculated based on the outputs from the life-cycle analysis.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPR, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (''OMB'') to Federal agencies on the development of regulatory analysis.[107] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this NOPR, DOE analyzed the impacts of the considered standard levels on small businesses. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups, and used inputs specific to that subgroup. Chapter 11 in the NOPR TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of new energy conservation standards on manufacturers of fans and blowers and to estimate the potential impacts of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected industry cash flows, the INPV, investments in research and development (''R&D'') and manufacturing capital, and domestic manufacturing employment. Additionally, the MIA seeks to determine how new energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, equipment shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant equipment. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact on domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of new energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (*i.e.,* TSLs). To capture the uncertainty relating to manufacturer pricing strategies following new standards, the GRIM estimates a range of possible impacts under different markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA

Available at: *www.eia.gov/forecasts/aeo/index.cfm* (last accessed April 4, 2023).

[107] Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf.*

considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the NOPR TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the fan and blower manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. This included a top-down analysis of fan and blower manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (''SG&A''); and R&D expenses). DOE also used public sources of information to further calibrate its initial characterization of the fan and blower manufacturing industry, including company filings of form 10–K from the SEC,[108] corporate annual reports, the U.S. Census Bureau's *Economic Census,*[109] and reports from D&B Hoovers.[110]

In Phase 2 of the MIA, DOE prepared a framework industry cash flow analysis to quantify the potential impacts of new energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the compliance date of the standard. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) creating a need for increased investment, (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes.

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of fans and blowers in order to develop other key GRIM inputs, including capital and product conversion costs, and to gather additional information on the anticipated effects of energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and subgroup impacts.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with representative 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. *See* section IV.J.3 of this document for a description of the key issues raised by manufacturers during the interviews. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by new energy conservation standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers (''LVMs''), niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B, ''Review under the Regulatory Flexibility Act'' and in chapter 12 of the NOPR TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to new energy conservation standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from new energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2024 (the base year of the analysis) and continuing to 2059. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of fans and blowers, DOE used a real discount rate of 11.4 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 the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the new energy conservation standards on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering analysis, and information gathered from industry stakeholders during the course of manufacturer interviews and subsequent Working Group meetings. The GRIM results are presented in section V.B.2. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the NOPR TSD.

a. Manufacturer Production Costs

Manufacturing more efficient equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered equipment can affect the revenues, gross margins, and cash flow of the industry.

For GFBs, DOE developed baseline MSP versus diameter curves and incremental costs for each design option for each equipment class. DOE used these correlations to estimate the MSP at each EL for each equipment class at all nominal impeller diameters. As such, each equipment class has multiple MSP versus FEI curves representing the range of impeller diameters that exist on the market. For ACFs, DOE developed curves for each representative unit. The methodology for developing the curves started with determining the efficiency for baseline equipment and the MPCs for this equipment. Above the baseline, DOE implemented design options until all available design options were employed (*i.e.,* at the max-tech level).

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

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments 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 projections derived from the shipments analysis from 2024 (the base year) to 2059 (the end year of the analysis period). *See* chapter 9 of the NOPR TSD for additional details.

c. Product and Capital Conversion Costs

New energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and equipment designs into compliance. DOE evaluated the level of conversion-related

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[108] *See www.sec.gov/edgar.*

[109] *See www.census.gov/programs-surveys/asm/data/tables.html.*

[110] *See app.avention.com.*

expenditures that would be needed to comply with each considered efficiency level in each equipment 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 investments in research, development, testing, marketing, and other non-capitalized costs necessary to make equipment designs comply with new energy conservation standards. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant equipment designs can be fabricated and assembled.

In response to the October 2022 NODA, AMCA commented that DOE should conduct interviews with individual manufacturers to gather information regarding potential conversion costs for fan and blower manufacturers. (AMCA, No. 132 at p. 12) DOE conducted manufacturer interviews with several interested parties, including several fan and blower manufacturers, after the publication of the October 2022 NODA and prior to conducting this NOPR analysis. The results and methodology for estimating conversion costs are described in this section.

DOE used a bottom-up cost estimate to arrive at a total product conversion cost at each EL for all equipment classes. DOE first estimated the number of unique basic models for each equipment class and at each EL using the AMCA sales database for GFBs and the updated ACF database for ACFs. Next, DOE estimated the percentage of models that would not meet each analyzed EL based on information from the appropriate database. DOE also estimated the percentage of failing models that are assumed to be redesigned at each analyzed EL. DOE then estimated the amount of engineering time needed to redesign and test a single non-compliant basic model into a compliant model and the time necessary to conduct additional air, sound, and certification testing once the model is redesigned. DOE used data from the U.S. Bureau of Labor Statistics[111] (''BLS'') to estimate the total hourly employer compensation to conduct the redesign and to conduct testing. DOE based the number of hours associated with a per model redesign and per model testing estimates on information received during manufacturer interviews. DOE estimated that longer per model redesign engineering hours would be required to achieve higher ELs, since more engineering resources would be required to achieve higher ELs. However, DOE assumed the same per model testing cost for all ELs, since DOE did not assume the testing cost will increase at higher ELs. Lastly, DOE multiplied the per model redesign (for each EL) and per model testing costs by the number models that are estimated to be redesigned at each EL.

DOE estimated the capital conversion costs based on information received during manufacturer interviews. During manufacturer interviews, manufacturers provided estimates on the percentage of total conversion costs that would be associated with the purchasing on equipment and machinery (capital conversion costs) and the percentage of total conversion costs that would be associated with engineering resources to conduct redesigns and testing (product conversion costs). In addition to assuming increased product costs at higher ELs, DOE also assumed that the ratio of product conversion costs to capital conversion costs would decrease at higher ELs (*i.e.,* higher ELs are expected to have higher capital conversion costs since manufacturers would be expected to increase investments in new tooling and potentially different production processes). In sum, DOE used these percentage estimates provided during manufacturer interviews and the product conversion cost estimates previously described to estimate the total capital conversion costs for each equipment class at each analyzed EL.

CA IOUs stated that some ACF manufacturers purchase the impellors that they use rather than design and manufacture them in-house. Therefore, CA IOUs stated purchasing more efficient impeller designs may be possible without significant design and capital costs. (CA IOUs, No. 127 at p.3) DOE conducted manufacturer interviews with a variety of ACF manufacturers. The cost estimates included in this analysis assume that ACF manufacturers produce their impellors in-house. While some ACF manufacturers might purchase impellors from another company, whatever company that is manufacturing the more efficient impellors is will incur additional product and capital conversion costs and those costs will likely be passed on to their customers. Section IV.J.2.d discusses how an increase in product and capital conversion costs (regardless of if an impellor manufacturer or an ACF manufacturer incurs them) could result in an increased ACF MSP that is incorporated into all down-stream and consumer analyses.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. For additional information on the estimated capital and product conversion costs, *see* chapter 12 of the NOPR TSD.

d. Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for ACFs at each equipment class and efficiency level. For GFBs, the engineering analysis estimated the MSPs. Therefore, the MIA did not calculate the MSPs for GFBs using the MPCs. Instead, the MIA estimated the MPC by dividing the MSPs, which were estimated in the engineering analysis, by a manufacturer markup. For GFBs, DOE estimated a manufacturer markup of 1.35 for all equipment classes in the no-new-standards case. This corresponds to a manufacturer gross margin percentage of approximately 25.9 percent. For ACFs, DOE estimated a manufacturer markup of 1.50 for all equipment classes in the no-new-standards case. This corresponds to a manufacturer gross margin percentage of approximately 33.3 percent. DOE estimated these manufacturers markups based on information obtained during manufacturer interviews. Modifying these manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of new energy conservation standards: (1) a conversion cost recovery markup scenario; and (2) a preservation of operating profit markup scenario. These scenarios lead to different manufacturer markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the conversion cost recovery markup scenario, DOE modeled a scenario in which manufacturers increase their markups in response to new energy conservation standards. For

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[111] *See www.bls.gov/oes/current/oes_stru.htm* and *www.bls.gov/bls/news-release/ecec.htm#current.*

ELs that DOE's engineering analysis assumed would require an aerodynamic redesign, the engineering analysis assumed there is no increase in the MPCs (for the ELs that are assumed would require an aerodynamic redesign). However, DOE did assume that fan and blower manufacturers will incur conversion costs to redesign non-compliant models. Therefore, DOE modeled a manufacturer markup scenario in which fan and blower manufacturers attempt to recover the investments they must make to conduct these aerodynamic redesigns through an increase in their manufacturer markup. Therefore, in the standards cases, the manufacturer markup of models that would need to be re-designed is larger than the manufacturer markup used in the no-new-standards case. DOE calibrated these manufacturer markups, in the standards case conversion cost recovery scenario, for each equipment class at each EL to cause the manufacturer INPV in the standards cases to be approximately equal to the manufacturer INPV in the no-new-standards case. In this markup scenario, manufacturers earn additional revenue in the standards cases after the compliance date that offsets the conversion costs that were incurred prior to the compliance date. This represents the upper-bound of manufacturer profitability, as in this manufacturer markup scenario as measured by INPV, fan and blower manufacturers are able to fully recover their conversion costs by the end of the 30-year analysis period.

Under the preservation of operating profit markup scenario, DOE modeled a markup scenario where manufacturers are not able to increase their per-unit operating profit in proportion to increases in MPCs. Under this scenario, as the MPCs increase, manufacturers reduce their markups (on a percentage basis) to a level that maintains the no-new-standards operating profit (in absolute dollars). The implicit assumption behind this manufacturer markup scenario is that the industry can only maintain its operating profit in absolute dollars after compliance with new standards. Therefore, the percentage of the operating margin is reduced between the no-new-standards case and the analyzed standards cases. 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 no-new-standards case. This manufacturer markup scenario represents the lower bound to industry profitability under new energy conservation standards.

A comparison of industry financial impacts under the two manufacturer markup scenarios is presented in section V.B.2.a of this document.

3. Manufacturer Interviews

DOE interviewed a variety of fan and blower manufacturers prior to conducting this NOPR analysis. During these interviews, DOE asked manufacturers to describe their major concerns regarding this rulemaking. The following section highlights manufacturer concerns that helped inform the projected potential impacts of a new standard on the industry. Manufacturer interviews are conducted under non-disclosure agreements (''NDAs''), so DOE does not document these discussions in the same way that it does public comments in the comment summaries and DOE's responses throughout the rest of this document.

Embedded Fans

Several fan and blower manufacturers stated that they are concerned that including fans and blowers that are embedded in other products or equipment already regulated by DOE creates redundant regulations. Additionally, manufacturers stated that the electricity used by the fan or blower in these systems is a relatively insignificant portion of the energy consumed by the entire system. Lastly, manufacturers stated that increasing the efficiency of a fan or blower used in a product or equipment already regulated by DOE could limit the effectiveness of a future energy conservation standard on the performance of those products or equipment covered by DOE.

DOE is proposing to exclude fans and blowers that are embedded in specific types of equipment. Table III–1 lists the embedded fans and blowers that are excluded from the scope of this energy conservation standards rulemaking.

Testing Costs and Burden

Several fan and blower manufacturers stated that a concern that compliance with energy conservation standards would require fan and blower manufacturers to test all covered fans and blowers. Manufacturers specifically are concerned that the legacy testing data that they have already conducted for the AMCA certification testing program would need to be re-tested to demonstrate compliance with a DOE energy conservation standard. As stated in the May 2023 TP Final Rule, DOE understands that manufacturers of fans and blowers likely have historical test data which were developed with methods consistent with the DOE test procedure adopted in the May 2023 Final Rule, and does not expect manufacturers to regenerate all of the historical test data unless the rating resulting from the historical methods would no longer be valid. 88 FR 27312, 27378.

Additionally, manufacturers were concerned that requiring a test sample of two fans or blowers would be overly burdensome for manufacturers to comply with an energy conservation standard. As stated in the May 2023 TP Final Rule ''DOE believe it is appropriate to allow a minimum of one unit for fans and blowers other than air circulating fans'' to be tested to comply with any DOE energy conservation standard. 88 FR 27312, 27378.

Lastly, some manufacturers were concerned that if DOE did not allow the use of an alternative energy determination method (''AEDM'') to determine fan performance, manufacturers would have to physically test all covered fans and blowers. Manufacturers stated that physically testing every fan and blower would place a larger and costly testing burden on manufacturers. As stated in the May 2023 TP Final Rule, ''DOE allows the use of an AEDM in lieu of testing to determine fan performance, which would mitigate the potential cost associated with having to physically test units.'' 88 FR 27312, 27372.

4. Discussion of MIA Comments

AHRI stated that for end-use products (*i.e.,* a product or equipment that has a fan or blower embedded in it) testing must take place following internal component swaps or cabinet redesigns. This testing could include seismic and wind load testing for HVAC equipment installed exterior to the building; electric heat, safety, refrigerant, and sound testing for heating equipment; and transportation, vibration, and sound testing for most end-use products. AHRI stated that testing lab availability is limited at this time, given the wide-ranging changes in refrigerant and safety standards requirements, and standards that result in a redesign to accommodate a new fan will impact virtually every model of HVACR product on the market. (AHRI, No. 130 at pp. 5–6) DOE acknowledges that end-use products may have to be re-test if the current fan that they use does not meet the adopted energy conservation standards. However, DOE's engineering analysis primarily examined replacement fans and blowers with the same diameter and would not require a cabinet redesign for an end-use product.

AHRI stated that there is a significant monetary impact for OEMs for a fan swap, as a significant amount of re-testing and potential re-certification would need to be conducted for a fan swap, even if the size of the cabinet does not change. AHRI stated that based on a review of their AHRI Certification Program they identified approximately 6,000 basic models that have a covered fan embedded in these end-use products. AHRI continued by stating they estimate it would cost approximately $300,000 for each end-use product basic model that would be required to incorporate a new fan if the existing fan used in their end-use product does not comply with DOE's energy conservation standards for that fan. (AHRI, No. 130 at p. 6–7) DOE acknowledges that OEMs may incur re-testing and re-certification costs if the fan used in their equipment does not meet the adopted energy conservation standard for fans. The MIA for this rulemaking specifically examines the conversion costs that fan and blower manufacturers would incur due to the analyzed energy conservation standards for fans and blowers in comparison to the revenue and free cash fan and blower manufacturers receive. The OEM testing and certification costs were not included in the MIA, and neither were the OEM revenues and free cash flows, as these costs and revenue are not specific to fan and blower manufacturers.

MIAQ also stated that redesign of the end-use product to accommodate a new fan will result in retesting and possible recertification and model number changes for end-use products, which will be a massive, costly, and time-consuming undertaking (and could even cause a disruption in the market) as there would be changes to electrical, physical, or functional characteristics of the end-use product that affect energy consumption/efficiency. (MIAQ, No. 124 at pp. 2–3) DOE is proposing to exclude fans that are embedded in commercial HVAC equipment that is already covered by DOE energy conservation standards as well as a variety of other products. The full list of embedded fans proposed for exclusion from the scope of this energy conservation standards rulemaking can be found in Table III–1.

DOE requests comment on the number of end-use product (*i.e.,* a product or equipment that has a fan or blower embedded in it) basic models that would not be excluded by the list of products or equipment listed in Table III–1.

MIAQ and AHRI stated that it was not realistic to expect manufacturers to comply with any energy conservation standards within 180 days. (MIAQ, No. 124 at p. 2–3; AHRI, No. 130 at p. 5) DOE notes that the May 2023 TP Final Rule stated that beginning 180 days after the publication of the May 2023 TP Final Rule, any representations made with respect to energy use or efficiency of fans or blowers must be made based on testing in accordance with the May 2023 TP Final Rule. Neither the May 2023 TP Final Rule nor this NOPR requires that fan and blower manufacturers meet a minimum energy conservation standard 180 days after the publication of the May 2023 TP Final Rule. Compliance with any energy conservation standards would not be required until 5 years after publication of the energy conservation standard final rule.

AHRI expressed concern about unfair advantage given to imported HVAC products that may not need to comply with components regulations. AHRI stated that imported HVAC products with embedded fans are excluded from the fan and blower energy conservation standard, but fans assembled into similar equipment manufactured domestically would be subject to DOE energy conservation standards (AHRI, No. 130, at p. 4) DOE is proposing to require fans and blowers that are imported in HVAC products to comply with the energy conservation standards established in this rulemaking as long as those products or equipment are not listed in Table III–1. This is the same requirement that applies to fans and blowers that are assembled into the same equipment manufactured domestically.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH_4 and N_2O, as well as the reductions to emissions of other gases due to ''upstream'' activities in the fuel production chain. These upstream activities comprise extracting, processing, and transporting fuels to the site of combustion.

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions factors intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A of the NOPR TSD. The analysis presented in this notice uses projections from *AEO2023.* Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the Environmental Protection Agency (EPA).[112]

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

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

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2023* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2023,* including the emissions control programs discussed in the following paragraphs.[113]

SO_2 emissions from affected electric generating units (''EGUs'') are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (DC). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and

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[112] Available at: *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed July 12, 2021).

[113] For further information, see the Assumptions to *AEO2023* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at: *www.eia.gov/outlooks/aeo/assumptions/* (last accessed February 6, 2023).

went into effect as of January 1, 2015.[114] *AEO2023* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (''HAP''), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. In order to continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Because of the emissions reductions under the MATS, it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation would generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2023*.

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NO_X emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards might reduce NO_X emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Energy conservation standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO2023* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would be expected to slightly reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2023,* which incorporates the MATS.

L. Monetizing Emissions Impacts

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

To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the SC of each pollutant (*e.g.,* SC–CO_2). These estimates represent the monetary value of the net harm to society associated with a marginal increase in emissions of these pollutants in a given year, or the benefit of avoiding that increase. These estimates are intended to include (but are not limited to) climate-change-related changes in net agricultural productivity, human health, property damages from increased flood risk, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services.

DOE exercises its own judgment in presenting monetized climate benefits as recommended by applicable Executive orders, and DOE would reach the same conclusion presented in this proposed rulemaking in the absence of the social cost of greenhouse gases. That is, the social costs of greenhouse gases, whether measured using the February 2021 interim estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases or by another means, did not affect the rule ultimately proposed by DOE.

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

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

estimates have been developed reflecting the latest, peer-reviewed science.

The SC–GHGs estimates presented here were developed over many years, using transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, which included the DOE and other executive branch agencies and offices, was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC-CO_2) values used across agencies. The IWG published SC-CO_2 estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity—a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016, the IWG published estimates of the social cost of methane (SC-CH_4) and nitrous oxide (SC-N_2O) using methodologies that are consistent with the methodology underlying the SC-CO_2 estimates. The modeling approach that extends the IWG SC-CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC-CH_4 and SC-N_2O estimates were developed by Marten *et al.*[115] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC-CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC-CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and recommended specific criteria for future updates to the SC-CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017).[116] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC-CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

On January 20, 2021, President Biden issued Executive Order 13990, which re-established the IWG and directed it to ensure that the U.S. Government's estimates of the social cost of carbon and other greenhouse gases reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the SC–GHG estimates currently used in Federal analyses and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including by taking global damages into account. The interim SC–GHG estimates published in February 2021 are used here to estimate the climate benefits for this proposed rulemaking. The E.O. instructs the IWG to update the interim SC–GHG estimates by January 2022 taking into consideration the advice of the National Academies of Science, Engineering, and Medicine as reported in Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (2017) and other recent scientific literature. The February 2021 SC–GHG TSD provides a complete discussion of the IWG's initial review conducted under E.O. 13990. In particular, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways.

First, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to fully capture many climate impacts that affect the welfare of U.S. citizens and residents, and those impacts are better reflected by global measures of the SC–GHG. Examples of omitted effects from the E.O. 13783 estimates include direct effects on U.S. citizens, assets, and investments located abroad; supply chains, U.S. military assets and interests abroad, and tourism; and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. If the United States does not consider impacts on other countries, it is difficult to convince other countries to consider the impacts of their emissions on the United States. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the United States and its citizens—is for all countries to base their policies on global estimates of damages. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with this assessment and, therefore, in this proposed rule DOE centers attention on a global measure of SC–GHG. This approach is the same as that taken in DOE regulatory analyses from 2012 through 2016. A robust estimate of climate damages that accrue only to U.S. citizens and residents does not currently exist in the literature. As explained in the February 2021 TSD, existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. As noted in the February 2021 SC–GHG TSD, the

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[115] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold, and A. Wolverton. Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO_2 estimates. *Climate Policy.* 2015. 15(2): pp. 272–298.

[116] National Academies of Sciences, Engineering, and Medicine. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.* 2017. The National Academies Press: Washington, DC.

IWG will continue to review developments in the literature, including more robust methodologies for estimating a U.S.-specific SC–GHG value, and explore ways to better inform the public of the full range of carbon impacts. As a member of the IWG, DOE will continue to follow developments in the literature pertaining to this issue.

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC–GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context[117] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

Furthermore, the damage estimates developed for use in the SC–GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A–4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC–GHG. DOE agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. DOE also notes that while OMB Circular A–4, as published in 2003, recommends using 3 percent and 7 percent discount rates as ''default'' values, Circular A–4 also reminds agencies that ''different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.'' On discounting, Circular A–4 recognizes that ''special ethical considerations arise when comparing benefits and costs across generations,'' and Circular A–4 acknowledges that analyses may appropriately ''discount future costs and consumption benefits . . . at a lower rate than for intragenerational analysis.'' In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that ''Circular A–4 is a living document'' and ''the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A–4 itself.'' Thus, DOE concludes that a 7% discount rate is not appropriate to apply to value the social cost of greenhouse gases in the analysis presented in this analysis.

To calculate the present and annualized values of climate benefits, DOE uses the same discount rate as the rate used to discount the value of damages from future GHG emissions, for internal consistency. That approach to discounting follows the same approach that the February 2021 SC–GHG TSD recommends ''to ensure internal consistency—*i.e.,* future damages from climate change using the SC–GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate.'' DOE has also consulted the National Academies' 2017 recommendations on how SC–GHG estimates can ''be combined in RIAs with other cost and benefits estimates that may use different discount rates.'' The National Academies reviewed several options, including ''presenting all discount rate combinations of other costs and benefits with [SC–GHG] estimates.'' As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with the above assessment and will continue to follow developments in the literature pertaining to this issue. While the IWG works to assess how best to incorporate the latest, peer-reviewed science to develop an updated set of SC–GHG estimates, it set the interim estimates to be the most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As explained in the February 2021 SC–GHG TSD, the IWG has recommended that agencies revert to the same set of four values drawn from the SC–GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and were subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values recommended for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change. As explained in the February 2021 SC–GHG TSD, and DOE agrees, this update reflects the immediate need to have an operational SC–GHG for use in regulatory benefit-cost analyses and other applications that is developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

There are a number of limitations and uncertainties associated with the SC–GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[118] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their ''damage functions'' (*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages) lags behind the most recent research. For

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[117] Interagency Working Group on Social Cost of Carbon. *Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866.* 2010. United States Government. Available at: *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf* (last accessed April 15, 2022); Interagency Working Group on Social Cost of Carbon. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* 2013. Available at: *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact* (last accessed April 15, 2022); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. August 2016. Available at: *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf* (last accessed January 18, 2022); Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. Available at: *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf* (last accessed January 18, 2022).

[118] Interagency Working Group on Social Cost of Greenhouse Gases (IWG). 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February. United States Government. Available at: *www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/.*

example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long-time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–CO_2 estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this proposed rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

DOE's derivations of the SC–CO_2, SC–N_2O, and SC–CH_4 values used for this NOPR are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section IV.L.1.a of this document.

a. Social Cost of Carbon

The SC–CO_2 values used for this NOPR were based on the values presented for the IWG's February 2021 TSD. Table IV shows the updated sets of SC–CO_2 estimates from the IWG's TSD in 5-year increments from 2020 to 2050. The full set of annual values that DOE used is presented in appendix 14–A of the NOPR TSD. For purposes of capturing the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate include all four sets of SC–CO_2 values, as recommended by the IWG.[119]

Table IV-22 Annual SC-CO_2 Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton CO_2)

Year	Discount Rate and Statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

For 2051 to 2070, DOE used SC–CO_2 estimates published by EPA, adjusted to 2020$.[120] These estimates are based on methods, assumptions, and parameters identical to the 2020–2050 estimates published by the IWG (which were based on EPA modeling). DOE expects additional climate benefits to accrue for any longer-life fans and blowers after 2070, but a lack of available SC–CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC–CO_2 value for that year in each of the four cases. DOE adjusted the values to 2022 dollars using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC–CO_2 values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this NOPR were based on the values developed for the February 2021 TSD. Table IV–23 shows the updated sets of SC–CH_4 and SC–N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14–A of the NOPR TSD. To capture the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CH_4 and SC–N_2O values, as recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC–CO_2.

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[119] For example, the February 2021 TSD discusses how the understanding of discounting approaches suggests that discount rates appropriate for intergenerational analysis in the context of climate change may be lower than 3 percent.

[120] See EPA, *Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis,* Washington, DC, December 2021. Available at: *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed January 13, 2023).

Table IV-23 Annual SC-CH_4 and SC-N_2O Values from 2021 Interagency Update, 2020–2050 (2020$ per Metric Ton)

Year	SC-CH_4				SC-N_2O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5 %	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC–CH_4 and SC–N_2O estimates for that year in each of the cases. DOE adjusted the values to 2022 dollars using the implicit price deflator for gross domestic product ("GDP") from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC–CH_4 and SC–N_2O estimates in each case.

2. Monetization of Other Emissions Impacts

For the NOPR, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using the latest benefit per ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[121] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025, 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040 the values are held constant. DOE combined the EPA benefit per ton estimates with regional information on electricity consumption and emissions to define weighted-average national values for NO_X and SO_2 as a function of sector (see appendix 14B of the NOPR TSD). DOE multiplied the site emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate.

M. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2023.* NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the NOPR TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of potential new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the equipment subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the equipment to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics ("BLS"). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[122] 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

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[121] *See Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 21 Sectors.* Available at: *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors.*

[122] *See* U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II).* 1997. U.S. Government Printing Office: Washington, DC. Available at: *https://apps.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf* (last accessed March 27, 2023).

activity from a less labor-intensive sector (*i.e.,* the utility sector) to more labor-intensive sectors (*e.g.,* the retail and service sectors). Thus, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this NOPR using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (''ImSET'').[123] 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 containing structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and that the uncertainties involved in projecting employment impacts especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may overestimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2034), where these uncertainties are reduced. For more details on the employment impact analysis, *see* chapter 16 of the NOPR TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for GFBs and ACFs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for GFBs and ACFs, and the standards levels that DOE is proposing to adopt in this NOPR. Additional details regarding DOE's analyses are contained in the NOPR TSD supporting this document.

A. Trial Standard Levels

In general, DOE typically evaluates potential standards for products and equipment by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider manufacturer cost interactions between the equipment classes, to the extent that there are such interactions, and market cross elasticity from consumer purchasing decisions that may change when different standard levels are set.

For GFBs, in the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of 6 TSLs. DOE developed TSLs that combine efficiency levels for each analyzed equipment class.

Table V–1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential new energy conservation standards for GFBs. TSL 6 represents the max-tech energy efficiency for all product classes. TSL 5 represents the highest efficiency level with positive LCC savings. TSL 4 is an intermediate level consisting of the next level below TSL 5 with positive LCC savings. TSL 3 is an intermediate level consisting of the same level as TSL 4 or in the next level below TSL 4 with positive LCC savings and above TSL 2, where available. TSL 2 represents a combination of efficiency levels that correspond to a FEI of 1 across all equipment classes as required in ASHRAE 90.1, except for Axial Power Roof Ventilator—Exhaust, where it is set one efficiency level lower due to negative LCC savings at the EL corresponding to a FEI value of 1 (EL 5). TSL 1 represents combination of efficiency levels that corresponds to one efficiency level below the efficiency level corresponding to a FEI value of 1.

Table V-1 Trial Standard Levels for GFBs

Equipment Class	TSL1	TSL2	TSL3	TSL4	TSL5	TSL6
Axial Inline Fans	EL1	EL2	EL3	EL3	EL4	EL5
Axial Panel Fans	EL1	EL2	EL3	EL4	EL5	EL5
Centrifugal Housed Fans	EL1	EL2	EL3	EL4	EL5	EL5
Centrifugal Inline Fans	EL2	EL3	EL4	EL5	EL6	EL6
Centrifugal Unhoused Fans	EL1	EL1	EL3	EL4	EL5	EL5
Axial Power Roof–Ventilator - Exhaust	EL4	EL4	EL4	EL4	EL4	EL7
Centrifugal Power Roof–Ventilator - Exhaust	EL3	EL4	EL4	EL4	EL4	EL6
Centrifugal Power Roof–Ventilator - Supply	EL3	EL4	EL5	EL5	EL6	EL6
Radial Housed Fans	EL2	EL3	EL4	EL4	EL5	EL5

DOE constructed the TSLs for this NOPR to include ELs representative of ELs with similar characteristics (*i.e.,* using similar technologies and/or efficiencies, and having roughly comparable equipment availability). The use of representative ELs provided for greater distinction between the TSLs. DOE did not consider ELs for which the average LCC savings were negative other than for TSL 6 (max-tech). While representative ELs were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[124]

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[123] Livingston, O.V., S.R. Bender, M.J. Scott, and R.W. Schultz. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User Guide.* 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL–24563.

[124] Efficiency levels that were analyzed for this NOPR are discussed in section IV.C of this document. Results by efficiency level are presented in NOPR TSD chapter 8.

For ACFs, in the analysis conducted for this NOPR, DOE analyzed the benefits and burdens of six TSLs. DOE developed TSLs that combine efficiency levels for each analyzed equipment class.

Table V–2 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential new energy conservation standards for ACFs. TSL 6 represents the max-tech energy efficiency for all equipment classes. TSL 5 represents a level corresponding to EL 5 for all axial ACFs and EL 3 for housed centrifugal ACFs. It represents the highest EL below max-tech with positive LCC savings. TSL 4 is constructed with the same efficiency level EL 4 for all axial ACFs and represents EL 0 for housed centrifugal ACFs. Similarly, TSL 3 through TSL 1 represent levels corresponding to EL 3 through EL 1 for all axial ACFs and EL 0 for housed centrifugal ACFs.

Table V-2 Trial Standard Levels for ACFs

Equipment Class	TSL1	TSL2	TSL3	TSL4	TSL5	TSL6
Axial ACFs; 12” ≤ D < 36” (ACF1)	EL1	EL2	EL3	EL4	EL5	EL6
Axial ACFs; 36” ≤ D < 48” (ACF2)	EL1	EL2	EL3	EL4	EL5	EL6
Axial ACFs; 48” ≤ D (ACF3)	EL1	EL2	EL3	EL4	EL5	EL6
Housed Centrifugal ACFs (ACF4)	EL0	EL0	EL0	EL0	EL3	EL6

DOE constructed the TSLs for this NOPR to include ELs representative of ELs with similar characteristics (*i.e.,* using similar technologies within similar equipment classes). DOE did not consider EL 1 through EL 2 for housed centrifugal ACFs as the average LCC savings are negative at these levels for this equipment class. While representative ELs were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[125]

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on fan and blower consumers by looking at the effects that potential new standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed in the following sections.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency equipment affects consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* product price plus installation costs), and operating costs (*i.e.,* annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses equipment lifetime and a discount rate. Chapter 8 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

Table V–3 through Table V–20 show the LCC and PBP results for the TSLs considered for each equipment class for GFBs. Table V–21 through Table V–28 show the LCC and PBP results for the TSLs considered for each equipment class for ACFs. The simple payback and other impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (*see* section IV.F.8 of this document). Because the average LCC savings refer only to consumers who are affected by a standard at a given TSL, the average savings are greater than the difference between the average LCC in the no-new-standards case and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase equipment with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

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Table V-3 Average LCC and PBP Results for Axial Inline Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	11,748	1,690	20,464	32,212	-	27.6
1	1	11,756	1,682	20,364	32,120	1.0	27.6
2	2	11,873	1,669	20,209	32,082	5.8	27.6
3-4	3	12,465	1,616	19,563	32,028	9.6	27.6
5	4	13,704	1,490	18,034	31,738	9.8	27.6
6	5	18,129	1,334	16,148	34,276	17.9	27.6

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new-standards case.

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[125] Efficiency levels that were analyzed for this NOPR are discussed in section IV.C.1.b of this document. Results by efficiency level are presented in NOPR TSD chapters 8.

Table V-4 Average LCC Savings Relative to the No-New-Standards Case for Axial Inline Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1	1,766	0.9%
2	2	1,029	7.5%
3-4	3	550	23.6%
5	4	670	51.3%
6	5	-2,169	79.3%

* The savings represent the average LCC for affected consumers.

Table V-5 Average LCC and PBP Results for Axial Panel Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	6,304	782	7,575	13,879	-	15.2
1	1	6,434	770	7,461	13,895	10.9	15.2
2	2	6,452	750	7,268	13,720	4.7	15.2
3	3	6,499	688	6,654	13,153	2.1	15.2
4	4	6,597	607	5,864	12,460	1.7	15.2
5-6	5	6,922	530	5,120	12,042	2.5	15.2

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-6 Average LCC Savings Relative to the No-New-Standards Case for Axial Panel Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1	-194	6.3%
2	2	802	7.3%
3	3	1,413	11.0%
4	4	1,702	19.5%
5-6	5	1,902	29.9%

* The savings represent the average LCC for affected consumers.

Table V-7 Average LCC and PBP Results for Centrifugal Housed Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	9,734	1,750	17,492	27,227	-	15.0
1	1	9,742	1,710	17,128	26,871	0.2	15.0
2	2	9,755	1,692	16,951	26,706	0.4	15.0
3	3	9,779	1,636	16,421	26,200	0.4	15.0
4	4	9,868	1,531	15,397	25,266	0.6	15.0
5-6	5	10,825	1,397	14,065	24,890	3.1	15.0

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-8 Average LCC Savings Relative to the No-New-Standards Case for Centrifugal Housed Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1	1,714	1.5%
2	2	1,977	2.4%
3	3	2,092	6.0%
4	4	2,423	12.9%
5-6	5	2,398	41.5%

* The savings represent the average LCC for affected consumers.

Table V-9 Average LCC and PBP Results for Centrifugal Inline Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	10,598	1,180	11,996	22,593	-	16.7
-	1	10,623	1,168	11,880	22,503	2.2	16.7
1	2	10,751	1,159	11,791	22,542	7.6	16.7
2	3	10,674	1,107	11,267	21,941	1.1	16.7
3	4	11,325	1,080	10,993	22,318	7.3	16.7
4	5	11,858	972	9,899	21,757	6.1	16.7
5-6	6	13,457	865	8,809	22,265	9.1	16.7

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-10 Average LCC Savings Relative to the No-New-Standards Case for Centrifugal Inline Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
-	1	1,073	3.4%
1	2	355	9.9%
2	3	1,389	4.6%
3	4	454	36.6%
4	5	955	49.2%
5-6	6	335	66.7%

* The savings represent the average LCC for affected consumers.

Table V-11 Average LCC and PBP Results for Centrifugal Unhoused Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	8,983	1,482	14,318	23,301	-	14.9
1-2	1	9,006	1,475	14,252	23,258	3.5	14.9
-	2	9,085	1,466	14,172	23,256	6.7	14.9
3	3	9,086	1,441	13,932	23,018	2.6	14.9
4	4	9,118	1,368	13,223	22,341	1.2	14.9
5-6	5	9,199	1,257	12,148	21,346	1.0	14.9

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-12 Average LCC Savings Relative to the No-New-Standards Case for Centrifugal Unhoused Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1-2	1	1,009	2.2%
-	2	433	7.0%
3	3	884	4.8%
4	4	1,170	10.5%
5-6	5	2,004	13.7%

* The savings represent the average LCC for affected consumers.

Table V-13 Average LCC and PBP Results for Axial Power Roof–Ventilator - APRV

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	9,488	1,085	11,173	20,661	-	17.5
-	1	9,652	1,063	10,940	20,592	7.5	17.5
-	2	9,665	1,058	10,884	20,549	6.5	17.5
-	3	9,470	1,050	10,803	20,273	N/A	17.5
1-5	4	9,958	1,017	10,458	20,416	7.0	17.5
-	5	11,695	945	9,704	21,399	15.8	17.5
-	6	14,382	802	8,232	22,614	17.3	17.5
6	7	22,584	687	7,046	29,630	32.9	17.5

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case. The entry "N/A" means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new-standards case.

Table V-14 Average LCC Savings Relative to the No-New-Standards Case for Axial Power Roof–Ventilator - APRV

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
-	1	1,132	4.0%
-	2	1,076	5.9%
-	3	2,988	1.8%
1-5	4	945	14.3%
-	5	-1,463	41.7%
-	6	-2,402	68.3%
6	7	-9,470	89.0%

* The savings represent the average LCC for affected consumers.

Table V-15 Average LCC and PBP Results for Centrifugal Power Roof Ventilator – Exhaust CPRV

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	7,213	582	5,809	13,023	-	16.0
-	1	7,303	575	5,746	13,049	14.0	16.0
-	2	7,248	574	5,732	12,980	4.4	16.0
1	3	7,409	560	5,591	13,000	9.0	16.0
2-5	4	7,608	537	5,360	12,968	8.9	16.0
-	5	8,267	490	4,879	13,146	11.5	16.0
6	6	10,570	434	4,326	14,896	22.8	16.0

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-16 Average LCC Savings Relative to the No-New-Standards Case for Centrifugal Power Roof Ventilator – Exhaust CPRV

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
-	1	-339	5.8%
-	2	468	4.9%
1	3	122	13.1%
2-5	4	154	25.8%
-	5	-178	53.7%
6	6	-1,992	84.7%

* The savings represent the average LCC for affected consumers.

Table V-17 Average LCC and PBP Results for Centrifugal Power Roof Ventilator – Supply CPRV

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	6,538	529	5,239	11,777	-	15.9
-	1	6,680	522	5,175	11,855	22.9	15.9
-	2	6,541	519	5,141	11,682	0.3	15.9
1	3	6,577	503	4,981	11,558	1.5	15.9
2	4	6,613	478	4,734	11,347	1.5	15.9
3-4	5	6,714	426	4,211	10,925	1.7	15.9
5-6	6	6,961	377	3,727	10,688	2.8	15.9

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-18 Average LCC Savings Relative to the No-New-Standards Case for Centrifugal Power Roof Ventilator – Supply CPRV

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
-	1	-1,228	5.5%
-	2	932	3.1%
1	3	831	8.8%
2	4	827	16.5%
3-4	5	973	24.9%
5-6	6	1,126	32.3%

* The savings represent the average LCC for affected consumers.

Table V-19 Average LCC and PBP Results for Radial Housed Fans

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	11,072	2,498	31,987	43,059	-	28.7
-	1	11,111	2,487	31,851	42,962	3.6	28.7
1	2	11,131	2,478	31,743	42,874	3.0	28.7
2	3	11,177	2,459	31,499	42,676	2.7	28.7
3-4	4	11,349	2,330	29,831	41,180	1.7	28.7
5-6	5	11,944	2,104	26,923	38,867	2.2	28.7

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

Table V-20 Average LCC Savings Relative to the No-New-Standards Case for Radial Housed Fans

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
-	1	1,337	2.8%
1	2	1,708	3.3%
2	3	2,145	5.1%
3-4	4	3,714	13.3%
5-6	5	5,391	24.4%

* The savings represent the average LCC for affected consumers.

Table V-21 Average LCC and PBP Results for Equipment Class: Axial ACF, 12” ≤ D <36” (ACF1)

TSL	Efficiency Level	Average Costs (2022$) Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	Simple Payback Period (years)	Average Lifetime (years)
-	0	297	95	498	795	-	6.3
1	1*	297	95	498	795	-	6.3
2	2	297	95	497	794	2.7	6.3
3	3	298	88	461	759	0.2	6.3
4	4	313	62	327	640	0.5	6.3
5	5	445	41	219	664	2.8	6.3
6	6	484	35	188	672	3.1	6.3

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

[*] EL0 = EL1

Table V-22 Average LCC Savings Relative to the No-New-Standards Case for Axial ACF, 12” ≤ D <36” (ACF1)

TSL	Efficiency Level	Life-Cycle Cost Savings: Average LCC Savings[*] (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1[**]	-	-
2	2	35	0.1%
3	3	495	0.0%
4	4	327	0.2%
5	5	141	40.4%
6	6	126	45.1%

[*] The savings represent the average LCC for affected consumers.

[**] EL0 = EL1

Table V-23 Average LCC and PBP Results for Axial ACF, 36” ≤ D <48” (ACF2)

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	561	166	870	1,431	-	6.3
1	1	556	164	859	1,415	N/A	6.3
2	2	558	162	849	1,407	N/A	6.3
3	3	560	147	770	1,329	N/A	6.3
4	4	575	100	527	1,103	0.2	6.3
5	5	717	71	374	1,091	1.6	6.3
6	6	762	61	323	1,085	1.9	6.3

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case. The entry “N/A” means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new standards case.

Table V-24 Average LCC Savings Relative to the No-New-Standards Case for Axial ACF, 36” ≤ D <48” (ACF2)

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1	297	0.0%
2	2	291	0.2%
3	3	606	0.0%
4	4	478	0.0%
5	5	341	22.7%
6	6	346	23.6%

* The savings represent the average LCC for affected consumers.

Table V-25 Average LCC and PBP Results for Axial ACF, 48” ≤ D (ACF3)

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
-	0	939	305	1,595	2,533	-	6.3
1	1	932	303	1,579	2,511	N/A	6.3
2	2	935	299	1,560	2,495	N/A	6.3
3	3	936	274	1,432	2,368	N/A	6.3
4	4	954	197	1,029	1,983	0.1	6.3
5	5	1,093	158	829	1,923	1.1	6.3
6	6	1,161	141	742	1,903	1.4	6.3

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case. The entry “N/A” means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new standards case.

Table V-26 Average LCC Savings Relative to the No-New-Standards Case for Axial ACF, 48" ≤ D (ACF3)

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
-	0	-	-
1	1	343	0.0%
2	2	587	0.0%
3	3	628	0.0%
4	4	668	0.0%
5	5	613	9.3%
6	6	630	11.3%

* The savings represent the average LCC for affected consumers.

Table V-27 Average LCC and PBP Results for Housed Centrifugal ACFs (ACF4)

TSL	Efficiency Level	Average Costs (2022$)				Simple Payback Period (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-4	0	250	93	490	740	-	6.3
-	1*	250	93	490	740	-	6.3
-	2	253	93	488	741	7.8	6.3
5	3	307	81	428	735	4.8	6.3
-	4	535	56	295	830	7.7	6.3
-	5	1,675	37	198	1,873	25.5	6.3
6	6	1,779	32	171	1,950	25.0	6.3

Note: The results for each TSL are calculated considering all consumers. The PBP is measured relative to the no-new standards case.

* EL0 = EL1

Table V-28 Average LCC Savings Relative to the No-New-Standards Case for Housed Centrifugal ACFs (ACF4)

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* (2022$)	Percent of Consumers that Experience Net Cost
1-4	0	-	-
-	1**	-	-
-	2	-25	3.2%
5	3	18	14.1%
-	4	-118	60.0%
-	5	-1,164	97.2%
6	6	-1,210	99.7%

* The savings represent the average LCC for affected consumers.

** EL0 = EL1

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on small businesses. Table V–29 and Table V–30 compare the average LCC savings and PBP at each efficiency level for the consumer subgroup with similar metrics for the entire consumer sample for GFBs and ACFs, respectively. In most cases, the average LCC savings and PBP for small businesses at the considered TSLs are not substantially different from the average for all consumers. Chapter 11 of the NOPR TSD presents the complete LCC and PBP results for the subgroup.

Table V-29 Comparison of LCC Savings and PBP for Small Businesses and All Consumers; GFBs

TSL	EL	Average LCC Savings* 2022$		Simple Payback years		Consumers with Net Cost (%)	
		Small Businesses	All Businesses	Small Businesses	All Businesses	Small Businesses	All Businesses
Axial Inline Fans							
-	0	-	-	-	-	-	-
1	1	1,533	1,766	0.9	1.0	1.0	0.9
2	2	771	1,029	5.4	5.8	8.2	7.5
3 - 4	3	164	550	9.0	9.6	25.1	23.6
5	4	162	670	9.1	9.8	53.4	51.3
6	5	-2,841	-2,169	16.8	17.9	82.1	79.4
Axial Panel							

-	0	-	-	-	-	-	-
1	1	-49	-194	8.4	10.9	6.1	6.3
2	2	967	802	3.6	4.7	6.7	7.3
3	3	1,613	1,413	1.6	2.1	9.8	11.0
4	4	1,942	1,702	1.3	1.7	17.4	19.5
5-6	5	2,212	1,902	1.9	2.5	26.6	29.9
Centrifugal Housed							
-	0	-	-	-	-	-	-
1	1	2,026	1,714	0.2	0.2	1.2	1.5
2	2	2,346	1,977	0.3	0.4	2.0	2.4
3	3	2,463	2,092	0.3	0.4	5.1	6.0
4	4	2,813	2,423	0.5	0.6	11.4	12.9
5-6	5	2,852	2,398	2.3	3.1	37.7	41.5
Centrifugal Inline							
-	0	-	-	-	-	-	-
-	1	1,192	1,073	1.7	2.2	3.2	3.4
1	2	482	355	5.9	7.6	9.5	9.9
2	3	1,516	1,389	0.8	1.1	4.2	4.6
3	4	588	454	5.7	7.3	34.5	36.6
4	5	1,134	955	4.8	6.1	45.9	49.2
5-6	6	562	335	7.2	9.1	63.6	66.7
Centrifugal Unhoused							
-	0	-	-	-	-	-	-
1-2	1	1,235	1,009	2.6	3.5	2.1	2.2
-	2	658	433	5.0	6.7	6.6	7.0
3	3	1,075	884	1.9	2.6	4.2	4.8
4	4	1,366	1,170	0.9	1.2	9.1	10.5
5-6	5	2,326	2,004	0.7	1.0	11.7	13.7
Axial Power Roof Ventilator							
-	0	-	-	-	-	-	-
-	1	1,220	1,132	6.1	7.5	4.1	4.0
-	2	1,147	1,076	5.3	6.5	5.8	5.9
-	3	3,069	2,988	N/A	N/A	1.6	1.8
1-5	4	1,037	945	5.6	7.0	14.1	14.3
-	5	-1,336	-1,463	12.6	15.8	41.3	41.7
-	6	-2,218	-2,402	13.8	17.3	67.6	68.3
6	7	-9,236	-9,470	26.1	32.9	88.6	89.0
Centrifugal Power Roof–Ventilator - Exhaust							
-	0	-	-	-	-	-	-
-	1	-282	-339	11.0	14.0	5.6	5.8
-	2	529	468	3.5	4.4	4.8	4.9
1	3	210	122	7.1	9.0	12.6	13.1
2-5	4	251	154	7.0	8.9	24.7	25.8
-	5	-69	-178	9.0	11.5	51.6	53.7
6	6	-1853	-1992	17.7	22.8	83.1	84.7
Centrifugal Power Roof–Ventilator - Supply							
-	0	-	-	-	-	-	-
-	1	-1,159	-1,228	18.1	22.9	5.4	5.5
-	2	996	933	0.2	0.3	2.9	3.2

1	3	904	831	1.2	1.5	8.1	8.8
2	4	913	827	1.2	1.5	14.9	16.5
3-4	5	1,088	973	1.3	1.7	22.1	24.9
5-6	6	1,283	1,126	2.2	2.8	29.2	32.3
Radial Housed							
-	0	-	-	-	-	-	-
-	1	979	1338	3.6	3.6	3.2	2.8
1	2	1270	1708	3.1	3.0	4.0	3.3
2	3	1601	2145	2.7	2.7	6.0	5.1
3-4	4	2847	3714	1.7	1.7	15.6	13.3
5-6	5	4067	5391	2.2	2.2	28.3	24.4

The entry “N/A” means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new-standards case.

Table V-30 Comparison of LCC Savings and PBP for Small Businesses and All Consumers; ACFs

TSL	EL	Average LCC Savings* 2022$		Simple Payback years		Consumers with Net Cost (%)	
		Small Businesses	All Businesses	Small Businesses	All Businesses	Small Businesses	All Businesses
Axial ACF, 12” ≤ D <36”							
-	**0**	-	-	-	-	-	-
1	**1**	-	-	-	-	-	-
2	**2**	33	35	2.6	2.7	0.1	0.1
3	**3**	504	495	0.2	0.2	0.0	0.0
4	**4**	335	327	0.5	0.5	0.2	0.2
5	**5**	148	141	2.6	2.8	40.1	40.4
6	**6**	133	126	2.9	3.1	45.0	45.1
Axial ACF, 36” ≤ D <48”							
-	**0**	-	-	-	-	-	-
1	**1**	300	297	N/A	N/A	0.0	0.0
2	**2**	296	291	N/A	N/A	0.2	0.2
3	**3**	618	606	N/A	N/A	0.0	0.0
4	**4**	489	478	0.2	0.2	0.0	0.0
5	**5**	351	341	1.5	1.6	22.9	22.7
6	**6**	358	346	1.8	1.9	23.8	23.6
Axial ACF, 48” ≤ D							
-	**0**	-	-	-	-	-	-
1	**1**	347	343	N/A	N/A	0.0	0.0
2	**2**	597	587	N/A	N/A	0.0	0.0
3	**3**	643	628	N/A	N/A	0.0	0.0
4	**4**	684	668	0.1	0.1	0.0	0.0
5	**5**	632	613	1.0	1.1	9.5	9.3
6	**6**	651	630	1.2	1.4	11.5	11.3
Housed Centrifugal ACFS							
1-4	**0**	-	-	-	-	-	-
-	**1**	-	-	-	-	-	-
-	**2**	-11	-25	5.7	7.8	2.6	3.2
5	**3**	80	18	3.5	4.8	11.1	14.1
-	**4**	-47	-118	5.6	7.7	51.7	60.0
-	**5**	-1,080	-1,164	18.7	25.5	96.2	97.2
6	**6**	-1,121	-1,210	18.3	25.0	98.8	99.7

The entry “N/A” means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new-standards case.

c. Rebuttable Presumption Payback

As discussed in section III.F.2, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for equipment that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values and, as required by EPCA, based the energy use calculation on the DOE test procedure for fans and blowers. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V–31 and Table V–32 present the rebuttable-presumption payback periods for the considered TSLs for GFBs and ACFs. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for the NOPR are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C 6316(a); 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V-31 Rebuttable-Presumption Payback Periods for GFBs

Equipment Class	Rebuttable Payback Period *years*					
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Axial Inline Fans	1.0	5.9	9.7	9.7	9.8	17.9
Axial Panel Fans	10.8	4.6	2.1	1.7	2.5	2.5
Centrifugal Housed Fans	0.2	0.4	0.4	0.6	3.1	3.1
Centrifugal Inline Fans	7.6	1.1	7.3	6.1	9.1	9.1
Centrifugal Unhoused Fans	3.5	3.5	2.6	1.2	1.0	1.0
Axial Power Roof Ventilator	7.0	7.0	7.0	7.0	7.0	32.9
Centrifugal Power Roof–Ventilator - Exhaust	9.0	9.0	9.0	9.0	9.0	22.8
Centrifugal Power Roof–Ventilator - Supply	1.5	1.5	1.7	1.7	2.8	2.8
Radial Housed Fans	3.0	2.7	1.7	1.7	2.2	2.2

Table V-32 Rebuttable-Presumption Payback Periods for ACFs

Equipment Class	Rebuttable Payback Period *years*					
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Axial ACFs; 12” ≤ D < 36”	-	2.6	0.2	0.5	2.8	3.1
Axial ACFs; 36” ≤ D < 48”	N/A	N/A	N/A	0.2	1.6	1.9
Axial ACFs; 48” ≤ D	N/A	N/A	N/A	0.1	1.1	1.4
Housed Centrifugal ACFs	-	-	-	-	25.5	25.0

The entry “N/A” means not applicable because there is a decrease in average installed costs at higher TSLs compared to the no-new standards case.

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of new energy conservation standards on manufacturers of fans and blowers. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the NOPR TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from new standards. The following tables summarize the estimated financial impacts (represented by changes in INPV) of potential new energy conservation standards on manufacturers of fans and blowers, as well as the conversion costs that DOE estimates manufacturers of fans and blowers would incur at each TSL. DOE analyzes the potential impacts on INPV separately for ACFs and GFBs. To evaluate the range of cash flow impacts on the fan and blower industry, DOE modeled two manufacturer markup scenarios using different assumptions that correspond to the range of anticipated market responses to new energy conservation standards: (1) the conversion cost recovery markup scenario and (2) the preservation of operating profit markup scenario.

To assess the less severe end of the range of potential impacts, DOE modeled a conversion cost recovery markup scenario in which manufacturers are able to increase their manufacturer markups in response to new energy conservation standards. To assess the more severe end of the range of potential impacts, DOE modeled a preservation of operating profit markup scenario in which manufacturers are not able to maintain their original manufacturer markup, used in the no-new-standards case, in the standards cases. Instead, manufacturers maintain the same operating profit (in absolute dollars) in the standards cases as in the no-new-standards case, despite higher MPCs.

Each of the modeled manufacturer markup scenarios results in a unique set of cash flows and corresponding industry values at the given TSLs for each group of fan and blower manufacturers. In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and each standards case resulting from the sum of discounted cash flows from 2024 through 2059. To provide perspective on the short-run cash flow impact, DOE includes in the discussion of results a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before new standards take effect.

DOE presents the range in INPV for GFB manufacturers in Table V–33 and Table V–34 and the range in INPV for ACF manufacturers in Table V–36 and Table V–37.

General Fans and Blowers

Table V-33 Industry Net Present Value for General Fans and Blowers – Conversion Cost Recovery Markup Scenario

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
INPV	*2022$ millions*	4,935	4,948	4,940	4,936	4,936	4,946	4,975
Change in INPV	*2022$ millions*	-	13	5	1	1	11	40
	%	-	0.3	0.1	0.0	0.0	0.2	0.8

Table V-34 Industry Net Present Value for General Fans and Blowers – Preservation of Operating Profit Scenario

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
INPV	*2022$ millions*	4,935	4,907	4,847	4,697	4,479	3,671	2,647
Change in INPV	*2022$ millions*	-	(28)	(87)	(238)	(455)	(1,263)	(2,287)
	%	-	(0.6)	(1.8)	(4.8)	(9.2)	(25.6)	(46.4)

Table V-35 Cash Flow Analysis for General Fans and Blowers

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
Free Cash Flow (2029)	*2022$ millions*	480	463	420	316	161	(407)	(1,132)
Change in Free Cash Flow (2029)	*2022$ millions*	-	(17.3)	(59.7)	(164.4)	(318.5)	(886.7)	(1,612.2)
	%	-	(3.6)	(12.4)	(34.3)	(66.4)	(184.8)	(335.9)
Product Conversion Costs	*2022$ millions*	-	20	62	154	260	435	698
Capital Conversion Costs	*2022$ millions*	-	23	86	248	510	1,640	3,052
Total Conversion Costs	*2022$ millions*	-	43	147	402	770	2,075	3,750

At TSL 6, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$2,287 million to $40 million, which represents a change of −46.4 percent to 0.8 percent, respectively. At TSL 6, industry free cash flow decreases to −$1,132 million, which represents a decrease of approximately 336 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year. The negative cash flow in the years leading up to the modeled compliance date implies that most, if not all, GFB manufacturers will need to borrow funds in order to make the investments necessary to comply with standards. This has the potential to significantly alter the market dynamics as some smaller manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 6.

TSL 6 would set energy conservation standards at max-tech for all GFBs. DOE estimates that approximately 4 percent of the GFB shipments would already meet the efficiency levels required at TSL 6 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 96 percent of GFB shipments by the estimated compliance date. It is unclear if most GFB manufacturers would have the engineering capacity to complete the necessary redesigns within the 5-year compliance period. If manufacturers require more than 5 years to redesign their non-compliant GFB models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant GFBs covering the duty points that they require.

At TSL 6, DOE expects GFB manufacturers to incur approximately $698 million in product conversion costs to conduct aerodynamic redesigns for non-compliant GFB models.

Additionally, GFB manufacturers would incur approximately $3,052 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 6, the $3,750 million in conversion costs are fully recovered, over the 30-year analysis period, causing INPV at TSL 6 to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. Given the large size of the conversion costs, approximately 1.3 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred), it is highly unlikely that the GFB market will accept the large increases in the MSPs that would be needed for GFB manufacturers to fully recover these conversion costs, making the MSPs that result from this manufacturer markup scenario less likely to be obtained by manufacturers. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 2.2 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $3,750 million in conversion costs incurred by manufacturers cause a significantly negative change in INPV at TSL 6 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 5, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$1,263 million to $11 million, which represents a change of −25.6 percent to 0.2 percent, respectively. At TSL 5, industry free cash flow decreases to −$407 million, which represents a decrease of approximately 185 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year. The negative cash flow in the years leading up to the modeled compliance date implies that most, if not all, GFB manufacturers will need to borrow funds in order to make the investments necessary to comply with standards. This has the potential to significantly alter the market dynamics as some smaller manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 5.

TSL 5 would set energy conservation standards for axial inline fans at EL 4; axial panel fans at EL 5; centrifugal housed fans at EL 5; centrifugal inline fans at EL 6; centrifugal unhoused fans at EL 5; axial PRVs at EL 4; centrifugal PRV exhaust fans at EL 4; centrifugal PRV supply fans at EL 6; and radial housed fans at EL 5. DOE estimates that approximately 7 percent of the GFB shipments would already meet or exceed the efficiency levels required at TSL 5 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 93 percent of GFB shipments by the estimated compliance date. It is unclear if most GFB manufacturers would have the engineering capacity to complete the necessary redesigns within the 5-year compliance period. If manufacturers require more than 5 years to redesign their non-compliant GFB models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant GFBs covering the duty points that they require.

At TSL 5, DOE expects GFB manufacturers to incur approximately $435 million in product conversion costs to conduct aerodynamic redesigns for non-compliant GFB models. Additionally, GFB manufacturers would incur approximately $1,640 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 5, the $2,075 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. Given the large size of the conversion costs, approximately 90 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred), it is unlikely that the GFB market will accept the large increases in the MSPs that would be needed for GFB manufacturers to fully recover these conversion costs, making the MSPs that result from this manufacturer markup scenario less likely to be obtained by manufacturers. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 2.2 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $2,075 million in conversion costs incurred by manufacturers cause a significantly negative change in INPV at TSL 5 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 4, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$455 million to $1 million, which represents a change of −9.2 percent to less than 0.1 percent, respectively. At TSL 4, industry free cash flow decreases to $161 million, which represents a decrease of approximately 66.4 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year.

TSL 4 would set energy conservation standards for axial inline fans at EL 3; axial panel fans at EL 4; centrifugal housed fans at EL 4; centrifugal inline fans at EL 5; centrifugal unhoused fans at EL 4; axial PRVs at EL 4; centrifugal PRV exhaust fans at EL 4; centrifugal PRV supply fans at EL 5; and radial housed fans at EL 4. DOE estimates that approximately 25 percent of the GFB shipments would already meet or exceed the efficiency levels required at TSL 4 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 75 percent of GFB shipments by the estimated compliance date.

At TSL 4, DOE expects GFB manufacturers to incur approximately $260 million in product conversion costs to conduct aerodynamic redesigns for non-compliant GFB models. Additionally, GFB manufacturers would incur approximately $510 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 4, the $770 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. At TSL 4, conversion costs represent approximately 33 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred). It is possible that the GFB market will not accept the full increase in the MSPs that would be needed for GFB manufacturers to fully recover these conversion costs. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 1.1 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $770 million in conversion costs incurred by manufacturers cause a moderately negative change in INPV at TSL 4 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 3, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$238 million to $1 million, which represents a change of −4.8 percent to less than 0.1 percent, respectively. At TSL 3, industry free cash flow decreases to $316 million, which represents a decrease of approximately 34.3 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year.

TSL 3 would set energy conservation standards for axial inline fans at EL 3; axial panel fans at EL 3; centrifugal housed fans at EL 3; centrifugal inline fans at EL 4; centrifugal unhoused fans at EL 3; axial PRVs at EL 4; centrifugal PRV exhaust fans at EL 4; centrifugal PRV supply fans at EL 5; and radial housed fans at EL 4. DOE estimates that approximately 60 percent of the GFB shipments would already meet or exceed the efficiency levels required at TSL 3 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 40 percent of GFB shipments by the estimated compliance date.

At TSL 3, DOE expects GFB manufacturers to incur approximately $154 million in product conversion costs to redesign all non-compliant GFB models. Additionally, GFB manufacturers would incur approximately $248 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 3, the $402 million in conversion costs are fully recovered, causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 1.1 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $402 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 3 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 2, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$87 million to $5 million, which represents a change of −1.8 percent to 0.1 percent, respectively. At TSL 2, industry free cash flow decreases to $420 million, which represents a decrease of approximately 12.4 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year.

TSL 2 would set energy conservation standards for axial inline fans at EL 2; axial panel fans at EL 2; centrifugal housed fans at EL 2; centrifugal inline fans at EL 3; centrifugal unhoused fans at EL 1; axial PRVs at EL 4; centrifugal PRV exhaust fans at EL 4; centrifugal PRV supply fans at EL 4; and radial housed fans at EL 3. DOE estimates that approximately 85 percent of the GFB shipments would already meet or exceed the efficiency levels required at TSL 2 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 15 percent of GFB shipments by the estimated compliance date.

At TSL 2, DOE expects GFB manufacturers to incur approximately $62 million in product conversion costs to redesign all non-compliant GFB models. Additionally, GFB manufacturers would incur approximately $86 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 2, the $147 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 0.6 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $147 million in conversion costs incurred by manufacturers cause a slight negative change in INPV at TSL 2 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 1, for GFB manufacturers, DOE estimates the impacts on INPV will range from −$28 million to $13 million, which represents a change of −0.6 percent to 0.3 percent, respectively. At TSL 1, industry free cash flow decreases to $463 million, which represents a decrease of approximately 3.6 percent, compared to the no-new-standards case value of $480 million in 2029, the year before the modeled compliance year.

TSL 1 would set energy conservation standards for axial inline fans at EL 1; axial panel fans at EL 1; centrifugal housed fans at EL 1; centrifugal inline fans at EL 2; centrifugal unhoused fans at EL 1; axial PRVs at EL 4; centrifugal PRV exhaust fans at EL 3; centrifugal PRV supply fans at EL 3; and radial housed fans at EL 2. DOE estimates that approximately 91 percent of the GFB shipments would already meet or exceed the efficiency levels required at TSL 1 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 9 percent of GFB shipments by the estimated compliance date.

At TSL 1, DOE expects GFB manufacturers to incur approximately $20 million in product conversion costs to redesign all non-compliant GFB models. Additionally, GFB manufacturers would incur approximately $23 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant GFB models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 1, the $43 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increases by approximately 0.6 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $43 million in conversion costs incurred by manufacturers cause a very slight negative change in INPV at TSL 1 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

Air Circulating Fans

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Table V-36 Industry Net Present Value for Air Circulating Fans – Conversion Cost Recovery Markup Scenario

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
INPV	*2022$ millions*	649	649	649	649	649	652	653
Change in INPV	*2022$ millions*	-	0	0	0	0	3	3
	%	-	0.0	0.0	0.0	0.0	0.5	0.5

Table V-37 Industry Net Present Value for Air Circulating Fans – Preservation of Operating Profit Scenario

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
INPV	*2022$ millions*	649	650	649	645	579	16	(85)
Change in INPV	*2022$ millions*	-	1	0	(4)	(71)	(633)	(734)
	%	-	0.1	0.0	(0.6)	(10.9)	(97.5)	(113.1)

Table V-38 Cash Flow Analysis for Air Circulating Fans

	Units	No-New Standards Case	Trial Standard Levels					
			1	2	3	4	5	6
Free Cash Flow (2029)	*2022$ millions*	51	51	51	48	1	(400)	(456)
Change in Free Cash Flow (2029)	*2022$ millions*	-	(0.0)	(0.1)	(3.1)	(50.2)	(451.0)	(507.1)
	%	-	(0.1)	(0.1)	(6.2)	(99.0)	(888.8)	(999.3)
Product Conversion Costs	*2022$ millions*	-	0.1	0.2	1.9	27.0	213.6	239.1
Capital Conversion Costs	*2022$ millions*	-	0.0	0.0	5.5	91.1	829.0	928.1
Total Conversion Costs	*2022$ millions*	-	0.1	0.2	7.4	118.1	1,042.6	1,167.2

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At TSL 6, for ACF manufacturers, DOE estimates the impacts on INPV will range from −$734 million to $3 million, which represents a change of −113.1 percent to 0.5 percent, respectively. At TSL 6, industry free cash flow decreases to −$456 million, which represents a decrease of approximately 999 percent, compared to the no-new-standards case value of $51 million in 2029, the year before the modeled compliance year. The negative cash flow in the years leading up to the modeled compliance date implies that most, if not all, ACF manufacturers will need to borrow funds in order to make the investments necessary to comply with standards. This has the potential to significantly alter the market dynamics as some smaller manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 6.

TSL 6 would set energy conservation standards at max-tech for all ACFs. DOE estimates that approximately 1 percent of the ACF shipments would already meet the efficiency levels required at TSL 6 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 99 percent of ACF shipments by the estimated compliance date. It is unclear if most ACF manufacturers would have the engineering capacity to complete the necessary redesigns within the 5-year compliance period. If manufacturers require more than 5 years to redesign their non-compliant ACF models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant ACFs covering the duty points that they require.

At TSL 6, DOE expects ACF manufacturers to incur approximately $239 million in product conversion costs to conduct aerodynamic redesigns for non-compliant ACF models. Additionally, ACF manufacturers would incur approximately $928 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant ACF models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 6, the $1,167 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. Given the large size of the conversion costs, over 5 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred), it is unlikely that the ACF market will accept the large increases in the MSPs that would be needed for ACF manufacturers to fully recover these conversion costs, making the MSPs that result from this manufacturer markup scenario less likely to be obtained by manufacturers. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. In this scenario, the shipment weighted average MPC increase by approximately 4.7 percent, causing a reduction in the manufacturer margin after the analyzed compliance year. This reduction in the manufacturer margin and the $1,167 million in conversion costs incurred by manufacturers cause an extremely negative change in INPV at TSL 6 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 5, for ACF manufacturers, DOE estimates the impacts on INPV will range from −$633 million to $3 million, which represents a change of −97.5 percent to 0.5 percent, respectively. At TSL 5, industry free cash flow decreases to −$400 million, which represents a decrease of approximately 889 percent, compared to the no-new-standards case value of $51 million in 2029, the year before the modeled compliance year. The negative cash flow in the years leading up to the modeled compliance date implies that most, if not all, ACF manufacturers will need to borrow funds in order to make the investments necessary to comply with standards. This has the potential to significantly alter the market dynamics as some smaller manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 5.

TSL 5 would set energy conservation standards at EL 5 for all ACFs, except housed centrifugal ACFs which are set at EL 3. DOE estimates that approximately 4 percent of the ACF shipments would already meet or exceed the efficiency levels required at

TSL 5 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 96 percent of ACF shipments by the estimated compliance date. It is unclear if most ACF manufacturers would have the engineering capacity to complete the necessary redesigns within the 5-year compliance period. If manufacturers require more than 5 years to redesign their non-compliant ACF models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant ACFs covering the duty points that they require.

At TSL 5, DOE expects ACF manufacturers to incur approximately $214 million in product conversion costs to conduct aerodynamic redesigns for non-compliant ACF models. Additionally, ACF manufacturers would incur approximately $829 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant ACF models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 5, the $1,043 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. Given the large size of the conversion costs, over 4.5 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred), it is unlikely that the ACF market will accept the large increases in the MSPs that would be needed for ACF manufacturers to fully recover these conversion costs, making the MSPs that result from this manufacturer markup scenario less likely to be obtained by manufacturers. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. The $1,043 million in conversion costs incurred by manufacturers cause a significantly negative change in INPV at TSL 5 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 4, for ACF manufacturers, DOE estimates the impacts on INPV will range from −$71 million to no change, which represents a maximum possible change of −10.9 percent. At TSL 4, industry free cash flow decreases to $1 million, which represents a decrease of approximately 99.0 percent, compared to the no-new-standards case value of $51 million in 2029, the year before the modeled compliance year.

TSL 4 would set energy conservation standards at EL 4 for all ACFs, except housed centrifugal ACFs which would not have any energy conservation standard. DOE estimates that approximately 36 percent of the ACF shipments would already meet or exceed the efficiency levels required at TSL 4 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 64 percent of ACF shipments by the estimated compliance date.

At TSL 4, DOE expects ACF manufacturers to incur approximately $27 million in product conversion costs to conduct aerodynamic redesigns for non-compliant ACF models. Additionally, ACF manufacturers would incur approximately $91 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant ACF models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 4, the $118 million in conversion costs are fully recovered causing INPV to remain approximately equal to the no-new-standards case INPV in this conversion cost recovery scenario. At TSL 4, conversion costs represent approximately 50 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred). It is possible that the ACF market will not accept the full increase in the MSPs that would be needed for ACF manufacturers to fully recover these conversion costs. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. The $118 million in conversion costs incurred by manufacturers cause a moderately negative change in INPV at TSL 4 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 3, for ACF manufacturers, DOE estimates the impacts on INPV will range from −$4 million to no change, which represents a maximum change of −0.6 percent. At TSL 3, industry free cash flow decreases to $48 million, which represents a decrease of approximately 6.2 percent, compared to the no-new-standards case value of $51 million in 2029, the year before the modeled compliance year.

TSL 3 would set energy conservation standards at EL 3 for all ACFs, except housed centrifugal ACFs which would not have any energy conservation standard. DOE estimates that approximately 84 percent of the ACF shipments would already meet or exceed the efficiency levels required at TSL 3 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 16 percent of ACF shipments by the estimated compliance date.

At TSL 3, DOE expects ACF manufacturers to incur approximately $1.9 million in product conversion costs to conduct aerodynamic redesigns for non-compliant ACF models. Additionally, ACF manufacturers would incur approximately $5.5 million in capital conversion costs to purchase new tooling and equipment necessary to produce compliant ACF models to meet these energy conservation standards.

In the conversion cost recovery markup scenario, manufacturers increase their manufacturer markups to fully recover the conversion costs they incur to redesign non-compliant equipment. At TSL 3, the $7.4 million in conversion costs are fully recovered causing INPV to remain equal to the no-new-standards case INPV in this conversion cost recovery scenario. This represents the upper-bound, or least-severe impact, on manufacturer profitability and is the manufacturer markup scenario used in all down-stream consumer analyses.

Under the preservation of operating profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments or potentially higher MPCs. The $7.4 million in conversion costs incurred by manufacturers cause a slight negative change in INPV at TSL 3 in this preservation of operating profit scenario. This represents the lower-bound, or most severe impact, on manufacturer profitability.

At TSL 2, for ACF manufacturers, DOE estimates there will be no substantive change to INPV. At TSL 2, industry free cash flow sightly decreases by approximately 0.1 percent in 2029, the year before the modeled compliance year.

TSL 2 would set energy conservation standards at EL 2 for all ACFs, except housed centrifugal ACFs which would not have any energy conservation standard. DOE estimates that approximately 96 percent of the ACF shipments would already meet or exceed the efficiency levels required at TSL 2 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 4 percent of ACF shipments by the estimated compliance date.

At TSL 2, DOE expects ACF manufacturers to incur approximately $0.2 million in product conversion costs to redesign the few non-compliant ACF models. DOE estimates that ACF manufacturers would not incur any capital conversion costs, as manufacturers already have the tooling and production equipment necessary to produce ACF models that meet these energy conservation standards.

The conversion costs incurred by manufacturers, which are relatively minor due to the majority of shipments already meeting the energy conservation standards, and changes in MPCs at TSL 2 are not severe enough to have a significant impact on ACF manufacturers in either of the manufacturer markup scenarios.

At TSL 1, for ACF manufacturers, DOE estimates the impacts on INPV will range from no change to an increase of $0.5 million, which represents a maximum change of 0.1 percent. At TSL 1, industry free cash flow sightly decreases by less than 0.1 percent in 2029, the year before the modeled compliance year.

TSL 1 would set energy conservation standards at EL 1 for all ACFs, except housed centrifugal ACFs which would not have any energy conservation standard. DOE estimates that approximately 96 percent of the ACF shipments would already meet or exceed the efficiency levels required at TSL 1 in 2030, in the no-new-standards case. Therefore, DOE estimates that manufacturers would have to redesign models representing approximately 4 percent of ACF shipments by the estimated compliance date.

At TSL 1, DOE expects ACF manufacturers to incur approximately $0.1 million in product conversion costs to redesign the few non-compliant ACF models. DOE estimates that ACF manufacturers would not incur any capital conversion costs, as manufacturers already have the tooling and production equipment necessary to produce ACF models that meet these energy conservation standards.

The conversion costs incurred by manufacturers, which are relatively minor due to the majority of shipments already meeting the energy conservation standards, and the change in MPCs at TSL 1 are not severe enough to have a significant impact on ACF manufacturers in either of the manufacturer markup scenarios.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of new energy conservation standards on direct employment in the fan and blower industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period.

Production employees are those who are directly involved in fabricating and assembling equipment within manufacturer facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are included as production labor, as well as line supervisors.

DOE used the GRIM to calculate the number of production employees from labor expenditures. DOE used statistical data from the U.S. Census Bureau's 2021 Annual Survey of Manufacturers[126] (''ASM'') and the results of the engineering analysis to calculate industry-wide labor expenditures. Labor expenditures related to product manufacturing depend on the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in the GRIM were then converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker.

Non-production employees account for those workers that are not directly engaged in the manufacturing of the covered equipment. This could include sales, human resources, engineering, and management. DOE estimated non-production employment levels by multiplying the number of fan and blower production workers by a scaling factor. The scaling factor is calculated by taking the ratio of the total number of employees, and the total production workers associated with the industry North American Industry Classification System (''NAICS'') code 333413, which covers fan and blower manufacturing.

Using the GRIM, DOE estimates that there would be approximately 13,819 domestic production workers, and 6,091 non-production workers for GFBs in 2030 in the absence of new energy conservation standards. DOE estimates that there would be approximately 648 domestic production workers and 286 non-production workers for ACFs in 2030 in the absence of new energy conservation standards. Table V–39 shows the range of the impacts of energy conservation standards on U.S. production of GFBs and Table V–40 shows the range of the impacts of energy conservation standards on U.S. production of ACFs.

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[126] *See www.census.gov/programs-surveys/asm/data/tables.html.*

Table V-39 Domestic Employment for General Fans and Blowers in 2030

	No-New-Standards Case	Trial Standard Levels					
		1	2	3	4	5	6
Domestic Production Workers in 2030	13,819	13,901	13,898	13,969	13,970	14,460	14,464
Domestic Non-Production Workers in 2030	6,091	6,127	6,126	6,157	6,157	6,373	6,375
Total Direct Employment in 2030*	19,910	20,028	20,024	20,126	20,127	20,833	20,839
Potential Changes in Total Direct Employment in 2030*	-	0 – 118	0 – 114	(1,991) – 216	(2,986) – 217	(4,977) – 923	(5,973) – 929

* Numbers may not sum exactly due to rounding. Number in parentheses indicate a negative number.

Table V-40 Domestic Employment for Air Circulating Fans in 2030

	No-New-Standards Case	Trial Standard Levels					
		1	2	3	4	5	6
Domestic Production Workers in 2030	648	644	644	644	644	644	591
Domestic Non-Production Workers in 2030	286	284	284	284	284	284	261
Total Direct Employment in 2030*	934	928	928	928	928	928	852
Potential Changes in Total Direct Employment in 2030*	-	(6) – 0	–6) – 0	(93)– (6)	(140)– (6)	(234)– (6)	(280) - (82)

* Numbers may not sum exactly due to rounding. Number in parentheses indicate a negative number.

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The direct employment impacts shown in Table V–39 and Table V–40 represent the potential changes in direct employment that could result following the compliance date for GFBs and ACFs. Employment could increase or decrease due to the labor content of the various equipment being manufactured domestically that meet the analyzed standards or if manufacturers decided to move production facilities abroad because of new standards. At one end of the range, DOE assumes that all manufacturers continue to manufacture the same scope of equipment domestically after new standards are required. However, since the labor content of GFBs and ACFs vary by efficiency level, this can either result in an increase or decrease in domestic employment, even if all domestic production remains in the U.S.

The lower end of the range assumes that some domestic manufacturing either is eliminated or moves abroad due to the analyzed new standards. DOE assumes that for TSL 1 and TSL 2 ACF and GFB manufacturers already have the tooling and production equipment necessary to produce ACF and GFB models that meet these energy conservation standards, making it unlikely that manufacturers would move any domestic product abroad at these analyzed TSLs. At TSL 3 through TSL 6, DOE conservatively estimates that some domestic manufacturing could move abroad as these TSLs require manufacturers to make larger investments in production equipment that could cause some manufacturers to consider moving production facilities to a lower-labor cost country.

c. Impacts on Manufacturing Capacity

During manufacturer interviews most manufacturers stated that any standards set at max-tech would severely disrupt manufacturing capacity. Many fan and blower manufacturers do not offer any GFB or ACF models that would meet these max-tech efficiency levels. Based on the shipments analysis used in the NIA, DOE estimates that approximately 4 percent of all GFB shipments and approximately 1 percent of ACF shipments will meet max-tech efficiency levels, in the no-new-standards case in 2030, the modeled compliance year of new energy conservation standards. Manufacturers stated that they do not have the necessary engineers that would be required to convert models that represent approximately 96 percent of GFB shipments and approximately 99 percent of ACF shipments into compliant models.

Additionally, most manufacturers stated they would not be able to provide a full portfolio of fans and blower, covering their current offering of operating pressure and airflow ranges, for any equipment class that required max-tech efficiency levels. Most manufacturers stated that they do not currently have the machinery, technology, or engineering resources to manufacture these fans and blowers. Additionally, the few manufacturers that do have the capability of producing max-tech fans and blowers are not able to produce these fans and blowers for all necessary operating pressures and airflows that the market requires and in the volumes that would fulfill the entire fan and blower markets. Lastly, most manufacturers stated that they would not be able to ramp up those production volumes over the five-year compliance period.

For fan and blower manufacturers to either completely redesign their fan and blower production lines to be capable of producing max-tech fans and blowers or to significantly expand their limited max-tech fan and blower production lines to meet larger production volumes would require a massive retooling and engineering effort, which would take more than the five-year compliance period.

DOE estimates there is a strong likelihood of manufacturer capacity constraints for any equipment classes that require max-tech efficiency levels.

d. Impacts on Subgroups of Manufacturers

As discussed in section IV.J.1 of this document, using average cost assumptions to develop an industry cash flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Consequently, DOE considered three manufacturer subgroups in the MIA: GFB manufacturers, ACF manufacturers, and small manufacturers as a subgroup for a separate impact analysis. DOE discussed the potential impacts on GFB manufacturers and ACF manufacturers separately in sections V.B.2.a and V.B.2.b.

For the small business subgroup analysis, DOE applied the small business size standards published by the Small Business Administration (''SBA'') to determine whether a company is considered a small business. The size standards are codified at 13 CFR part 121. To be categorized as a small business under NAICS code 333413, ''industrial and commercial fan and blower and air purification equipment manufacturing,'' a fan and blower manufacturer and its affiliates may employ a maximum of 500 employees. The 500-employee threshold includes all employees in a business's parent company and any other subsidiaries. For a discussion of the impacts on the small manufacturer subgroup, *see* the Regulatory Flexibility Analysis in section VI.B.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the equipment-specific regulatory actions of other Federal agencies that affect the manufacturers of a covered product or equipment. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several existing 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.

DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of fans and blowers associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

DOE evaluates product-specific regulations that will take effect approximately 3 years before or after the estimated 2030 compliance date of any new energy conservation standards for fans and blowers. This information is presented in Table V–41.

Table V-41 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Fan and Blower Manufacturers

Federal Energy Conservation Standard	Number of Mfrs*	Number of Manufacturers Affected from this Rule**	Approx. Standards Year	Industry Conversion Costs (*millions*)	Industry Conversion Costs / Product Revenue***
Ceiling Fans, 88 FR 40932 (Jun. 22, 2023)†	91	5	2028	107.2 *(2022$)*	1.9%
Electric Motors 88 FR 36066 (Jun. 1, 2023)	74	1	2027	468.5 (*2021$*)	2.6%

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.

** This column presents the number of manufacturers producing fans and blowers that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.

*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the energy conservation standard. The conversion period typically ranges from 3 to 5 years, depending on the rulemaking.

† Indicated a NOPR publication. The values listed could change upon the publication of a final rule.

MIAQ and AHRI expressed concerns about the HVAC industry burden of multiple DOE energy conservation standards and safety standards being passed in close succession, requiring significant retesting to be performed on equipment. (MIAQ, No. 124 at p. 3–4) and (AHRI, No. 130 at p.13–14) DOE conducts a cumulative regulatory burden on the manufactures of the products or equipment that is being regulated, so for this rulemaking that is a cumulative regulatory burden on fan and blower manufacturers. Table V–41 lists other products or equipment that fan and blower manufacturers make that also have a potential DOE energy conservation standard required within 3 years of the compliance date for this rulemaking, modeled to be 2030. Additionally, Table III–1 listed products and equipment, including several HVAC equipment that if they have a fan embedded in the equipment, the fans would be excluded for this energy conservation standard, if finalized as proposed.

3. National Impact Analysis

This section presents DOE's estimates of the national energy savings and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for fans and blowers, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the first full year of anticipated compliance with new standards (2030–2059). Table V–42 and Table V–43 present DOE's projections of the national energy savings for each TSL considered for GFBs and ACFs. The savings were calculated using the approach described in section IV.H of this document.

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Table V-42 Cumulative National Energy Savings for GFBs; 30 Years of Shipments (2030–2059)

	Trial Standard Level					
	1	2	3	4	5	6
	quads					
Primary energy	1.7	2.9	7.5	13.4	23.1	24.6
FFC energy	1.7	3.0	7.7	13.8	23.7	25.3

Table V-43 Cumulative National Energy Savings for ACFs; 30 Years of Shipments (2030–2059)

	Trial Standard Level					
	1	2	3	4	5	6
	quads					
Primary energy	0.1	0.2	1.2	4.4	6.3	7.0
FFC energy	0.1	0.2	1.2	4.5	6.5	7.2

OMB Circular A–4[127] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[128] The review timeframe established in EPCA is generally not synchronized with the equipment lifetime, equipment manufacturing cycles, or other factors specific to fans and blowers. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodologies. NES sensitivity analysis results based on a 9-year analytical period are presented in Table V–44 and Table V–45 for GFBs and ACFs. The impacts are counted over the lifetime of equipment purchased in 2030–2038.

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[127] Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Available at *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf.*

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

Table V-44 Cumulative National Energy Savings for GFBs; 9 Years of Shipments (2030–2038)

	Trial Standard Level					
	1	2	3	4	5	6
	quads					
Primary energy	0.4	0.8	2.0	3.6	6.1	6.5
FFC energy	0.5	0.8	2.0	3.7	6.3	6.7

Table V-45 Cumulative National Energy Savings for ACFs; 9 Years of Shipments (2030–2038)

	Trial Standard Level					
	1	2	3	4	5	6
	quads					
Primary energy	0.0	0.0	0.2	0.8	1.1	3.5
FFC energy	0.0	0.0	0.2	1.2	1.3	3.6

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for fans and blowers. In accordance with OMB's guidelines on regulatory analysis,[129] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V–46 and Table V–47 show the consumer NPV results with impacts counted over the lifetime of equipment purchased in 2030–2059 for GFBs and ACFs.

Table V-46 Cumulative Net Present Value of Consumer Benefits for GFBs; 30 Years of Shipments (2030–2059)

Discount Rate	Trial Standard Level					
	1	2	3	4	5	6
	billion 2022$					
3 percent	3.8	7.2	19.0	36.9	54.8	49.3
7 percent	1.3	2.6	6.8	13.7	19.2	15.8

Table V-47 Cumulative Net Present Value of Consumer Benefits for ACFs; 30 Years of Shipments (2030–2059)

Discount Rate	Trial Standard Level					
	1	2	3	4	5	6
	billion 2022$					
3 percent	0.4	0.7	3.6	12.6	13.1	14.5
7 percent	0.2	0.3	1.5	5.3	5.2	5.7

The NPV results based on the aforementioned 9-year analytical period are presented in Table V–48 and Table V–49 for GFBs and ACFs. The impacts are counted over the lifetime of products purchased in 2030–2038. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

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[129] Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Available at *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf.*

Table V-48 Cumulative Net Present Value of Consumer Benefits for GFBs; 9 Years of Shipments (2030–2038)

Discount Rate	Trial Standard Level					
	1	2	3	4	5	6
	billion 2022$					
3 percent	1.4	2.6	6.9	13.4	20.0	18.0
7 percent	0.6	1.3	3.4	6.7	9.4	7.8

Table V-49 Cumulative Net Present Value of Consumer Benefits for ACFs; 9 Years of Shipments (2030–2038)

Discount Rate	Trial Standard Level					
	1	2	3	4	5	6
	billion 2022$					
3 percent	0.1	0.2	0.9	3.3	3.4	3.4
7 percent	0.1	0.1	0.6	2.0	2.0	2.0

The previous results reflect the use of a default trend to estimate the change in price for fans and blowers over the analysis period (*see* section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the NOPR TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

It is estimated that new energy conservation standards for fans and blowers would reduce energy expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2030–2035), where these uncertainties are reduced.

The results suggest that the proposed standards would be likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the NOPR TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section III.F.1.d of this document, DOE has tentatively concluded that the standards proposed in this NOPR would not lessen the utility or performance of the fans and blowers under consideration in this rulemaking. Manufacturers of these equipment currently offer units that meet or exceed the proposed standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.F.1.e, the Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination in writing to the Secretary, together with an analysis of the nature and extent of such impact. To assist the Attorney General in making this determination, DOE has provided DOJ with copies of this NOPR and the accompanying NOPR TSD for review. DOE will consider DOJ's comments on the proposed rule in determining whether to proceed to a final rule. DOE will publish and respond to DOJ's comments in that document. DOE invites comment from the public regarding the competitive impacts that are likely to result from this proposed rule. In addition, stakeholders may also provide comments separately to DOJ regarding these potential impacts. See the **ADDRESSES** section for information to send comments to DOJ.

6. Need of the Nation To Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. Chapter 15 in the NOPR TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential energy conservation standards for fans and blowers is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V–50 and Table V–51 provide DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking for GFBs and ACFs, respectively. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the NOPR TSD.

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Table V-50 Cumulative Emissions Reduction for GFBs Shipped in 2030–2059

	Trial Standard Level					
	1	**2**	**3**	**4**	**5**	**6**
Power Sector Emissions						
CO_2 (*million metric tons*)	26.82	46.75	120.73	216.82	372.65	397.92
CH_4 (*thousand tons*)	1.95	3.40	8.77	15.78	27.09	28.92
N_2O (*thousand tons*)	0.27	0.47	1.22	2.19	3.76	4.01
NO_X (*thousand tons*)	12.13	21.11	54.39	98.08	168.27	179.43
SO_2 (*thousand tons*)	8.87	15.47	39.95	71.74	123.30	131.66
Hg (*tons*)	0.06	0.11	0.28	0.50	0.86	0.92
Upstream Emissions						
CO2 (*million metric tons*)	2.80	4.88	12.60	22.60	38.86	41.52
CH4 (*thousand tons*)	254.61	444.08	1,148.00	2,058.08	3,539.94	3,782.34
N2O (*thousand tons*)	0.01	0.02	0.05	0.10	0.17	0.18
NO_X (*thousand tons*)	43.65	76.13	196.81	352.83	606.87	648.43
SO2 (*thousand tons*)	0.16	0.28	0.73	1.31	2.25	2.41
Hg (*tons*)	0.00	0.00	0.00	0.00	0.00	0.00
Total FFC Emissions						
CO_2 (*million metric tons*)	29.61	51.62	133.33	239.41	411.51	439.45
CH_4 (*thousand tons*)	256.56	447.48	1,156.77	2,073.86	3,567.04	3,811.26
N_2O (*thousand tons*)	0.28	0.49	1.27	2.29	3.93	4.19
NO_X (*thousand tons*)	55.78	97.24	251.20	450.91	775.15	827.86
SO_2 (*thousand tons*)	9.04	15.75	40.68	73.06	125.56	134.07
Hg (*tons*)	0.06	0.11	0.28	0.50	0.86	0.92

Table V-51 Cumulative Emissions Reduction for ACFs Shipped in 2030–2059

	Trial Standard Level					
	1	**2**	**3**	**4**	**5**	**6**
Power Sector Emissions						
CO_2 (*million metric tons*)	1.58	3.46	19.45	71.01	101.82	113.80
CH_4 (*thousand tons*)	0.10	0.22	1.23	4.50	6.46	7.22
N_2O (*thousand tons*)	0.01	0.03	0.17	0.61	0.88	0.99
NO_X (*thousand tons*)	0.69	1.51	8.50	31.04	44.51	49.75
SO_2 (*thousand tons*)	0.43	0.94	5.27	19.24	27.59	30.84
Hg (*tons*)	0.00	0.01	0.04	0.13	0.19	0.21
Upstream Emissions						
CO2 (million metric tons)	0.17	0.36	2.05	7.50	10.75	12.02
CH4 (thousand tons)	15.15	33.21	186.82	682.18	978.13	1,093.20
N2O (thousand tons)	0.00	0.00	0.01	0.03	0.05	0.05
NO_X (thousand tons)	2.60	5.69	32.03	116.98	167.72	187.45
SO2 (thousand tons)	0.01	0.02	0.12	0.44	0.63	0.71
Hg (tons)	0.00	0.00	0.00	0.00	0.00	0.00
Total FFC Emissions						
CO_2 (*million metric tons*)	1.74	3.82	21.50	78.51	112.57	125.81
CH_4 (*thousand tons*)	15.25	33.43	188.05	686.69	984.59	1,100.41
N_2O (*thousand tons*)	0.01	0.03	0.18	0.65	0.93	1.04
NO_X (*thousand tons*)	3.29	7.21	40.54	148.02	212.23	237.20
SO_2 (*thousand tons*)	0.44	0.96	5.39	19.69	28.23	31.55
Hg (*tons*)	0.00	0.01	0.04	0.13	0.19	0.21

As part of the analysis for this rulemaking, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for GFBs and AFCs. Section IV.L of this document discusses the SC–CO_2 values that DOE used. Table V–52 and Table V–53 present the value of CO_2 emissions reduction at each TSL for each of the SC–CO_2 cases for GFBs and ACFs, respectively. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V-52 Present Value of CO_2 Emissions Reduction for GFBs Shipped in 2030–2059

TSL	**SC-CO_2 Case**			
	Discount Rate and Statistics			
	5%	**3%**	**2.5%**	**3%**
	Average	**Average**	**Average**	**95th percentile**
	Billion 2022$			
1	0.26	1.14	1.79	3.45
2	0.45	1.97	3.11	5.98
3	1.15	5.03	7.92	15.22
4	2.11	9.23	14.53	27.97
5	3.59	15.71	24.73	47.58
6	3.80	16.65	26.21	50.42

Table V-53 Present Value of CO_2 Emissions Reduction for ACFs Shipped in 2030–2059

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2022$			
1	0.02	0.08	0.12	0.23
2	0.04	0.17	0.26	0.51
3	0.22	0.94	1.47	2.85
4	0.80	3.43	5.37	10.40
5	1.14	4.92	7.70	14.91
6	1.28	5.50	8.61	16.66

As discussed in section IV.L.2, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for GFBs and ACFs. Table V–54 and Table V–55 present the value of the CH_4 emissions reduction at each TSL for GFBs and ACFs, respectively, and Table V–56 and Table V–57 present the value of the N_2O emissions reduction at each TSL for GFBs and ACFs, respectively. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V-54 Present Value of Methane Emissions Reduction for GFBs Shipped in 2030–2059

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2022$			
1	0.10	0.32	0.45	0.85
2	0.18	0.56	0.79	1.48
3	0.46	1.43	2.01	3.77
4	0.85	2.61	3.67	6.91
5	1.44	4.45	6.25	11.77
6	1.53	4.72	6.64	12.48

Table V-55 Present Value of Methane Emissions Reduction for ACFs Shipped in 2030–2059

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2022$			
1	0.01	0.02	0.03	0.06
2	0.02	0.05	0.07	0.12
3	0.09	0.26	0.37	0.70
4	0.32	0.97	1.35	2.54
5	0.46	1.38	1.93	3.64
6	0.51	1.55	2.16	4.07

Table V-56 Present Value of Nitrous Oxide Emissions Reduction for GFBs Shipped in 2030–2059

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2022$			
1	0.00	0.00	0.01	0.01
2	0.00	0.01	0.01	0.02
3	0.00	0.02	0.03	0.05
4	0.01	0.03	0.05	0.09
5	0.01	0.05	0.08	0.15
6	0.01	0.06	0.09	0.15

Table V-57 Present Value of Nitrous Oxide Emissions Reduction for ACFs Shipped in 2030–2059

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	Billion 2022$			
1	0.000	0.000	0.000	0.001
2	0.000	0.000	0.001	0.001
3	0.001	0.003	0.004	0.007
4	0.003	0.010	0.016	0.027
5	0.004	0.015	0.023	0.039
6	0.004	0.016	0.025	0.043

DOE is well aware that scientific and economic knowledge continues to evolve rapidly about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy. DOE, together with other Federal agencies, will continue to review methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. DOE notes that the proposed standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the health benefits associated with NO_X and SO_2 emissions reductions anticipated to result from the considered TSLs for GFBs and ACFs. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V–58 and Table V–59 present the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, for GFBs and ACFs, respectively; and Table V–60 and Table V–61 present similar results for SO_2 emissions reductions for GFBs and ACFs, respectively. The results in these tables reflect application of EPA's low dollar-per-ton values, which DOE used to be conservative. The time-series of annual values is presented for the proposed TSL in chapter 14 of the NOPR TSD.

Table V-58 Present Value of NO_X Emissions Reduction for GFBs Shipped in 2030–2059

TSL	3% Discount Rate	7% Discount Rate
	million 2022$	
1	827	2,353
2	1,428	4,082
3	3,626	10,443
4	6,702	19,053
5	11,376	32,519
6	12,026	34,536

Table V-59 Present Value of NO_X Emissions Reduction for ACFs Shipped in 2030–2059

TSL	3% Discount Rate	7% Discount Rate
	million 2022$	
1	58	153
2	128	336
3	718	1,890
4	2,622	6,902
5	3,760	9,897
6	4,202	11,061

Table V-60 Present Value of SO_2 Emissions Reduction for GFBs Shipped in 2030–2059

TSL	3% Discount Rate	7% Discount Rate
	million 2022$	
1	191	537
2	329	931
3	836	2,382
4	1,546	4,346
5	2,624	7,417
6	2,774	7,877

Table V-61 Present Value of SO_2 Emissions Reduction for ACFs Shipped in 2030–2059

TSL	3% Discount Rate	7% Discount Rate
	million 2022$	
1	11	29
2	24	63
3	137	354
4	498	1,292
5	715	1,852
6	799	2,070

Not all the public health and environmental benefits from the reduction of greenhouse gases, NO_X, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of direct PM and other co-pollutants may be significant. DOE has not included monetary benefits of the reduction of Hg emissions because the amount of reduction is very small.

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 6216(a); 42 U.S.C. 6295(o)(2)(B)(i)(VII)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V–62 and Table V–63 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced GHG and NO_X and SO_2 emissions to the NPV of consumer benefits calculated for each TSL considered in this rulemaking, for GFBs and ACFs, respectively. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered GFBs and ACFs, and are measured for the lifetime of equipment shipped in 2030–2059. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits, and are also calculated based on the lifetime of GFBs and ACFs shipped in 2030–2059.

Table V-62 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for GFBs

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC-GHG case	7.1	12.8	33.5	63.3	99.8	97.1
3% Average SC-GHG case	8.2	14.8	38.3	72.2	115.0	113.2
2.5% Average SC-GHG case	8.9	16.1	41.8	78.6	125.9	124.7
3% 95th percentile SC-GHG case	11.0	19.7	50.9	95.3	154.3	154.8
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC-GHG case	2.7	5.0	12.9	24.9	38.2	36.0
3% Average SC-GHG case	3.8	6.9	17.8	33.8	53.4	52.0
2.5% Average SC-GHG case	4.6	8.2	21.3	40.2	64.3	63.6
3% 95th percentile SC-GHG case	6.6	11.8	30.3	56.9	92.7	93.7

Table V-63 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for ACFs

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC-GHG case	0.6	1.2	6.2	21.9	26.4	29.4
3% Average SC-GHG case	0.7	1.3	7.1	25.2	31.1	34.7
2.5% Average SC-GHG case	0.8	1.4	7.7	27.5	34.5	38.4
3% 95th percentile SC-GHG case	0.9	1.7	9.4	33.7	43.4	48.4
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2022$)						
5% Average SC-GHG case	0.3	0.5	2.7	9.5	11.3	12.5
3% Average SC-GHG case	0.4	0.7	3.6	12.8	16.0	17.7
2.5% Average SC-GHG case	0.4	0.8	4.2	15.1	19.4	21.5
3% 95th percentile SC-GHG case	0.5	1.1	5.9	21.3	28.3	31.5

C. Conclusion

When considering new or amended energy conservation standards, the standards that DOE adopts for any type (or class) of covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6316(a); 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. 6316(a); 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. 6316(a); 42 U.S.C. 6295(o)(3)(B))

For this NOPR, DOE considered the impacts of new standards for GFBs and ACFs at each TSL, beginning with the max-tech feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

1. Benefits and Burdens of TSLs Considered for Fans and Blowers Standards

a. General Fans and Blowers

Table V–64 and Table V–65 summarize the quantitative impacts estimated for each TSL for GFBs. The national impacts are measured over the lifetime of GFBs purchased in the 30-year period that begins in the anticipated first full year of compliance with new standards (2030–2059). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this document.

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Table V-64 Summary of Analytical Results for GFBs TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Cumulative FFC National Energy Savings						
Quads	1.7	3.0	7.7	13.8	23.7	25.3
Cumulative FFC Emissions Reduction						
CO_2 (*million metric tons*)	29.6	51.6	133.3	239.4	411.5	439.4
CH_4 (*thousand tons*)	256.6	447.5	1156.8	2073.9	3567.0	3811.3
N_2O (*thousand tons*)	0.3	0.5	1.3	2.3	3.9	4.2
NO_X (*thousand tons*)	55.8	97.2	251.2	450.9	775.1	827.9
SO_2 (*thousand tons*)	9.0	15.8	40.7	73.1	125.6	134.1
Hg (*tons*)	0.1	0.1	0.3	0.5	0.9	0.9
Present Value of Monetized Benefits and Costs (*3% discount rate, billion 2022$*)						
Consumer Operating Cost Savings	5.3	9.1	23.0	42.7	72.3	76.4
Climate Benefits*	1.5	2.5	6.5	11.9	20.2	21.4
Health Benefits**	2.9	5.0	12.8	23.4	39.9	42.4
Total Benefits†	9.6	16.7	42.3	78.0	132.4	140.2
Consumer Incremental Product Costs‡	1.5	1.9	4.0	5.7	17.4	27.0
Consumer Net Benefits	3.8	7.2	19.0	36.9	54.8	49.3
Total Net Benefits	8.2	14.8	38.3	72.2	115.0	113.2
Present Value of Monetized Benefits and Costs (*7% discount rate, billion 2022$*)						
Consumer Operating Cost Savings	2.1	3.5	8.9	16.6	28.0	29.5
Climate Benefits*	1.5	2.5	6.5	11.9	20.2	21.4
Health Benefits**	1.0	1.8	4.5	8.2	14.0	14.8
Total Benefits†	4.5	7.8	19.8	36.8	62.3	65.7
Consumer Incremental Product Costs‡	0.7	1.0	2.0	2.9	8.9	13.7
Consumer Net Benefits	1.3	2.6	6.8	13.7	19.2	15.8
Total Net Benefits	3.8	6.9	17.8	33.8	53.4	52.0

Note: This table presents the costs and benefits associated with GFBs shipped in 2030−2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 20230−2059.

* Climate benefits are calculated using four different estimates of the SC-CO_2, SC-CH_4 and SC-N_2O. Together, these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for NO_X and SO_2) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.M of this document for more details.

† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate.

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

Table V-65 Summary of Analytical Results for GFBs TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Manufacturer Impacts						
Industry NPV (*million 2022$*) (No-new-standards case INPV = 4,935)	4,907 – 4,948	4,847 – 4,940	4,697 – 4,936	4,479 – 4,936	3,671 – 4,946	2,647 – 4,975
Industry NPV *(% change*)	(0.6) – 0.3	(1.8) – 0.1	(4.8) – 0.0	(9.2) – 0.0	(25.6) – 0.2	(46.4) – 0.8
Consumer Average LCC Savings (<u>2022$</u>)						
Axial Inline	1,766	1,029	550	550	670	(2,169)
Axial Panel	(194)	802	1,413	1,702	1,902	1,902
Centrifugal Housed	1,714	1,977	2,092	2,423	2,398	2,398
Centrifugal Inline	355	1,389	454	955	335	335
Centrifugal Unhoused	1,009	1,009	884	1,170	2,004	2,004
Axial Power Roof Ventilator	945	945	945	945	945	(9,470)
Centrifugal Power Roo– Ventilator - Exhaust	122	154	154	154	154	(1,992)
Centrifugal Power Roo– Ventilator - Supply	831	827	973	973	1,126	1,126
Radial Housed	1,708	2,145	3,714	3,714	5,391	5,391
Shipment-Weighted Average*	907	1,256	1,425	1,694	2,030	1,751
Consumer Simple PBP (<u>years</u>)						
Axial Inline	1.0	5.8	9.6	9.6	9.8	17.9
Axial Panel	10.9	4.7	2.1	1.7	2.5	2.5
Centrifugal Housed	0.2	0.4	0.4	0.6	3.1	3.1
Centrifugal Inline	7.6	1.1	7.3	6.1	9.1	9.1
Centrifugal Unhoused	3.5	3.5	2.6	1.2	1.0	1.0
Axial Power Roof Ventilator	7.0	7.0	7.0	7.0	7.0	32.9
Centrifugal Power Roo– Ventilator - Exhaust	9.0	8.9	8.9	8.9	8.9	22.8
Centrifugal Power Roo– Ventilator - Supply	1.5	1.5	1.7	1.7	2.8	2.8
Radial Housed	3.0	2.7	1.7	1.7	2.2	2.2
Shipment-	4.6	3.0	2.3	1.8	2.9	3.8

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Weighted Average*						
Percent of Consumers that Experience a Net Cost						
Axial Inline	0.9%	7.5%	23.6%	23.6%	51.3%	79.4%
Axial Panel	6.3%	7.3%	11.0%	19.5%	29.9%	29.9%
Centrifugal Housed	1.5%	2.4%	6.0%	12.9%	41.5%	41.5%
Centrifugal Inline	9.9%	4.6%	36.6%	49.2%	66.7%	66.7%
Centrifugal Unhoused	2.2%	2.2%	4.8%	10.5%	13.7%	13.7%
Axial Power Roof Ventilator	14.3%	14.3%	14.3%	14.3%	14.3%	89.0%
Centrifugal Power Roo– Ventilator - Exhaust	13.1%	25.8%	25.8%	25.8%	25.8%	84.7%
Centrifugal Power Roo– Ventilator - Supply	8.8%	16.5%	24.9%	24.9%	32.3%	32.3%
Radial Housed	3.3%	5.1%	13.3%	13.3%	24.4%	24.4%
Shipment-Weighted Average*	3.8%	5.0%	9.5%	15.7%	30.2%	32.8%

Parentheses indicate negative (-) values. The entry "-" means no impact because the TSL considered is equivalent to the no-new standards case. The entry "N/A." means not applicable because there is a decrease in average installed costs at the considered TSLs compared to the no-new standards case.

* Weighted by shares of each equipment class in total projected shipments in 2030.

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DOE first considered TSL 6, which represents the max-tech efficiency levels. At TSL 6, DOE expects all equipment classes would require the highest tier aerodynamic redesign.

TSL 6 would save an estimated 25.3 quads of full-fuel cycle energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $15.8 billion using a discount rate of 7 percent, and $49.3 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 439.4 Mt of CO_2, 134.1 thousand tons of SO_2, 827.9 thousand tons of NO_X, 0.9 tons of Hg, 3,811.3 thousand tons of CH_4, and 4.2 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 6 is $21.4 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 6 is $14.8 billion using a 7-percent discount rate and $42.4 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 6 is $52.0 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 6 is $113.2 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 6, for the largest equipment classes, which are represented by axial panel fans, centrifugal housed fans, and centrifugal unhoused fans—which together represent approximately 85 percent of annual shipments—there is a life-cycle cost savings of $1,902, $2,398, and $2,004 and a payback period of 2.5 years, 3.1 years, and 1.0 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 29.9 percent, 41.5 percent, and 13.7 percent due to increases in total installed cost of $618, $1,090 and $215, respectively. The life-cycle costs savings are negative for axial inline fans, axial PRV, and centrifugal PRV exhaust, and equal to −$2,169, −$9,470, and −$1,992. For these equipment classes the payback is 17.9, 32.9 and 22.8 years and the fraction of customers experiencing a net LCC cost is 79.4 percent, 89.0 percent, and 84.7 percent. The life-cycle costs savings for centrifugal inline, centrifugal PRV supply, and radial housed fans are positive and equal to $335, $1,126, and $5,391, respectively. For these equipment classes the payback is 9.1, 2.8, and 2.2 years and the fraction of customers experiencing a net LCC cost is 66.7 percent, 32.3 percent, and 24.4 percent. At TSL 6, the shipments-weighted average LCC is equal to $1,751, the payback period is equal to 3.8 and the fraction of customers experiencing a net LCC cost is 32.8 percent.

At TSL 6, the projected change in INPV ranges from a decrease of $2,287 million to an increase of $40 million, which corresponds to a decrease of 46.4 percent and an increase of 0.8 percent, respectively. DOE estimates that industry must invest $3,750 million to conduct aerodynamic redesigns on all equipment classes to comply with standards set at TSL 6. An investment of $3,750 million in conversion costs represents approximately 1.3 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents over 75 percent of the entire no-new-standards case INPV over the 30-year analysis period.[130]

In the no-new-standards case, free cash flow is estimated to be $480 million in 2029, the year before the modeled compliance date. At TSL 6, the estimated free cash flow is −$1,132 million in 2029. This represents a decrease in free cash flow of 336 percent, or a decrease of $1,612 million, in 2029. A negative free cash flow implies that most, if not all, manufacturers will need to borrow substantial funds to be able to make investments necessary to comply with energy conservation standards at TSL 6. The extremely large drop in free cash flows could cause some GFB manufacturers to discontinue certain products offerings and shift their resources to other business units not impacted by this rule, even though recovery may be possible over the 30-year analysis period. DOE is concerned about the uncertainty of the market that may exists at TSL 6 if manufacturers choose not to maintain their full product offerings in response to the investments needed to support TSL 6. Additionally, most small businesses will struggle to secure this funding, due to their size and the uncertainty of recovering their investments. At TSL 6, models representing 4 percent of all GFB shipments are estimated to meet the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 96 percent of all GFB shipments will need be remodeled in the 5-year compliance period.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 5 years. Instead, they will likely prioritize redesigns based on sales volume, which could leave market gaps in equipment offered by manufacturers and even the entire industry. The resulting market gaps in equipment offerings could result in sub-optimal selection of fan duty points (airflow, pressure, speed combination) for some applications, potentially leading to a reduction in the estimated energy savings, and estimated consumer benefits, at this TSL. Most small businesses will be at a competitive disadvantage at this TSL because they have less technical and financial resources and the capital investments required will be spread over fewer units.

The Secretary tentatively concludes that at TSL 6 for GFBs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on many consumers, and the impacts on manufacturers, including the extremely large conversion costs (representing approximately 1.3 times the sum of the annual free cash flows during the time period that these conversion costs will be incurred and are approximately equal to 75 percent of the entire no-new-standards case INPV), profitability impacts that could result in a large reduction in INPV (up to a decrease of 46.4 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be −$1,132 million in the year before the compliance date), the lack of manufacturers currently offering equipment meeting the efficiency levels required at this TSL (models representing 96 percent of shipments will need to be redesigned to meet this TSL), including most small businesses, and the likelihood of the significant disruption in the GFB market. Due to the limited amount of engineering resources each manufacturer has, it is unclear if most manufacturers will be able to redesign models representing on average 96 percent of their GFB shipments covered by this rulemaking in the 5-year compliance period. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

DOE then considered TSL 5, which represents a combination of the highest efficiency levels resulting in positive life-cycle costs savings. At TSL 5, DOE expects all equipment classes, except for axial PRVs, would require an aerodynamic redesign. Axial panel, centrifugal housed, centrifugal inline, centrifugal unhoused, centrifugal PRV supply, and radial housed fans would all require the highest tier aerodynamic redesign. Axial inline and centrifugal PRV exhaust fans would require the second to highest tier aerodynamic redesign. Axial PRV fans would require two size increases in diameter.

TSL 5 would save an estimated 23.7 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $19.2 billion using a discount rate of 7 percent, and $54.8 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 411.5 Mt of CO_2, 125.6 thousand tons of SO_2, 775.1 thousand tons of NO_X, 0.9 tons of Hg, 3,567.0 thousand tons of CH_4, and 3.9 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 5 is $20.2 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $14.0 billion using a 7-percent discount rate and $39.9 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is $53.4 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $115.0 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 5, for the largest equipment classes (which are represented by axial panel fans, centrifugal housed fans, and centrifugal unhoused fans) the standards are set at the max-tech EL as with TSL 6. There is a life-cycle cost savings of $1,902, $2,398, and $2,004 and a payback period of 2.5 years, 3.1 years, and 1.0 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 29.9 percent, 41.5 percent, and 13.7 percent due to increases in total installed cost of $618, $1,090 and $215, respectively. The life-cycle costs savings for axial inline, centrifugal inline, and radial housed fans are positive and equal to $670, $335, and $5,391, respectively. For these equipment classes the payback is 9.8, 9.1, and 2.2 years and the fraction of customers experiencing a net LCC cost is 51.3 percent, 66.7 percent, and 24.4 percent. The life-cycle costs savings for axial PRVs, centrifugal PRV exhaust, and centrifugal PRV supply fans are positive and equal to $945, $154, and $1,126, respectively. For these equipment classes the payback is 7.0, 8.9, and 2.8 years and the fraction of customers

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[130] The sum of annual free cash flows is estimated to be $2,348 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $4,935 million.

experiencing a net LCC cost is 14.3 percent, 25.8 percent, and 32.3 percent. At TSL5, the shipments-weighted average LCC is equal to $2,030, the payback period is equal to 2.9 and the fraction of customers experiencing a net LCC cost is 30.2 percent.

At TSL 5, the projected change in INPV ranges from a decrease of $1,263 million to an increase of $11 million, which corresponds to a decrease of 25.6 percent and an increase of 0.2 percent, respectively. DOE estimates that industry must invest $2,075 million to conduct aerodynamic redesigns on all equipment classes except axial PRVs and to increase the diameter by two sizes for axial PRVs to comply with standards set at TSL 5. An investment of $2,075 million in conversion costs represents approximately 90 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents over 42 percent of the entire no-new-standards case INPV over the 30-year analysis period.[131]

In the no-new-standards case, free cash flow is estimated to be $480 million in 2029, the year before the modeled compliance date. At TSL 5, the estimated free cash flow is -$407 million in 2029. This represents a decrease in free cash flow of 185 percent, or a decrease of $887 million, in 2029. A negative free cash flow implies that most, if not all, manufacturers will need to borrow substantial funds to be able to make investments necessary to comply with energy conservation standards at TSL 5. The large drop in free cash flows could cause some GFB manufacturers to exit the GFB market entirely, even though recovery may be possible over the 30-year analysis period. Additionally, most small businesses will struggle to secure this funding due to their size and the uncertainty of recovering their investments. At TSL 5, models representing 7 percent of all GFB shipments are estimated to meet or exceed the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 93 percent of all GFB shipments will need to be remodeled in the 5-year compliance period.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 5 years. Instead, they will likely prioritize redesigns based on sales volume, which could leave market gaps in equipment offered by manufacturers and even the entire industry. The resulting market gaps in equipment offerings could result in sub-optimal selection of fan duty points (airflow, pressure, speed combination) for some applications, potentially leading to a reduction in the estimated energy savings, and estimated consumer benefits, at this TSL. Most small businesses will be at a competitive disadvantage at this TSL because they have less technical and financial resources and the capital investments required will be spread over fewer units.

The Secretary tentatively concludes that at TSL 5 for GFBs, the benefits of energy savings, the economic benefits on many consumers, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, including the extremely large conversion costs (representing approximately 90 percent of the sum of the annual free cash flows during the time period these conversion costs will be incurred and are approximately equal to 42 percent of the entire no-new-standards case INPV), profitability margin impacts that could result in a large reduction in INPV (up to a decrease of 25.6 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be −$407 million in the year before the compliance date), the lack of manufacturers currently offering equipment meeting the efficiency levels required at this TSL (models representing 93 percent of all GFB shipments will need to be redesigned to meet this TSL), including most small businesses, and the likelihood of the significant disruption in the GFB market. Due to the limited amount of engineering resources each manufacturer has, it is unclear if most manufacturers will be able to redesign models representing on average 93 percent of their GFB shipments covered by this rulemaking in the 5-year compliance period. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which represents an intermediate level that is one efficiency level below TSL 5 for each equipment class. At TSL 4, DOE expects all equipment classes, except for axial PRVs, would require an aerodynamic redesign. Axial panel, centrifugal housed, centrifugal inline, centrifugal unhoused, centrifugal PRV supply, and radial housed fans would all require the second highest tier aerodynamic redesign. Axial inline fans would require the lowest tier aerodynamic redesign. Centrifugal PRV exhaust fans would require the second to lowest tier aerodynamic redesign. Axial PRV fans would require one size increase in diameter.

TSL 4 would save an estimated 13.8 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $13.7 billion using a discount rate of 7 percent, and $36.9 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 239.4 Mt of CO_2, 73.1 thousand tons of SO_2, 450.9 thousand tons of NO_X, 0.5 tons of Hg, 2,073.9 thousand tons of CH_4, and 2.3 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 4 is $11.9 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $8.2 billion using a 7-percent discount rate and $23.4 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is $33.8 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $72.2 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 4, for the largest equipment classes which are represented by axial panel fans, centrifugal housed fans, and centrifugal unhoused fans; there is a life-cycle cost savings of $1,702, $2,423, and $1,170; and a payback period of 1.7 years, 0.6 years, and 1.2 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 19.5 percent, 12.9 percent, and 10.5 percent due to increases in total installed cost of $293, $134 and $135, respectively. The life-cycle costs savings for axial inline, centrifugal inline, and radial housed fans are positive and equal to $550, $955, and $3,714, respectively. For these equipment classes the payback is 9.6, 6.1, and 1.7 years and the fraction of customers experiencing a net LCC cost is 23.6 percent, 49.2 percent, and

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[131] The sum of annual free cash flows is estimated to be $2,348 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $4,935 million.

13.3 percent. The life-cycle costs savings for axial PRVs, centrifugal PRV exhaust, and centrifugal PRV supply fans are positive and equal to $945, $154, and $973, respectively. For these equipment classes the payback is 7.0, 8.9, and 1.7 years and the fraction of customers experiencing a net LCC cost is 14.3 percent, 25.8 percent, and 24.9 percent At TSL 4, the shipment-weighted average LCC is equal to $1,694, the payback period is equal to 1.8 and the fraction of customers experiencing a net LCC cost is 15.7 percent.

At TSL 4, the projected change in INPV ranges from a decrease of $455 million to an increase of $1 million, which corresponds to a decrease of 9.2 percent and an increase of less than 0.1 percent, respectively. DOE estimates that industry must invest $770 million to comply with standards set at TSL 4. An investment of $770 million in conversion costs represents approximately 33 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents over 15 percent of the entire no-new-standards case INPV over the 30-year analysis period.[132]

In the no-new-standards case, free cash flow is estimated to be $480 million in 2029, the year before the modeled compliance date. At TSL 4, the estimated free cash flow is $161 million in 2029. This represents a decrease in free cash flow of 66.4 percent, or a decrease of $319 million, in 2029. Annual cash flows remain positive for all years leading up to the modeled compliance date. At TSL 4, models representing 25 percent of all GFB shipments are estimated to meet or exceed the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 75 percent of all GFB shipments will need to be remodeled in the 5-year compliance period. DOE estimates that while this represents a significant redesign effort, most GFB manufacturers will have the engineering capacity to complete these redesigns in a 5-year compliance period.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that a standard set at TSL 4 for GFBs would be economically justified. At this TSL, the average LCC savings for all GFB equipment class consumers is positive. An estimated 15.7 percent of consumers experience a net cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 4, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 30 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 4 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $11.9 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $23.4 billion (using a 3-percent discount rate) or $8.2 billion (using a 7-percent discount rate) in health benefits—the rationale for setting standards at TSL 4 for GFBs is further strengthened. Additionally, the impact to manufacturers is significantly reduced at TSL 4. While manufacturers have to invest $770 million to comply with standards at TSL 4, annual free cash flows remain positive for all years leading up to the compliance date. Lastly, DOE estimates that most GFB manufacturers will have the engineering capacity to complete these redesigns in a 5-year compliance period.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. 86 FR 70892, 70908. While DOE recognizes that TSL 4 is not the TSL that maximizes net monetized benefits, DOE has weighed other non-quantified and non-monetized factors in accordance with EPCA in reaching this determination. DOE notes that as compared to TSL 5 and TSL 6, TSL 4 has significantly smaller percentages of GFBs consumers experiencing a net cost, a lower simple payback period, a lower maximum decrease in INPV, lower manufacturer conversion costs, and significantly less likelihood of a major disruption to the GFB market, as DOE does not anticipate gaps in GFB equipment offerings at TSL 4.

Although DOE considered proposed new standard levels for GFBs by grouping the efficiency levels for each equipment class into TSLs, DOE evaluates all analyzed efficiency levels in its analysis. For all equipment classes, TSL 4 represents the maximum energy savings that does not result in significant negative economic impacts to GFB manufacturers. At TSL 4 conversion costs are estimated to be $770 million, significantly less than at TSL 5 ($2,075 million) and at TSL 6 ($3,750 million). At TSL 4 conversion costs represent a significantly smaller size of the sum of GFB manufacturers' annual free cash flows for 2025 to 2029 (33 percent), than at TSL 5 (90 percent) and at TSL 6 (130 percent) and a significantly smaller portion of GFB manufacturers' no-new-standards case INPV (15 percent), than at TSL 5 (42 percent) and at TSL 6 (75 percent). At TSL 4, GFB manufacturers will have to redesign a significantly smaller portion of their GFB models to meet the ELs set at TSL 4 (models representing 75 percent of all GFB shipments), than at TSL 5 (93 percent) and at TSL 6 (96 percent). Lastly, GFB manufacturers' free cash flow remains positive at TSL 4 for all years leading up to the compliance date. Whereas at TSL 5 annual free cash flow is estimated to be −$407 million and at TSL 6 annual free cash flow is estimated to be −$1,132 million in 2029, the year before the modeled compliance year. The ELs at the proposed TSL result in average positive LCC savings for all equipment classes, significantly reduce the number of consumers experiencing a net cost, and reduce the decrease in INPV and conversion costs to the point where DOE has concluded they are economically justified, as discussed for TSL 4 in the preceding paragraphs.

Therefore, based on the previous considerations, DOE proposes to adopt the energy conservation standards for GFBs at TSL 4. The proposed energy conservation standards for GFBs, which are expressed as FEI values, are shown in Table V–66.

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[132] The sum of annual free cash flows is estimated to be $2,348 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $4,935 million.

Table V-66 Proposed Energy Conservation Standards for GFBs

Equipment Class	With or Without Motor Controller	Fan Energy Index (FEI)*
Axial Inline	Without	1.18 * A
Axial Panel	Without	1.48 * A
Axial Power Roof Ventilator	Without	0.85 * A
Centrifugal Housed	Without	1.31 * A
Centrifugal Unhoused	Without	1.35 * A
Centrifugal Inline	Without	1.28 * A
Radial Housed	Without	1.17 * A
Centrifugal Power Roof Ventilator – Exhaust	Without	1.00 * A
Centrifugal Power Roof Ventilator – Supply	Without	1.19 * A
Axial Inline	With	1.18 * A* B
Axial Panel	With	1.48 * A* B
Axial Power Roof Ventilator	With	0.85 * A* B
Centrifugal Housed	With	1.31 * A* B
Centrifugal Unhoused	With	1.35 * A* B
Centrifugal Inline	With	1.28 * A* B
Radial Housed	With	1.17 * A* B
Centrifugal Power Roof Ventilator – Exhaust	With	1.00 * A* B
Centrifugal Power Roof Ventilator – Supply	With	1.19 * A* B

*A is a constant representing an adjustment in FEI for motor hp, which can be found in Table V-67. B is a constant representing an adjustment in FEI for motor controllers, which can be found in Table V-67.

Table V-67 Constants for GFB Proposed Energy Conservation Standards

Constant	Condition		Value
A	Motor hp < 100 hp		$A = 1.00$
	Motor hp ≥ 100 hp and ≤ 250 hp		$A = \frac{\eta_{mtr,2023}}{\eta_{mtr,2014}}$
B	With Motor Controller	FEPact of < 20 kW (26.8 hp)	$B = \frac{FEP_{act}-Credit}{FEP_{act}}$; where: $Credit = 0.03 \times FEP_{act} + 0.08$ **[SI]** $Credit = 0.03 \times FEP_{act} + 0.08 \times 1.341$ **[IP]**
		FEPact of ≥ 20 kW (26.8 hp)	$B = 0.966$

$\eta_{mtr,2023}$ is the motor efficiency in accordance with Table 8 at 10 CFR 431.25, $\eta_{mtr,2014}$ is the motor efficiency in accordance with Table 5 at 10 CFR 431.25, which DOE is proposing to adopt into 10 CFR 431.175, and FEP_{act} is determined according to the DOE test procedure in Appendix A to Subpart J of Part 431.

DOE is proposing an FEI level of 0.85 (EL4) for axial PRVs. In section IV.C.1.b, DOE developed the MSP-efficiency relationship based on data from the AMCA sales database as well as performance data from manufacturer fan selection software and performance data provided from confidential manufacturer interviews. From its analysis, DOE estimated that EL4 for axial PRVs would be achieved by implementing two impeller diameter increases. Based on the MSP-efficiency results, EL4 for axial PRVs is the highest level with positive life-cycle costs savings. Furthermore, as discussed in section IV.C.1.b, ASHRAE 90.1–2022 set an FEI target of 1.00 for all fans within the scope of that standard, which includes axial PRVs. CEC requires manufacturers to report fan operating boundaries that result in operation at a FEI of greater than or equal to 1.00 for all fans within the scope of that rulemaking, which includes axial PRVs. DOE also notes that, based on its shipments analysis, 50-percent of axial PRVs have an FEI of at least 1.00. Additionally, based on its review of the market, DOE has found that most manufacturers offer models of APRVs that have an FEI of at least 1.00 at a range of diameters. Based on this, DOE expects that the market is already shifting towards an FEI of 1.00 for axial PRVs and that this level may not be unduly burdensome for manufacturers to achieve.

DOE requests comment on the proposed standard level for axial PRVs, including the design options and costs, as well as the burdens and benefits associated with this level and the industry standards/California regulations FEI level of 1.00.

b. Air Circulating Fans

Table V–68 and Table V–69 summarize the quantitative impacts estimated for each TSL for ACFs. The national impacts are measured over the lifetime of ACFs purchased in the 30-year period that begins in the anticipated first full year of compliance with new standards (2030–2059). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V-68 Summary of Analytical Results for ACFs TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Cumulative FFC National Energy Savings						
Quads	0.1	0.2	1.2	4.5	6.5	7.2
Cumulative FFC Emissions Reduction						
CO_2 (*million metric tons*)	1.7	3.8	21.5	78.5	112.6	125.8
CH_4 (*thousand tons*)	15.3	33.4	188.0	686.7	984.6	1100.4
N_2O (*thousand tons*)	0.0	0.0	0.2	0.6	0.9	1.0
NO_X (*thousand tons*)	3.3	7.2	40.5	148.0	212.2	237.2
SO_2 (*thousand tons*)	0.4	1.0	5.4	19.7	28.2	31.5
Hg (*tons*)	0.0	0.0	0.0	0.1	0.2	0.2
Present Value of Monetized Benefits and Costs (*3% discount rate, billion 2022$*)						
Consumer Operating Cost Savings	0.3	0.6	3.6	13.2	18.9	20.6
Climate Benefits*	0.1	0.2	1.2	4.4	6.3	7.1
Health Benefits**	0.2	0.4	2.2	8.2	11.7	13.1
Total Benefits†	0.6	1.2	7.0	25.8	36.9	40.8
Consumer Incremental Product Costs‡	-0.1	-0.1	0.0	0.6	5.8	6.1
Consumer Net Benefits	0.4	0.7	3.6	12.6	13.1	14.5
Total Net Benefits	0.7	1.3	7.1	25.2	31.1	34.7
Present Value of Monetized Benefits and Costs (*7% discount rate, billion 2022$*)						
Consumer Operating Cost Savings	0.1	0.3	1.5	5.5	7.9	8.7
Climate Benefits*	0.1	0.2	1.2	4.4	6.3	7.1
Health Benefits**	0.1	0.2	0.9	3.1	4.5	5.0
Total Benefits†	0.3	0.6	3.6	13.1	18.7	20.7
Consumer Incremental Equipment Costs	-0.1	0.0	0.0	0.3	2.7	3.0
Consumer Net Benefits	0.2	0.3	1.5	5.3	5.2	5.7
Total Net Benefits	0.4	0.7	3.6	12.8	16.0	17.7

Note: This table presents the costs and benefits associated with ACFs shipped in 2030−2059. These results include benefits to consumers which accrue after 2059 from the products shipped in 2030−2059.

* Climate benefits are calculated using four different estimates of the SC-CO_2, SC-CH_4 and SC-N_2O. Together, these represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for NO_X and SO_2) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.L of this document for more details.

† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 3-percent discount rate. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates.

Table V-69 Summary of Analytical Results for ACFs TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL5	TSL6
Manufacturer Impacts						
Industry NPV (*million 2022*$) (No-new-standards case INPV = 649)	649 – 650	649 – 649	645 – 649	579 – 649	16 – 652	(85) – 653
Industry NPV *(% change)*	0.0 – 0.1	0.0 – 0.0	(0.6) – 0.0	(10.9) – 0.0	(97.5) – 0.5	(113.1) – 0.5
Consumer Average LCC Savings (2022$)						
Axial ACFs; 12” ≤ D < 36” (ACF1)	-	35	495	327	141	126
Axial ACFs; 36” ≤ D < 48” (ACF2)	297	291	606	478	341	346
Axial ACFs; 48” ≤ D (ACF3)	343	587	628	668	613	630
Housed Centrifugal ACFs (ACF4)	-	-	-	-	18	-1,210
Shipment-Weighted Average*	192	289	564	479	353	342
Consumer Simple PBP (years)						
Axial ACFs; 12” ≤ D < 36” (ACF1)	-	2.7	0.2	0.5	2.8	3.1
Axial ACFs; 36” ≤ D < 48” (ACF2)	N/A	N/A	N/A	0.2	1.6	1.9
Axial ACFs; 48” ≤ D (ACF3)	N/A	N/A	N/A	0.1	1.1	1.4
Housed Centrifugal ACFs (ACF4)	-	-	-	-	4.8	25.0
Shipment-Weighted Average*	N/A	1.1	0.1	0.3	1.9	2.4
Percent of Consumers that Experience a Net Cost						
Axial ACFs; 12” ≤ D < 36” (ACF1)	-	0.1%	0.0%	0.2%	40.4%	45.1%
Axial ACFs; 36” ≤ D < 48” (ACF2)	0.0%	0.2%	0.0%	0.0%	22.7%	23.6%
Axial ACFs; 48” ≤ D (ACF3)	0.0%	0.0%	0.0%	0.0%	9.3%	11.3%
Housed Centrifugal ACFs (ACF4)	-	-	-	-	14.1%	99.7%
Shipment-Weighted Average*	0.0%	0.1%	0.0%	0.1%	24.8%	28.6%

Parentheses indicate negative (-) values. The entry “-” means no impact because the TSL considered is equivalent to the no-new standards case. The entry “N/A.” means not applicable because there is a decrease in average installed costs at the considered TSLs compared to the no-new standards case.

* Weighted by shares of each equipment class in total projected shipments in 2030.

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DOE first considered TSL 6, which represents the max-tech efficiency levels. At TSL 6, DOE expects all equipment classes would require an

ECM. TSL 6 would save an estimated 7.2 quads of energy, an amount DOE considers significant. Under TSL 6, the NPV of consumer benefit would be $5.7 billion using a discount rate of 7 percent, and $14.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 6 are 125.8 Mt of CO_2, 31.5 thousand tons of SO_2, 237.2 thousand tons of NO_X, 0.2 tons of Hg, 1,100.4 thousand tons of CH_4, and 1.0 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 6 is $7.1 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 6 is $5.0 billion using a 7-percent discount rate and $13.1 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 6 is $17.7 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 6 is $34.7 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 6, for the largest equipment classes, which are represented by ACF1, ACF2, and ACF3—which together represent approximately 99 percent of annual shipments—there is a life-cycle cost savings of $126, $346, and $630 and a payback period of 3.1 years, 1.9 years, and 1.4 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 45.1 percent, 23.6 percent, and 11.3 percent due to increases in total installed cost of $187, $201 and $222, respectively. For the remaining equipment class (ACF4), the average LCC savings are −$1,210, a majority of consumers (99.7 percent) would experience a net cost and the payback period is 25.0 years.

At TSL 6, the projected change in INPV ranges from a decrease of $734 million to an increase of $3 million, which corresponds to decreases of 113.1 percent and an increase of 0.5 percent, respectively. DOE estimates that industry must invest $1,167 million to conduct aerodynamic redesigns on all equipment classes and to implement ECMs for all equipment classes to comply with standards set at TSL 6. An investment of $1,167 million in conversion costs represents over 5 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents approximately 1.8 times the entire no-new-standards case INPV over the 30-year analysis period.[133]

In the no-new-standards case, free cash flow is estimated to be $51 million in 2029, the year before the modeled compliance date. At TSL 6, the estimated free cash flow is −$456 million in 2029. This represents a decrease in free cash flow of 999 percent, or a decrease of $507 million, in 2029. A negative free cash flow implies that most, if not all, manufacturers will need to borrow substantial funds to be able to make investments necessary to comply with energy conservation standards at TSL 6. The extremely large drop in free cash flows could cause some ACF manufacturers to exit the ACF market entirely, even though recovery may be possible over the 30-year analysis period. Additionally, most small businesses will struggle to secure this funding, due to their size and the uncertainty of recovering their investments. At TSL 6, models representing 1 percent of all ACF shipments are estimated to meet the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 99 percent of all ACF shipments will need to be remodeled in the 5-year compliance period.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 5 years. Instead, they will likely prioritize redesigns based on sales volume, which could leave market gaps in equipment offered by manufacturers and even the entire industry. The resulting market gaps in equipment offerings could result in sub-optimal selection of fan duty points (airflow, pressure, speed combination) for some applications, potentially leading to a reduction in the estimated energy savings, and estimated consumer benefits, at this TSL. Most small businesses will be at a competitive disadvantage at this TSL because they have less technical and financial resources and the capital investments required will be spread over fewer units.

The Secretary tentatively concludes that at TSL 6 for ACFs, the benefits of energy savings, the economic benefits on many consumers, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, including the extremely large conversion costs (representing approximately 5 times the sum of the annual free cash flows during the time period that these conversion costs will be incurred and are approximately equal to 1.8 times the entire no-new-standards case INPV), profitability impacts that could result in a large reduction in INPV (up to a decrease of 113.1 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be −$456 million in the year before the compliance date), the lack of manufacturers currently offering equipment meeting the efficiency levels required at TSL 6 (models representing 99 percent of all ACF shipments will need to be redesigned to meet this TSL), including most small businesses, and the likelihood of the significant disruption in the ACF market. Due to the limited amount of engineering resources each manufacturer has, it is unclear if most manufacturers will be able to redesign models representing on average 99 percent of their ACF shipments covered by this rulemaking in the 5-year compliance period. Consequently, the Secretary has tentatively concluded that TSL 6 is not economically justified.

DOE then considered TSL 5, which represents the highest EL below max-tech with positive LCC savings and is a combination of efficiency level 5 for axial ACFs and efficiency level 3 for housed centrifugal ACFs. At TSL 5, DOE expects that axial ACFs would require the highest tier of aerodynamic redesign and housed centrifugal ACFs would require the lowest tier of aerodynamic redesign. TSL 5 would save an estimated 6.5 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $5.2 billion using a discount rate of 7 percent, and $13.1 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 112.6 Mt of CO_2, 28.2 thousand tons of SO_2, 212.2 thousand tons of NO_X, 0.2 tons of Hg, 984.6 thousand tons of CH_4, and 0.9 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated

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[133] The sum of annual free cash flows is estimated to be $227 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $649 million.

with the average SC–GHG at a 3-percent discount rate) at TSL 5 is $6.3 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $4.5 billion using a 7-percent discount rate and $11.7 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is $16.0 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 5 is $31.1 billion. The estimated total NPV is provided for additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 5, for the largest equipment classes, which are represented by ACF1, ACF2, and ACF3—which together represent approximately 99 percent of annual shipments—there is a life-cycle cost savings of $141, $341, and $613 and a payback period of 2.8 years, 1.6 years, and 1.1 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 40.4 percent, 22.7 percent, and 9.3 percent due to increases in total installed cost of $148, $156 and $155, respectively. For the remaining equipment class (ACF4), the average LCC savings are $18 and 14.1 percent of consumers would experience a net cost and the payback period is 4.8 years.

At TSL 5, the projected change in INPV ranges from a decrease of $633 million to an increase of $3 million, which corresponds to a decrease of 97.5 percent and an increase of 0.5 percent, respectively. DOE estimates that industry must invest $1,043 million to conduct significant aerodynamic redesigns for non-compliant axial ACFs and minor aerodynamic redesign for non-compliant housed centrifugal ACFs to comply with standards set at TSL 5. An investment of $1,043 million in conversion costs represents over 4.5 times the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents approximately 1.6 times the entire no-new-standards case INPV over the 30-year analysis period.[134]

In the no-new-standards case, free cash flow is estimated to be $51 million in 2029, the year before the modeled compliance date. At TSL 5, the estimated free cash flow is −$400 million in 2029. This represents a decrease in free cash flow of 889 percent, or a decrease of $451 million, in 2029. A negative free cash flow implies that most, if not all, manufacturers will need to borrow substantial funds to be able to make investments necessary to comply with energy conservation standards at TSL 5. The large drop in free cash flows could cause some ACF manufacturers to exit the ACF market entirely, even though recovery may be possible over the 30-year analysis period. Additionally, most small businesses will struggle to secure this funding, due to their size and the uncertainty of recovering their investments. At TSL 5, models representing 4 percent of all ACF shipments are estimated to meet or exceed the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 96 percent of all ACF shipments will need to be remodeled in the 5-year compliance period.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 5 years. Instead, they will likely prioritize redesigns based on sales volume, which could leave market gaps in equipment offered by manufacturers and even the entire industry. The resulting market gaps in equipment offerings could result in sub-optimal selection of fan duty points (airflow, pressure, speed combination) for some applications, potentially leading to a reduction in the estimated energy savings, and estimated consumer benefits, at this TSL. Most small businesses will be at a competitive disadvantage at this TSL because they have less technical and financial resources and the capital investments required will be spread over fewer units.

The Secretary tentatively concludes that at TSL 5 for ACFs, the benefits of energy savings, the economic benefits on many consumers, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, including the extremely large conversion costs (representing approximately 4.5 times the sum of the annual free cash flows during the time period that these conversion costs will be incurred and are approximately equal to 1.6 times the entire no-new-standards case INPV), profitability impacts that could result in a large reduction in INPV (up to a decrease of 97.5 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be −$400 million in the year before the compliance date), the lack of manufacturers currently offering equipment meeting the efficiency levels required at TSL 5 (models representing 96 percent of all ACF shipments will need to be redesigned to meet this TSL), including most small businesses, and the likelihood of the significant disruption in the ACF market. Due to the limited amount of engineering resources each manufacturer has, it is unclear if most manufacturers will be able to redesign models representing on average 96 percent of their ACF shipments covered by this rulemaking in the 5-year compliance period. Consequently, the Secretary has tentatively concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which represents efficiency level 4 for axial ACFs and efficiency level 0 for housed centrifugal ACFs (no new standards for housed centrifugal ACFs). DOE expects that the second highest tier of aerodynamic redesign would be required for axial ACFs at TSL 4 would save an estimated 4.5 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $5.3 billion using a discount rate of 7 percent, and $12.6 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 78.5 Mt of CO_2, 19.7 thousand tons of SO_2, 148.0 thousand tons of NO_X, 0.1 tons of Hg, 686.7 thousand tons of CH_4, and 0.6 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 4 is $4.4 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $3.1 billion using a 7-percent discount rate and $8.2 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is $12.8 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is $25.2 billion. The estimated total NPV is provided for

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[134] The sum of annual free cash flows is estimated to be $227 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $649 million.

additional information, however DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 4, for the largest equipment classes, which are represented by ACF1, ACF2, and ACF3—which together represent approximately 99 percent of annual shipments—there is a life-cycle cost savings of $327, $478, and $668 and a payback period of 0.5 years, 0.2 years, and 0.1 years, respectively. For these equipment classes, the fraction of customers experiencing a net LCC cost is 0.2 percent, 0 percent, and 0 percent due to increases in total installed cost of $16, $14, and $15, respectively. For the remaining equipment class (ACF4), the considered TSL would not set any energy conservation standards.

At TSL 4, the projected change in INPV ranges from a decrease of $71 million to an increase of less than $0.1 million, which correspond to a decrease of 10.9 percent and an increase of less than 0.1 percent, respectively. DOE estimates that industry must invest $118.1 million to implement the second highest tier of aerodynamic redesign for axial ACFs to comply with standards set at TSL 4. An investment of $118.1 million in conversion costs represents approximately 50 percent of the sum of the annual free cash flows over the years between the estimated final rule announcement date and the estimated standards year (*i.e.,* the time period that these conversion costs would be incurred) and represents over 18 percent of the entire no-new-standards case INPV over the 30-year analysis period.[135]

In the no-new-standards case, free cash flow is estimated to be $51 million in 2029, the year before the modeled compliance date. At TSL 4, the estimated free cash flow is $1 million in 2029. This represents a decrease in free cash flow of 99.0 percent, or a decrease of $50.2 million, in 2029. Annual cash flows remain positive for all years leading up to the modeled compliance date. At TSL 4, models representing 36 percent of all ACF shipments are estimated to meet or exceed the efficiency requirements at this TSL in the no-new-standards case by 2030, the modeled compliance year. Therefore, models representing 64 percent of all ACF shipments will need to be remodeled in the 5-year compliance period. DOE estimates that while this represents a significant redesign effort, most ACF manufacturers will have the engineering capacity to complete these redesigns in a 5-year compliance period.

After considering the analysis and weighing the benefits and burdens, the Secretary has tentatively concluded that at a standard set at TSL 4 for ACFs would be economically justified. While DOE recognizes that TSL 4 is not the TSL that maximizes net monetized benefits, DOE has weighed other non-quantified and non-monetized factors in accordance with EPCA in reaching this determination. At this TSL, the average LCC savings for all ACF consumers are positive. An estimated 0.1 percent of consumers experience a net cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 4, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 74 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 4 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $4.4 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $8.2 billion (using a 3-percent discount rate) or $3.1 billion (using a 7-percent discount rate) in health benefits—the rationale for setting standards at TSL 4 for ACFs is further strengthened. Additionally, the impact to manufacturers is significantly reduced at TSL 4. While manufacturers have to invest $118.1 million to comply with standards at TSL 4, annual free cash flows remain positive for all years leading up to the compliance date. Lastly, DOE estimates that most ACF manufacturers will have the engineering capacity to complete these redesigns in a 5-year compliance period.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. 86 FR 70892, 70908. Although DOE has not conducted a comparative analysis to select the proposed energy conservation standards, DOE notes that as compared to TSL 5 and TSL 6, TSL 4 has higher average LCC savings, significantly smaller percentages of GFBs consumers experiencing a net cost, a lower simple payback period, a lower maximum decrease in INPV, lower manufacturer conversion costs, and significantly less likelihood of a major disruption to the ACF market, as DOE does not anticipate gaps in ACF equipment offerings at TSL 4.

Although DOE considered proposed new standard levels for ACFs by grouping the efficiency levels for each equipment class into TSLs, DOE evaluates all analyzed efficiency levels in its analysis. For all equipment classes, TSL 4 represents the maximum energy savings that does not result in significant negative economic impacts to ACF manufacturers. At TSL 4 conversion costs are estimated to be $118.1 million, significantly less than at TSL 5 ($1,043 million) and at TSL 6 ($1,167 million). At TSL 4 conversion costs represent a significantly smaller size of the sum of ACF manufacturers' annual free cash flows for 2025 to 2029 (50 percent), than at TSL 5 (450 percent) and at TSL 6 (500 percent) and a significantly smaller portion of ACF manufacturers' no-new-standards case INPV (18 percent), than at TSL 5 (161 percent) and at TSL 6 (180 percent). At TSL 4, ACF manufacturers will have to redesign a significantly smaller portion of their ACF models to meet the ELs set at TSL 4 (models representing 64 percent of all ACF shipments), than at TSL 5 (96 percent) and at TSL 6 (99 percent). Lastly, ACF manufacturers' free cash flow remains positive at TSL 4 for all years leading up to the compliance date. Whereas at TSL 5 annual free cash flow is estimated to be −$400 million and at TSL 6 annual free cash flow is estimated to be −$456 million in 2029, the year before the modeled compliance year. The ELs at the proposed TSL result in average positive LCC savings for all equipment classes, significantly reduce the number of consumers experiencing a net cost, and reduce the decrease in INPV and conversion costs to the point where DOE has concluded they are economically justified, as discussed for TSL 4 in the preceding paragraphs.

Therefore, based on the previous considerations, DOE proposes to adopt the energy conservation standards for ACFs at TSL 4. The proposed new energy conservation standards for ACFs,

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[135] The sum of annual free cash flows is estimated to be $227 million for 2025–2029 in the no-new-standards case and the no-new-standards case INPV is estimated to be $649 million.

which are expressed as efficacy in CFM/W, are shown in Table V–70.

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Table V-70 Proposed New Energy Conservation Standards for ACFs

Equipment Class*	Efficacy (CFM/W)
Axial ACFs; 12” ≤ D < 36”	12.2
Axial ACFs; 36” ≤ D < 48”	17.3
Axial ACFs; 48” ≤ D	21.5
Housed Centrifugal ACFs	N/A

*D: diameter in inches

N/A means not applicable as DOE is not proposing to set a standard for this equipment class.

Table V–71 summarizes the quantitative impacts estimated at the proposed TSLs for GFBs and ACFs. The quantitative impacts estimated for each TSL for GFBs and ACFs are discussed in sections V.C.1.a and V.C.1.b and of this document.

Table V-71 Summary of Cumulative Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs and ACFs (TSL 4)

	Million 2022$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	55.8	52.0	59.5
Climate Benefits*	16.3	15.7	16.9
Health Benefits**	31.6	30.4	32.9
Total Benefits†	103.7	98.0	109.4
Consumer Incremental Equipment Costs‡	6.3	8.1	4.7
Net Benefits	97.4	89.9	104.7
Change in Producer Cashflow (INPV‡‡)	(0.5) - 0	(0.5) - 0	(0.5) - 0
7% discount rate			
Consumer Operating Cost Savings	22.2	20.8	23.5
Climate Benefits* (3% discount rate)	16.3	15.7	16.9
Health Benefits**	11.4	11.0	11.8
Total Benefits†	49.8	47.4	52.2
Consumer Incremental Equipment Costs‡	3.2	3.9	2.5
Net Benefits	46.6	43.5	49.8
Change in Producer Cashflow (INPV‡‡)	(0.5) - 0	(0.5) - 0	(0.5) - 0

Note: This table presents the costs and benefits associated with GFBs and ACFs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a declining rate in the High Net Benefits Estimate for GFBs, and a low declining rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a high declining rate in the High Net Benefits Estimate for ACFs. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

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

† Total benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate, but DOE does not have a single central SC-GHG point estimate.

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

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB & ACF, those values are -$526 million and $1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in Section IV.J, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this proposed rule, the net benefits would range from $96.9 billion to $97.4 billion at 3-percent discount rate and would range from $46.1 billion to $46.6 billion at 7-percent discount rate. Parentheses indicate negative values.

2. Annualized Benefits and Costs of the Proposed Standards

This section presents the combined results for GFBs and ACFs. Specific results for GFBs and ACFs are also discussed in section V.C.2.a and V.C.2.b, respectively.

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2022 dollars) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Table V–72 shows the annualized values for GFBs and ACFs under TSL 4, expressed in 2022 dollars. The results under the primary estimate are as follows.

Using a 7 percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3 percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards proposed in this rule is $360 million per year in increased equipment costs, while the estimated annual benefits are $2,506 million in reduced equipment operating costs, $963 million in monetized climate benefits, and $1,285 million in monetized health benefits. In this case, the monetized net benefit would amount to $4,394 million per year.

Using a 3 percent discount rate for all benefits and costs, the estimated cost of the proposed standards is $374 million per year in increased equipment costs, while the estimated annual benefits are $3,302 million in reduced operating costs, $963 million in monetized climate benefits, and $1,869 million in monetized health benefits. In this case, the monetized net benefit would amount to $5,760 million per year.

Table V-72 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs and ACFs (TSL 4)

	Million 2022$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	3,302	3,074	3,521
Climate Benefits*	963	926	1,002
Health Benefits**	1,869	1,796	1,945
Total Benefits†	6,134	5,796	6,469
Consumer Incremental Equipment Costs‡	374	478	276
Net Benefits	5,760	5,317	6,192
Change in Producer Cashflow (INPV‡‡)	(62) - 0	(62) - 0	(62) - 0
7% discount rate			
Consumer Operating Cost Savings	2,506	2,346	2,658
Climate Benefits* (3% discount rate)	963	926	1,002
Health Benefits**	1,285	1,240	1,330
Total Benefits†	4,754	4,513	4,991
Consumer Incremental Equipment Costs‡	360	441	280
Net Benefits	4,394	4,072	4,710
Change in Producer Cashflow (INPV‡‡)	(62) - 0	(62) - 0	(62) - 0

Note: This table presents the costs and benefits associated with GFBs and ACFs shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a constant rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a declining rate in the High Net Benefits Estimate for GFBs, and a low declining rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a high declining rate in the High Net Benefits Estimate for ACFs. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990*, published in February 2021 by the IWG.

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

† Total benefits for both the 3 percent and 7 percent cases are presented using the average SC-GHG with a 3 percent discount rate, but DOE does not have a single central SC-GHG point estimate.

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

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB & ACF, those values are -$62 million and less than $0.1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $5,698 million to $5,760 million at 3-percent discount rate and would range from $4,332 million to $4,394 million at 7-percent discount rate. Parentheses indicate negative values.

a. General Fans and Blowers

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2022 dollars) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Table V–73 shows the annualized values for GFBs under TSL 4, expressed in 2022 dollars. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for GFBs is $329 million per year in increased equipment costs, while the estimated annual benefits are $1,880 million from reduced equipment operating costs, $703 million in climate benefits, and $932 million in health benefits. In this case, the net benefit amounts to $3,185 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards for GFBs is $340 million per year in increased equipment costs, while the estimated annual benefits are $2,524 million in reduced operating costs, $703 million in monetized climate benefits, and $1,384 million from in monetized health benefits. In this case, the net benefit amounts to $4,271 million per year.

Table V-73 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for GFBs (TSL 4)

	Million 2022$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
	3% discount rate		
Consumer Operating Cost Savings	2,524	2,321	2,724
Climate Benefits*	703	666	742
Health Benefits**	1,384	1,311	1,461
Total Monetized Benefits†	4,611	4,297	4,927
Consumer Incremental Equipment Costs‡	340	442	243
Net Monetized Benefits	4,271	3,855	4,684
Change in Producer Cashflow (–NPV‡‡)	(53) - 0	(53) - 0	(53) - 0
	7% discount rate		
Consumer Operating Cost Savings	1,880	1,739	2,017
Climate Benefits* (3% discount rate)	703	666	742
Health Benefits**	932	888	978
Total Monetized Benefits†	3,515	3,293	3,736
Consumer Incremental Equipment Costs‡	329	409	251
Net Monetized Benefits	3,185	2,884	3,486
Change in Producer Cashflow (–NPV‡‡)	(53) - 0	(53) - 0	(53) - 0

Note: This table presents the costs and benefits associated with products shipped in 2030–2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030–2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a constant price in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a declining rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (see section IV.M of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).

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

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 3-percent discount rate, but DOE does not have a single central SC-GHG point estimate.

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

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For GFB, those values are -$53 million and less than $0.1 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturer increase markups to account for changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $4,218 million to $4,271 million at 3-percent discount rate and would range from $3,132 million to $3,185 million at 7-percent discount rate. Parentheses indicate negative values.

b. Air Circulating Fans

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2022 dollars) of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits from emission reductions.

Table V–74 shows the annualized values for ACFs under TSL 4, expressed in 2022 dollars. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the proposed standards for ACFs is $31 million per year in increased equipment costs, while the estimated annual benefits are $626 million from reduced equipment operating costs, $261 million from GHG reductions, and $353 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $1,209 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the proposed standards for ACFs is $34 million per year in increased equipment costs, while the estimated annual benefits are $778 million in reduced operating costs, $261 million in monetized climate benefits, and $485 million in monetized health benefits. In this case, the net benefit amounts to $1,489 million per year.

Table V-74 Annualized Monetized Benefits and Costs of Proposed Energy Conservation Standards for ACFs (TSL 4)

	Million 2022$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	778	753	796
Climate Benefits*	261	261	261
Health Benefits**	485	485	485
Total Monetized Benefits†	1,523	1,498	1,542
Consumer Incremental Equipment Costs‡	34	36	33
Net Monetized Benefits	1,489	1,462	1,509
Change in Producer Cashflow (INPV‡‡)	(8) – 0	(8) – 0	(8) - 0
7% discount rate			
Consumer Operating Cost Savings	626	607	641
Climate Benefits* (3% discount rate)	261	261	261
Health Benefits**	353	353	353
Total Monetized Benefits†	1,239	1,221	1,254
Consumer Incremental Equipment Costs‡	31	32	30
Net Monetized Benefits	1,209	1,188	1,225
Change in Producer Cashflow (INPV‡‡)	(8) – 0	(8) – 0	(8) - 0

Note: This table presents the costs and benefits associated with products shipped in 2030−2059. These results include consumer, climate, and health benefits that accrue after 2059 from the products shipped in 2030−2059. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the AEO2023 Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a low declining rate in the Primary Estimate, an increasing rate in the Low Net Benefits Estimate, and a high declining rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.3 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC-GHG (*see* section IV.M of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC-GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published in February 2021 by the IWG.

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

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 3-percent discount rate, but DOE does not have a single central SC-GHG point estimate.

‡ Costs include incremental equipment costs.

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's NIA includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (the MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted average cost of capital value of 11.4 percent that is estimated in the MIA (see chapter 12 of the NOPR TSD for a complete description of the industry weighted average cost of capital). For ACF, those values are -$8 million and no annualized change in INPV. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C. DOE is presenting the range of impacts to the INPV under two markup scenarios: the Conversion Cost Recovery scenario, which is the manufacturer markup scenario where manufacturers increase their markups in response to changes in energy conservation standards, and the Preservation of Operating Profit Markup scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document, to provide additional context for assessing the estimated impacts of this rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this proposed rule, the annualized net benefits would range from $1,481 million to $1,489 million at 3-percent discount rate and would range from $1,201 million to $1,209 million at 7-percent discount rate. Parentheses indicate negative values.

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D. Reporting, Certification, and Sampling Plan

Manufacturers, including importers, must use equipment-specific certification templates to certify compliance to DOE. For fans and blowers, the certification template reflects the general certification requirements specified at 10 CFR 429.12 and the product-specific requirements specified at 10 CFR 429.69. DOE is not proposing to amend the product-specific certification requirements for this equipment. DOE may consider certification reporting requirements for GFBs in a separate rulemaking.

E. Representations and Enforcement Provisions

1. Representations for General Fans and Blowers

In the May 2023 TP Final Rule, DOE summarized stakeholder comments related to FEI representations at compliant and non-compliant duty points. DOE stated that it was not establishing energy conservation standards for fans and blowers and therefore, the May 2023 TP final rule would not result in any compliant or non-compliant operating points. DOE further stated that it would consider representations and any issues related to compliance with any potential energy conservation standard in a separate energy conservation standards rulemaking. 88 FR 27312, 27369.

In response to the October 2022 NODA, the CA IOUs recommended that DOE consider allowing representations at all duty points for fans designed for low-pressure, space-constrained applications. (CA IOUs, No. 127 at pp. 6–7) The CA IOUs stated that for a low-pressure application fan to meet an energy conservation standard, a consumer would have to either increase the diameter of the fan, which would result in a costly redesign of the system, or the consumer would have to replace the non-compliant fan with a compliant fan of the same diameter running at a higher pressure, which could result in greater power consumption of the system. *Id.* Furthermore, the CA IOUs encouraged DOE to discuss the issue of whether to allow the publication of non-compliant, low-pressure duty points with manufacturers. *Id.*

Damas and Boldt commented that they disagree with DOE's proposal to restrict the publication of fan and blower performance data at duty points that do not comply with a proposed energy conservation standard and recommended that DOE instead require that any non-compliant duty points be highlighted. (Damas and Boldt, No. 131 at pp. 1, 5) They provided several example scenarios where a fan may be selected for use that is outside its compliant range: space-constrained low-flow high-pressure applications, space-constrained low-pressure applications, retrofitted systems, VAV systems that require operation over a wide range of duty points, systems with pressure consuming elements that may vary in their pressure consumption such that a fan must be selected for a worst case scenario instead of an average use scenario, and situations where the system that a fan is operating in changes. (Damas and Boldt, No. 131 at pp. 2–4) Furthermore, Damas and Boldt commented that they are concerned that designers may artificially increase the pressure consumption of a system by closing dampers to allow the fan to operate at a compliant duty point, which could ultimately increase energy consumption. (Damas and Boldt, No. 131 at pp. 3–4) Additionally, Damas and Boldt stated that there may be safety issues when a fan operates near its highest efficiency duty point, which is often near the unstable region of a fan. (Damas and Boldt, No. 131 at p. 4) Damas and Boldt commented that system engineers need full fan performance data to ensure that a system design does not push the fan into its unstable operating region. *Id.*

As discussed in detail in section IV.C.1, DOE evaluated improved efficiency options while maintaining constant diameter and duty point (*i.e.,* air flow and operating pressures remained constant as efficiency increased); therefore, DOE has tentatively concluded that a compliant fan of the same equipment class, diameter, and duty point would be available.

As discussed in section III.C.1 of this document, the FEI metric is evaluated at each duty point as specified by the manufacturer as required by the DOE test procedure. If adopted, the proposed energy conservation standards would have to be met at each duty point at which the fan is sold.

Consistent with stakeholder feedback from the CA IOUs and Damas and Boldt, DOE recognizes that not allowing representations of a fan's entire performance map could result in increased energy consumption or potential unintended consequences. Therefore, DOE proposes that a manufacturer could make representations at non-compliant duty points provided representations include a disclaimer; however, the manufacturer would be responsible for ensuring that the fan is not sold and selected at the non-compliant duty points. To ensure this, a manufacturer could, for example: (1) choose to make representations of non-compliant duty points and identify those duty points as non-compliant, but would need to know the duty point(s) for which the fan was selected and sold; or (2) choose to only make representations at compliant duty points in the case where the manufacturer does not know the duty point(s) for which the fan is selected and sold.

In accordance with 42 U.S.C. 6295(r), energy conservation standards may include any requirement which the Secretary determines is necessary to assure that each covered product to which such standard applies meets the required minimum level of energy efficiency. As such, to assure that each GFB to which the proposed standard would apply meets the required FEI specified in such standard, and in accordance with 42 U.S.C. 6295(r), DOE proposes to additionally require that all representations at non-compliant duty points would be (1) identified by the following disclaimer: ''Sale at these duty points violates Department of Energy Regulations under EPCA'' in all capital letters, red, and bold font; and (2) grayed out in any graphs or tables in which they are included.

2. Enforcement Provisions for General Fans and Blowers

Subpart C of 10 CFR part 429 establishes enforcement provisions applicable to covered products and covered equipment, including fans and blowers. General enforcement provisions are established in 10 CFR 429.110. Various provisions in 10 CFR 429.110 specify when DOE may test for enforcement, how DOE will obtain units for enforcement testing, where selected units will be tested, and how DOE will determine basic model compliance, both in general and for specific products and equipment. DOE is proposing to add specific enforcement testing provisions for GFBs at 10 CFR 429.110(e).

As previously stated, the FEI metric would be evaluated at each duty point as specified by the manufacturer and, if adopted, the proposed energy conservation standards would have to be met at each duty point at which the fan is sold. Therefore, while DOE requires GFBs to follow the basic model structure outlined in the May 2023 TP Final Rule, DOE proposes that GFB compliance will be determined by duty point offered for sale. In other words, if DOE finds that one or more duty point(s) certified as compliant by a manufacturer is not compliant with proposed energy conservation standards, if adopted, the basic model would be considered non-compliant.

Pursuant to 10.CFR 429.104, DOE may, at any time, test a basic model to assess whether the basic model is in compliance with the applicable energy conservation standard(s). If DOE has reason to believe that a basic model is not in compliance it may test for enforcement pursuant to 10 CFR 429.110. To verify compliance of GFBs, DOE proposes to add the following enforcement testing approach at 10 CFR 429.110(e).

When conducting assessment and enforcement testing, DOE proposes to test each basic model according to the DOE test procedure, using the test method specified by the manufacturer submitted in their certification report (*i.e.,* based on section 6.1, 6.2, 6.3 or 6.4 of AMCA 214–21) pursuant to 10 CFR 429.69. When conducting enforcement testing, DOE proposes that it may choose to test either one fan at multiple duty points or multiple fans at one or more duty points to evaluate compliance of a certified basic model at each certified duty point.

a. Testing a Single Fan at Multiple Duty Points

When testing a single fan at multiple duty points, DOE proposes to first determine either bhp or FEP, dependent on the test method specified by the manufacturer, for the range of certified airflow, pressure, and speed (duty points) according to appendix A of subpart J to 10 CFR part 431. DOE acknowledges that it may not be feasible to exactly replicate the measurements at the certified duty points, or within the certified range of duty points; therefore, DOE will verify that, at a given speed, the airflow at which the test is being conducted is within 5-percent of the certified airflow and the pressure is within between $P \times (1 - 0.05)^2$ and where P is the certified static or total pressure. If DOE is unable to verify some or all certified duty points (*i.e.,* the fan is unable to perform at airflows and pressures at a given speed that are within the prescribed margin of the certified airflows and pressures), the certified rating cannot be used to determine compliance. DOE will consider the certified rating to be invalid and DOE will rely on the measured duty point (*i.e.,* measured flow and pressure at the given speed) to determine compliance. If DOE is able to verify the certified duty points (*i.e.,* DOE is able to test the fan at airflows and pressures at a given speed that are within the prescribed margin of the certified airflows and pressures), DOE will convert the tested bhp or FEP at the tested airflow to the certified airflow and use the converted bhp or FEP calculate the corresponding FEI at each certified duty point, in accordance with the DOE test procedure. To convert the tested bhp or FEP at the tested airflow to the certified airflow DOE will use the following equations:

For fan shaft power:

$$Converted\ bhp = tested\ bhp \times \left(\frac{certified\ duty\ point\ airflow}{tested\ duty\ point\ airflow}\right)^3$$

For fan electrical power:

$$Converted\ FEP = tested\ FEP \times \left(\frac{certified\ duty\ point\ airflow}{tested\ duty\ point\ airflow}\right)^3$$

DOE proposes that if the FEI calculated at the certified or measured duty point is greater than or equal to the minimum required FEI, then testing would be complete and DOE would consider the certified duty point to be compliant. If the FEI calculated at a certified or measured duty point is less than the minimum required FEI, DOE may make a determination of noncompliance based on that single test or may select no more than three additional identical model numbers and evaluate (a) specific duty point(s) according to the procedure just described to further determine whether (a) specific duty point(s) is/are compliant based on the average FEI of all units tested when multiple units are tested.

DOE also proposes to add the provisions related to the verification of duty points at 10 CFR 429.134.

b. Testing Multiple Fans at One or Several Duty Points

If the FEI calculated at a certified or measured duty point is less than the minimum required FEI, DOE may make a determination of noncompliance based on that single test or may select no more than three additional units of a certified basic model for testing. For each of the units tested, if the duty point can be verified, DOE proposes to then follow the approach described in the preceding paragraph, to determine the converted FEP or bhp and the associated FEI at certified duty point(s). Similarly, DOE proposes to determine compliance at each duty point using the average FEI for each certified duty point. If the duty point(s) cannot be verified, DOE proposes to use the same approach as in the sampling provisions (see 10 CFR 429.69) to determine the average FEP or bhp and the associated average FEI at measured duty point(s).

3. Enforcement Provisions for Air Circulating Fans

For air circulating fans, DOE proposes to follow the general enforcement testing provisions at 10 CFR 429.110.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011) and amended by E.O. 14094, ''Modernizing Regulatory Review,'' 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this proposed regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this proposed regulatory action constitutes a ''significant regulatory action'' within the scope of section 3(f)(1) of E.O. 12866. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the proposed regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this proposed rulemaking. Finally, in accordance with 5 U.S.C. 553(b)(4), a summary of this proposed rule may be found at *www.regulations.gov/docket/EERE-2020-BT-STD-0007.*

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (Aug. 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*www.energy.gov/gc/office-general-counsel*). DOE has prepared the following IRFA for the industrial equipment that is the subject of this rulemaking.

1. Description of Reasons Why Action Is Being Considered

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. EPCA specifies the types of industrial equipment that can be classified as covered in addition to the equipment enumerated in 42 U.S.C. 6311(1). This industrial equipment includes fans and blowers. (42 U.S.C. 6311(2)(B)(ii) and (iii)) DOE is undertaking this NOPR pursuant to its obligations under EPCA to propose standards for covered industrial equipment.

2. Objectives of, and Legal Basis for, Rule

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including fans and blowers. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B))

3. Description on Estimated Number of Small Entities Regulated

For manufacturers of fans and blowers, the SBA has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. (*See* 13 CFR part 121.) The size standards are listed by North American Industry Classification System (''NAICS'') code and industry description and are available at *www.sba.gov/document/support-table-size-standards.* Manufacturing of fans and blowers is classified under NAICS 335220, ''Industrial and Commercial Fan and Blower and Air Purification Equipment Manufacturing.'' The SBA sets a threshold of 500 employees or fewer for an entity to be considered as a small business for this category.

DOE conducted a focused inquiry of the companies that could be small businesses that manufacture fans and blowers covered by this rulemaking. DOE used data from the AMCA sales database; from the BESS Labs database; and from ENERGY STAR's certified product database to create a list of companies that potentially sell fans and blowers covered by this rulemaking. Additionally, DOE received feedback from interested parties in response to previous stages of this rulemaking. DOE contacted select companies on its list, as necessary, to determine whether they met the SBA's definition of a fan and blower small business. DOE screened out companies that did not offer equipment covered by this rulemaking, did not meet the definition of a ''small business,'' or are foreign owned and operated.

Using these data sources, DOE identified 91 manufacturers of fans and blowers. DOE then referenced D&B Hoovers reports,[136] as well as the online presence of identified businesses in order to determine whether they might the criteria of a small business. 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. Additionally, DOE filters out businesses that do not directly produce fans and blowers, but instead relabel fans and blowers or integrate them into a different product.

From these sources, DOE identified 46 unique businesses manufacturing at least one covered fan or blower product family and that also fall under SBA's employee threshold for this rulemaking. Of the 46 small businesses, 41 manufacture at least one model of a covered GFB and 15 of these small businesses additionally manufacture at least one model of a covered ACF. Lastly, there are five small businesses that only manufacture ACF models (and do not manufacture any GFB models).

DOE requests comment on the number of small business OEMs identified that manufacture fans and blowers covered by this rulemaking.

4. Description and Estimate of Compliance Requirements Including Differences in Cost, if Any, for Different Groups of Small Entities

In section IV.J.2.c of this NOPR, DOE reviews the methodology used to calculate conversion costs, this is further elaborated in chapter 12 of the NOPR TSD. DOE used the same methodology to estimate per small business conversion costs as with the broader industry—developing estimates of the number of product families for each small business using their websites and product catalogs. DOE was also able to find revenue estimates for each small business identified.

Across the identified small businesses, DOE identified 457 covered GFB product families and 97 ACF product families. DOE evaluated how many of each type for each small business would be compliant with TSL 4 based on the shipments analysis efficiency level estimates. Then, DOE assumed that all non-compliant product families would be redesigned and calculated the appropriate conversion costs. DOE estimates that the total cost to all small businesses to redesign GFB product families would be approximately $233.0 million and to redesign ACF would be an additional $29.1 million. DOE provides estimates of conversion costs for each small business in the following tables for small businesses that manufacture both GFBs and ACFs, GFBs only, and ACFs only.

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[136] D&B Hoovers reports require a subscription to D&B Hoovers and can be accessed at: *app.dnbhoovers.com.*

Table VI-1 Small Business Impacts for Manufacturers of both General Fans and Blowers and Air Circulating Fans

Small Business	Estimated Annual Revenue (*2022$*)	GFB Product Family Count	GFB Non-Compliant Product Families	ACF Product Family Count	ACF Non-Compliant Product Families	Conversion Costs (*2022$*)	Conversion Costs (% of Compliance -Period Revenue)
Small Business 1	$416,790	6	5	5	2	$8,978,604	430.8%
Small Business 2	$4,490,000	53	22	2	0	$27,717,925	123.5%
Small Business 3	$6,150,000	22	11	1	0	$12,855,803	41.8%
Small Business 4	$12,460,000	27	12	5	2	$18,618,710	29.9%
Small Business 5	$29,020,000	23	11	21	11	$24,414,048	16.8%
Small Business 6	$3,180,000	7	3	4	0	$2,411,773	15.2%
Small Business 7	$5,210,000	7	2	1	0	$2,945,394	11.3%
Small Business 8	$11,390,000	13	6	1	0	$6,161,091	10.8%
Small Business 9	$4,190,000	7	2	1	0	$1,607,849	7.7%
Small Business 10	$33,470,000	13	7	13	5	$11,002,812	6.6%
Small Business 11	$43,389,999	3	1	20	10	$9,548,291	4.4%
Small Business 12	$103,000,000	32	20	2	0	$20,091,122	3.9%
Small Business 13	$15,380,000	7	2	1	0	$1,607,849	2.1%
Small Business 14	$63,950,000	6	2	4	2	$4,560,513	1.4%
Small Business 15	$14,190,000	1	0	3	0	$0	0.0%

Table VI-2 Small Business Impacts – General Fans and Blowers Only

Small Business	Estimated Annual Revenue (*2022$*)	Product Family Count	Non-Compliant Product Families	Conversion Costs (*2022$*)	Conversion Costs (% of Compliance-Period Revenue)
Small Business 1	$990,000	15	10	$9,376,788	189.4%
Small Business 2	$1,200,000	19	11	$8,843,167	147.4%
Small Business 3	$1,030,000	8	4	$3,884,470	75.4%
Small Business 4	$1,530,000	5	3	$4,418,091	57.8%
Small Business 5	$2,590,000	14	9	$7,235,318	55.9%
Small Business 6	$590,000	6	2	$1,607,849	54.5%
Small Business 7	$810,000	3	1	$803,924	19.8%
Small Business 8	$18,860,000	36	18	$18,483,273	19.6%
Small Business 9	$870,000	4	1	$803,924	18.5%
Small Business 10	$12,400,000	18	10	$8,039,243	13.0%
Small Business 11	$21,010,000	17	9	$9,241,637	8.8%
Small Business 12	$4,690,000	4	1	$1,472,697	6.3%
Small Business 13	$16,630,000	11	6	$4,823,546	5.8%
Small Business 14	$21,880,000	9	4	$5,222,015	4.8%
Small Business 15	$10,560,000	6	3	$2,411,773	4.6%
Small Business 16	$25,500,000	14	6	$5,492,318	4.3%
Small Business 17	$9,360,000	4	2	$1,607,849	3.4%
Small Business 18	$23,900,000	9	5	$4,019,621	3.4%
Small Business 19	$6,660,000	2	1	$803,924	2.4%
Small Business 20	$29,740,000	6	2	$2,945,394	2.0%
Small Business 21	$25,620,000	5	2	$1,607,849	1.3%
Small Business 22	$33,599,999	3	2	$1,607,849	1.0%
Small Business 23	$17,870,000	5	1	$803,924	0.9%
Small Business 24	$21,170,000	2	1	$803,924	0.8%
Small Business 25	$7,910,000	3	0	-	0.0%
Small Business 26	$7,760,000	2	0	-	0.0%

Table VI-3 Small Business Impacts – Air Circulating Fans Only

Small Business	Estimated Annual Revenue (*2022$*)	Product Family Count	Non-Compliant Product Families	Conversion Costs (*2022$*)	Conversion Costs (% of Compliance-Period Revenue)
Small Business 1	$9,300,000	6	4	$3,230,237	6.9%
Small Business 2	$2,290,000	3	0	-	0.0%
Small Business 3	$5,420,000	2	0	-	0.0%
Small Business 4	$5,050,000	1	0	-	0.0%
Small Business 5	$1,440,000	1	0	-	0.0%

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Costs as a percentage of revenue vary significantly across the small businesses. For small manufacturers that make both GFBs and ACFs, median costs as a percentage of revenue are 10.8 percent. For small manufacturers that only make GFBs, median costs as a percentage of revenue are 5.3 percent. For small businesses that only make ACFs, most small businesses are expected to incur zero redesign costs, the highest cost estimated represents 6.9 percent of the affected small business' compliance period revenue. Small businesses that experience high conversion costs as a percentage of revenue will likely need to seek outside capital to finance redesign efforts and or prioritize redesigning product families based on sales volume.

DOE requests comment on the estimated small business costs and how those may differ from the costs incurred by larger manufacturers.

5. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any other rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's proposed rule, represented by TSL 4. In reviewing alternatives to the proposed rule, DOE examined energy conservation standards set at lower efficiency levels. While selecting TSLs 1, 2, or 3 would reduce the possible impacts on small businesses, it would come at the expense of a significant reduction in energy savings and consumer NPV.

For GFBs, TSL 1 achieves 88 percent lower energy savings and 90 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4. TSL 2 achieves 78 percent lower energy savings and 80 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4. TSL 3 achieves 44 percent lower energy savings and 49 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4.

For ACFs, TSL 1 achieves 98 percent lower energy savings and 96 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4. TSL 2 achieves 96 percent lower energy savings and 94 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4. TSL 3 achieves 73 percent lower energy savings and 71 percent lower consumer net benefits compared to the energy savings and consumer net benefits at TSL 4.

Based on the presented discussion, establishing standards at TSL 4 for GFBs and for ACFs balances the benefits of the energy savings and consumer benefits with the potential burdens placed on manufacturers and small businesses better than alternate standard levels. Accordingly, DOE does not propose one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the NOPR TSD.

C. Review Under the Paperwork Reduction Act

Under the procedures established by the Paperwork Reduction Act of 1995 (''PRA''), a person is not required to respond to a collection of information by a Federal agency unless that collection of information displays a currently valid OMB Control Number.

OMB Control Number 1910–1400, Compliance Statement Energy/Water Conservation Standards for Appliances, is currently valid and assigned to the certification reporting requirements applicable to covered equipment, including fans and blowers.

DOE's certification and compliance activities ensure accurate and comprehensive information about the energy and water use characteristics of covered products and covered equipment sold in the United States. Manufacturers of all covered products and covered equipment must submit a certification report before a basic model is distributed in commerce, annually thereafter, and if the basic model is redesigned in such a manner to increase the consumption or decrease the efficiency of the basic model such that the certified rating is no longer supported by the test data. Additionally, manufacturers must report when production of a basic model has ceased and is no longer offered for sale as part of the next annual certification report following such cessation. DOE requires the manufacturer of any covered product or covered equipment to establish, maintain, and retain the records of certification reports, of the underlying test data for all certification testing, and of any other testing conducted to satisfy the requirements of part 429, part 430, and/or part 431. Certification reports provide DOE and consumers with comprehensive, up-to-date efficiency information and support effective enforcement.

Certification data would be required for fans and blowers were this NOPR to be finalized as proposed; however, DOE is not proposing certification or reporting requirements for fans and blowers in this NOPR. Instead, DOE may consider proposals to establish certification requirements and reporting for fans and blowers under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

DOE is analyzing this proposed regulation in accordance with the National Environmental Policy Act of 1969 (''NEPA'') and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for rulemakings that establish energy conservation standards for consumer products or industrial equipment. 10 CFR part 1021, subpart D, appendix B5.1. DOE anticipates that this rulemaking qualifies for categorical exclusion B5.1 because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in categorical exclusion B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it otherwise meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final rule.

E. Review Under Executive Order 13132

E.O. 13132, ''Federalism,'' 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 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 E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, section 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

Although this proposed rule does not contain a Federal intergovernmental mandate, it may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by fans and blowers 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 fans and blowers, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the proposed rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. This **SUPPLEMENTARY INFORMATION** section of this NOPR and the TSD for this proposed rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the proposed rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C 6316(a); 42 U.S.C. 6295(m), this proposed rule would establish energy conservation standards for fans and blowers that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 42 U.S.C 6316(a); 42 U.S.C. 6295(o)(2)(A) and (o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the NOPR TSD for this proposed rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (Mar. 15, 1988), DOE has determined that this proposed rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this NOPR under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has tentatively concluded that this regulatory action, which proposes energy conservation standards for fans and blowers, is not a significant energy action because the proposed standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on this proposed rule.

L. Information Quality

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (''OSTP''), issued its Final Information Quality Bulletin for Peer Review (''the Bulletin''). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information,'' which the Bulletin defines as ''scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions.'' 70 FR 2664, 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and has prepared a report describing that peer review.[137] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve DOE's analyses. DOE is in the process of evaluating the resulting report.[138]

M. Description of Materials Incorporated by Reference

In this NOPR, DOE proposes to incorporate by reference the following test standards published by the IEC.

IEC 61800–9–2:2023 specifies test methods to determine the efficiency of motor controllers as well as the efficiency of motor and motor controller combinations. It also establishes efficiency classifications for this equipment.

IEC TS 60034–30–2:2016 establishes efficiency classifications for motors driven by motor controllers.

IEC TS 60034–31:2021 provides a guideline of technical and economical aspects for the application of energy-efficient electric AC motors and example calculations.

IEC 61800–9–2:2023, IEC TS 60034–30–2:2016, and IEC TS 60034–31:2021 are available for purchase from the International Electrotechnical Committee (IEC), Central Office, 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland; + 41 22 919 02 11; *webstore.iec.ch.*

The following standards appear in the amendatory text of this document and have already been approved for the locations in which they appear: AMCA 210–16, AMCA 214–21, and ISO 5801:2017.

VII. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify the Appliance and Equipment Standards staff at (202) 287–1445 or *Appliance_Standards_Public_Meetings@ee.doe.gov.*

Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. If a foreign national wishes to participate in the public meeting, please inform DOE of this fact as soon as possible by contacting Ms. Regina Washington at (202) 586–1214 or by email (*Regina.Washington@ee.doe.gov*) so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the Forrestal Building. Any person wishing to bring these devices into the building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (''DHS''), there have been recent changes regarding ID requirements for individuals wishing to enter Federal buildings from specific States and U.S. territories. DHS maintains an updated website identifying the State and territory driver's licenses that currently are acceptable for entry into DOE facilities at *www.dhs.gov/real-id-enforcement-brief.* A driver's license from a State or territory identified as not compliant by DHS will not be accepted for building entry and one of the alternate forms of ID listed below will be required. Acceptable alternate forms of Photo-ID include U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by States and territories as identified on the DHS website (Enhanced licenses issued by these States and territories are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government-issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website at *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=51.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and are to be emailed. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

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[137] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at the following website: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed December 5, 2023).

[138] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards.*

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA. (42 U.S.C. 6306) A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the proposed rulemaking, until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present a general overview of the topics addressed in this proposed rulemaking, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this proposed rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the previous procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document and will be accessible on the DOE website. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via *www.regulations.gov.* The *www.regulations.gov* web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (''CBI'')). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or postal mail. Comments and documents submitted via email, hand delivery/courier, or postal mail also will be posted to *www.regulations.gov.* If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via postal mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (''faxes'') will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: one copy of the document marked ''confidential'' including all the information believed to be confidential, and one copy of the document marked ''non-confidential'' with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

(1) DOE requests comment on its proposed clarification for fans that create a vacuum. Specifically, DOE requests comment on whether fans that are manufactured and marketed exclusively to create a vacuum of 30 inches water gauge or greater could also be used in positive pressure applications. Additionally, DOE requests information on the applications in which a fan not manufactured or marketed exclusively for creating a vacuum would be used to create a vacuum of 30 inches water gauge or greater.

(2) DOE requests comments and feedback on the proposed methodology and calculation of motor and motor controller losses as well as potentially using an alternative calculation based on adjusted AMCA 214–21 equations.

(3) DOE requests comment on whether there are specific fans that meet the axial ACF definition that provide utility substantially different from the utility provided from other axial ACFs and that would impact energy use. If so, DOE requests information on how the utility of these fans differs from other axial ACFs and requests data showing the differences in energy use due to differences in utility between these fans and other axial ACFs.

(4) DOE requests comment on its understanding that the diameter increase design option could be applied to non-embedded, non-space-constrained equipment classes.

(5) DOE requests comment on whether the FEI increases associated with an impeller diameter increase for centrifugal PRVs and for axial PRVs are realistic. Specifically, DOE requests comment on whether it is realistic for axial PRVs to have a FEI increase that is 3 times greater than that for centrifugal PRVs when starting at the same initial diameter. Additionally, DOE requests comment on the factors that may impact how much an impeller diameter increase impacts a FEI increase.

(6) DOE requests comment on the ordering and implementation of design options for centrifugal PRV exhaust and supply fans and axial PRV fans.

(7) DOE requests comment on its approach for estimating the industry-wide conversion costs that may be necessary to redesign fans with forward-curved impellers to meet higher FEI values. Specifically, DOE is interested in the costs associated with any capital equipment, research and development, or additional labor that would be required to design more efficient fans with forward-curved impellers. DOE additionally requests comment and data on the percentage of forward-curved impellers that manufacturers would expect to maintain as a forward-curved impeller relative to those expected to transition to a backward-inclined or airfoil impeller.

(8) DOE requests comment on the equations developed to calculate the credit for determining the FEI standard for GFBs sold with a motor controller and with an FEPact less than 20 kW and on potentially using an alternative credit calculation based on the proposed equations in section III.C.1.b of this document. Additionally, DOE requests comment on its use of a constant value, and its proposed value, of the credit applied for determining the FEI standard for GFBs with a motor controller and an FEPact of greater than or equal for 20 kW.

(9) DOE requests comments on whether it should apply a correction factor to the analyzed efficiency levels to account for the tolerance allowed in AMCA 211–22 and if so, DOE requests comment on the appropriate correction factor. DOE requests comment on the potential revised levels as presented in Table IV–12. Additionally, DOE requests comments on whether it should continue to evaluate an FEI of 1.00 for all fan classes if it updates the databases used in its analysis to consider the tolerance allowed in AMCA 211–22.

(10) Additionally, DOE does not anticipate that the efficiency levels captured in Table IV–12 would impact the cost, energy, and economic analyses presented in this document. As such, DOE considers the results of these analyses presented throughout this document applicable to the efficiency levels with a 5% tolerance allowance. DOE seeks comment on the analyses as applied to the efficiency levels in Table IV–12.

(11) DOE requests comment on its method to use both the AMCA sales database and sales data pulled from manufacturer fan selection data to estimate MSP. DOE also requests comment on the use of the MSP approach for its cost analysis for GFBs or whether an MPC-based approach would be appropriate. If interested parties believe an MPC-based approach would be more appropriate, DOE requests MPC data for the equipment classes and efficiency levels analyzed, which may be confidentially submitted to DOE using the confidential business information label.

(12) DOE requests feedback on whether using a more efficient motor would require an ACF redesign. Additionally, DOE requests feedback on what percentage of motor speed change would require an ACF redesign.

(13) DOE requests feedback on whether setting an ACF standard using discrete efficacy values over a defined diameter range appropriately represents the differences in efficacy between axial ACFs with different diameters, and if not, would a linear equation for efficacy as a function of diameter be appropriate.

(14) DOE seeks comment on the distribution channels identified for GFBs and ACFs and fraction of sales that go through each of these channels.

(15) DOE seeks comment on the overall methodology and inputs used to estimate GFBs and ACFs energy use. Specifically, for GFBs, DOE seeks feedback on the methodology and assumptions used to determine the operating point(s) both for constant and variable load fans. For ACFs, DOE requests feedback on the average daily operating hours, annual days of operation by sector and application, and input power assumptions. In addition, DOE requests feedback on the market share of GFBs and ACFs by sector (*i.e.,* commercial, industrial, and agricultural).

(16) DOE requests feedback on the price trends developed for GFBs and ACFs.

(17) DOE requests feedback on the installation costs developed for GFBs and on whether installation costs of ACFs may increase at higher ELs.

(18) DOE requests feedback on whether the maintenance and repair costs of GFBs may increase at higher ELs. Specifically, DOE requests comments on the frequency of motor replacements for ACFs. DOE also requests comments on whether the maintenance and repair costs of ACFs may increase at higher ELs and on the repair costs developed for ACFs.

(19) DOE requests comments on the average lifetime estimates used for GFBs and ACFs.

(20) DOE requests feedback and information on the no-new-standards case efficiency distributions used to characterize the market of GFBs and ACFs. DOE requests information to support any efficiency trends over time for GFBs and ACFs.

(21) DOE requests feedback on the methodology and inputs used to project shipments of GFBs in the no-new-standards case. DOE requests comments and feedback on the potential impact of standards on GFB shipments and

information to help quantify these impacts.

(22) DOE requests feedback on the methodology and inputs used to estimate and project shipments of ACFs in the no-new-standards case. DOE requests comments and feedback on the potential impact of standards on ACF shipments and information to help quantify these impacts.

(23) DOE requests comment and data regarding the potential increase in utilization of GFBs and ACFs due to any increase in efficiency.

(24) DOE requests comment on the number of end-use product (*i.e.,* a product or equipment that has a fan or blower embedded in it) basic models that would not be excluded by the list of products or equipment listed in Table III–1.

(25) DOE requests information regarding the impact of cumulative regulatory burden on manufacturers of fans and blowers associated with multiple DOE standards or product-specific regulatory actions of other Federal agencies.

(26) DOE requests comment on the proposed standard level for axial PRVs, including the design options and costs, as well as the burdens and benefits associated with this level and the industry standards/California regulations FEI level of 1.00.

(27) DOE requests comment on the number of small business OEMs identified that manufacture fans and blowers covered by this proposed rulemaking.

(28) DOE requests comment on the estimated small business costs and how those may differ from the costs incurred by larger manufacturers.

Additionally, DOE welcomes comments on other issues relevant to the conduct of this rulemaking that may not specifically be identified in this document.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and announcement of public meeting.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements.

10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Incorporation by reference, Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on December 28, 2023, by Jeffrey Marootian, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on December 29, 2023.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons set forth in the preamble, DOE proposes to amend parts 429 and 431 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 2. Amend § 429.69 by adding paragraph (a)(3) to read as follows:

§ 429.69 Fans and blowers.

(a) * * *

(3) *Required Disclaimer at Non-Compliant Duty Points.* Representation of fan performance at duty points with FEI that are not compliant with the energy conservation standards at § 431.175 of this chapter is allowed and must be identified by the following disclaimer: ''Sale at these duty points violates Department of Energy Regulations under EPCA'' in red and bold font; and (2) duty points must be grayed out in any graphs or tables in which they are included.

* * * * *

■ 3. Amend § 429.110 by redesignating paragraphs (e)(7), (8), and (9) as paragraphs (e)(8), (9), and (10), respectively, and adding a new paragraph (e)(7) to read as follows:

§ 429.110 Enforcement testing.

* * * * *

(e) * * *

(7) For fans and blowers other than air circulating fans, DOE will use an initial sample of one unit to determine compliance at each duty point for which the fan basic model is distributed in commerce. If one or more duty points is determined to be non-compliant, the fan basic model is determined to be non-compliant.

(i) When testing a single unit, DOE will first determine either fan shaft input power or FEP, dependent on the test method specified by the manufacturer, for the range of certified duty points according to appendix A to subpart J of part 431 of this chapter. For each point in the certified operating range (*i.e.,* each certified duty point), DOE will conduct a verification of the duty points as described in § 429.134(bb)(2) and determine the FEI at the certified duty point or at the measured duty point. If the FEI calculated at the certified or measured duty point is greater than or equal to the minimum required FEI, then testing is complete and the certified or measured duty point is compliant. If the FEI calculated at a certified or measured duty point is less than the minimum required FEI, DOE may select additional units to test in accordance with this paragraph (e)(7)(ii) of this section.

(ii) When testing more than one unit, DOE will select no more than three additional units of a certified basic model for testing and test each one at one or several duty points within the range of certified duty points. For each unit and at each certified duty point, DOE will conduct a verification of the duty points as described in § 429.134(bb)(2) and determine the FEI at the certified duty point or at the measured duty point. In the case where the certified duty point can be verified, DOE will calculate the average FEI of all units tested for each certified duty point. If the duty point cannot be verified, DOE will follow the sampling procedures at § 429.69 to determine the average FEI of all units tested at the measured duty point. If the average FEI calculated at the certified or measured duty point is greater than or equal to the minimum required FEI, then testing is complete and the certified or measured duty point is compliant. If the average FEI calculated at a certified or measured duty point is less than the minimum required FEI, then testing is complete and the certified or measured duty point is not compliant.

* * * * *

■ 4. Amend § 429.134 by adding paragraph (gg) to read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(gg) *Fans and blowers.* (1) *Testing.* For fans and blowers other than air circulating fans, DOE will test each fan or blower basic model according to the test method specified by the manufacturer (*i.e.,* based on the method listed in table 1 to appendix A to subpart J of part 431 of this chapter).

(2) *Verification of duty points.* For fans and blowers other than air circulating fans, at a given speed within the certified operating range, the pressure and flow of a duty point in the certified range of operation (*i.e.,* certified duty point) will be determined in accordance with appendix A to subpart J of part 431 of this chapter. At a given speed, the certified duty point will be considered valid only if the measured airflow is within five percent of the certified airflow and the measured static or total pressure is between $P \times (1 - 0.05)^2$ and $P \times (1 + 0.05)^2$ where P is the certified static or total pressure.

(i)(A) If the certified duty point is found to be valid, the certified duty point will be used as the basis for determining compliance. DOE will convert the measured fan shaft power or FEP at the measured airflow to the certified airflow using the following equations:

For fan shaft power:

$$Converted\ fan\ shaft\ power = Measured\ fan\ shaft\ power \left(\frac{certified\ airflow}{Measured\ airflow}\right)^3$$

For fan electrical power:

$$Converted\ FEP = Measured\ FEP \times \left(\frac{certified\ airflow}{Measured\ airflow}\right)^3$$

(B) DOE will use the converted fan shaft power or FEP to calculate the corresponding FEI at the certified duty point, in accordance with the DOE test procedure.

(ii) If the certified duty point is found to be invalid, the measured flow and pressure will be used as the basis for determining compliance. DOE will use the measured fan shaft power or FEP to calculate the corresponding FEI at the measured duty point, in accordance with the DOE test procedure.

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 5. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 6. Amend § 431.172 by adding in alphabetical order definitions for ''Axial air circulating fan'', ''Axial power roof ventilator'', ''Centrifugal power roof ventilator—exhaust'', ''Centrifugal power roof ventilator—supply'', ''Diameter'', ''Fan housing'', ''Mixed flow impeller'', and ''Radial impeller'' to read as follows:

§ 431.172 Definitions.

* * * * *

Axial air circulating fan means an air circulating fan with an axial impeller that is either housed or unhoused.

* * * * *

Axial power roof ventilator means a PRV with an axial impeller that either supplies or exhausts air to a building where the inlet and outlet are not typically ducted.

* * * * *

Centrifugal power roof ventilator—exhaust means a PRV with a centrifugal or mixed-flow impeller that exhausts air from a building and which is typically mounted on a roof or a wall.

Centrifugal power roof ventilator—supply means a PRV with a centrifugal or mixed-flow impeller that supplies air to a building and which is typically mounted on a roof or a wall.

* * * * *

Diameter means the impeller diameter of a fan, which is twice the measured radial distance between the tip of one of the impeller blades of a fan to the center axis of its impeller hub.

* * * * *

Fan housing means any fan component(s) that direct(s) airflow into or away from the impeller and/or provide protection for the internal components of a fan or blower that is not an air circulating fan. A housing may serve as a fan's structure.

* * * * *

Mixed flow impeller means an impeller featuring construction characteristics between those of an axial and centrifugal impeller. A mixed-flow impeller has a fan flow angle greater than 20 degrees and less than 70 degrees. Airflow enters axially through a single inlet and exits with combined axial and radial directions at a mean diameter greater than the inlet.

* * * * *

Radial impeller means a form of centrifugal impeller with several blades extending radially from a central hub. Airflow enters axially through a single inlet and exits radially at the impeller periphery into a housing with impeller blades; the blades are positioned so their outward direction is perpendicular within 25 degrees to the axis of rotation. Impellers can have a back plate and/or shroud.

* * * * *

■ 7. Amend § 431.173 by redesignating paragraphs (c) and (d) as paragraphs (d) and (e), respectively, and adding a new paragraph (c) to read as follows:

§ 431.173 Materials incorporated by reference.

* * * * *

(c) *IEC.* International Electrotechnical Committee, Central Office, 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland; + 41 22 919 02 11; *webstore.iec.ch.*

(1) IEC 61800–9–2:2023, *Adjustable speed electrical power drive systems (PDS)—Part 9–2: Ecodesign for motor systems—Energy efficiency determination and classification,* Edition 2.0, 2023–10; IBR approved for appendix A to this subpart.

(2) IEC TS 60034–30–2:2016, *Rotating electrical machines—Part 30–2: Efficiency classes of variable speed AC motors (IE-code),* Edition 1.0, 2016–12; IBR approved for appendix A to this subpart.

(3) IEC TS 60034–31:2021, *Rotating electrical machines—Part 31: Selection of energy-efficient motors including variable speed applications—Application guidelines,* Edition 2.0, 2021–03; IBR approved for appendix A to this subpart.

* * * * *

■ 8. Section 431.175 is added to read as follows:

§ 431.175 Energy conservation standards and compliance dates.

(a) Each fan and blower, other than an air circulating fan manufactured starting on [DATE FIVE YEARS AFTER DATE OF PUBLICATION OF FINAL RULE] that is subject to the test procedure in § 431.174(a), must have a FEI value at each duty point for which the fan is distributed in commerce, that is equal or greater than the value in table 1 of this section. The manufacturer is responsible for ensuring that each fan and blower, other than an air circulating fan manufactured starting on [DATE FIVE YEARS AFTER DATE OF PUBLICATION OF FINAL RULE] that is subject to the test procedure in § 431.174(a), is sold and selected at compliant duty points.

TABLE 1 TO PARAGRAPH (a)—ENERGY CONSERVATION STANDARDS FOR FANS AND BLOWERS OTHER THAN AIR CIRCULATING FANS

Equipment class	With or without motor controller	Fan energy index (FEI) *
Axial Inline	Without	1.18 * A.
Axial Panel	Without	1.48 * A.
Axial Power Roof Ventilator	Without	0.85 * A.
Centrifugal Housed	Without	1.31 * A.
Centrifugal Unhoused	Without	1.35 * A.
Centrifugal Inline	Without	1.28 * A
Radial Housed	Without	1.17 * A.
Centrifugal Power Roof Ventilator—Exhaust	Without	1.00 * A.
Centrifugal Power Roof Ventilator—Supply	Without	1.19 * A.
Axial Inline	With	1.18 * A * B.
Axial Panel	With	1.48 * A * B.
Axial Power Roof Ventilator	With	0.85 * A * B.
Centrifugal Housed	With	1.31 * A * B.
Centrifugal Unhoused	With	1.35 * A * B.
Centrifugal Inline	With	1.28 * A * B.
Radial Housed	With	1.17 * A * B.
Centrifugal Power Roof Ventilator—Exhaust	With	1.00 * A * B.
Centrifugal Power Roof Ventilator—Supply	With	1.19 * A * B.

* A is a constant representing an adjustment in FEI for motor hp, which can be found in table 2 of this section. B is a constant representing an adjustment in FEI for motor controllers, which can be found in table 2 of this section.

Table 2 to Paragraph (a) – FEI Calculation Constants

Constant	**Condition**		**Value**
A	With Motor hp < 100 hp		$A = 1.00$
	With Motor hp ≥ 100 hp and ≤ 250 hp		$A = \frac{\eta_{mtr,2023}}{\eta_{mtr,2014}}$
B	With Motor Controller	FEP_{act} of < 20 kW (26.8 hp)	$B = \frac{FEP_{act} - Credit}{FEP_{act}}$; where: $Credit = 0.03 \times FEP_{act} + 0.08$ **[SI]** $Credit = 0.03 \times FEP_{act} + 0.08 \times 1.341$ **[IP]**
		FEP_{act} of ≥ 20 kW (26.8 hp)	$B = 0.966$

$\eta_{mtr,2023}$ is the motor efficiency in accordance with table 8 at § 431.25, $\eta_{mtr,2014}$ is the motor efficiency in accordance with table 5 at § 431.25, which DOE is proposing to adopt into this section, and FEP_{act} is determined according to the DOE test procedure in appendix A to subpart J of this part.

TABLE 3 TO PARAGRAPH (a)—2014 MOTOR EFFICIENCY VALUES, $\eta_{mtr,2014}$

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
100/75	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125/95	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200/150	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1
250/186	95.8	95.0	96.2	95.8	95.8	95.8	95.0	95.0

(b) Each air circulating fan manufactured starting on [DATE FIVE YEARS AFTER DATE OF PUBLICATION OF FINAL RULE] that is subject to the test procedure in § 431.174(b), must have an efficacy value in CFM/W at maximum speed that is equal or greater than the value in table 4 to this paragraph (b).

TABLE 4 TO PARAGRAPH (b)—ENERGY CONSERVATION STANDARDS FOR AIR CIRCULATING FANS

Equipment class *	Efficacy at maximum speed (CFM/W)
Axial Air Circulating Fans; 12″ ≤ D < 36″	12.2
Axial Air Circulating Fans; 36″ ≤ D < 48″	17.3
Axial Air Circulating Fans; 48″ ≤ D	21.5
Housed Centrifugal ACFs	N/A

* D: diameter in inches.

N/A means not applicable as DOE is not proposing to set a standard for this equipment class.

■ 9. Amend appendix A to subpart J of part 431 by:

■ a. Revising the section 0 introductory text and paragraph 0.2.(h);

■ b. Redesignating section 0.3 as 0.6;

■ c. Adding new section 0.3, and sections 0.4 and 0.5;

■ d. Revising section 2.2.1;

■ e. Redesignating section 2.6 as 2.7; and

■ f. Adding new section 2.6.

The revisions and additions read as follows:

Appendix A to Subpart J of Part 431—Uniform Test Method for the Measurement of Energy Consumption of Fans and Blowers Other Than Air Circulating Fans

* * * * *

0. *Incorporation by reference.*

In § 431.173, DOE incorporated by reference the entire standard for AMCA 210–16, AMCA 214–21, IEC 61800–9–2:2023, IEC TS 60034–30–2:2016, IEC TS 60034–31:2021, and ISO 5801:2017; however, only enumerated provisions of those documents are applicable as follows. In cases where there is a conflict, the language of this appendix takes precedence over those documents.

* * * * *

0.2 * * *

(h) Section 6.4, ‘‘Fans with Polyphase Regulated Motor’’ as referenced in sections 2.2 and 2.6 of this appendix;

* * * * *

0.3 IEC 61800–9–2:2023:

(a) Section 6.2 as referenced in section 2.6.2.2 of this appendix;

(b) Table A.1 as referenced in section 2.6.2.2 of this appendix; and

(c) Table E.4 as referenced in 2.6.1.2.1. of this appendix; and

(d) Section F.2.1 as referenced in section 2.6.2.2 of this appendix.

0.4 IEC TS 60034–30–2:2016:

(a) Section 4.7 as referenced in section 2.6.1.2.2 of this appendix; and

(b) Table 4 as referenced in section 2.6.1.2.2 of this appendix.

0.5 IEC TS 60034–31:2021:

(a) Section A.3 as referenced in section 2.6.1.2.1 of this appendix; and

* * * * *

2. * * *

2.2 * * *

2.2.1. *General.* The fan electrical power (FEPact) in kilowatts must be determined at every duty point specified by the manufacturer in accordance with one of the test methods listed in table 1, and the following sections of AMCA 214–21: Section 2, ‘‘References (Normative)’’; Section 7, ‘‘Testing,’’ including the provisions of AMCA 210–16 and ISO 5801:2017 as referenced by Section 7 and implicated by sections 2.2.2 and 2.2.3 of this appendix; Section 8.1, ‘‘Laboratory Measurement Only’’ (as applicable); and Annex J, ‘‘Other data and calculations to be retained.’’ In addition, the provisions in this appendix apply.

TABLE 1 TO APPENDIX A TO SUBPART J OF PART 431

Driver	Motor controller present?	Transmission configuration?	Test method	Applicable section(s) of AMCA 214–21
Electric motor	Yes or No	Any	Wire-to-air	6.1 “Wire-to-Air Testing at the Required Duty Point”.
Electric motor	Yes or No	Any	Calculation based on Wire-to-air testing.	6.2 “Calculated Ratings Based on Wire to Air Testing” (references Section 8.2.3, “Calculation to other speeds and densities for wire-to-air testing,” and Annex G, ”Wire-to-Air Measurement—Calculation to Other Speeds and Densities (Normative)”).

TABLE 1 TO APPENDIX A TO SUBPART J OF PART 431—Continued

Driver	Motor controller present?	Transmission configuration?	Test method	Applicable section(s) of AMCA 214–21
Regulated polyphase motor.	Yes or No	Direct drive, V-belt drive, flexible coupling or synchronous belt drive.	Shaft-to-air	6.4 “Fans with Polyphase Regulated Motors,” * (references Annex D, “Motor Performance Constants (Normative)”).
None or non-electric	No	None	Shaft-to-air	Section 6.3, “Bare Shaft Fans”.
Regulated polyphase motor.	No	Direct drive, V-belt drive, flexible coupling or synchronous belt drive.	Calculation based on Shaft-to-air testing.	Section 8.2.1, “Fan laws and other calculation methods for shaft-to-air testing” (references Annex D, “Motor Performance Constants (Normative),” Annex E, “Calculation Methods for Fans Tested Shaft-to-Air,” and Annex K, “Proportionality and Dimensional Requirements (Normative)”).
None or non-electric	No	None	Calculation based on Shaft-to-air testing.	Section 8.2.1, “Fan laws and other calculation methods for shaft-to-air testing” (references Annex E, “Calculation Methods for Fans Tested Shaft-to-Air,” and Annex K, “Proportionality and Dimensional Requirements (Normative)”).

* With the modifications in section 2.6 of this appendix.

Testing must be performed in accordance with the required test configuration listed in table 7.1 of AMCA 214–21. The following values must be determined in accordance with this appendix at each duty point specified by the manufacturer: fan airflow in cubic feet per minute; fan air density; fan total pressure in inches of water gauge for fans using a total pressure basis FEI in accordance with table 7.1 of AMCA 214–21; fan static pressure in inches of water gauge for fans using a static pressure basis FEI in accordance with table 7.1 of AMCA 214–21; fan speed in revolutions per minute; and fan shaft input power in horsepower for fans tested in accordance with sections 6.3 or 6.4 of AMCA 214–21.

In addition, if applying the equations in section E.2 of annex E of AMCA 214–21 for compressible flows, the compressibility coefficients must be included in the equations as applicable.

All measurements must be recorded at the resolution of the test instrumentation and calculations must be rounded to the number of significant digits present at the resolution of the test instrumentation.

In cases where there is a conflict, the provisions in AMCA 214–21 take precedence over AMCA 210–16 and ISO 5801:2017. In addition, the provisions in this appendix apply.

* * * * *

2.6. Calculation based on Shaft-to-air testing for Fans with Motors and Motor Controllers. The provisions of section 6.4 of AMCA 214–21 apply except that the instructions in section 6.4.2.4.1 of AMCA 214–21 are replaced by section 2.6.1 of this appendix, and the instructions in section 6.4.2.4.2. of AMCA 214–21 are replaced by section 2.6.2 of this appendix.

2.6.1 Motor efficiency if used in combination with a VFD. This section replaces section 6.4.2.4.1 of AMCA 214–21 and provides methods to calculate the efficiency of the motor if it is combined with a VFD.

2.6.1.1 Motor efficiency Calculation, if used in combination with a VFD. The efficiency of the motor if it is combined with a VFD is calculated as follows:

$$\eta_{mtr',act} = \frac{Lm}{(Lm + p_{L'})}$$

Where:

$\eta_{mtr',act}$ is the actual motor efficiency if used in combination with a VFD.

L_m is the is motor load ratio calculated per section 6.4.2.4.1.3 of AMCA 214–21

${}_{p}{'}_{L}$ are the relative losses of a motor of if used in combination with a VFD that that exactly meets the applicable standards at § 431.25 per section 2.6.1.2. of this appendix.

2.6.1.2. Relative losses of the actual motor if used in combination with a VFD. This section provides the methods to calculate the relative losses P'_L of a motor that exactly meets the applicable standards at § 431.25, if used in combination with a VFD:

$$p'_L = p_L(n,T) \times \frac{100 - \eta_r}{\eta_r} \times \frac{\eta_{IE3}}{100 - \eta_{IE3}}$$

Where:

$p_L(n,T)$ are the relative losses of an IE3 motor if used in combination with a VFD calculated per section 2.6.1.2.1 of this appendix.

η_r nominal full load efficiency per section 6.4.2.4.1.1 of AMCA 214–21

η_{IE3} is nominal full load efficiency of an IE3 motor per section 2.6.1.2.2. of this appendix.

2.6.1.2.1. Relative losses of an IE3 motor if used in combination with a VFD. The relative losses of an IE3 motor if used in combination with a VFD, $p_L(n,T)$ are based on the actual motor nameplate rated speed and the motor nameplate output power and must be calculated per section A.3 of IEC TS 60034–31:2021, using the coefficients in table E.4 of IEC 61800–9–2:2023. If the motor nameplate output power value is not shown in table E.4 of IEC 61800–9–2:2023, the instructions in section 6.4.2.4.1.1 of AMCA 214–21 must be used.

The calculation of $p_L(n,T)$ relies on the relative speed (n) and relative torque (T) values which are determined for each duty point as follows:

$$n = \frac{n_{act}}{n_r}$$

And:

$$T = \frac{L_m}{n}$$

Where:

η_{act} is the fan speed in revolutions per minute at the given duty point;

η_r is the nameplate nominal rated speed of the actual motor revolutions per minute; and

L_m is the motor load ratio calculated per section 6.4.2.4.1.3 of AMCA 214–21.

2.6.1.2.2. Nominal full load efficiency of an IE3 motor. The nominal full load efficiency of an IE3 motor must be determined per section 4.7 of IEC TS 60034–30–2:2016 and is based on the actual motor nameplate rated speed and the motor nameplate output power. If the motor nameplate output power value is not shown in table 4 of IEC TS 60034–30–2:2016, the instructions in section 6.4.2.4.1.1 of AMCA 214–21 must be used.

2.6.2 VFD efficiency at the required motor electrical power input. This section replaces section 6.4.2.4.2 of AMCA 214–21 and provides methods to calculate the efficiency of the VFD at the required motor electrical power input. A single VFD may operate one or many motors.

2.6.2.1 *VFD efficiency calculation.* The efficiency of the VFD at the required motor electrical power input is calculated as follows:

$$\eta_{VFD} = \frac{Lc}{(Lc+ \ p_{VFD,L}(f,i_q))}$$

Where:

η_{VFD} is the VFD efficiency at the required motor electrical power input;

L_c is the is VFD load ratio calculated per section 6.4.2.4.2.2 of AMCA 214–21; and

$p_{VFD,L}(f, i_q)$ are the relative losses of a VFD at IE2 levels per section 2.6.2.2 of this appendix.

2.6.2.2. Relative losses of a VFD at IE2 levels. The relative losses of an IE2 VFD, $\eta_{VFD,L}(f, i_q)$ are inter- or extrapolated from the relative losses in table A.1 of IEC 61800–9–2:2023, adapted for IE2 in accordance with section 6.2 of IEC 61800–9–2:2023. The calculations must follow the two-dimensional linear inter- or extrapolation from neighboring loss points in accordance with section F.2.1 of IEC 61800–9–2:2023. In addition, the relative losses of an IE2 VFD, $p_{VFD,L}(f, i_q)$, are based on the actual VFD nameplate rated output power. If the motor nameplate output power value is not shown in table A.1 of IEC 61800–9–2:2023, the instructions in section 6.4.2.4.1.1 of AMCA 214–21 must be used.

The calculation of $p_{VFD,L}(f, i_q)$ relies on the relative motor frequency (f) and relative torque current (i_q) values which are determined for each duty point as follows:

$f = n$

And:

$$i_q = \frac{T \times H_{mo}}{H_{co}}$$

Where:

n is the relative speed per section 2.6.1.2.1. of this appendix;

T is the relative torque per section 2.6.1.2.1. of this appendix;

H_{mo} is motor nameplate output power; and

H_{co} is rated power output of the VFD.

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